Contents

AIR INLET AND EXHAUST SYSTEM

BASIC ENGINE

COOLING SYSTEM

ELECTRICAL AND STARTING SYSTEM

ENGINE ARRANGEMENT

FRAME AND BODY

FUEL SYSTEM

HYDRAULIC SYSTEM

IMPLEMENTS

LUBRICATION SYSTEM

MACHINE ARRANGEMENT

OPERATOR STATION

POWER TRAIN

SERVICE EQUIPMENT AND SUPPLIES

WORK TOOLS

Systems Operation

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Air Inlet and Exhaust System

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Air Inlet and Exhaust System

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Air Inlet and Exhaust System - Inspect
- Turbocharger - Inspect
- Exhaust Temperature - Test

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Air Inlet and Exhaust System - Inspect
- Turbocharger - Inspect
- Exhaust Temperature - Test

Specifications / Disassembly and Assembly

AIR CLEANER GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Air Cleaner - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Air Cleaner - Remove and Install

EXHAUST GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Exhaust Manifold - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Exhaust Manifold - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Exhaust Manifold - Remove and Install

MANIFOLD GP-EXHAUST - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Exhaust Manifold

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Exhaust Manifold

MANIFOLD GP-EXHAUST - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Exhaust Manifold - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Exhaust Manifold - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Exhaust Manifold - Remove and Install

MANIFOLD GP-INLET - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Inlet Manifold - Remove
- Inlet Manifold - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Inlet Manifold - Remove
- Inlet Manifold - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Inlet Manifold - Remove and Install

MUFFLER GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Muffler - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Muffler - Remove and Install

TURBOCHARGER GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Turbocharger - Remove
- Turbocharger - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Turbocharger - Remove
- Turbocharger - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Turbocharger - Remove
- Turbocharger - Install

Systems Operation

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Basic Engine

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Basic Engine

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Finding Top Center Position for No. 1 Piston
- Fuel Injection Nozzle - Test
- Engine Crankcase Pressure (Blowby) - Test
- Compression - Test
- Engine Valve Lash - Inspect/Adjust
- Valve Depth - Inspect
- Valve Guide - Inspect
- Excessive Bearing Wear - Inspect
- Piston Ring Groove - Inspect
- Connecting Rod - Inspect
- Connecting Rod Bearings - Inspect
- Main Bearings - Inspect
- Cylinder Block - Inspect
- Cylinder Head - Inspect
- Piston Height - Inspect
- Flywheel - Inspect
- Flywheel Housing - Inspect
- Gear Group - Inspect

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Finding Top Center Position for No. 1 Piston
- Fuel Injection Nozzle - Test
- Engine Crankcase Pressure (Blowby) - Test
- Compression - Test
- Engine Valve Lash - Inspect/Adjust
- Valve Depth - Inspect
- Valve Guide - Inspect
- Excessive Bearing Wear - Inspect
- Piston Ring Groove - Inspect
- Connecting Rod - Inspect

- Connecting Rod Bearings - Inspect
- Main Bearings - Inspect
- Cylinder Block - Inspect
- Cylinder Head - Inspect
- Piston Height - Inspect
- Flywheel - Inspect
- Flywheel Housing - Inspect
- Gear Group - Inspect

Specifications / Disassembly and Assembly

BALANCER GP - Disassembly and Assembly

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Balancer - Remove
- Balancer - Disassemble
- Balancer - Assemble
- Balancer - Install

BELT TIGHTENER GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Belt Tension Chart

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Belt Tension Chart

CAMSHAFT GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Camshaft

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Camshaft

CAMSHAFT GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Camshaft - Remove and Install
- Camshaft Gear - Remove and Install
- Camshaft Bearings - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Camshaft - Remove and Install
- Camshaft Gear - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Camshaft - Remove and Install
- Camshaft Gear - Remove and Install

CRANKSHAFT GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Crankshaft
- Crankshaft Seals

- Connecting Rod Bearing Journal
- Main Bearing Journal

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Crankshaft
- Crankshaft Seals
- Connecting Rod Bearing Journal
- Main Bearing Journal

CRANKSHAFT GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Crankshaft Rear Seal - Remove
- Crankshaft Rear Seal - Install
- Crankshaft Pulley - Remove and Install
- Crankshaft Front Seal - Remove
- Crankshaft Front Seal - Install
- Crankshaft Main Bearings - Remove
- Crankshaft Main Bearings - Install
- Crankshaft - Remove
- Crankshaft - Install
- Crankshaft Gear - Remove and Install
- Bearing Clearance - Check

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Crankshaft Rear Seal - Remove
- Crankshaft Rear Seal - Install
- Crankshaft Wear Sleeve (Rear) - Remove
- Crankshaft Wear Sleeve (Rear) - Install
- Crankshaft Pulley - Remove and Install
- Crankshaft Front Seal - Remove
- Crankshaft Front Seal - Install
- Crankshaft Main Bearings - Remove
- Crankshaft Main Bearings - Install
- Crankshaft - Remove
- Crankshaft - Install
- Crankshaft Gear - Remove and Install
- Bearing Clearance - Check

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Crankshaft Rear Seal - Remove and Install
- Crankshaft Wear Sleeve (Rear) - Remove and Install

- Crankshaft Pulley - Remove and Install
- Crankshaft Front Seal - Remove and Install
- Crankshaft Main Bearings - Remove and Install - Crankshaft in position
- Crankshaft - Remove
- Crankshaft - Install
- Crankshaft Gear - Remove and Install
- Bearing Clearance - Check

CYLINDER BLOCK GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Cylinder Block
- Main Bearing Journal

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Cylinder Block
- Main Bearing Journal

CYLINDER BLOCK GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Camshaft Bearings - Remove and Install
- Crankshaft Main Bearings - Remove
- Crankshaft Main Bearings - Install
- Bearing Clearance - Check

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Crankshaft Main Bearings - Remove
- Crankshaft Main Bearings - Install
- Bearing Clearance - Check

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Bearing Clearance - Check

CYLINDER HEAD GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Fuel Injection Nozzles
- Cylinder Head Valves
- Cylinder Head

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Fuel Injection Nozzles
- Cylinder Head Valves
- Cylinder Head

CYLINDER HEAD GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Inlet and Exhaust Valve Springs - Remove and Install
- Inlet and Exhaust Valves - Remove and Install

- Inlet and Exhaust Valve Guides - Remove and Install
- Inlet and Exhaust Valve Seat Inserts - Remove and Install
- Cylinder Head - Remove
- Cylinder Head - Install
- Camshaft Bearings - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Inlet and Exhaust Valve Springs - Remove and Install
- Inlet and Exhaust Valves - Remove and Install
- Inlet and Exhaust Valve Guides - Remove and Install
- Inlet and Exhaust Valve Seat Inserts - Remove and Install
- Cylinder Head - Remove
- Cylinder Head - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Inlet and Exhaust Valve Springs - Remove and Install - Alternative Method
- Inlet and Exhaust Valve Springs - Remove and Install
- Inlet and Exhaust Valves - Remove and Install
- Inlet and Exhaust Valve Guides - Remove and Install
- Inlet and Exhaust Valve Seat Inserts - Remove and Install
- Cylinder Head - Remove
- Cylinder Head - Install

FLYWHEEL GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Flywheel

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Flywheel

FLYWHEEL GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Flywheel - Remove
- Flywheel - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Flywheel - Remove
- Flywheel - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Flywheel - Remove
- Flywheel - Install

GEAR GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Gear Group (Front)

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Gear Group (Front)

GEAR GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Idler Gear - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Idler Gear - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Idler Gear - Remove and Install

HOUSING GP-FLYWHEEL - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Flywheel Housing - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Flywheel Housing - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Flywheel Housing - Remove and Install

HOUSING GP-FRONT - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Crankshaft Seals
- Front Housing and Covers

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Crankshaft Seals
- Front Housing and Covers

HOUSING GP-FRONT - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Housing (Front) - Remove
- Housing (Front) - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Front Cover - Remove and Install
- Housing (Front) - Remove
- Housing (Front) - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Front Cover - Remove and Install
- Housing (Front) - Remove and Install
- Front Plate - Remove
- Front Plate - Install

PAN GP-OIL - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Oil Pan

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Oil Pan

PAN GP-OIL - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Pan - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Pan - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Engine Oil Pan - Remove and Install

PISTON & ROD GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Connecting Rod Bearing Journal
- Connecting Rod
- Piston and Rings

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Connecting Rod Bearing Journal
- Connecting Rod
- Piston and Rings

PISTON & ROD GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Pistons and Connecting Rods - Remove
- Pistons and Connecting Rods - Disassemble
- Pistons and Connecting Rods - Assemble
- Pistons and Connecting Rods - Install
- Connecting Rod Bearings - Remove
- Connecting Rod Bearings - Install
- Bearing Clearance - Check

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Pistons and Connecting Rods - Remove
- Pistons and Connecting Rods - Disassemble
- Pistons and Connecting Rods - Assemble
- Pistons and Connecting Rods - Install
- Connecting Rod Bearings - Remove
- Connecting Rod Bearings - Install
- Bearing Clearance - Check

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Pistons and Connecting Rods - Remove
- Pistons and Connecting Rods - Disassemble
- Pistons and Connecting Rods - Assemble
- Pistons and Connecting Rods - Install
- Connecting Rod Bearings - Remove - Connecting rods in position
- Connecting Rod Bearings - Install - Connecting rods in position
- Bearing Clearance - Check

PULLEY GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Crankshaft Pulley

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Crankshaft Pulley

PULLEY GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Crankshaft Pulley - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Crankshaft Pulley - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Crankshaft Pulley - Remove and Install

SERPENTINE/V-BELTS - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Belt Tension Chart

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Belt Tension Chart

SERPENTINE/V-BELTS - Disassembly and Assembly

C3.4 Engines for Caterpillar Built Machines - KENR6941

- V-Belts - Remove and Install

VALVE MECHANISM GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Lifter Group
- Rocker Shaft
- Valve Mechanism Cover

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Lifter Group
- Rocker Shaft
- Valve Mechanism Cover

VALVE MECHANISM GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Valve Mechanism Cover - Remove and Install
- Rocker Shaft and Pushrod - Remove
- Rocker Shaft - Disassemble
- Rocker Shaft - Assemble
- Rocker Shaft and Pushrod - Install
- Lifter Group - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Valve Mechanism Cover - Remove and Install
- Rocker Shaft and Pushrod - Remove
- Rocker Shaft - Disassemble
- Rocker Shaft - Assemble

- Rocker Shaft and Pushrod - Install
- Lifter Group - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Valve Mechanism Cover - Remove and Install
- Rocker Shaft and Pushrod - Remove
- Rocker Shaft - Disassemble
- Rocker Shaft - Assemble
- Rocker Shaft and Pushrod - Install
- Lifter Group - Remove and Install

Systems Operation

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Cooling System

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Cooling System

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Cooling System - Check - Overheating
- Cooling System - Inspect
- Cooling System - Test
- Engine Oil Cooler - Inspect
- Water Temperature Regulator - Test

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Cooling System - Check - Overheating
- Cooling System - Inspect
- Cooling System - Test
- Engine Oil Cooler - Inspect
- Water Temperature Regulator - Test

Specifications / Disassembly and Assembly

COOLING SYSTEM - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Disconnecting Snap To Connect Fittings

COOLER GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Cooler - Remove
- Engine Oil Cooler - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Cooler - Remove
- Engine Oil Cooler - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Engine Oil Cooler - Remove
- Engine Oil Cooler - Install

FAN GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)
- Gear Motor (Fan)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Radiator and Hydraulic Oil Cooler

- Radiator and Hydraulic Oil Cooler (Fan)
- Gear Motor (Fan)

FAN GP - Disassembly and Assembly

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Fan - Remove and Install

LINES GP-WATER - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Water Temperature Regulator

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Water Temperature Regulator

LINES GP-WATER - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Water Temperature Regulator Housing - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Water Temperature Regulator Housing - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Water Temperature Regulator Housing - Remove and Install

PUMP GP-WATER - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Water Temperature Regulator - Remove and Install
- Water Pump - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Water Temperature Regulator - Remove and Install
- Water Pump - Remove and Install

3044C Engine for Caterpillar Built Machines - SENR9823

- Water Pump - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Water Pump - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Water Pump - Remove and Install

RADIATOR GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)

RADIATOR GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Radiator and Hydraulic Oil Cooler - Remove

- Radiator and Hydraulic Oil Cooler - Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Radiator and Hydraulic Oil Cooler - Remove

- Radiator and Hydraulic Oil Cooler - Install

REGULATOR GP-TEMPERATURE - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Water Temperature Regulator

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Water Temperature Regulator

REGULATOR GP-TEMPERATURE - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Water Temperature Regulator - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Water Temperature Regulator - Remove and Install

3044C Engine for Caterpillar Built Machines - SENR9823

- Water Temperature Regulator Housing - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Water Temperature Regulator Housing - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Water Temperature Regulator Housing - Remove and Install

Systems Operation

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- General Information
- Normal Operation
- Electronic Control Module (ECM)
- Solenoid Valves
- Cat Data Link
- Related Components

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- General Information
- Normal Operation
- Engine Start Interlock
- Hydrostatic System Interlock and Parking Brake Interlock
- Work Tool Interlock
- Diagnostic Operation
- Electronic Control Module (ECM)
- Solenoid Valve
- Relays
- Related Components

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Electrical System

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Pressure Switch (Refrigerant)

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Electrical System

EquipmentManager Dealer Administrator Manual - KENR6304

- General Information
- Getting Started
- Enable Program
- Verify Machine Records and Ownership
- Manage Users
- Product Link Installation
- Setup Subscriptions
- Administration
- Manage Equipment Groups

- Manage Hardware
- Manage Event Tracking
- Upload Data
- Manage Major Repair Tracking
- Manage Time Fence and Geographic Fence
- Manage Planned Maintenance
- Preferences
- Preference Detail
- Asset Watch
- Time Fence and Geographic Fence
- Maintenance Watch
- Planned Maintenance
- Major Repair
- Health Watch
- Fuel Results
- Fault Codes
- Reports
- Product Usage
- Product Monitoring
- Operation and Maintenance Manual
- Equipment Usage
- Active Fleet

EquipmentManager User Guide - KENR6303

- General Information
- Getting Started
- Verify Machine Records and Ownership
- Manage Users
- Product Link Installation
- Administration
- Manage Equipment Groups
- Manage Hardware
- Manage Event Tracking
- Upload Data
- Manage Major Repair Tracking
- Manage Time Fence and Geographic Fence

- Manage Planned Maintenance
- Preferences
- Preference Detail
- Asset Watch
- Time Fence and Geographic Fence
- Maintenance Watch
- Planned Maintenance
- Major Repair
- Health Watch
- Fuel Results
- Fault Codes
- Reports
- Product Usage
- Product Monitoring
- Operation and Maintenance Manual
- Equipment Usage

Machine Security System - RENR2462

- General Information
- System Overview
- Normal Operation
- Operation of Status Indicator
- Key Information
- Scheduled Access - "Security System Bypass Times"
- Diagnostic Operation
- Events
- Protected Functions
- Service Operation Using Machine Security System
- Service Operation Using Service Tool
- Electronic Control Module (ECM)
- System Components
- Cat Data Link

Product Link - PL522/523 - RENR8143

- System Overview
- System Components
- Installation Parameters Configure
- Configuration

- Spare Input Configure
- Commands

Product Link 121S/300 - RENR7911

- System Overview
- System Components
- Spare Inputs
- Configuration
- Installation Parameters Configure
- Report Parameters Configure
- Wireless Service Configure
- Spare Input Configure
- Commands

Testing and Adjusting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- Wiring Harness (Open Circuit) - Test
- Wiring Harness (Short Circuit) - Test
- Electronic Control Module (ECM) - Flash Program
- Electronic Control Module (ECM) - Replace
- Glossary of Electrical Terms
- System Schematic

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- Electronic Control Module (ECM) - Replace
- Glossary of Electrical Terms
- System Schematic

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Alternator - Test
- Battery - Test
- Electric Starting System - Test
- Glow Plugs - Test

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Alternator - Test
- Battery - Test
- Electric Starting System - Test
- Glow Plugs - Test

Machine Security System - RENR2462

- General Information

- Product Identification Number - Program
- Key - Program
- System Disarm - Program - Security System Bypass
- Factory Password - Obtain
- Time - Set
- Software - Uninstall - "Immobilizer" Feature
- Electrical Connector - Inspect
- Electronic Control Module (ECM) - Flash Program
- Electronic Control Module (ECM) - Replace
- Glossary of Terms
- System Schematic

Product Link - PL522/523 - RENR8143

- Electronic Control Module (ECM) - Flash Program
- Electronic Control Module (ECM) - Replace
- Electrical Connector - Inspect
- Wiring Harness (Open Circuit) - Test
- Wiring Harness (Short Circuit) - Test
- Specifications
- System Schematic

Product Link 121S/300 - RENR7911

- Electronic Control Module (ECM) - Flash Program
- Electronic Control Module (ECM) - Replace
- Electrical Connector - Inspect
- Wiring Harness (Open Circuit) - Test
- Wiring Harness (Short Circuit) - Test
- Specifications
- System Schematic

Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- General Information
- Service Tools
- Electrical Component and Connector Locations
- Diagnostic Capabilities
- Diagnostic Code List
- MID 106 - CID 0168 - FMI 03

- MID 106 - CID 0168 - FMI 04
- MID 106 - CID 1180 - FMI 03
- MID 106 - CID 1180 - FMI 05
- MID 106 - CID 1180 - FMI 06
- MID 106 - CID 1181 - FMI 03
- MID 106 - CID 1181 - FMI 05
- MID 106 - CID 1181 - FMI 06
- MID 106 - CID 1184 - FMI 03
- MID 106 - CID 1184 - FMI 06
- MID 106 - CID 1187 - FMI 04
- MID 106 - CID 1694 - FMI 03
- MID 106 - CID 1694 - FMI 06
- MID 106 - CID 1931 - FMI 03
- MID 106 - CID 1931 - FMI 05
- MID 106 - CID 1931 - FMI 06
- MID 106 - CID 1942 - FMI 04
- Power Supply Circuit of Electronic Control Module
- Auxiliary Hydraulic Does Not Function in One Direction
- Auxiliary Hydraulic Does Not Function in Either Direction
- High Flow Does Not Function in One Direction
- High Flow Does Not Function in Either Direction

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- General Information
- Service Tools
- Electrical Component and Connector Locations
- Initial Troubleshooting Procedure
- Engine Does Not Crank
- Solenoid Valve (Parking Brake) Does Not Function Correctly
- Work Tool Does Not Function
- Electrical System
- Charging System

Machine Security System - RENR2462

- General Information
- Service Tools
- Electrical Component and Connector Locations

- Symptom Troubleshooting
- Emerging Symptom Information
- Lost Key
- Engine Does Not Crank and Status Indicator Is Green
- Engine Does Not Start and Status Indicator Is Continuously Red
- Diagnostic Code List
- Using Caterpillar Electronic Technician to Determine Diagnostic Codes
- MID 124 - CID 0168 - FMI 00
- MID 124 - CID 0168 - FMI 01
- MID 124 - CID 0248 - FMI 12
- MID 124 - CID 0817 - FMI 04
- MID 124 - CID 1391 - FMI 03
- MID 124 - CID 1391 - FMI 04
- MID 124 - CID 1392 - FMI 03
- MID 124 - CID 1392 - FMI 04

Product Link - PL522/523 - RENR8143

- General Information
- Service Tools
- Diagnostic Capabilities
- Electronic Service Tool Does Not Communicate with ECM
- Reports and Messages Not Available
- Position Reports Not Available
- Reporting Interval Erratic
- Diagnostics and Events Not Available
- Operating Hours Discrepancy
- Event Code List
- Diagnostic Code List
- MID 161 - CID 0168 - FMI 00
- MID 161 - CID 0168 - FMI 01
- MID 161 - CID 0254 - FMI 04
- MID 161 - CID 0254 - FMI 12
- MID 161 - CID 1250 - FMI 09
- MID 161 - CID 1251 - FMI 03
- MID 161 - CID 1888 - FMI 14
- MID 161 - CID 3766- FMI 14

Product Link 121S/300 - RENR7911

- General Information
- Service Tools
- Diagnostic Capabilities
- Electronic Service Tool Does Not Communicate with ECM
- Reports and Messages Not Available
- Position Reports Not Available
- Reporting Interval Erratic
- Diagnostics and Events Not Available
- Operating Hours Discrepancy
- Event Code List
- Diagnostic Code List
- MID 122 - CID 0168 - FMI 00
- MID 122 - CID 0168 - FMI 01
- MID 122 - CID 0254 - FMI 04
- MID 122 - CID 0254 - FMI 12
- MID 122 - CID 0269 - FMI 03
- MID 122 - CID 0269 - FMI 04
- MID 122 - CID 1250 - FMI 09
- MID 122 - CID 1251 - FMI 03

Specifications / Disassembly and Assembly

ALTERNATOR GP-CHARGING - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Alternator and Regulator

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Alternator and Regulator

ALTERNATOR GP-CHARGING - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Alternator - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Alternator - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Alternator - Remove and Install

BATTERY GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Battery and Battery Cable - Separate and Connect

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Battery and Battery Cable - Separate and Connect

GLOW PLUG GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Glow Plugs

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Glow Plugs

GLOW PLUG GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Glow Plugs - Remove and Install - Turbocharged Engines

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Glow Plugs - Remove and Install - Turbocharged Engines

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Glow Plugs - Remove and Install

SENDER GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Machine Frame and Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Machine Frame and Mounting

SENSOR GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Oil Pressure

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Oil Pressure

SENSOR GP - Disassembly and Assembly

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Coolant Temperature Sensor - Remove and Install
- Engine Oil Pressure Sensor - Remove and Install

STARTING MOTOR GP - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Electric Starting Motor

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Electric Starting Motor

STARTING MOTOR GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Electric Starting Motor - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Electric Starting Motor - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Electric Starting Motor - Remove and Install

SWITCH GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Pressure Switch - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Pressure Switch - Remove and Install

Systems Operation

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- General Information

C3.4 Engines for Caterpillar Built Machines - KENR6940

- General Information

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Troubleshooting

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Troubleshooting

Specifications / Disassembly and Assembly

ENGINE AR - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Design

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Design

ENGINE AR - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Engine - Remove
- Engine - Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Engine - Remove
- Engine - Install

Specifications / Disassembly and Assembly

ARM GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Machine Frame and Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Machine Frame and Mounting

ENCLOSURE GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Engine Enclosure

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Engine Enclosure

FRAME GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Machine Frame and Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Machine Frame and Mounting

HOOD GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Engine Enclosure - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Engine Enclosure - Remove and Install

SUPPORT GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Lift Arm Cylinder and Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Lift Arm Cylinder and Mounting

Systems Operation

236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System - RENR4866

- Governor Control

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8822

- Governor Control

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Fuel System

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Fuel System

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Fuel System - Inspect
- Air in Fuel - Test
- Fuel Injection Nozzle - Test
- Fuel Injection Timing - Check - Distributor Pump
- Fuel Quality - Test
- Fuel System - Prime - Distributor Pump

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Fuel System - Inspect
- Air in Fuel - Test
- Fuel Injection Nozzle - Test
- Fuel Injection Timing - Check - Distributor Pump
- Fuel Quality - Test
- Fuel System - Prime - Distributor Pump

Specifications / Disassembly and Assembly

FUEL SYSTEM - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Disconnecting Snap To Connect Fittings

FILTER GP-FUEL - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Fuel Priming Pump and Fuel Filter Base - Remove and Install

LINES GP-FUEL INJECTION - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Fuel Injection Lines

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Fuel Injection Lines

LINES GP-FUEL INJECTION - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Fuel Injection Lines - Remove and Install - Turbocharged Engines

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Fuel Injection Lines - Remove and Install - Turbocharged Engines
- Fuel Injection Lines - Remove and Install - Naturally Aspirated Engines

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Fuel Injection Lines - Remove and Install - Turbocharged Engines
- Fuel Injection Lines - Remove and Install - Naturally Aspirated Engines

PUMP GP-FUEL INJECTION - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Fuel Injection Pump
- Fuel Injection Nozzles

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Fuel Injection Pump
- Fuel Injection Nozzles

PUMP GP-FUEL INJECTION - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Fuel Injection Nozzles - Remove - Turbocharged Engines
- Fuel Injection Nozzles - Install - Turbocharged Engines
- Fuel Injection Pump - Remove
- Fuel Injection Pump - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Fuel Injection Nozzles - Remove - Naturally Aspirated Engines
- Fuel Injection Nozzles - Remove - Turbocharged Engines
- Fuel Injection Nozzles - Install - Turbocharged Engines
- Fuel Injection Nozzles - Install - Naturally Aspirated Engines
- Fuel Injection Pump - Remove
- Fuel Injection Pump - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Fuel Injection Pump - Remove - Fuel Injection Pumps With a Water Heated Cold Start Device
- Fuel Injection Pump - Remove
- Fuel Injection Pump - Install
- Fuel Injection Pump - Install - Fuel Injection Pumps With a Water Heated Cold Start Device
- Fuel Injector - Remove and Install - Naturally Aspirated Engines
- Fuel Injector - Remove and Install - Turbocharged Engines

PUMP GP-FUEL PRIMING - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Fuel Priming Pump and Fuel Filter Base - Remove and Install

PUMP GP-FUEL TRANSFER - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Fuel Transfer Pump

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Fuel Transfer Pump

SEPARATOR GP-WATER - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

Systems Operation

236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System - RENR4866

- General Information
- Pilot Hydraulic System
- Work Tool Hydraulic System
- Control Valve (Work Tool)
- Control Manifold and Solenoid (Work Tool Positioner)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8822

- General Information
- Pilot Hydraulic System
- Pilot Valve (Joystick)
- Work Tool Hydraulic System
- Control Valve (Work Tool)
- Control Manifold and Solenoid (Work Tool Positioner)

Testing and Adjusting

236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System - RENR4867

- Machine Preparation
- Visual Inspection
- Operational Checks
- Hydraulic System Troubleshooting
- System Pressure - Release
- Hydraulic Oil Contamination - Test
- Main Relief Valve - Test and Adjust
- Line Relief Valve - Test and Adjust
- Accumulator (Pilot) - Test and Charge
- Pilot System Pressure - Test
- Pump Flow - Test
- Worksheets - Troubleshoot

236B2 and 252B2 Skid Steer Loaders Hydraulic System - KENR8823

- Machine Preparation
- Visual Inspection
- Operational Checks
- Hydraulic System Troubleshooting
- System Pressure - Release
- Hydraulic Oil Contamination - Test
- Main Relief Valve - Test and Adjust

- Line Relief Valve - Test and Adjust
- Accumulator (Pilot) - Test and Charge
- Pilot System Pressure - Test
- Pump Flow - Test
- Worksheets - Troubleshoot

Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- MID 106 - CID 1939 - FMI 03
- MID 106 - CID 1939 - FMI 06
- MID 106 - CID 1940 - FMI 03
- MID 106 - CID 1940 - FMI 05
- MID 106 - CID 1940 - FMI 06

Specifications / Disassembly and Assembly

HYDRAULIC SYSTEM - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Hydraulic System Pressure - Release
- Disconnecting Snap To Connect Fittings

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- System Pressure - Release

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- System Pressure - Release

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Hydraulic System Pressure - Release

ACCUMULATOR GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Accumulator - Remove and Install

COOLER GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)

COOLER GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Radiator and Hydraulic Oil Cooler - Remove

- Radiator and Hydraulic Oil Cooler - Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Radiator and Hydraulic Oil Cooler - Remove
- Radiator and Hydraulic Oil Cooler - Install

CYLINDER GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Lift Cylinder
- Lift Cylinder
- Tilt Cylinder
- Coupler Cylinder
- Lift Arm Cylinder and Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Lift Cylinder
- Lift Cylinder
- Tilt Cylinder
- Coupler Cylinder
- Lift Arm Cylinder and Mounting

CYLINDER GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Tilt Cylinder - Remove
- Tilt Cylinder - Install
- Lift Cylinder - Remove - Extended Reach Machines
- Lift Cylinder - Remove - Radial Arc Machines
- Lift Cylinder - Install - Extended Reach Machines
- Lift Cylinder - Install - Radial Arc Machines

LINES GP-HYDRAULIC - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Return Manifold

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Return Manifold

MANIFOLD GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Control Manifold (Quick Coupler)
- Control Manifold (Quick Coupler)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Control Manifold (Quick Coupler)
- Control Manifold (Quick Coupler)

MOTOR GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Radiator and Hydraulic Oil Cooler

- Radiator and Hydraulic Oil Cooler (Fan)
- Gear Motor (Fan)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Radiator and Hydraulic Oil Cooler
- Radiator and Hydraulic Oil Cooler (Fan)
- Gear Motor (Fan)

MOTOR GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Gear Motor (Fan) - Remove
- Gear Motor (Fan) - Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Gear Motor (Fan) - Remove
- Gear Motor (Fan) - Install

PUMP GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Gear Pump
- Gear Pump
- Gear Pump
- Gear Pump

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Gear Pump
- Gear Pump
- Gear Pump
- Gear Pump

PUMP GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Gear Pump - Remove
- Gear Pump - Disassemble
- Gear Pump - Assemble
- Gear Pump - Install

TANK GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Hydraulic Tank

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Hydraulic Tank

TANK GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Hydraulic Tank - Remove
- Hydraulic Tank - Install

VALVE GP-CONTROL - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Control Valve (Work Tool)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Control Valve (Work Tool)

VALVE GP-CONTROL - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Control Valve (Work Tool) - Remove
- Control Valve (Work Tool) - Disassemble
- Control Valve (Work Tool) - Assemble
- Control Valve (Work Tool) - Install

VALVE GP-DIVERTER - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Diverter Valve - Remove
- Diverter Valve - Install

VALVE GP-PILOT - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

VALVE GP-PILOT - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Pilot Operated Hydraulic Control - Remove
- Pilot Operated Hydraulic Control - Disassemble
- Pilot Operated Hydraulic Control - Assemble
- Pilot Operated Hydraulic Control - Install

VALVE GP-SOLENOID - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Control Manifold (Quick Coupler)
- Control Manifold (Quick Coupler)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Control Manifold (Quick Coupler)
- Control Manifold (Quick Coupler)

Specifications / Disassembly and Assembly

ARM GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Lift Arms - Remove - Extended Reach Machines
- Lift Arms - Remove - Radial Arc Machines
- Lift Arms - Install - Extended Reach Machines
- Lift Arms - Install - Radial Arc Machines

CONTROL GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Lift Arms - Remove - Extended Reach Machines
- Lift Arms - Remove - Radial Arc Machines
- Lift Arms - Install - Extended Reach Machines
- Lift Arms - Install - Radial Arc Machines

Systems Operation

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Lubrication System

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Lubrication System

Testing and Adjusting

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7578

- Engine Crankcase Pressure (Blowby) - Test
- Engine Oil Pressure - Test
- Engine Oil Pump - Inspect
- Excessive Engine Oil Consumption - Inspect
- Increased Engine Oil Temperature - Inspect

C3.4 Engines for Caterpillar Built Machines - KENR6940

- Engine Crankcase Pressure (Blowby) - Test
- Engine Oil Pressure - Test
- Engine Oil Pump - Inspect
- Excessive Engine Oil Consumption - Inspect
- Increased Engine Oil Temperature - Inspect

Specifications / Disassembly and Assembly

LUBRICATION SYSTEM - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Disconnecting Snap To Connect Fittings

BREATHER GP - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Crankcase Breather - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Crankcase Breather - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Crankcase Breather - Remove and Install - Turbocharged Engines

FILTER GP-ENGINE OIL - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Oil Bypass Valve

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Oil Bypass Valve

FILTER GP-ENGINE OIL - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Filter Base - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Filter Base - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Engine Oil Filter Base - Remove and Install

LINES GP-ENGINE OIL - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Oil Relief Valve

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Oil Relief Valve

LINES GP-ENGINE OIL - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Relief Valve - Remove and Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Relief Valve - Remove and Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Engine Oil Relief Valve - Remove and Install

PUMP GP-ENGINE OIL - Specifications

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7577

- Engine Oil Relief Valve
- Engine Oil Pump
- Engine Oil Bypass Valve

C3.4 Engines for Caterpillar Built Machines - KENR6939

- Engine Oil Relief Valve
- Engine Oil Pump
- Engine Oil Bypass Valve

PUMP GP-ENGINE OIL - Disassembly and Assembly

3044C Engine for Caterpillar Built Machines - SENR9823

- Engine Oil Relief Valve - Remove and Install
- Engine Oil Bypass Valve - Remove and Install
- Engine Oil Pump - Remove
- Engine Oil Pump - Install

3044C Industrial Engine and Engines for Caterpillar Built Machines - RENR7582

- Engine Oil Relief Valve - Remove and Install
- Engine Oil Bypass Valve - Remove and Install
- Engine Oil Pump - Remove
- Engine Oil Pump - Install

C3.4 Engines for Caterpillar Built Machines - KENR6941

- Engine Oil Relief Valve - Remove and Install
- Engine Oil Bypass Valve - Remove and Install
- Engine Oil Pump - Remove
- Engine Oil Pump - Install

Systems Operation

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Service Intervals

Testing and Adjusting

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Heating and Air Conditioning Service Publications

Systems Operation

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8822

- Pilot Valve (Joystick)

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- Switches
- Indicators
- Sensors

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- Switches
- Indicators

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- General Information
- Identifying the Refrigerant
- Identifying the Air Conditioning System
- Identifying the Heating System
- Refrigerant Expansion Valve System
- Refrigerant Orifice Tube System
- Refrigerant Compressor
- Refrigerant Condenser
- Refrigerant Receiver-Dryer
- Refrigerant Expansion Valve
- In-line Refrigerant Dryer
- Refrigerant Orifice Tube Assembly
- Evaporator Coil
- Refrigerant Accumulator
- Refrigerant Compressor Protection System
- Temperature Control
- Cab Pressurization and Filtration System
- Condensate Drainage System
- Service Intervals
- Glossary of Terms

Testing and Adjusting

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Machine Preparation for Testing and Adjusting
- Air Conditioning Performance - Test

- Refrigerant Leakage - Test
- Manifold Gauge Set (Refrigerant) - Install
- Refrigerant Recovery
- Refrigerant System - Flush
- Refrigerant Oil - Test
- Refrigerant Compressor - Test
- Refrigerant System - Evacuate
- Refrigerant System - Charge
- Manifold Gauge Set (Refrigerant) - Remove
- Compressor Protection System - Test
- Electronic Heat Control - Test
- Heater Performance - Test

Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- MID 106 - CID 0070 - FMI 04
- MID 106 - CID 1187 - FMI 04
- MID 106 - CID 1188 - FMI 04
- MID 106 - CID 1189 - FMI 00
- MID 106 - CID 1189 - FMI 01
- MID 106 - CID 1189 - FMI 04
- MID 106 - CID 1189 - FMI 08
- MID 106 - CID 1190 - FMI 04
- MID 106 - CID 1695 - FMI 04
- MID 106 - CID 1935 - FMI 03
- MID 106 - CID 1935 - FMI 04
- Switch (Two Speed)
- Switch (Hydraulic Lockout)
- Switch (Armrest) and Switch (Seat)
- Switch (Parking Brake)
- Switch (Interlock Override)
- Switch (Continuous Flow)

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- Armrest Indicator Is Flashing
- Parking Brake Indicator Is Flashing

- Parking Brake Indicator and Armrest Indicator Are Flashing
- Parking Brake Indicator and Armrest Indicator Do Not Function Correctly
- Switch (Hydraulic Lockout)
- Switch (Parking Brake)

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Required Tools
- Machine Preparation for Troubleshooting
- General Troubleshooting Information
- Visual Inspection (Troubleshooting)
- Air Conditioning System Troubleshooting
- Heating System Troubleshooting
- Troubleshooting Heating and Air Conditioning Control System
- Troubleshooting Condensate Drainage System

Specifications / Disassembly and Assembly

AIR CONDITIONER GP - Specifications

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- System Capacities for Refrigerant (Skid Steer Loaders)

AIR CONDITIONER GP - Disassembly and Assembly

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- General Information
- Machine Preparation for Disassembly and Assembly
- Air Conditioner Lines - Remove and Install
- Refrigerant Compressor - Remove and Install
- Refrigerant Accumulator - Remove and Install
- Refrigerant Expansion Valve - Remove and Install
- Refrigerant Receiver-Dryer - Remove and Install
- In-Line Refrigerant Dryer - Remove and Install
- Refrigerant Orifice Tube Assembly - Remove and Install

CAB GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Gas Spring Group (Cab)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Gas Spring Group (Cab)

CAB GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Cab - Tilt
- Cab - Remove
- Cab - Install

- Gas Spring - Remove and Install

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Cab - Tilt

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Cab - Tilt

CONTROL GP-JOYSTICK - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

CONTROL GP-JOYSTICK - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Pilot Operated Hydraulic Control - Remove
- Pilot Operated Hydraulic Control - Disassemble
- Pilot Operated Hydraulic Control - Assemble
- Pilot Operated Hydraulic Control - Install

CONTROL GP-PILOT OPERATED HYD - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

CONTROL GP-PILOT OPERATED HYD - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Pilot Operated Hydraulic Control - Remove
- Pilot Operated Hydraulic Control - Disassemble
- Pilot Operated Hydraulic Control - Assemble
- Pilot Operated Hydraulic Control - Install

HORN GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control

- Pilot Operated Hydraulic Control - Hydrostatic

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

HORN GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Pilot Operated Hydraulic Control - Remove
- Pilot Operated Hydraulic Control - Disassemble
- Pilot Operated Hydraulic Control - Assemble
- Pilot Operated Hydraulic Control - Install

ROPS/FOPS GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- ROPS Mounting

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- ROPS Mounting

SEAT GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Seat - Remove and Install

Systems Operation

236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System - RENR4866

- Hydrostatic System
- Piston Pump (Hydrostatic)
- Piston Motor (Hydrostatic)
- Tandem Drive and Axle

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8822

- Pilot Valve (Joystick)
- Hydrostatic System
- Piston Pump (Hydrostatic)
- Piston Motor (Hydrostatic)
- Tandem Drive and Axle

Testing and Adjusting

236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System - RENR4867

- Machine Preparation
- Visual Inspection
- Operational Checks
- Hydrostatic System Troubleshooting
- System Pressure - Release
- Hydrostatic System - Flush and Fill
- Hydrostatic System - Test and Adjust
- Worksheets - Troubleshoot

236B2 and 252B2 Skid Steer Loaders Hydraulic System - KENR8823

- Machine Preparation
- Visual Inspection
- Operational Checks
- Hydrostatic System Troubleshooting
- System Pressure - Release
- Hydrostatic System - Flush and Fill
- Hydrostatic System - Test and Adjust
- Worksheets - Troubleshoot

Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System - RENR6418

- MID 106 - CID 0598 - FMI 03
- MID 106 - CID 0598 - FMI 05

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System - RENR6417

- Parking Brake Intermittent

Specifications / Disassembly and Assembly

POWER TRAIN - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- System Pressure - Release

AXLE GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Axle

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Axle

AXLE GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Axle - Remove
- Axle - Disassemble
- Axle - Assemble
- Axle - Install

COUPLING GP - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Pump Mounting - Remove and Install

DRAIN GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Chain (Drive) Tension - Adjust

DRIVE GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pump Mounting (Hydrostatic)
- Tandem Drive

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pump Mounting (Hydrostatic)
- Tandem Drive

DRIVE GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Chain (Drive) - Remove
- Chain (Drive) - Install

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Pump Mounting - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Pump Mounting - Remove and Install

FILTER GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Hydraulic Oil Filter

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Hydraulic Oil Filter

LINES GP-HYDROSTATIC - Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Return Manifold

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Return Manifold

MANIFOLD GP - Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Control Manifold and Solenoid (Parking Brake and 2-Speed)
- Control Manifold and Solenoid (Parking Brake and 2-Speed)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Control Manifold and Solenoid (Parking Brake and 2-Speed)
- Control Manifold and Solenoid (Parking Brake and 2-Speed)

MOTOR GP - Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Motor Mounting (Hydrostatic)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Piston Motor
- Motor Mounting (Hydrostatic)

MOTOR GP - Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Piston Motor (Hydrostatic) - Remove
- Piston Motor (Hydrostatic) - Disassemble
- Piston Motor (Hydrostatic) - Assemble
- Piston Motor (Hydrostatic) - Install

PUMP GP - Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Piston Pump
- Piston Pump
- Piston Pump

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Piston Pump
- Piston Pump
- Piston Pump

PUMP GP - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Piston Pump (Hydrostatic) - Remove
- Piston Pump (Hydrostatic) - Install

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Pump Mounting - Remove and Install

VALVE GP-PILOT - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control
- Pilot Operated Hydraulic Control - Hydrostatic

VALVE GP-PILOT - Disassembly and Assembly

236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems - RENR4868

- Pilot Operated Hydraulic Control - Remove
- Pilot Operated Hydraulic Control - Disassemble
- Pilot Operated Hydraulic Control - Assemble
- Pilot Operated Hydraulic Control - Install

VALVE GP-SOLENOID - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Control Manifold and Solenoid (Parking Brake and 2-Speed)
- Control Manifold and Solenoid (Parking Brake and 2-Speed)

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Control Manifold and Solenoid (Parking Brake and 2-Speed)
- Control Manifold and Solenoid (Parking Brake and 2-Speed)

WHEEL GP - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Tire and Rim
- Tire and Rim

- Tire and Rim

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Tire and Rim
- Tire and Rim
- Tire and Rim

WHEEL GP - Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Power Train - RENR4864

- Tire and Rim - Remove and Install

Systems Operation

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Cab Pressurization and Filtration System

Testing and Adjusting

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Manifold Gauge Set (Refrigerant) - Install
- Manifold Gauge Set (Refrigerant) - Remove
- Heating and Air Conditioning Service Publications

Troubleshooting

All Products Air Conditioning and Heating R134a for All Caterpillar Machines - SENR5664

- Required Tools

Specifications / Disassembly and Assembly

FILTERS - Disassembly and Assembly

236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement - KENR5114

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement - RENR4863

- Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

Specifications / Disassembly and Assembly

COUPLER GP-QUICK - Specifications

236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems - RENR4865

- Coupler Cylinder
- Quick Coupler
- Quick Coupler

236B2 and 252B2 Skid Steer Loaders Machine Systems - KENR8821

- Coupler Cylinder
- Quick Coupler
- Quick Coupler

Schematic
Fluid Power and Electrical Graphic Symbols
Media Number -SENR3981-05 **Publication Date -01/09/2012** **Date Updated -05/09/2012**

i03480700

Fluid Power Graphic Symbols

SMCS - 5050

Note: Use this module as a basic reference guide for graphic symbols. Do not use this module as a comprehensive reference guide.

Line Identification

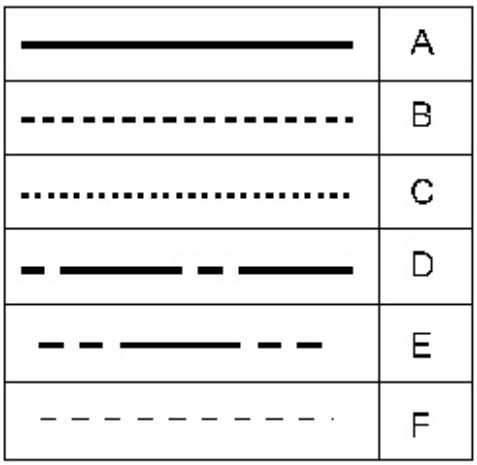


Illustration 1 g01387054

(A) Pressure line

(B) Pilot/Load sensing pressure line

(C) Drain/Return line

(D) Component line

(E) Attachment line

(F) Air Line

Valve Envelopes

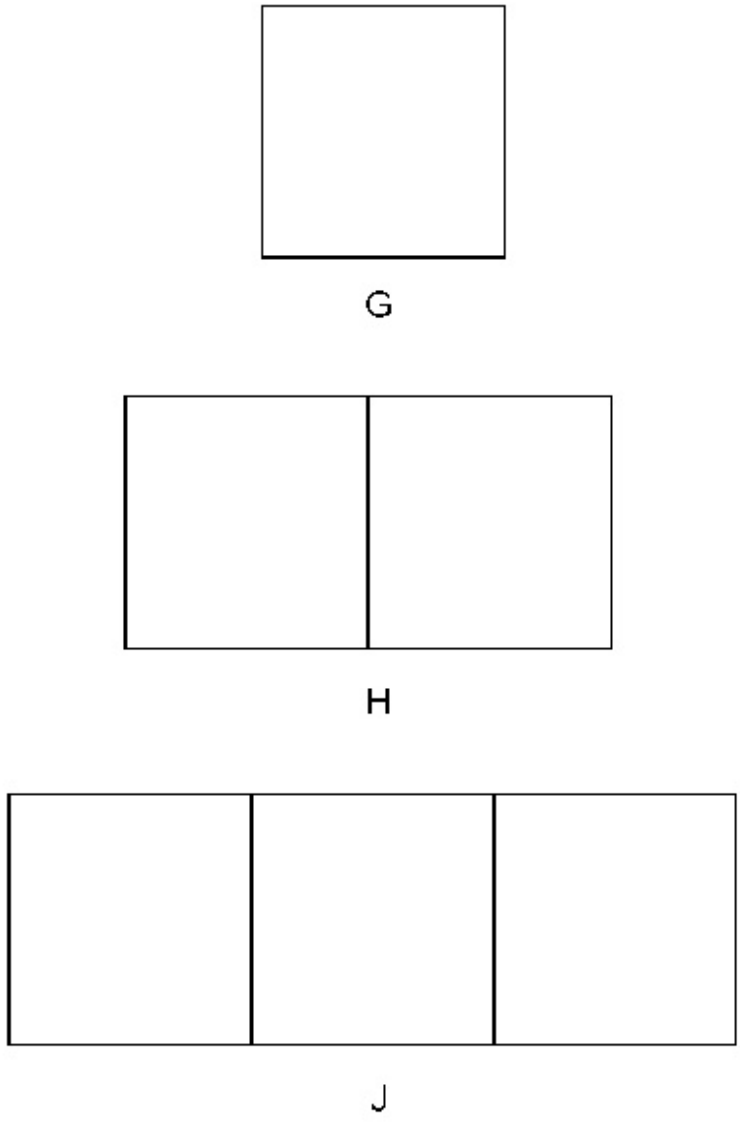


Illustration 2 g01345717

(G) One position

(H) Two-position

(J) Three-position

Fluid Storage Reservoirs

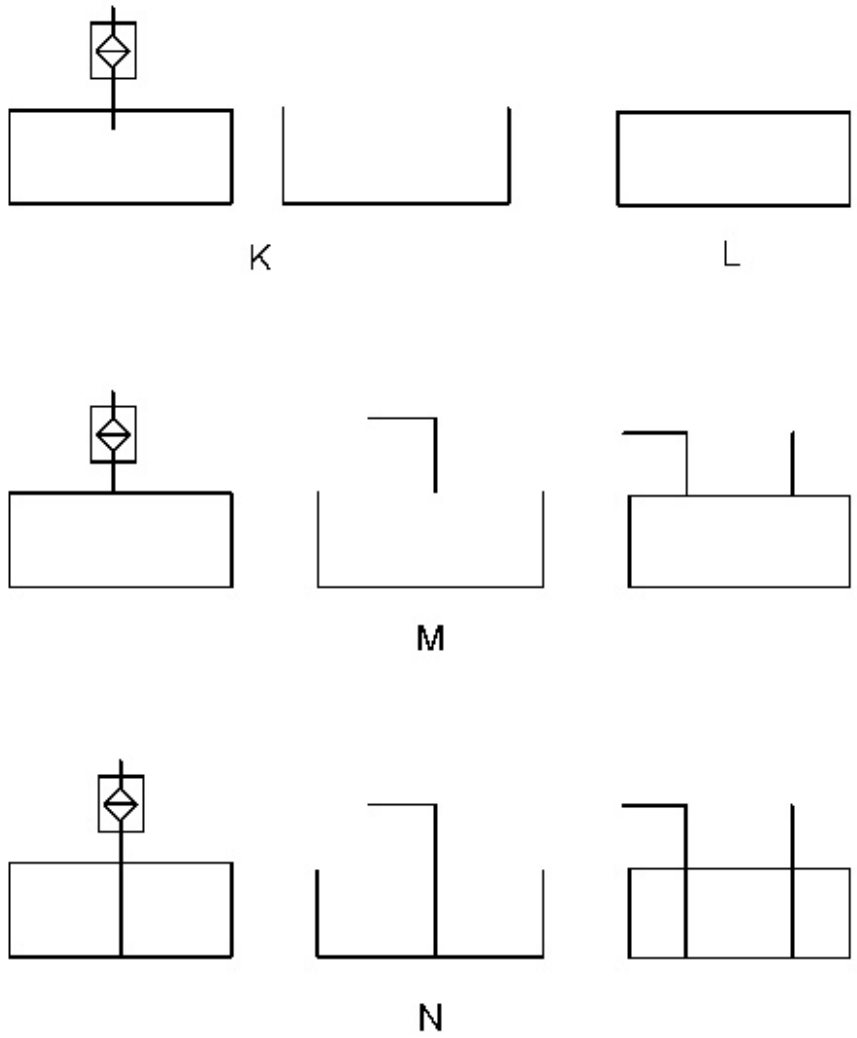


Illustration 3 g01345911

(K) Vented

(L) Pressurized

(M) Return above fluid level

(N) Return below fluid level

Techniques For Crossing and Joining Lines

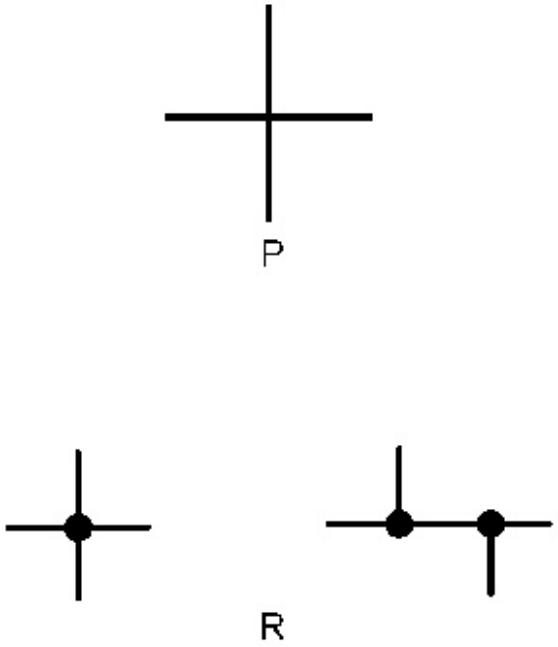


Illustration 4 g01819313

(P) Line crossing

(R) Lines joining

Valve Ports

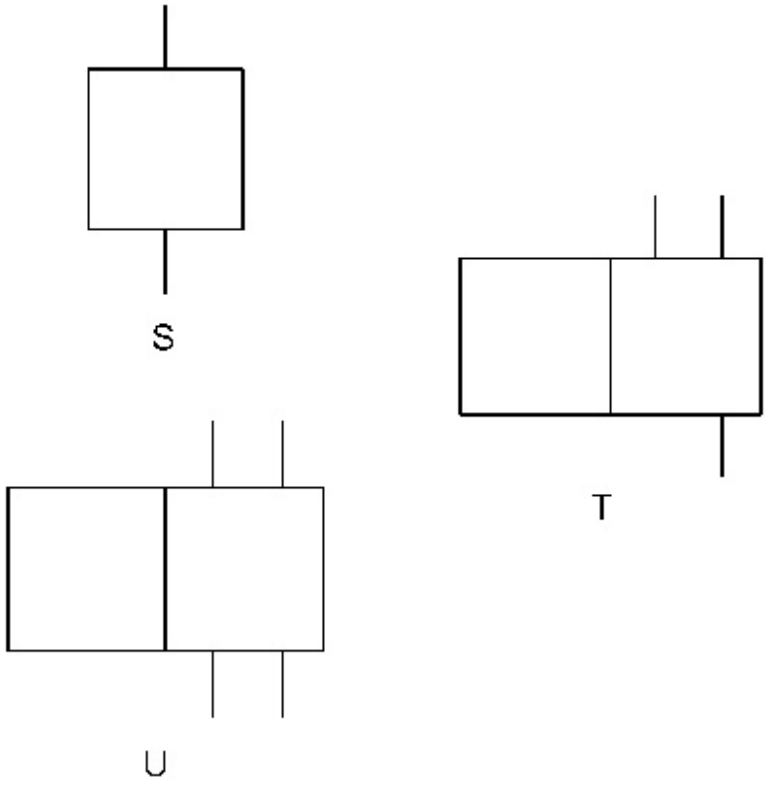


Illustration 5 g01353004

(S) Two-way

(T) Three-way

(U) Four way

Fluid Conditioners

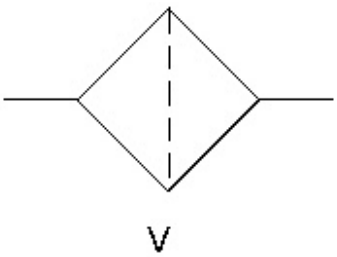


Illustration 6 g01353011

(V) Filter or strainer

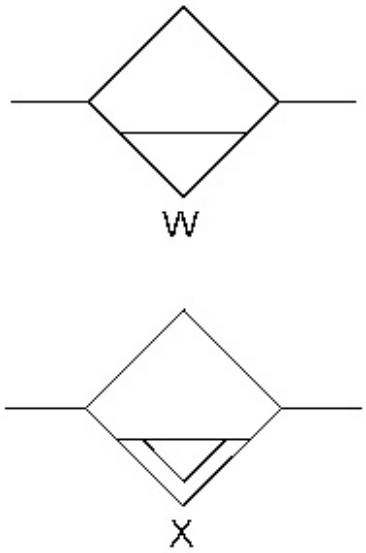


Illustration 7 g01386985

Separators

(W) Manual drain

(X) Automatic drain

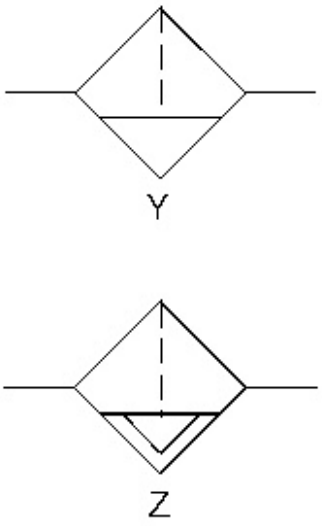


Illustration 8 g01386986

Filter separators

(Y) Manual drain

(Z) Automatic drain

Basic Component Symbols

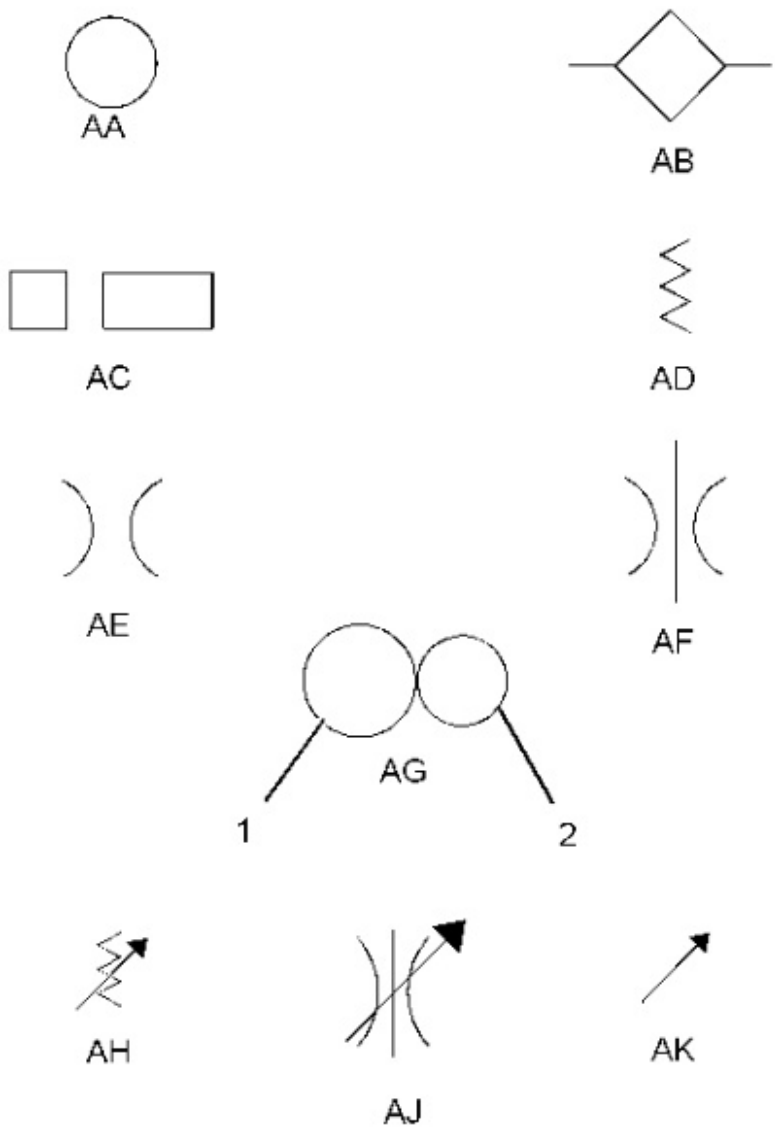


Illustration 9 g01819355

(AA) Pump or motor

(AB) Fluid conditioner

(AC) Control valves

(AD) Spring

(AE) Restriction

(AF) Line restriction

(AG) Two-section pump

(1) Main

(2) Auxiliary

(AH) Adjustable spring

(AJ) Line restriction (variable)

(AK) Variability

Supplemental Component Symbols



Illustration 10 g01819393

Energy triangles

(AL) Hydraulic

(AM) Pneumatic

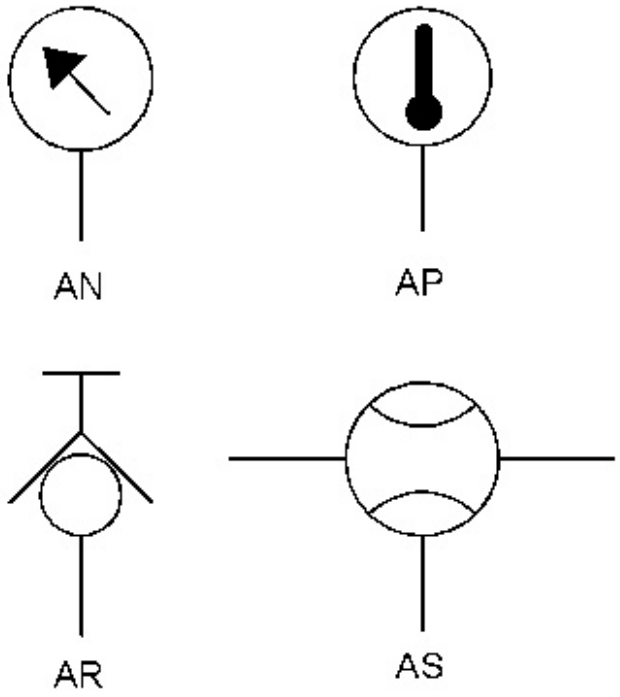


Illustration 11 g01819413

Measurement

(AN) Pressure

(AP) Temperature

(AR) Pressure tap

(AS) Flow

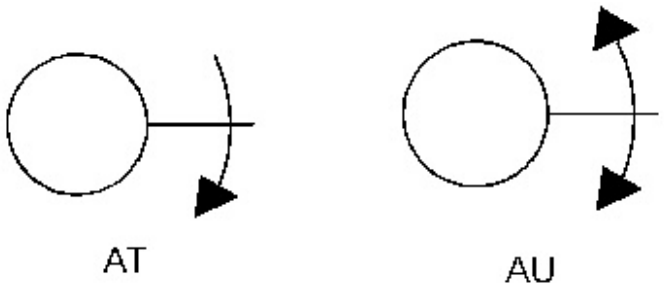


Illustration 12 g01819434

(AT) Unidirectional

(AU) Bidirectional

Pilot Control Symbols

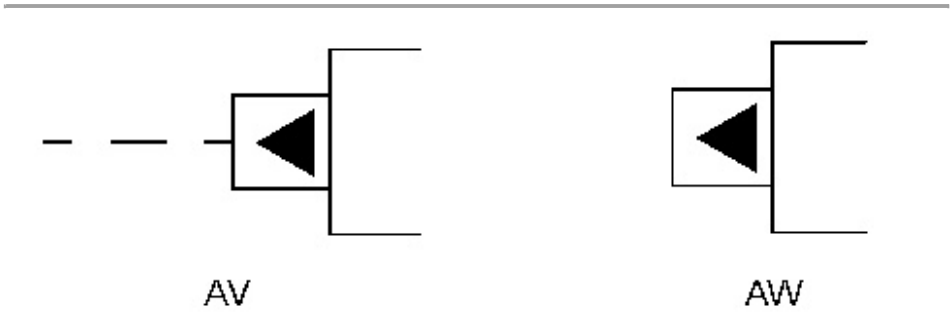


Illustration 13 g01820233

Released pressure

(AV) External return

(AW) Internal return

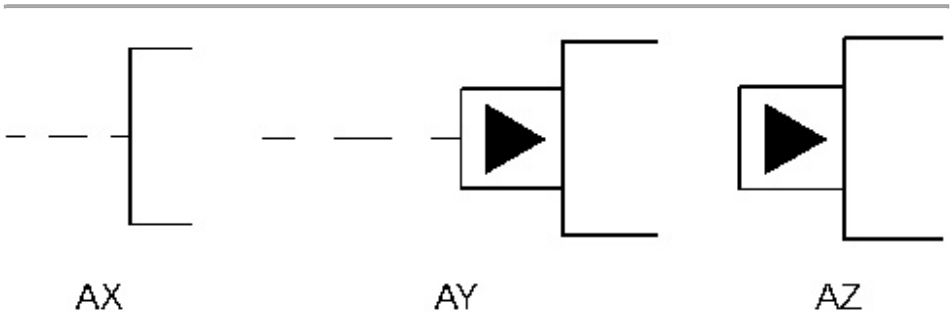


Illustration 14 g01820235

Remote supply pressure

(AX) Simplified

(AY) Complete

(AZ) Internal pressure supply

Manual Control Symbols

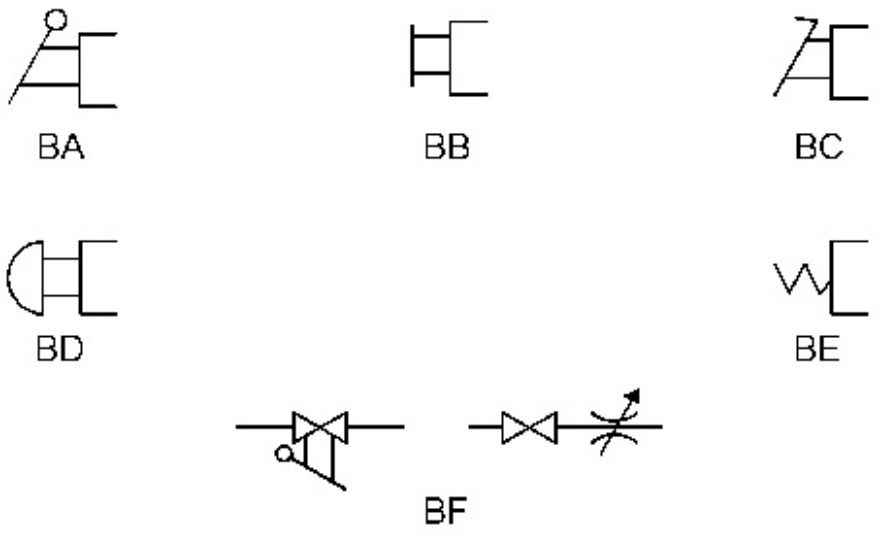


Illustration 15 g01820255

(BA) Push-pull lever

(BB) General manual

(BC) Pedal

(BD) Push button

(BE) Spring

(BF) Manual shutoff

Accumulators

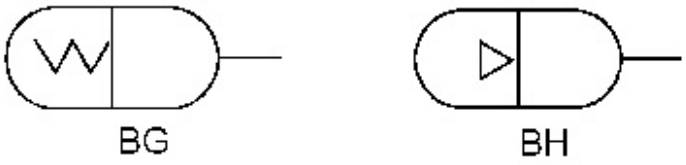


Illustration 16 g01353246

(BG) Spring loaded

(BH) Gas charged

Combination Controls

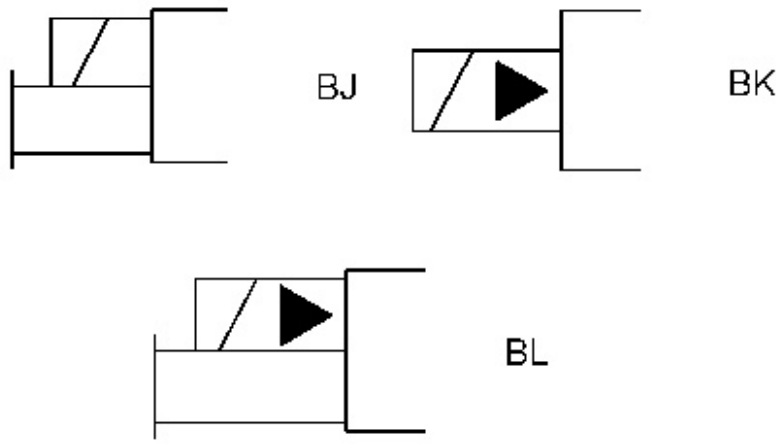


Illustration 17 g01820273

(BJ) Solenoid or manual

(BK) Solenoid and pilot

(BL) Solenoid, pilot, or manual

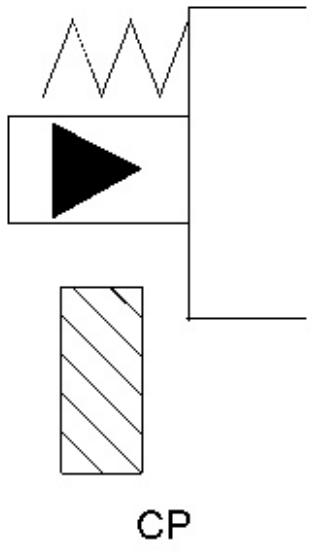


Illustration 18 g01629934

(CP) Connector (Mechanical Stop)

Electrical Controls

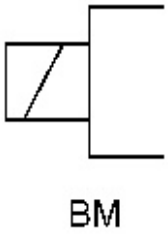


Illustration 19 g01353280

(BM) Solenoid

Miscellaneous Controls

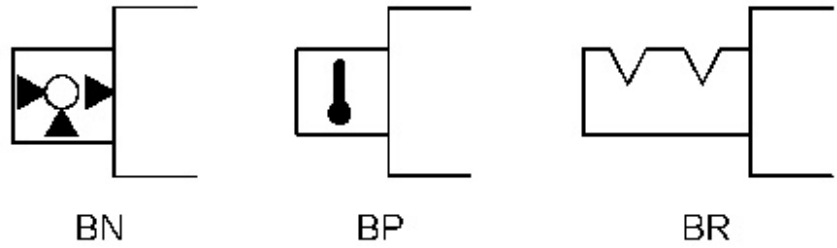


Illustration 20 g01820293

(BN) Servo

(BP) Thermal

(BR) Detent

Hydraulic, Pneumatic Cylinders

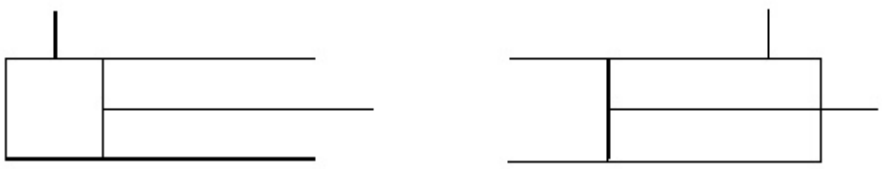


Illustration 21 g01353333

Single acting

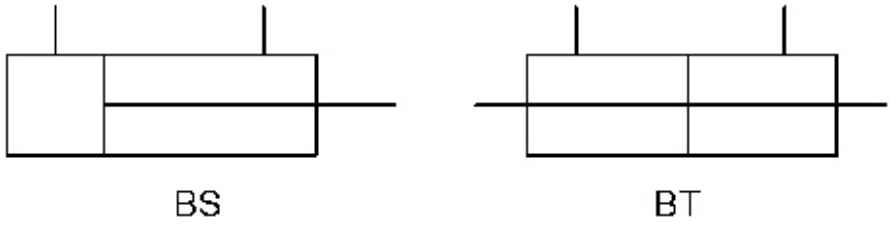


Illustration 22 g01387001

Double acting

(BS) Single end rod

(BT) Double end rod

Hydraulic Pumps



Illustration 23 g01820296

Fixed displacement

(BU) Unidirectional

(BV) Bidirectional

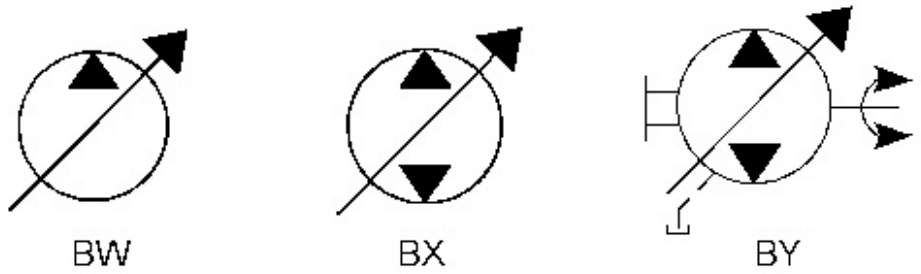


Illustration 24 g01820298

Variable displacement

(BW) Unidirectional

(BX) Bidirectional simplified

(BY) Bidirectional complete

Hydraulic Motors

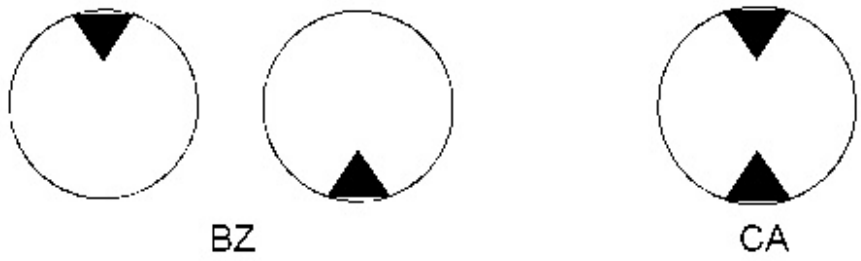


Illustration 25 g01820313

Fixed displacement

(BZ) Unidirectional

(CA) Bidirectional

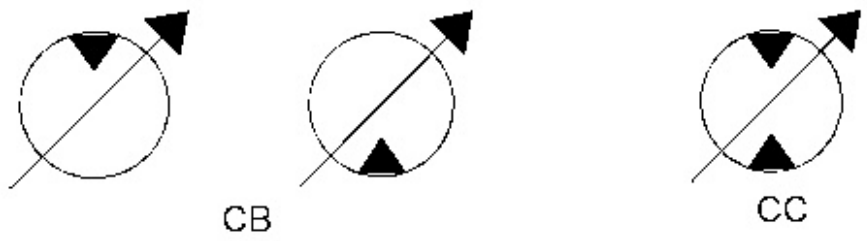


Illustration 26 g01820314

Variable displacement

(CB) Unidirectional

(CC) Bidirectional

Shutoff Valves

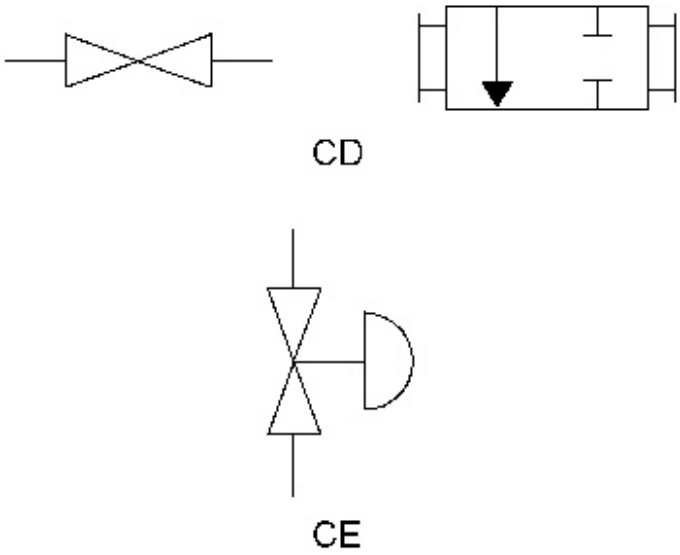


Illustration 27 g01820321

(CD) Basic symbols

(CE) Manual shutoff valve

One-Way Check Valves

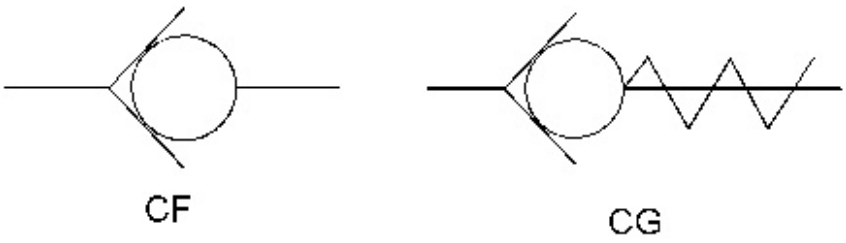


Illustration 28 g01353434

(CF) Basic symbol

(CG) Spring loaded

Internal Passageways

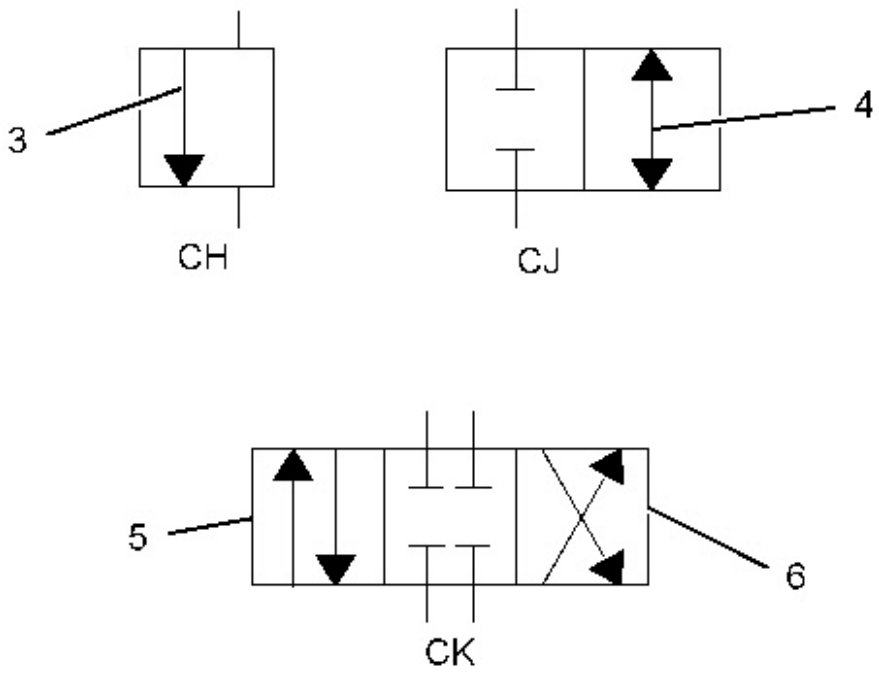


Illustration 29 g01820338

(CH) Infinite position

(3) Flow in one direction

(CJ) Two-position

(4) Flow allowed in either direction

(CK) Three-position

(5) Parallel flow

(6) Cross flow

Pressure Differential Valve

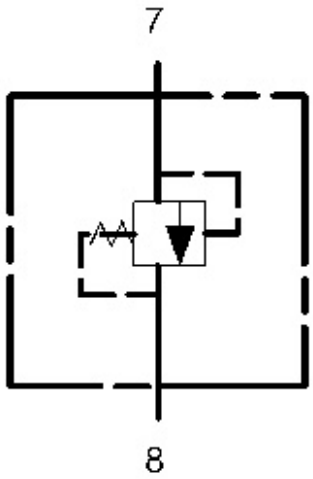


Illustration 30 g01358506

(7) Inlet (X psi)

(8) Outlet (Y psi)

Control Valves

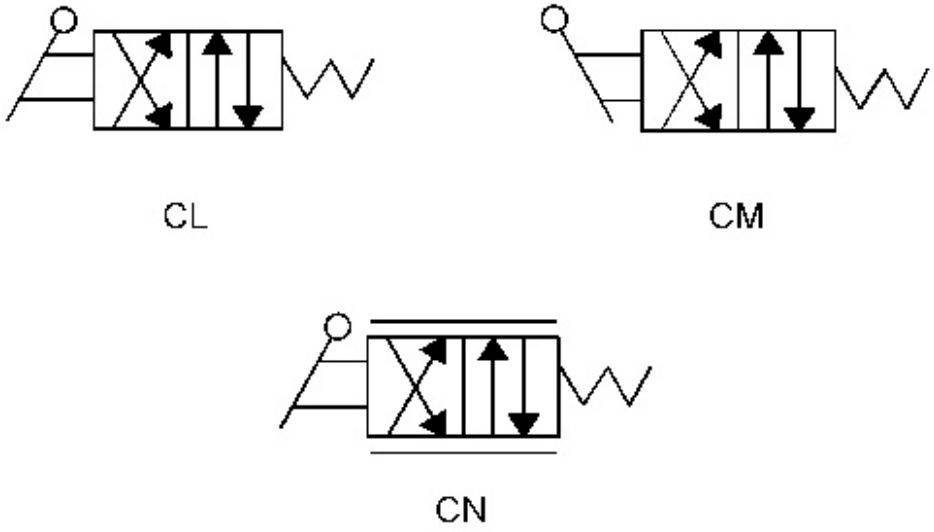


Illustration 31 g01820466

(CL) Normal position

(CM) Shifted position

(CN) Infinite Position

Simple Single Function Circuit

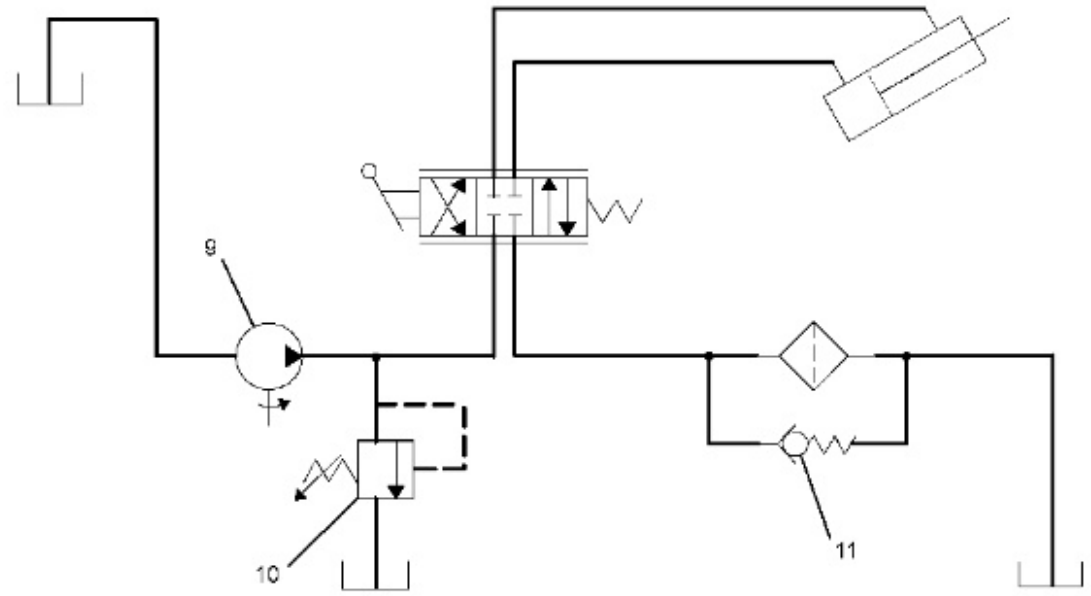


Illustration 32 g01358688

(9) 45 L/min (12 US gpm)

(10) 17000 kPa (2500 psi)

(11) 450 kPa (65 psi)

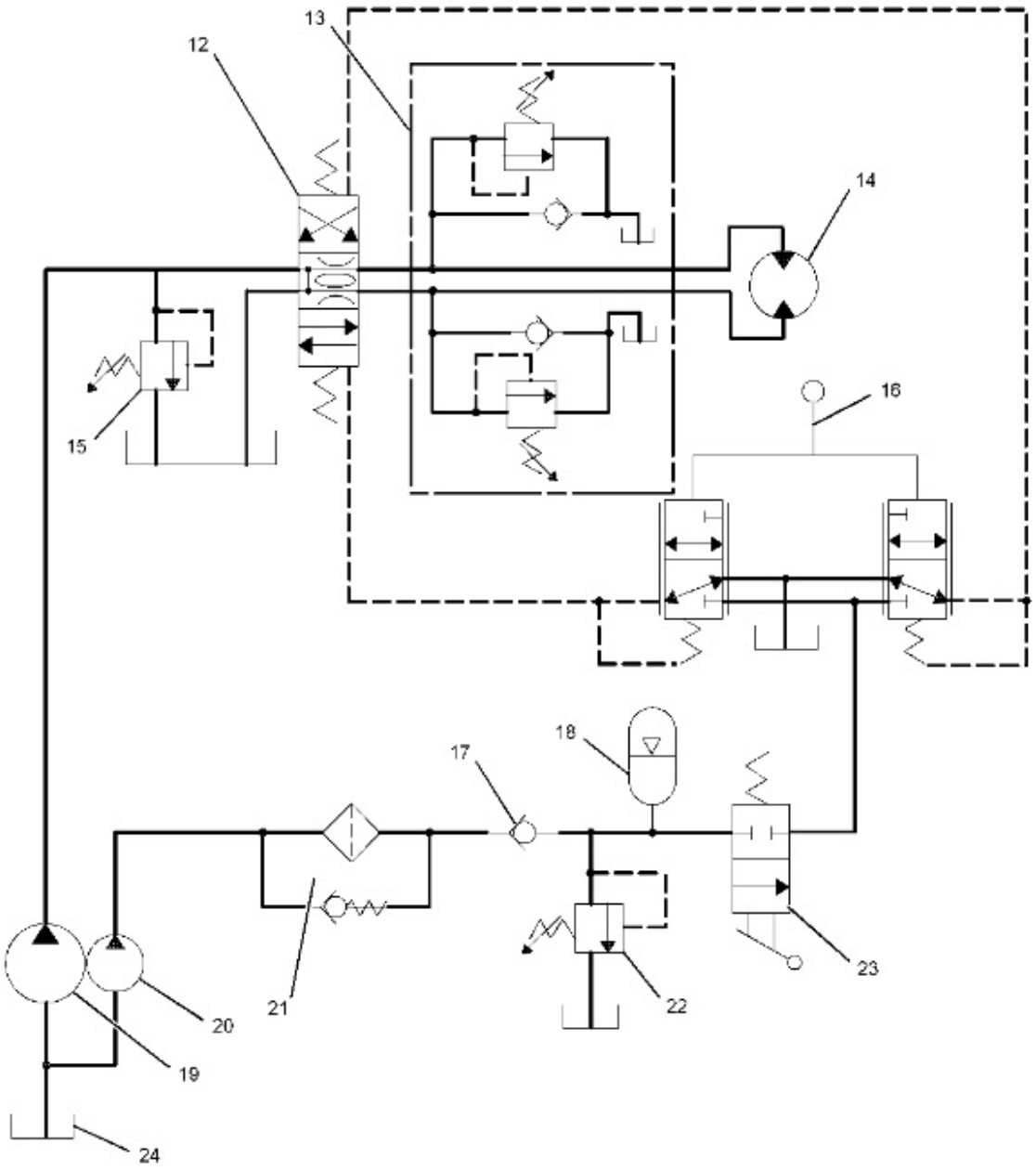


Illustration 33 g01358901

(12) Three-position four-way open centered motor spool and pilot controlled directional controlled valve

(13) Combination crossover relief valve and makeup valve (24000 kPa (3500 psi))

(14) Bidirectional motor

(15) Main system relief valve

(16) Pressure reducing pilot controlled valves

(17) Check valve

(18) Gas charged accumulator

(19) Main pump motor (115 L/min (30 us gpm))

(20) Pilot pump motor (19 L/min (5 us gpm))

(21) Pilot filter and bypass valve

(22) Pilot relief valve (2250 kPa (325 psi)

(23) Two positioned two-way pilot system disconnect valve

(24) Tank

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Schematic
Fluid Power and Electrical Graphic Symbols
Media Number -SENR3981-05 **Publication Date -01/09/2012** **Date Updated -05/09/2012**

i05041970

Electrical Power Graphic Symbols

SMCS - 1400

Note: Use this module as a basic reference guide for graphic symbols. Do not use this module as a comprehensive reference guide.

Basic Component Symbols

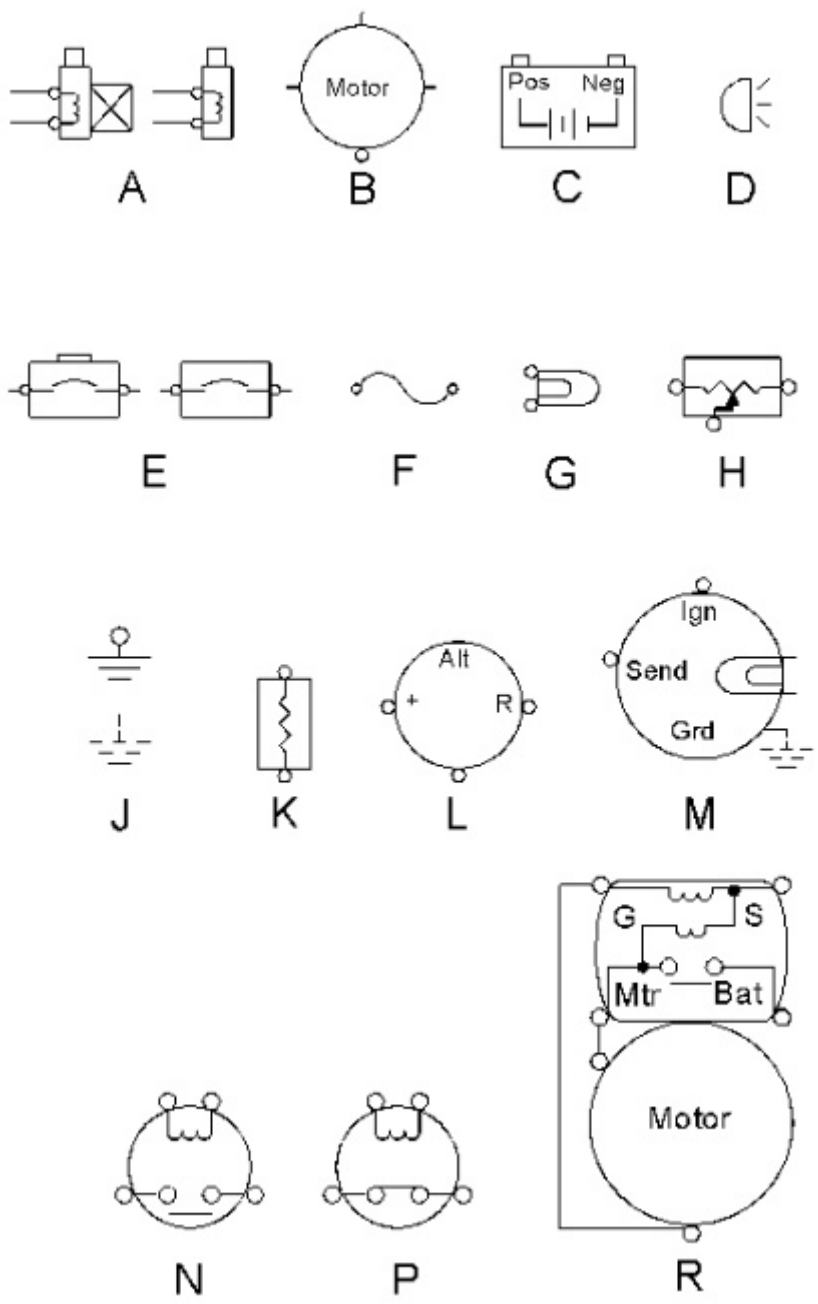


Illustration 1 g01390407

(A) Solenoid

(B) Motor

(C) Battery

(D) Exterior light

(E) Circuit breaker

(F) Fuse

(G) Backlight

(H) Potentiometer

(J) Ground

(K) Resistor

(L) Alternator

(M) Gauge

(N) Normally open relay

(P) Normally closed relay

(R) Starter

Switches

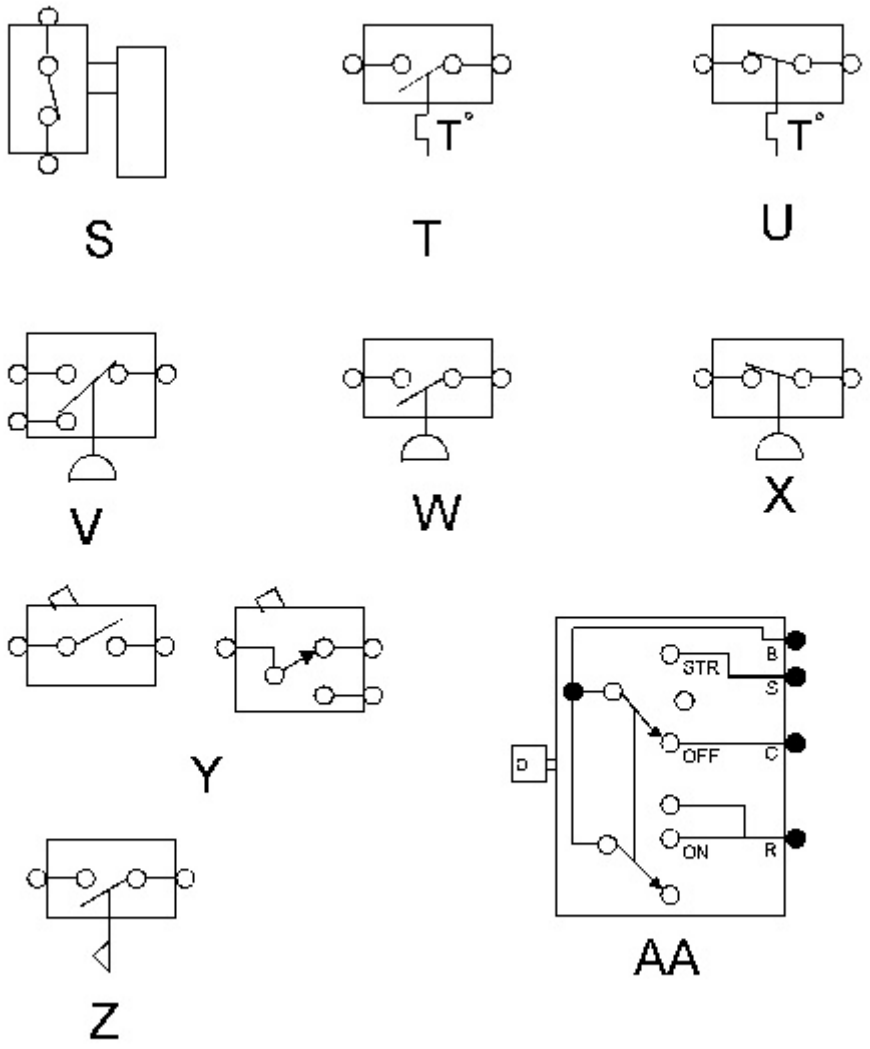


Illustration 2 g01390733

(S) Disconnect switch

(T) Normally open temperature switch

(U) Normally closed temperature switch

(V) Pressure switch

(W) Normally open pressure switch

(X) Normally closed pressure switch

(Y) Toggle switch

(Z) Flow switch

(AA) Key switch

Resistors

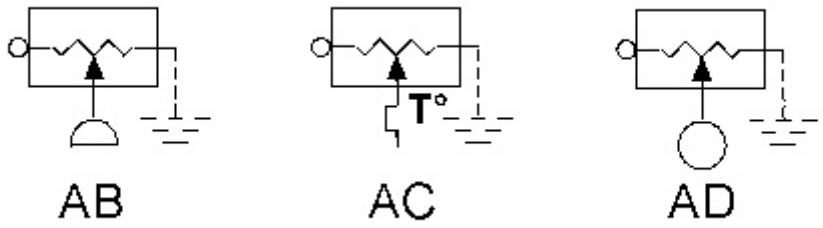


Illustration 3 g01390734

(AB) Pressure resistor

(AC) Temperature resistor

(AD) Float resistor

Wire Coloring

Red ... RD

White ... WH

Orange ... OR

Yellow ... YL

Pink ... PK

Black ... BK

Gray ... GY

Purple ... PU

Brown ... BR

Green ... GN

Blue ... BU

Wire Identification

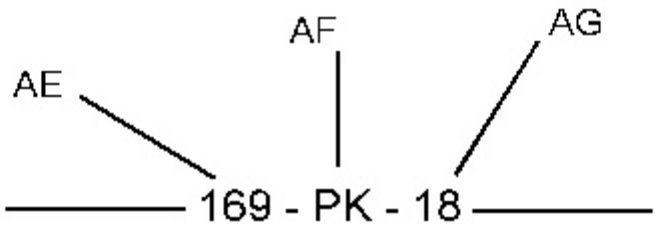


Illustration 4 g01409811

Old format

(AE) Wire label

(AF) Color code

(AG) Wire size

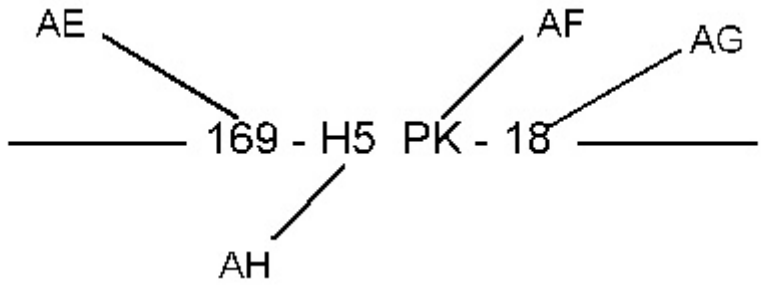


Illustration 5 g01409813

New format

(AE) Wire label

(AF) Color code

(AG) Wire size

(AH) Wire number 5 in harness "H"

Components

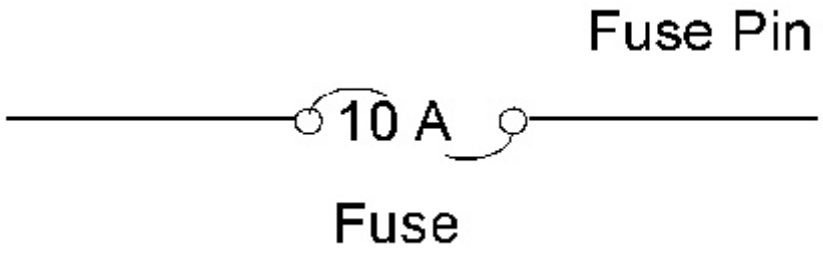


Illustration 6 g01409816

Old format

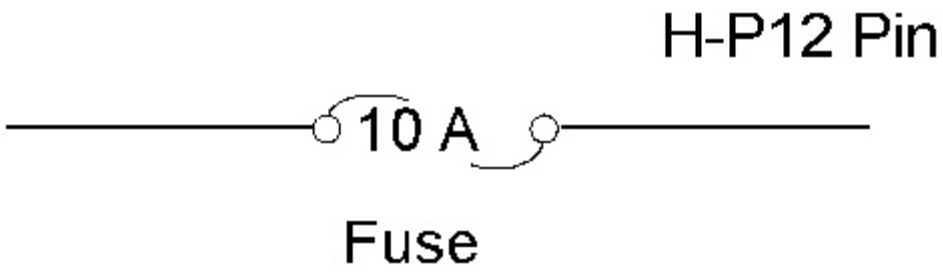


Illustration 7 g01409817

New format

Connectors

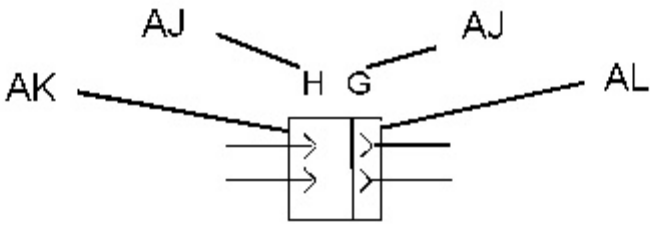


Illustration 8 g03212180

Old format

(AJ) Connector label

(AK) Receptacle side of connector

(AL) Plug side of connector

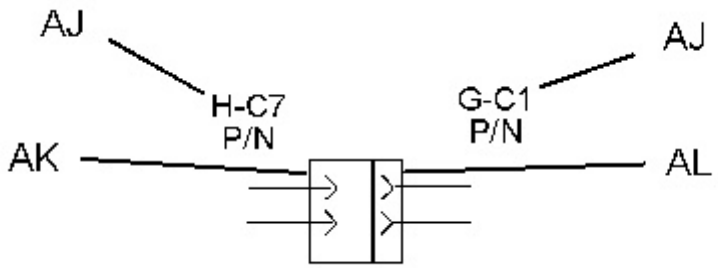


Illustration 9 g03212181

New format

(AJ) Connector label

(AK) Receptacle side of connector

(AL) Plug side of connector

Note: "H" is the harness identification, "C" stands for the connector, and "P/N" is the receptacle connector part number.

Splices

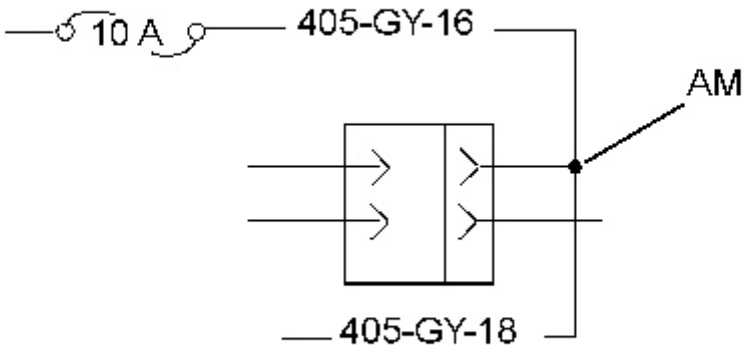


Illustration 10 g03212377

Old format

(AM) Splice

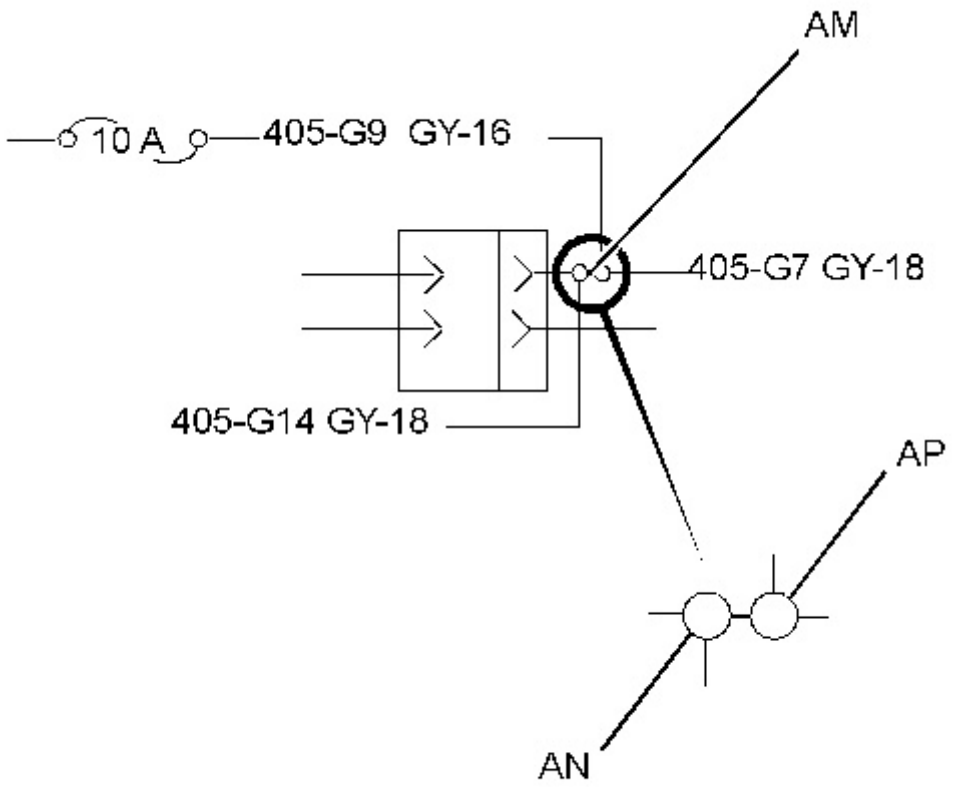


Illustration 11 g03212379

New format

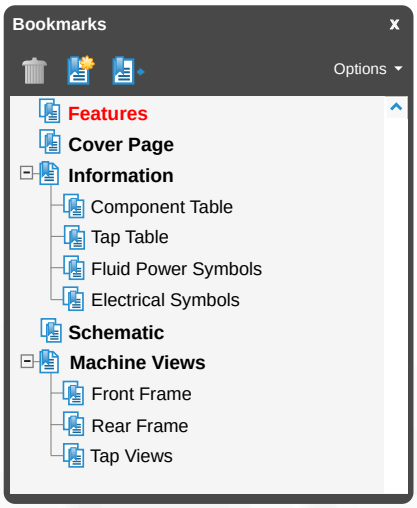
(AM) Splice

(AN) Side 2 of the splice

(AP) Side 1 of the splice

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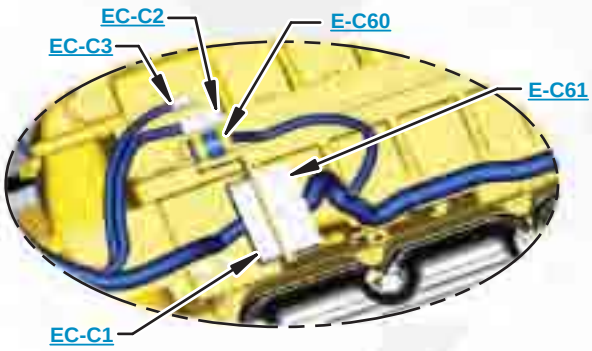
INTERACTIVE SCHEMATIC



The Bookmarks panel will allow you to quickly navigate to points of interest.

This document is best viewed at a screen resolution of 1024 X 768.

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CLICK the **SETTINGS TAB**.
MOVE THE SLIDER under **SCREEN RESOLUTION** until it shows **1024 X 768**.
CLICK OK to apply the resolution.



Click on any text that is BLUE and underlined. These are hyperlinks that can be used to navigate the schematic and machine views.

VIEW ALL CALLOUTS

When only one callout is showing on a machine view this button will make all of the callouts visible. This button is located in the top right corner of every machine view page.

HOTKEYS (Keyboard Shortcuts)		
	FUNCTION	**KEYS**
	Zoom In	**“CTRL” / “+”**
	Zoom Out	**“CTRL” / “-”**
	Fit to Page	**“CTRL” / “0” (zero)**
	Hand Tool	**“SPACEBAR” (hold down)**
	Find	**“CTRL” / “F”**



CATERPILLAR®

RENR8755
November 2003

Schematic

232B, 242B, 252B and 262B
Skid Steer Loaders
Hydraulic System

232B:	242B:	252B:	262B:
SCH1-UP	BXM1-UP	SCP1-UP	PDT1-UP

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COMPONENT LOCATION

Description	Part Number	Machine Location	Schematic Location
Accumulator	149-0686	32	D-6
Cooler As - Radiator 232 Cooler As - Radiator 242 Cooler As - Radiator 252/262	142-8861 228-2723 221-9126	4	C-6
Coupling - Female	193-8335	13	F-6
Coupling - Male	193-8334	14	F-6
Cylinder Gp - Hydraulic Coupler	192-2640	24	E-9
Cylinder Gp - Lift Lt. Hand 232/242 Cylinder Gp - Lift Lt. Hand 252/262	230-3703 230-3705	18	F-7
Cylinder Gp - Lift Rt. Hand 232/242 Cylinder Gp - Lift Rt. Hand 252/262	230-3703 230-3705	17	F-7
Cylinder Gp - Tilt Lt.. Hand 232/242 Cylinder Gp - Tilt Lt.. Hand 252/262	230-3684 230-3687	16	F-7
Cylinder Gp - Tilt Rt. Hand 232/242 Cylinder Gp - Tilt Rt. Hand 252/262	230-3694 230-3697	15	F-7
Filter Gp - Oil	223-9974	6	C-8
Manifold As - Drain Manifold	218-5560	7	C-8
Motor Gp - A/C Compressor	218-6840	26	C-7
Motor Gp - Fan 232 Motor Gp - Fan 242 Motor Gp - Fan 252 Motor Gp - Fan 262	216-6179 230-3727 225-9260 216-6193	5	C-7
Motor Gp - (Single Speed) 232/242 Motor Gp - (Single Speed) 252/262 Motor Gp - (Two Speed) 252/262	220-8152 220-8162 220-8172	8	B-10 , B-12 B-10 , B-12 E-3 , E-4
Pump GP - (Single Speed) 232/242 Pump GP - (Single Speed) 252/262 Pump GP - (Two Speed) 252/262	228-9216 191-9617 191-9700	2	A-9 A-9 D-1

COMPONENT LOCATION

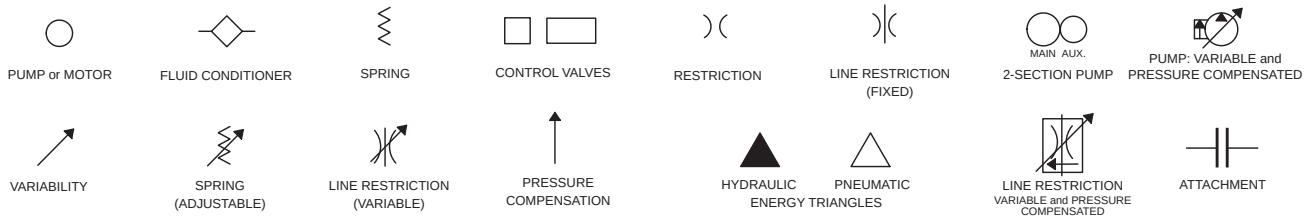
Description	Part Number	Machine Location	Schematic Location
Pump GP - Imp & Charge 232/242 Pump GP - Imp & Charge 252/262	236-5106 177-3397	1	A-8 , D-1
Screen	195-6768	23	E-6
Solenoid - Control Valve (12)	185-4254	31	E-6
Switch As - Back Up Alarm	192-0836	21	D-13
Tank GP - Hydraulic	204-1491	3	B-7
Valve - Check	123-4750	22	B-11 , D-4
Valve Gp - Ball	191-9783	19	E-9
Valve Gp - Control 232 Valve Gp - Control 242 Valve Gp - Control 252/262	216-6168 191-9686 216-6170	12	E-8
Valve Gp - Float Detent Magnet Handle As - A1 & A2 Handle As - A1 & A2 Handle As - A1 & A2 Proportional Pin - Spring - Slott	228-9228 218-6118 223-3725 215-8307 117-8683	11	F-12
Valve Gp - Hydraulic Coupler	209-0640	25	D-9
Valve Gp - Dual Self Level R/L 232/242 Valve Gp - Dual Self Level R/L 252/262	228-9218 220-8125	20	F-10
Valve Gp - S-Turn Resolver Block Handle As - Control Flow Handle As - Horn & Control Flow Handle As - Horn & Control Flow Pin - Spring - Slott	218-6119 218-6117 218-6118 223-3725 117-8683	10	F-13
Valve Gp - Brake (Single Speed) Valve Gp - Brake (Two Speed)	208-5681 222-3692	9	B-11 F-4

TAP LOCATION

Tap Number	Description	Schematic Location
AA	Main Worktool System Pressure	D-8
BB	SOS	C-7
CC	Signal Pressure	C-11
DD	Main System Pressure (Pump 1 Forward)	B-11, D-4
EE	Charge Pressure	B-11, D-3
FF	Main System Pressure (Pump 2 Forward)	B-10, D-3
GG	Main System Pressure (Pump 2 Reverse)	A-10, C-3
HH	Main System Pressure (Pump 1 Reverse)	A-11, C-4

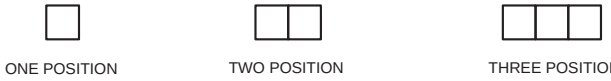
FLUID POWER SYMBOLS

BASIC COMPONENT SYMBOLS

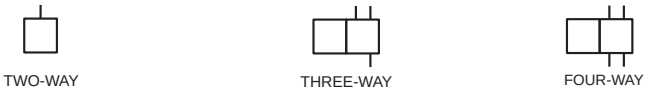


VALVES

VALVE ENVELOPES



VALVE PORTS



CONTROL VALVES



CHECK VALVES



FLUID STORAGE RESERVOIRS



MEASUREMENT



ROTATING SHAFTS



COMBINATION CONTROLS



MANUAL CONTROL SYMBOLS

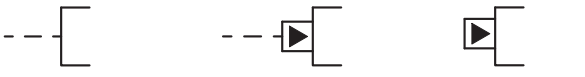


PILOT CONTROL SYMBOLS

RELEASED PRESSURE



REMOTE SUPPLY PRESSURE



ACCUMULATORS



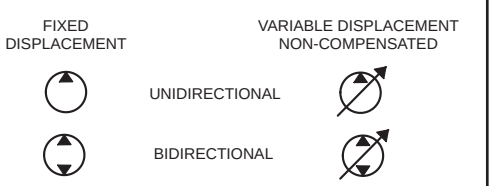
CROSSING AND JOINING LINES



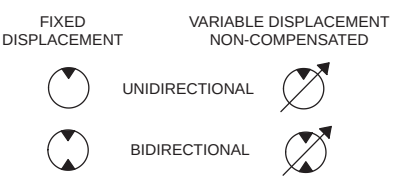
HYDRAULIC AND PNEUMATIC CYLINDERS



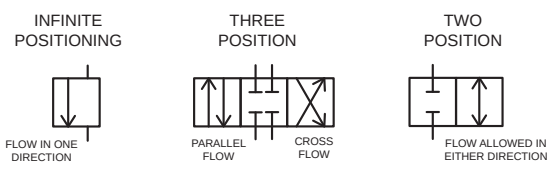
HYDRAULIC PUMPS



HYDRAULIC MOTORS



INTERNAL PASSAGEWAYS

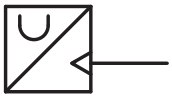


ELECTRICAL SYMBOLS

Hydraulic Symbols (Electrical)



Transducer (Fluid)



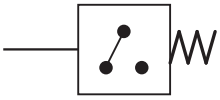
Transducer (Gas / Air)



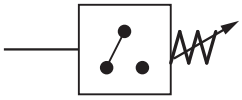
Generator



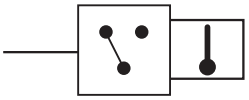
Electric Motor



Pressure Switch



Pressure Switch (Adjustable)

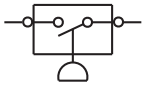


Temperature Switch

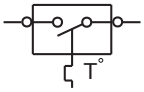


Electrical Wire

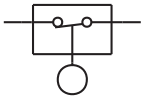
Electrical Symbols (Electrical)



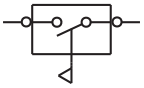
Pressure Symbol



Temperature Symbol



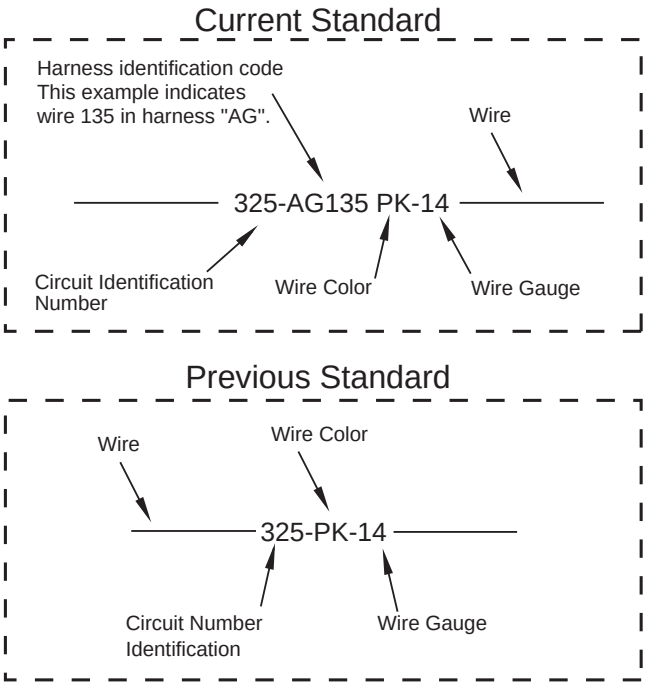
Level Symbol



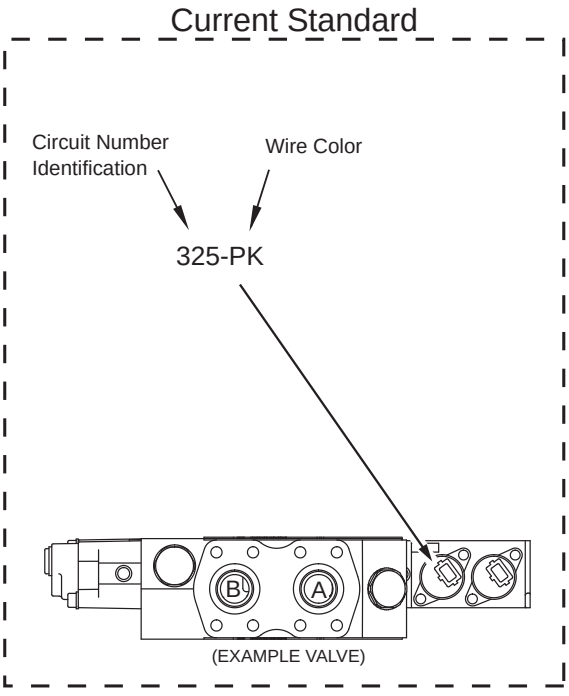
Flow Symbol

Wire Number Identification Codes

Electrical Schematic Example

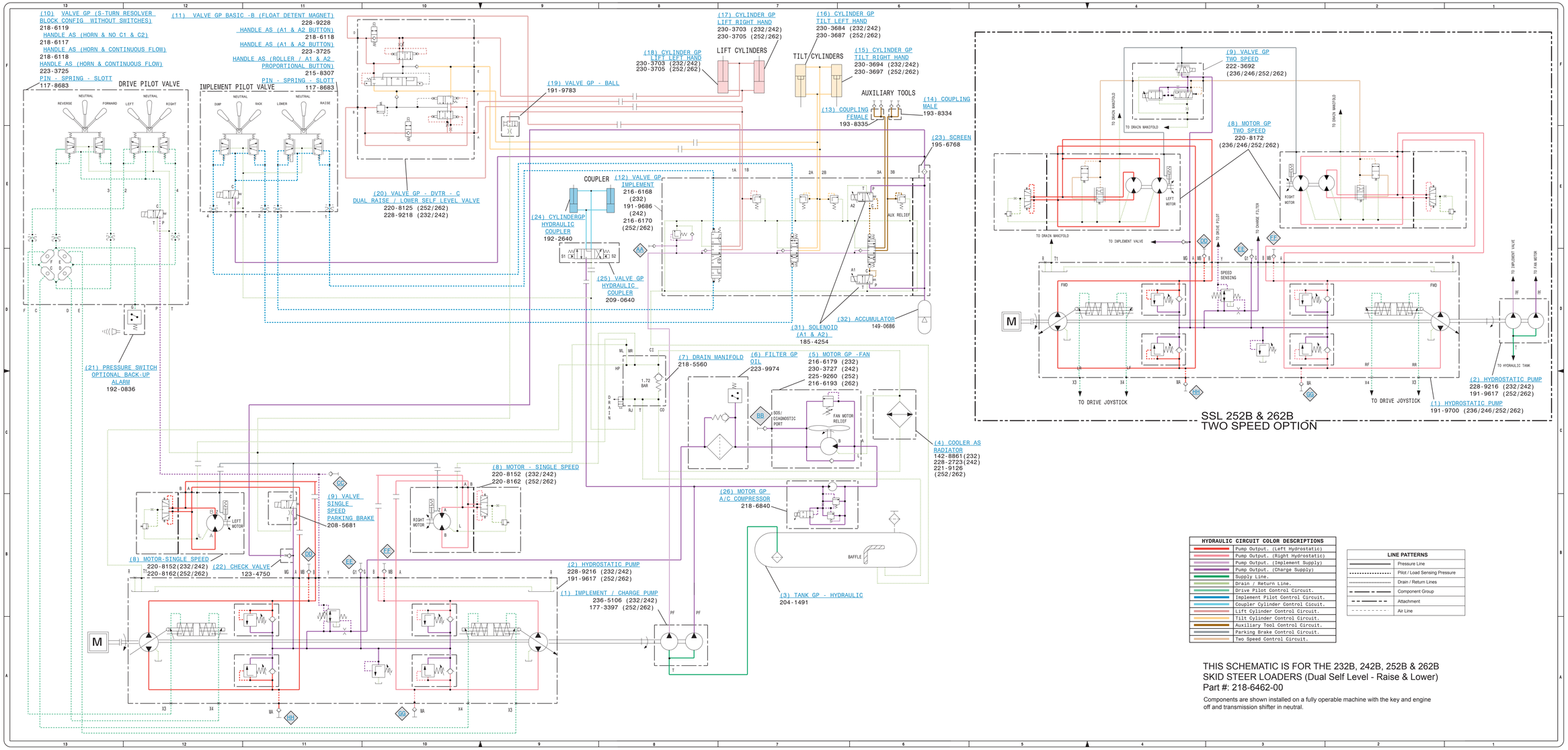


Hydraulic Schematic Example



SPECIFICATIONS AND RELATED MANUALS

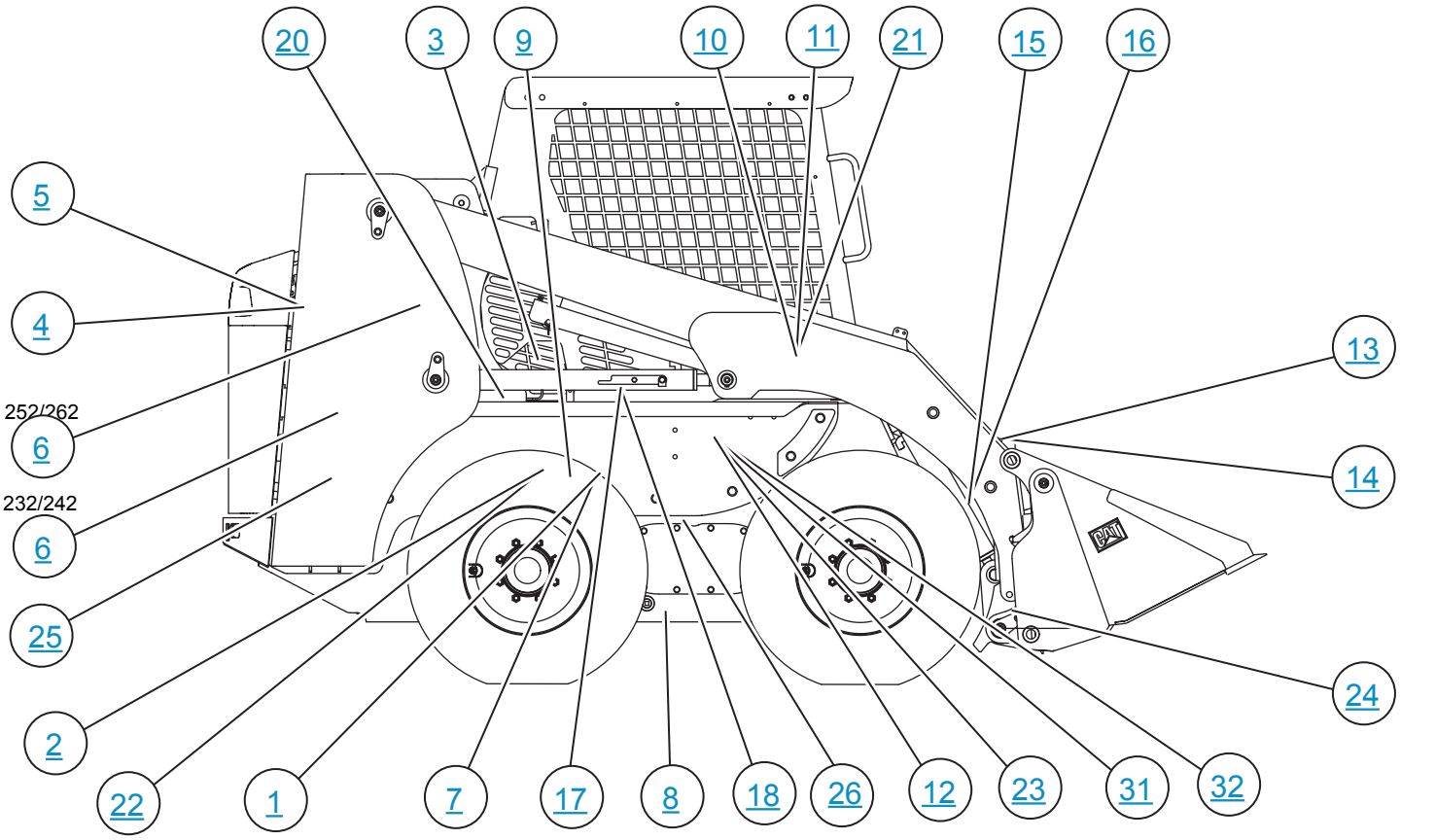
Description	Media Number
Parts Manual	
Skid Steer Loaders 232B & 242B	SEBP3770
Skid Steer Loaders 252B & 262B	SEBP3769
Machine System	
Specifications 232B & 242B	RENR4895
Testing and Adjusting 232B & 242B	RENR4897
Specifications 252B & 262B	RENR4865
Testing and Adjusting 252B & 262B	RENR4867
Electrical System	
Schematic: (Electrical System)	RENR6419

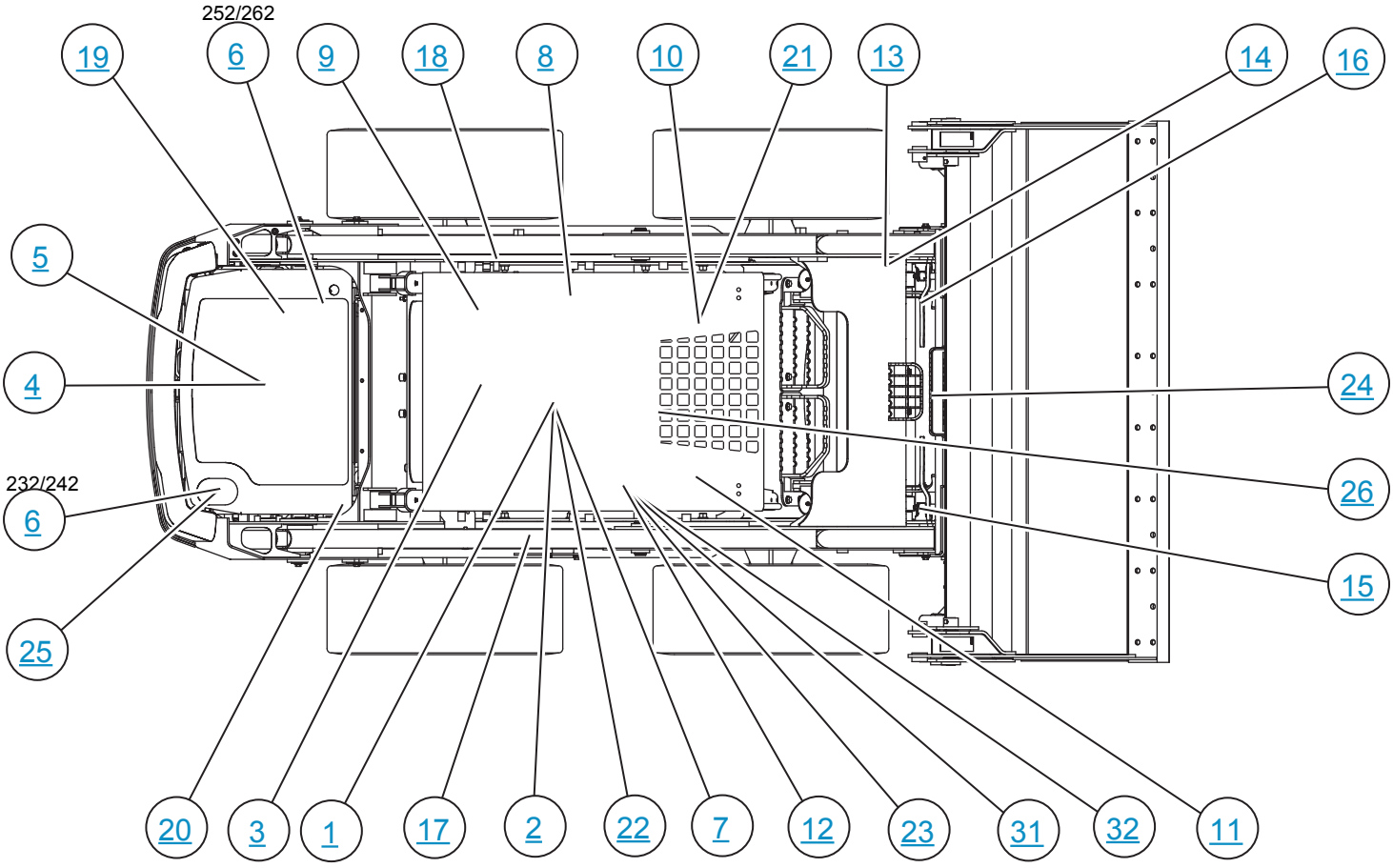


THIS SCHEMATIC IS FOR THE 232B, 242B, 252B & 262B SKID STEER LOADERS (Dual Self Level - Raise & Lower)
Part #: 218-6462-00

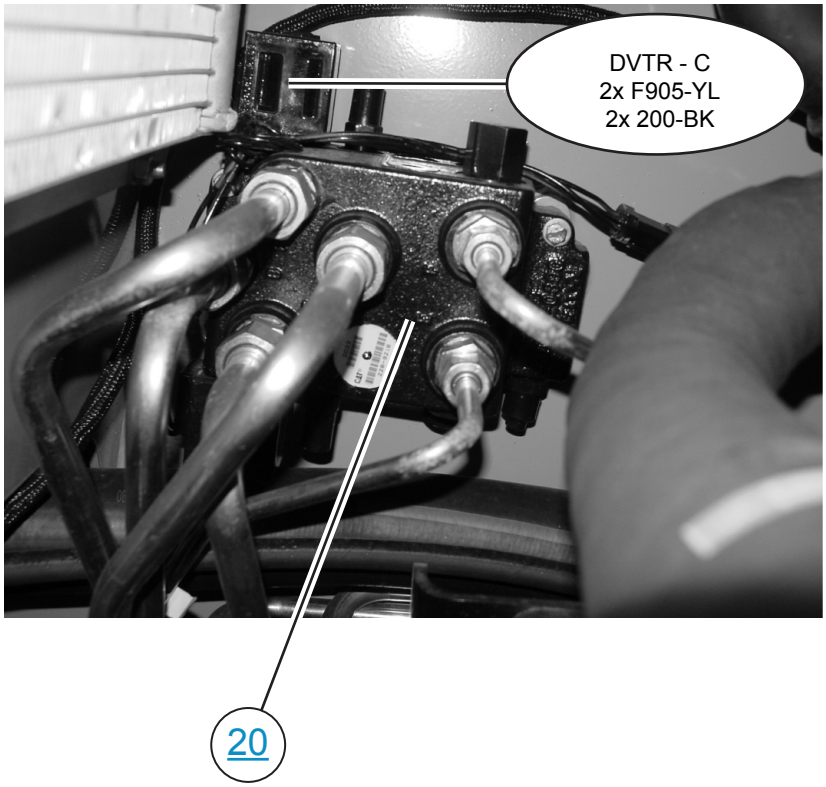
Components are shown installed on a fully operable machine with the key and engine off and transmission shifter in neutral.

MACHINE COMPONENT LOCATION

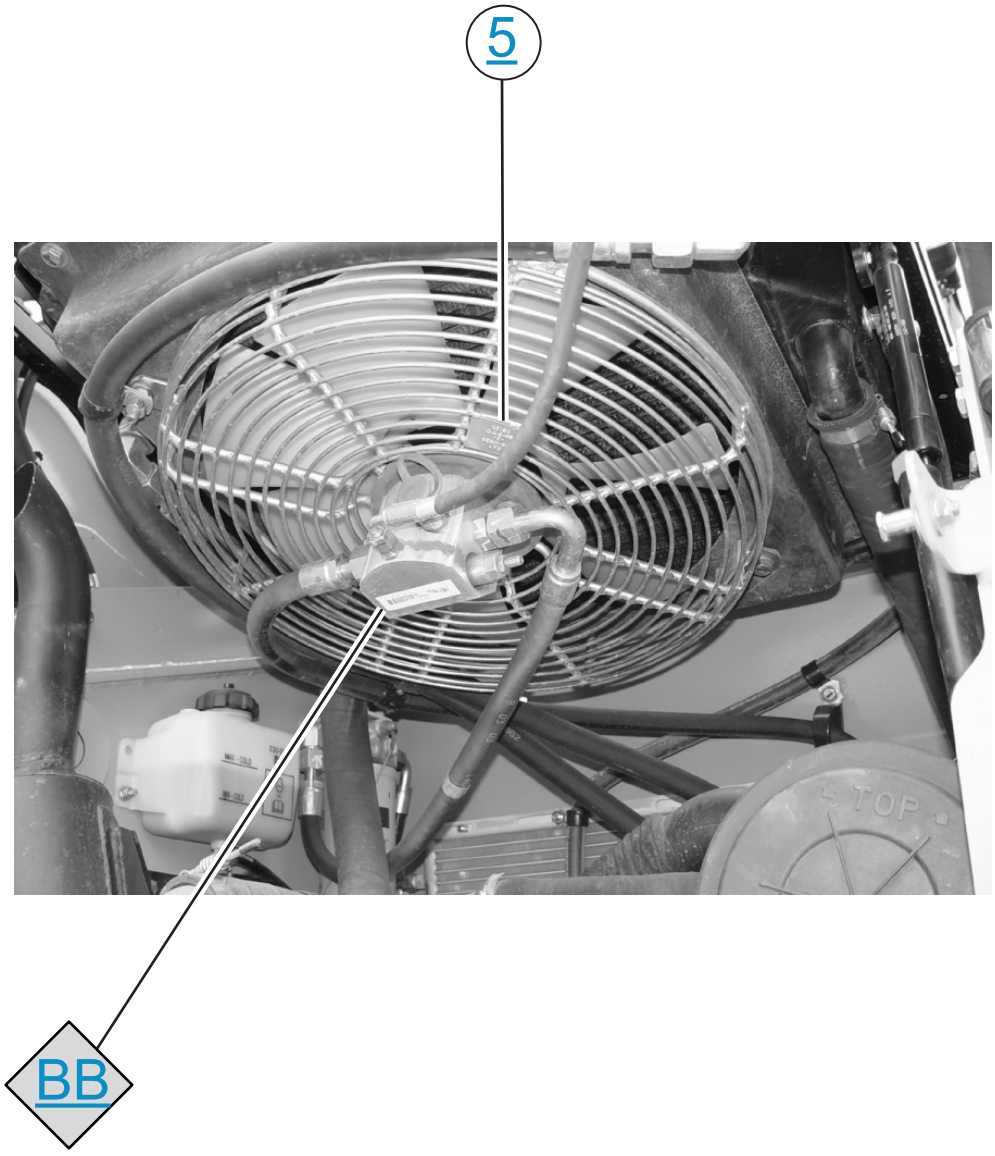




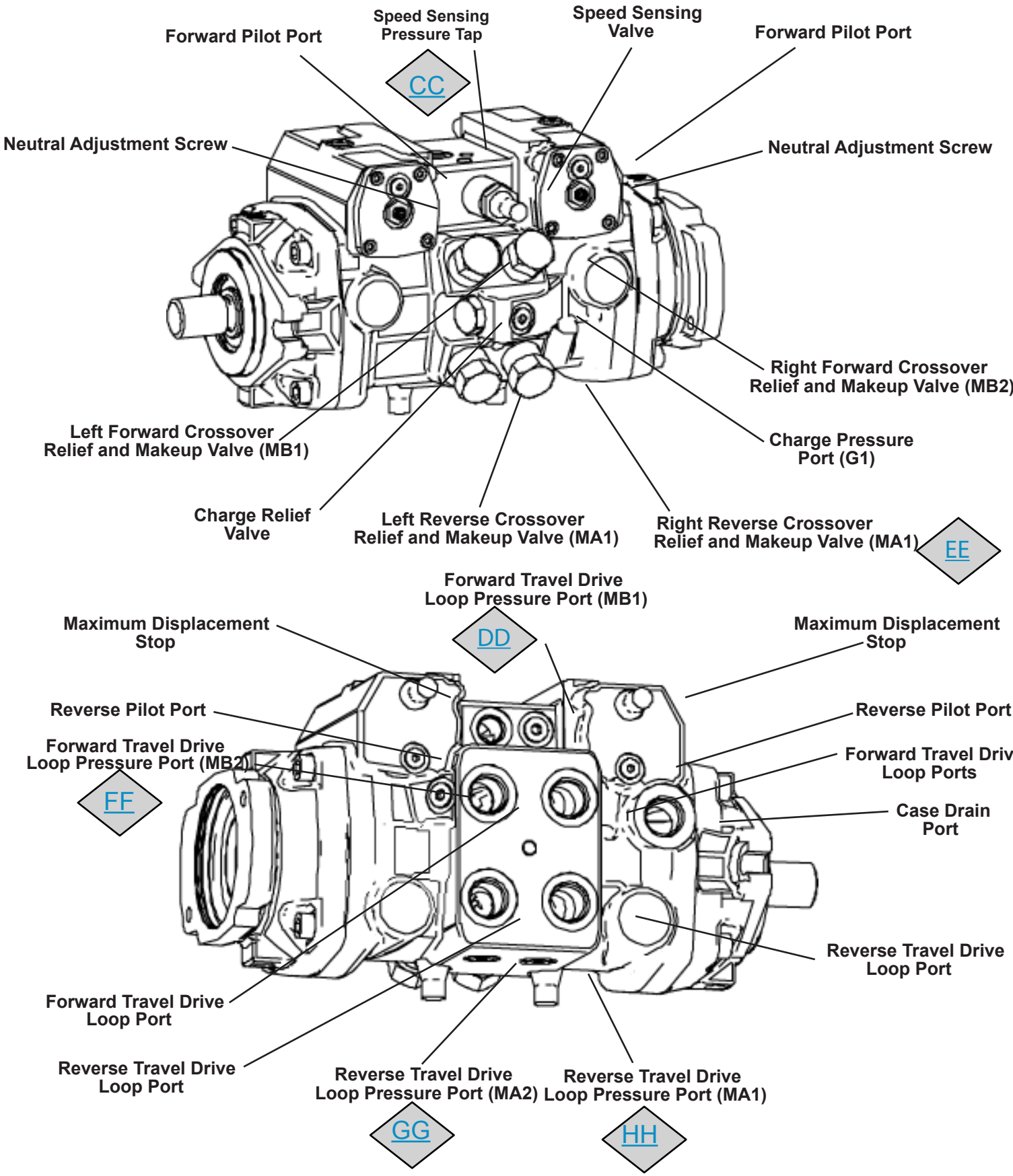
DUAL SELF LEVEL VALVE



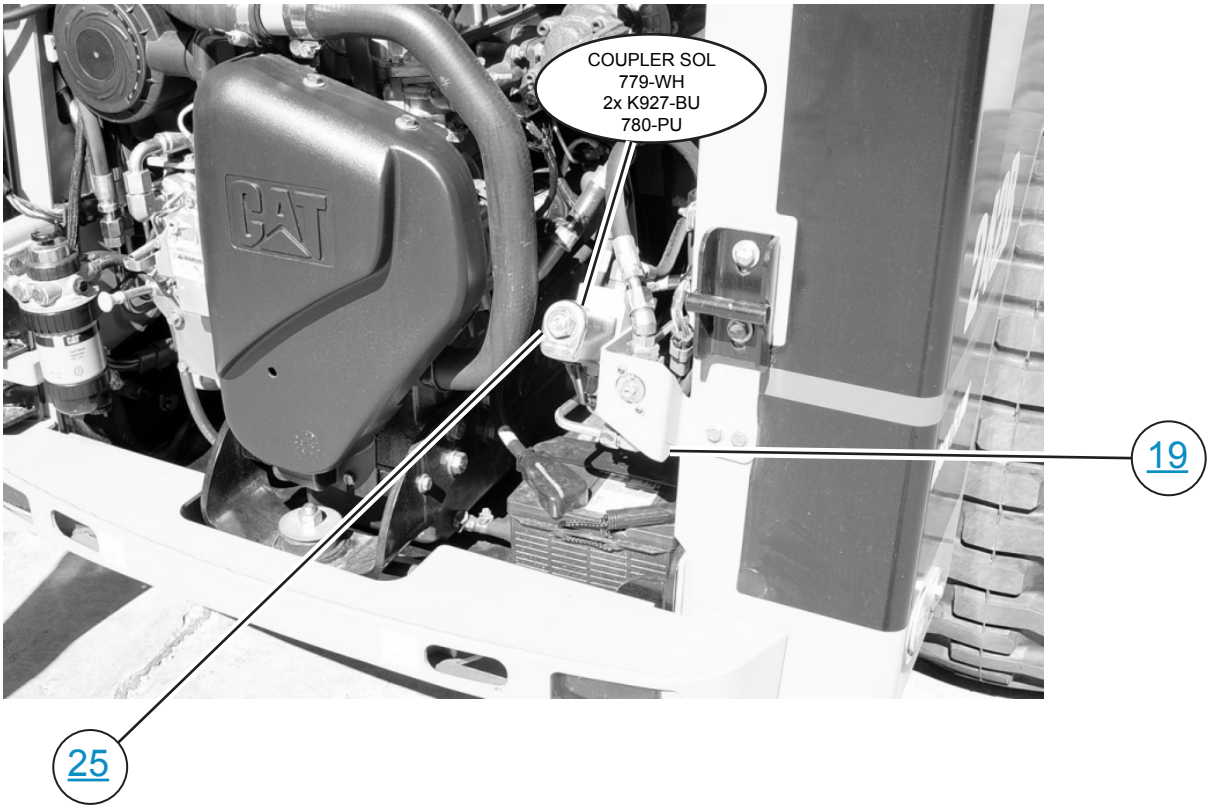
HYDRALIC FAN MOTOR AND SOS PART



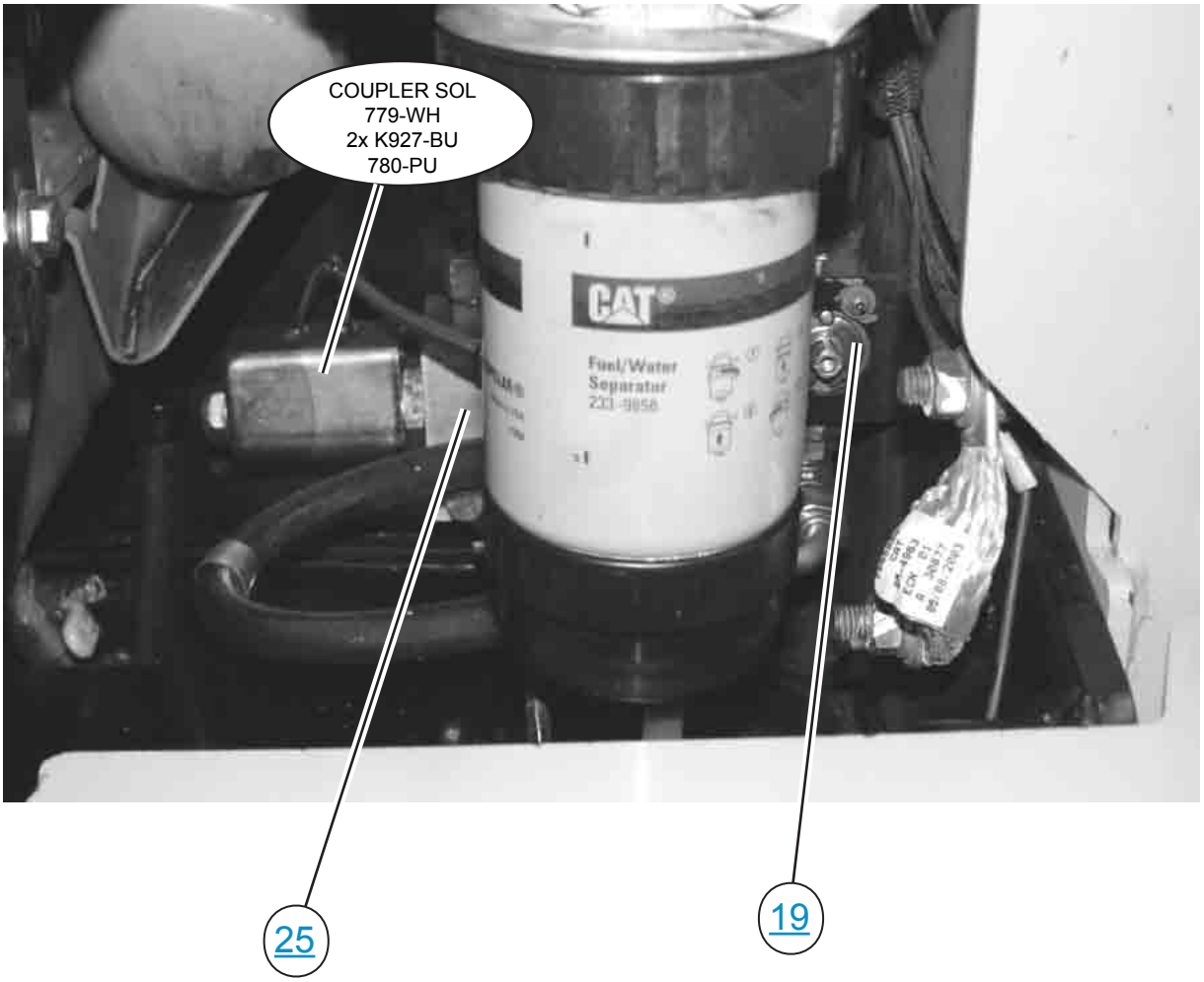
HYDROSTATIC DRIVE PUMP COMPONENTS



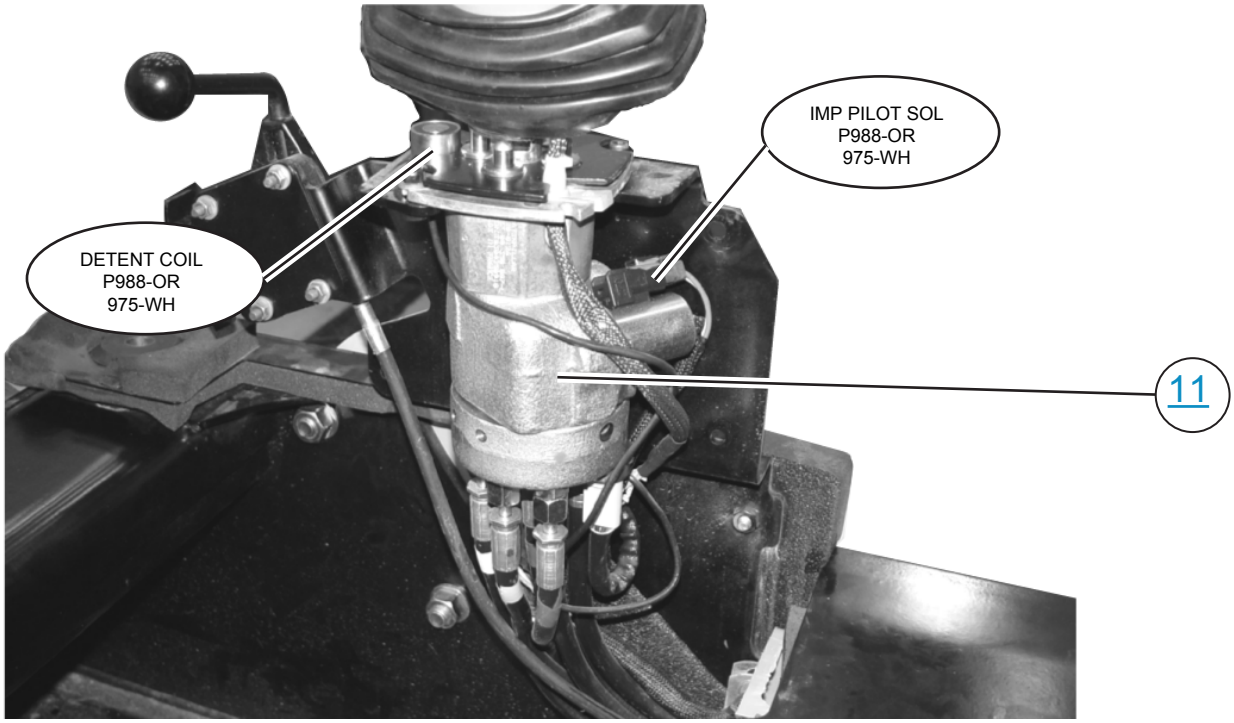
LOCATION FOR 232B AND 242B



MACHINE LOCATION FOR 252B AND 262B



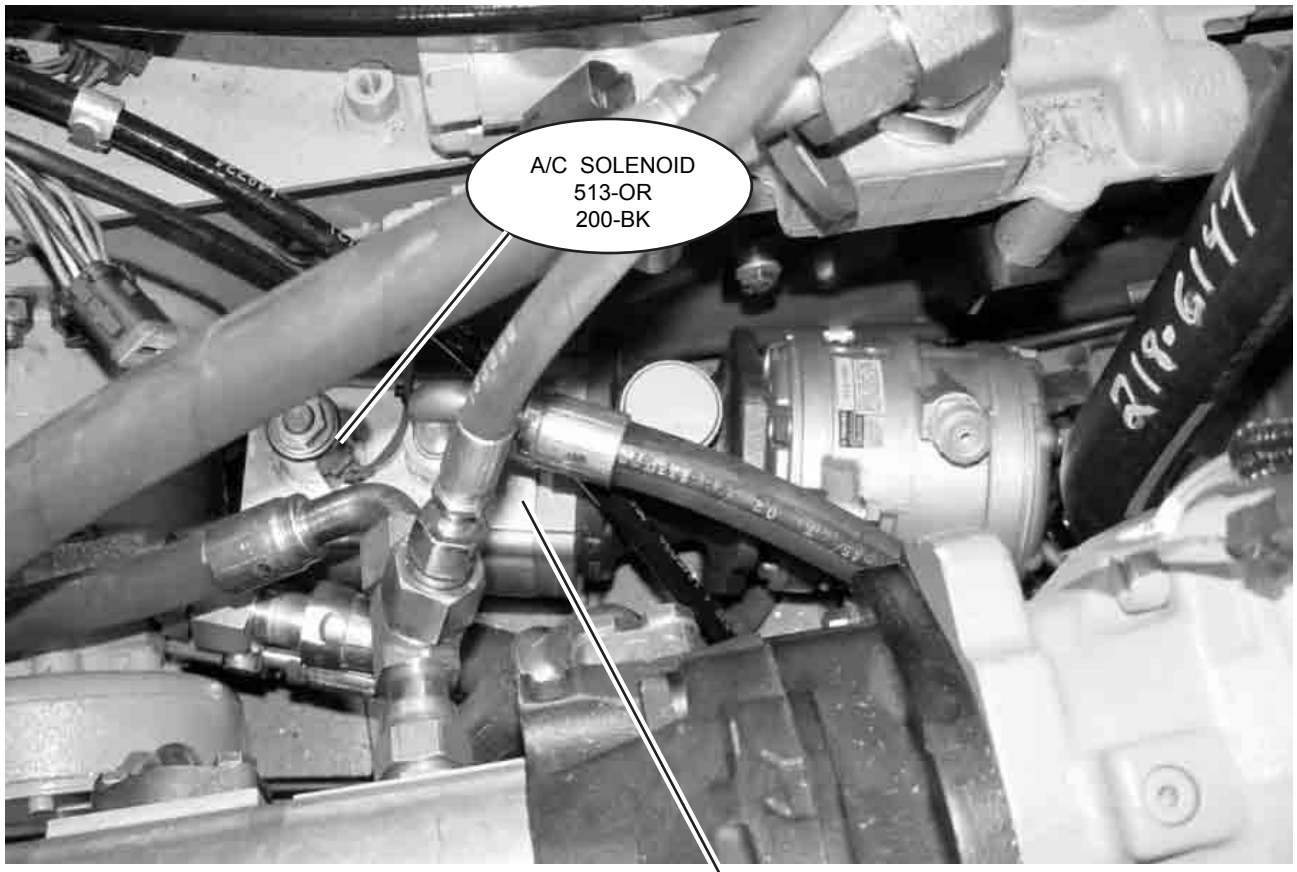
IMPLEMENT PILOT VALVE



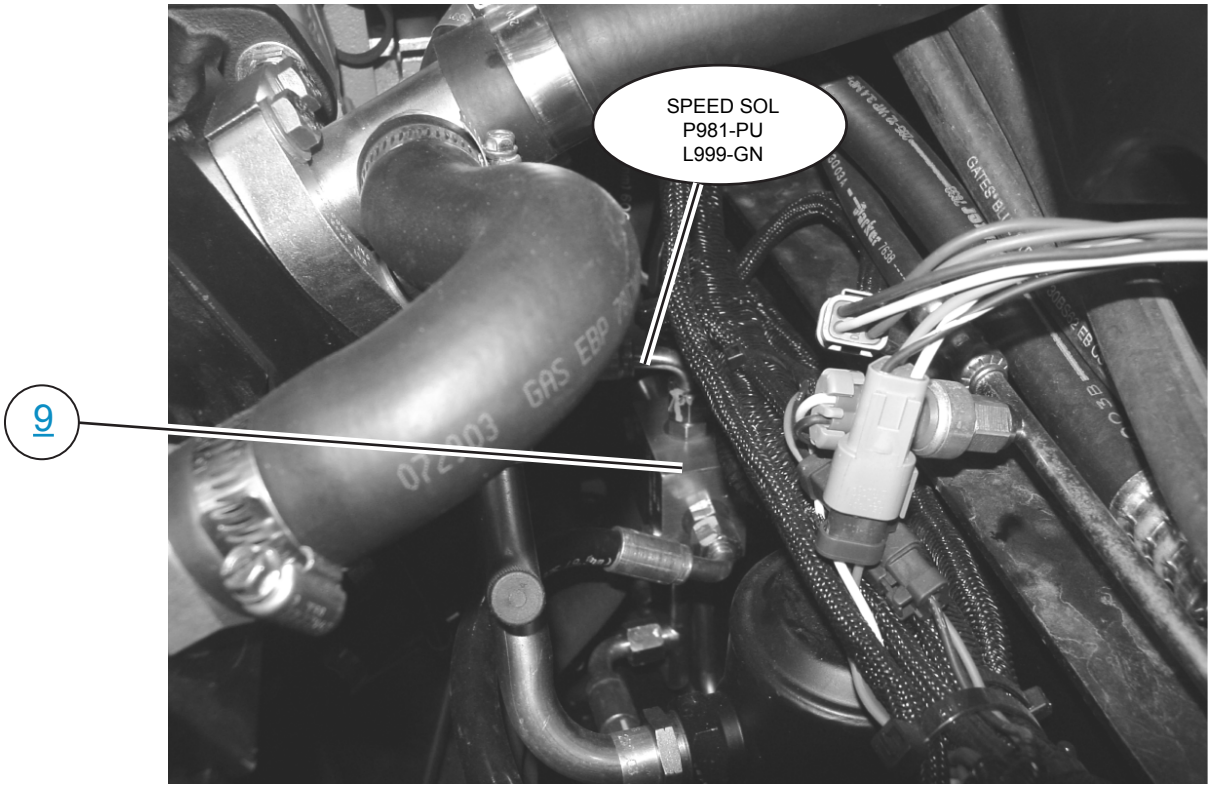
MAIN WORK TOOL



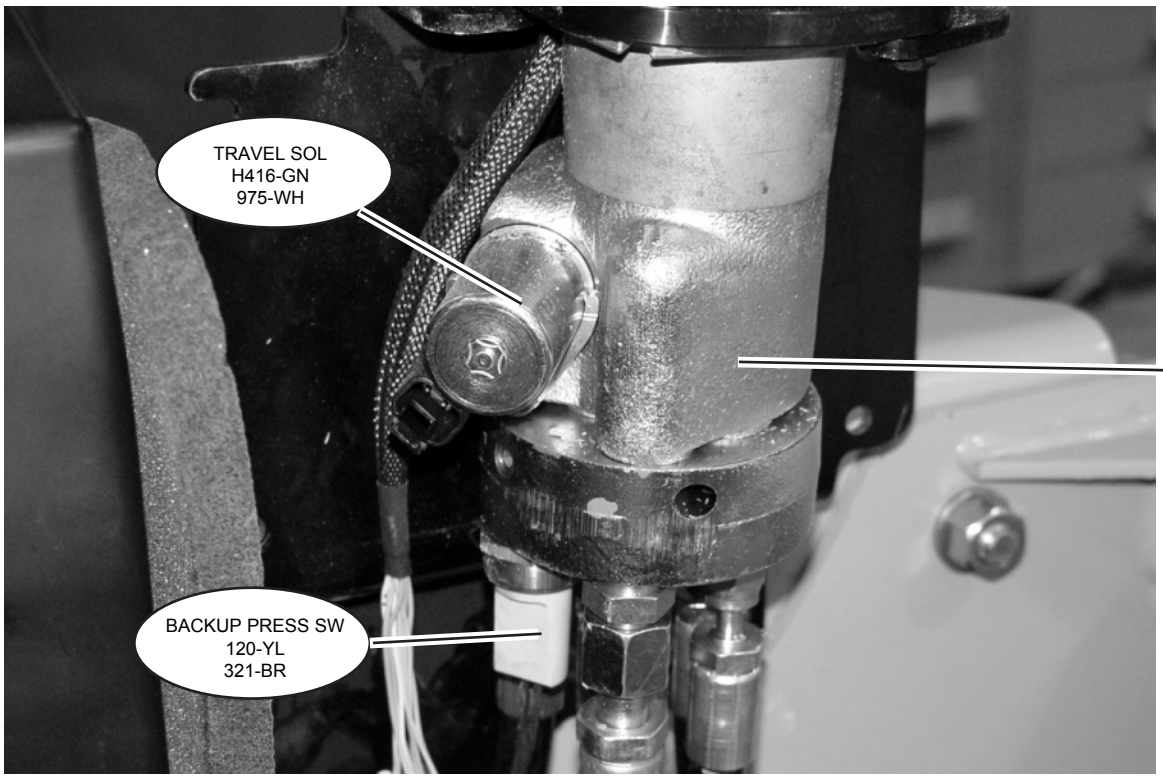
MOTOR GP A/C



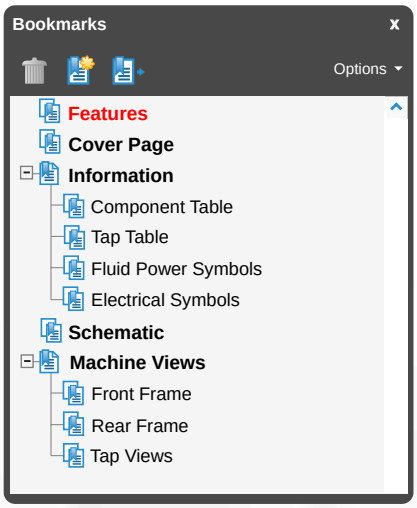
SINGLE SPEED VALVE



TRAVEL PILOT VALVE



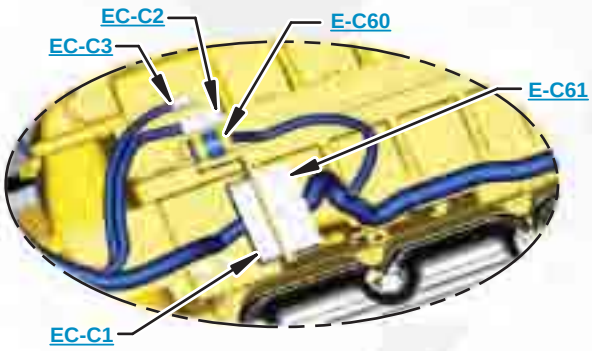
INTERACTIVE SCHEMATIC



This document is best viewed at a screen resolution of 1024 X 768.

To set your screen resolution do the following:
RIGHT CLICK on the **DESKTOP**.
Select **PROPERTIES**.
CLICK the **SETTINGS TAB**.
MOVE THE SLIDER under **SCREEN RESOLUTION** until it shows **1024 X 768**.
CLICK OK to apply the resolution.

The Bookmarks panel will allow you to quickly navigate to points of interest.



Click on any text that is BLUE and underlined. These are hyperlinks that can be used to navigate the schematic and machine views.

VIEW ALL CALLOUTS

When only one callout is showing on a machine view this button will make all of the callouts visible. This button is located in the top right corner of every machine view page.

HOTKEYS (Keyboard Shortcuts)		
	FUNCTION	**KEYS**
	Zoom In	**“CTRL” / “+”**
	Zoom Out	**“CTRL” / “-”**
	Fit to Page	**“CTRL” / “0” (zero)**
	Hand Tool	**“SPACEBAR” (hold down)**
	Find	**“CTRL” / “F”**



CATERPILLAR®

RENR4869-03
July 2010

Schematic

216B, 216B2, 226B, 226B2, 232B, 232B2, 236B, 236B2, 242B, 242B2, 246B, 252B, 252B2, and 262B Skid Steer Loader Hydraulic System

216B: **RLL1-6799**	**216B2:** **RLL6800-UP**	**226B:** **MJH1-10574**	**226B2:** **MJH10575-UP**	**232B:** **SCH1-2474**
232B2: **SCH2475-UP**	**236B:** **HEN1-6749**	**236B2:** **HEN6750-UP**	**242B:** **BXM1-4224**	**242B2:** **BXM4225-UP**
246B: **PAT1-UP**	**252B:** **SCP1-4599**	**252B2:** **SCP4600-UP**	**262B:** **PDT1-UP**	

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COMPONENT LOCATION

Description	Part Number	Machine Location	Schematic Location
Accumulator	149-0686	32	D-3
Cooler AS - Radiator (216/232) Cooler AS - Radiator (226/242) Cooler AS - Radiator (236/246/252/262)	280-8309 280-8310 280-8312	4	F-1
Coupling - Female	193-8335	13	F-3
Coupling - Male	193-8334	14	F-3
Cylinder GP - Hydraulic Coupler	192-2640	24	E-5
Cylinder GP - Lift LH (216/226) Cylinder GP - Lift LH (232/242) Cylinder GP - Lift LH (236/246) Cylinder GP - Lift LH (252/262)	230-3683 230-3703 230-3685 230-3705	18	F-4
Cylinder GP - Lift RH (216/226) Cylinder GP - Lift RH (232/242) Cylinder GP - Lift RH (236/246) Cylinder GP - Lift RH (252/262)	230-3693 230-3703 230-3695 230-3705	17	F-4
Cylinder GP - Tilt LH (216/226/232/242) Cylinder GP - Tilt LH (236/246/252/262)	230-3684 230-3687	16	F-4
Cylinder GP - Tilt RH (216/226/232/242) Cylinder GP - Tilt RH (236/246/252/262)	230-3694 230-3697	15	F-3
Filter GP - Oil (216/226/232/242) Filter GP - Oil (236/246/252/262)	223-9974 223-9974	6	F-2
Manifold AS - Drain Manifold	218-5560	7	D-5
Motor GP - A/C Compressor	218-6840	26	E-1
Motor GP - Fan (216/232) Motor GP - Fan (226/242) Motor GP - Fan (236/252) Motor GP - Fan (246/262)	216-6179 230-3727 225-9260 216-6193	5	F-2
Motor GP - (Single-Speed) (216/226/232/242) Motor GP - (Single-Speed) (236/246/252/262)	280-7854 280-7856	8	C-6
Motor GP - (Two-Speed) LH (236/246/252/262)	280-7858	8	B-3
Motor GP - (Two-Speed) RH (236/246/252/262)	280-7858	8	C-2
Pump GP - Hydrostatic (Single-Speed) (216/232) Pump GP - Hydrostatic (Single-Speed) (226/242)	289-6340 289-6342	2	B-6
Pump GP - Hydrostatic (Two-Speed) (236/246/252/262)	289-6351	2	A-1

COMPONENT LOCATION

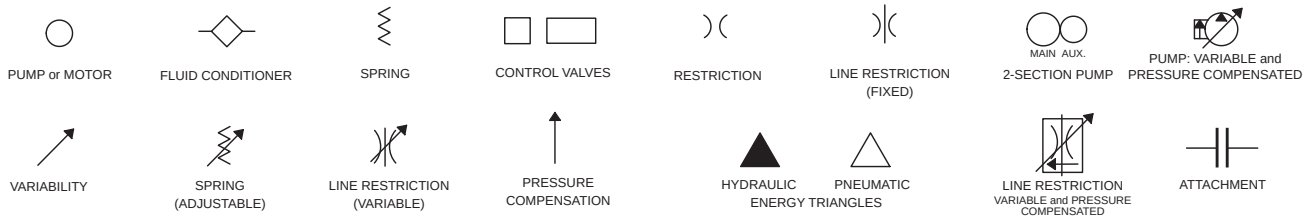
Description	Part Number	Machine Location	Schematic Location
Pump GP - Imp and Charge (216/226/232/242) Pump GP - Imp and Charge (236/246/252/262)	269-9427 238-7642	1	B-4
Screen	195-6768	23	E-3
Solenoid - Control Valve (A1 and A2)	185-4254	31	E-3
Switch AS - Pressure (Back Up Alarm)	192-0836	21	D-8
Tank GP - Hydraulic	204-1491	3	D-1
Valve GP - Check	123-4750	22	C-7
Valve GP - Ball	191-9783	19	F-5
Valve GP - Control (216) Valve GP - Control (226) Valve GP - Control (232) Valve GP - Control (242) Valve GP - Control (236/246) Valve GP - Control (252/262)	216-6166 216-6167 216-6168 191-9686 216-6169 216-6170	12	E-4
Valve GP - Basic - B - Float Detent Magnet Handle AS - A1 and A2 Button Handle AS - A1 and A2 Button Handle AS - Roller / A1 and A2 Proportional Button Pin - Spring	299-9119 218-6118 223-3725 215-8307 117-8683	11	E-7
Valve GP - Hydraulic Coupler	233-7128	25	E-5
Valve GP - Inline Self-Level Raise (216/226) Valve GP - Inline Self-Level Raise (232/242) Valve GP - Inline Self-Level Raise (236/246) Valve GP - Inline Self-Level Raise (252/262)	224-9408 223-8408 224-9418 223-8418	20	F-6
Valve GP - S -Turn Resolver Block Config Without Switches Handle AS - Horn and Normally Open C1 And C2 Handle AS - Horn and Continuous Flow Handle AS - Horn and Continuous Flow Pin - Spring	299-9116 218-6117 218-6118 223-3725 117-8683	10	F-8
Valve GP - Parking Brake (Single-Speed)	208-5681	9	C-7
Valve GP - Brake (Two-Speed) (236/246/252/262)	293-6591	9	C-3

TAP LOCATION

Tap Number	Description	Schematic Location
AA	Main Worktool System Pressure	E-4
BB	SOS	E-1
CC	Signal Pressure	C-7
DD	Main System Pressure (Pump 1 Forward)	B-3 , C-7
EE	Charge Pressure	B-2, C-6
FF	Main System Pressure (Pump 2 Forward)	B-2 , C-6
GG	Main System Pressure (Pump 2 Reverse)	A-2 , B-6
HH	Main System Pressure (Pump 1 Reverse)	A-3 , B-7

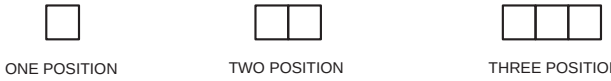
FLUID POWER SYMBOLS

BASIC COMPONENT SYMBOLS

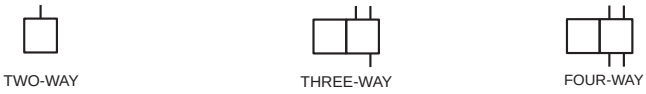


VALVES

VALVE ENVELOPES



VALVE PORTS



CONTROL VALVES



CHECK VALVES



FLUID STORAGE RESERVOIRS



MEASUREMENT



ROTATING SHAFTS



COMBINATION CONTROLS



MANUAL CONTROL SYMBOLS

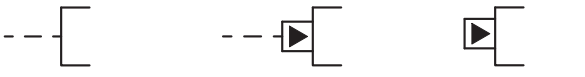


PILOT CONTROL SYMBOLS

RELEASED PRESSURE



REMOTE SUPPLY PRESSURE



ACCUMULATORS



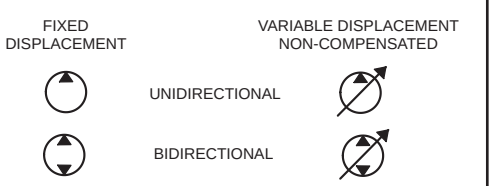
CROSSING AND JOINING LINES



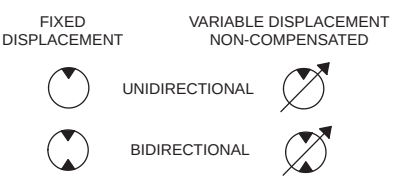
HYDRAULIC AND PNEUMATIC CYLINDERS



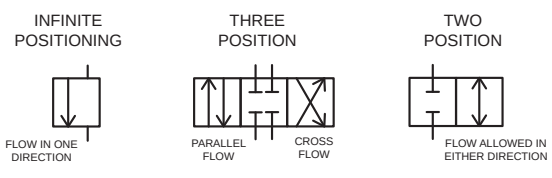
HYDRAULIC PUMPS



HYDRAULIC MOTORS



INTERNAL PASSAGEWAYS

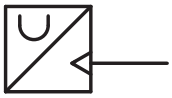


ELECTRICAL SYMBOLS

Hydraulic Symbols (Electrical)



Transducer (Fluid)



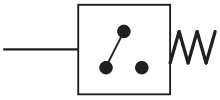
Transducer (Gas / Air)



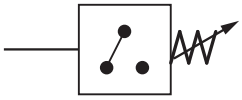
Generator



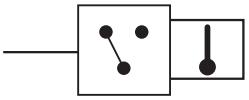
Electric Motor



Pressure Switch



Pressure Switch (Adjustable)

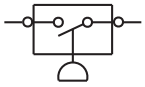


Temperature Switch

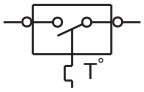


Electrical Wire

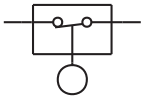
Electrical Symbols (Electrical)



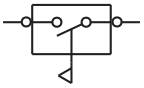
Pressure Symbol



Temperature Symbol



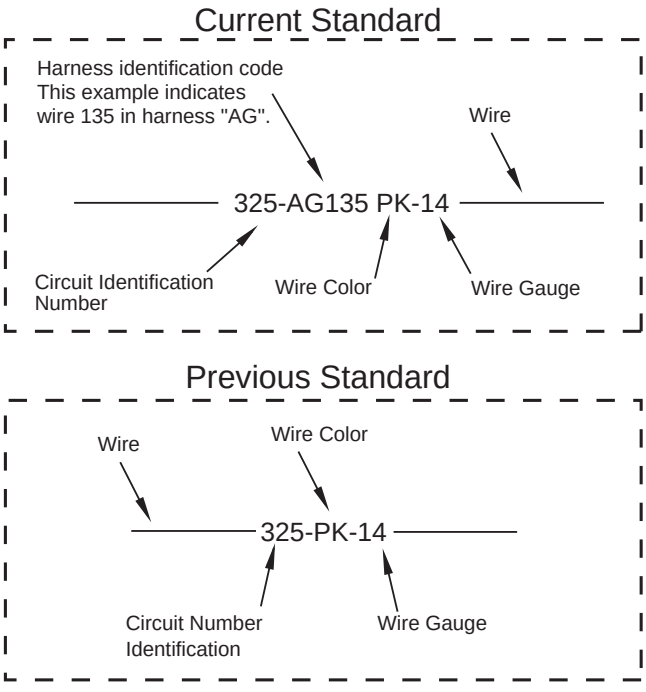
Level Symbol



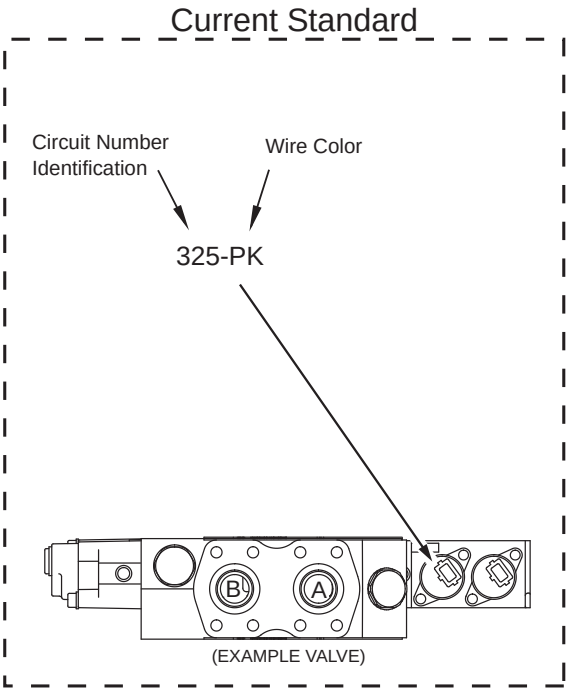
Flow Symbol

Wire Number Identification Codes

Electrical Schematic Example



Hydraulic Schematic Example



(10) DRIVE PILOT VALVE
VALVE GP - S -TURN RESOLVER BLOCK CONFIG WITHOUT SWITCHES 299-9116
HANDLE AS - HORN AND NORMALLY OPEN C1 AND C2 218-6117
HANDLE AS - HORN AND CONTINUOUS FLOW 218-6118
HANDLE AS - HORN AND CONTINUOUS FLOW 223-3725
PIN - SPRING 117-8683

DRIVE PILOT VALVE

IMPLEMENT PILOT VALVE

(20) VALVE GP - DIVERTER - C
INLINE SELF LEVEL RAISE (216/226) 224-9408
INLINE SELF LEVEL RAISE (232/242) 223-8408
INLINE SELF LEVEL RAISE (236/246) 224-9418
INLINE SELF LEVEL RAISE (252/262) 223-8418

(19) VALVE GP
BALL
191-9783

(17) CYLINDER GP
LIFT RH (216/226) 230-3693
LIFT RH (232/242) 230-3703
LIFT RH (236/246) 230-3695
LIFT RH (252/262) 230-3705

(16) CYLINDER GP
TILT LH (216/226/232/242) 230-3684
TILT LH (236/246/252/262) 230-3687

(18) CYLINDER GP
LIFT LH (216/226) 230-3683
LIFT LH (232/242) 230-3703
LIFT LH (236/246) 230-3685
LIFT LH (252/262) 230-3705

LIFT CYLINDERS

TILT CYLINDERS

(15) CYLINDER GP
TILT RH (216/226/232/242) 230-3694
TILT RH (236/246/252/262) 230-3697

AUXILIARY TOOLS

(14) COUPLING
MALE
193-8334

(13) COUPLING
FEMALE
193-8335

(5) MOTOR GP
FAN (216/232) 216-6179
FAN (226/242) 230-3727
FAN (236/252) 225-9260
FAN (246/262) 216-6193

(4) COOLER AS
RADIATOR (216/232) 280-8309
RADIATOR (226/242) 280-8310
RADIATOR (236/246/252/262) 280-8312

DEMAND FAN
269-9467 (226/242/246/262)

(6) FILTER GP
OIL (236/246/252/262) 223-9974
OIL (216/226/232/242) 223-9974

DEMAND FAN MOTOR RELIEF

SOS/ DIAGNOSTIC PORT

FAN MOTOR RELIEF

(23) SCREEN
195-6768

COUPLER

(24) CYLINDER GP
HYDRAULIC COUPLER
192-2640

(25) VALVE GP
HYDRAULIC COUPLER
233-7128

MAIN RELIEF

AUX RELIEF

(31) SOLENOID
CONTROL VALVE (A1 AND A2)
185-4254

(32) ACCUMULATOR
149-0686

(26) MOTOR GP
A/C COMPRESSOR
218-6840

BAFFLE

(3) TANK GP
HYDRAULIC
204-1491

(21) SWITCH AS
PRESSURE
(BACK-UP ALARM)
192-0836

(11) IMPLEMENT PILOT VALVE
VALVE GP BASIC - B - FLOAT DETENT MAGNET 299-9119
HANDLE AS - A1 AND A2 BUTTON 218-6118
HANDLE AS - A1 AND A2 BUTTON 223-3725
HANDLE AS - ROLLER / A1 AND A2 PROPORTIONAL BUTTON 215-8307
PIN - SPRING 117-8683

(12) VALVE GP
CONTROL (216) 216-6166
CONTROL (226) 216-6167
CONTROL (232) 216-6168
CONTROL (242) 191-9686
CONTROL (236/246) 216-6169
CONTROL (252/262) 216-6170

(7) MANIFOLD AS
DRAIN
218-5560

(8) MOTOR GP
SINGLE SPEED (216/226/232/242) 280-7854
SINGLE SPEED (236/246/252/262) 280-7856

(9) VALVE GP
SINGLE SPEED
PARKING BRAKE
208-5681

(22) VALVE GP
CHECK
123-4750

SPEED SENSING

(1) PUMP GP
IMPLEMENT AND CHARGE (216/226/232/242) 269-9427
IMPLEMENT AND CHARGE (236/246/252/262) 238-7642

(2) PUMP GP - HYDROSTATIC
(SINGLE SPEED) (216/232) 289-6340
(SINGLE SPEED) (226/242) 289-6342

(9) VALVE GP
BRAKE
TWO-SPEED
(236/246/252/262)
293-6591

(8) MOTOR GP
TWO-SPEED RH
(236/246/252/262)
280-7858

(8) MOTOR GP
TWO-SPEED LH
(236/246/252/262)
280-7858

TO DRAIN MANIFOLD

TO DRIVE PILOT

TO CHARGE FILTER

TO IMPLEMENT VALVE

TO FAN MOTOR

TO HYDRAULIC TANK

(2) PUMP GP
HYDROSTATIC
(TWO SPEED) (236/246/252/262)
289-6351

TO DRIVE JOYSTICK

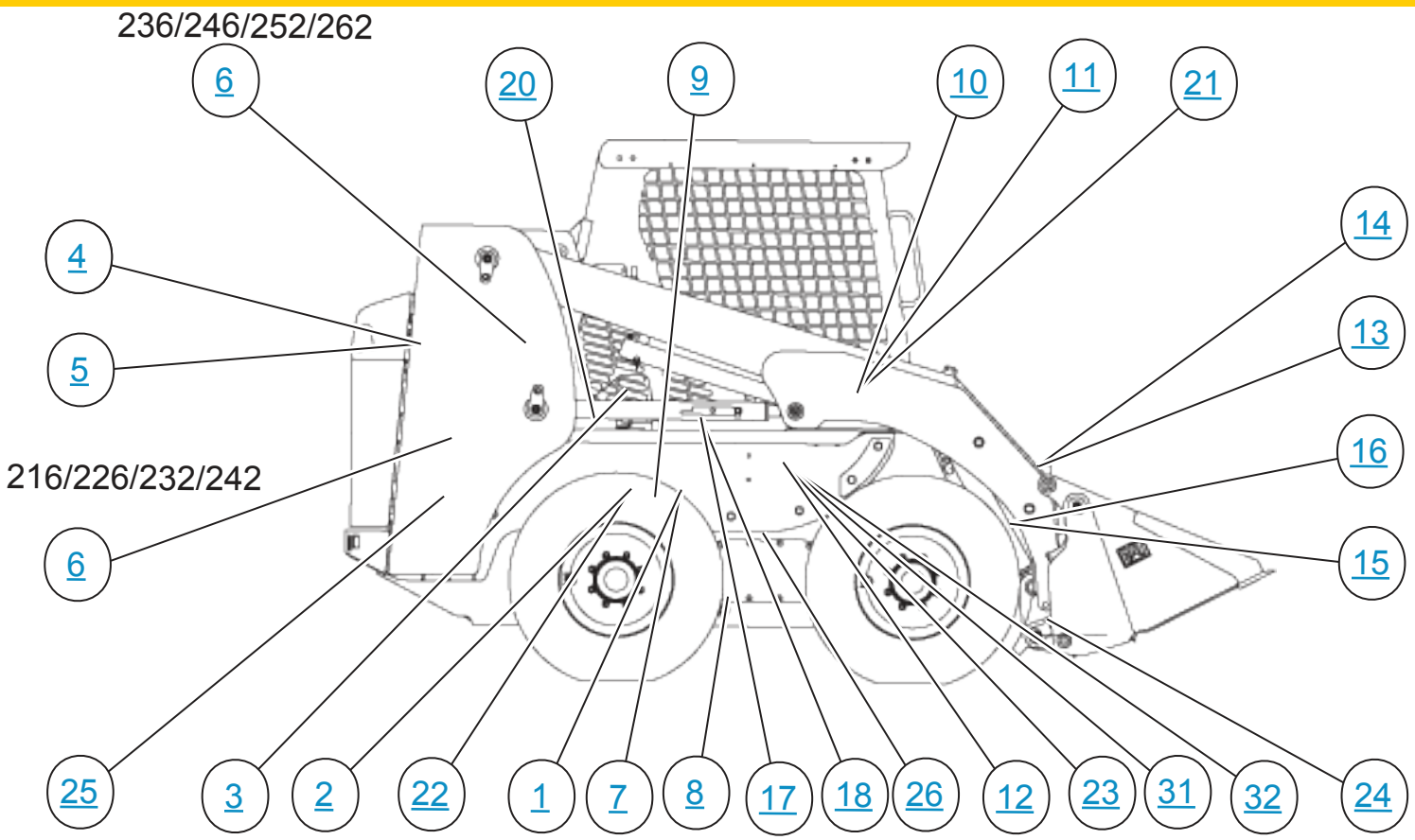
TWO-SPEED OPTION (236, 246, 252, AND 262)

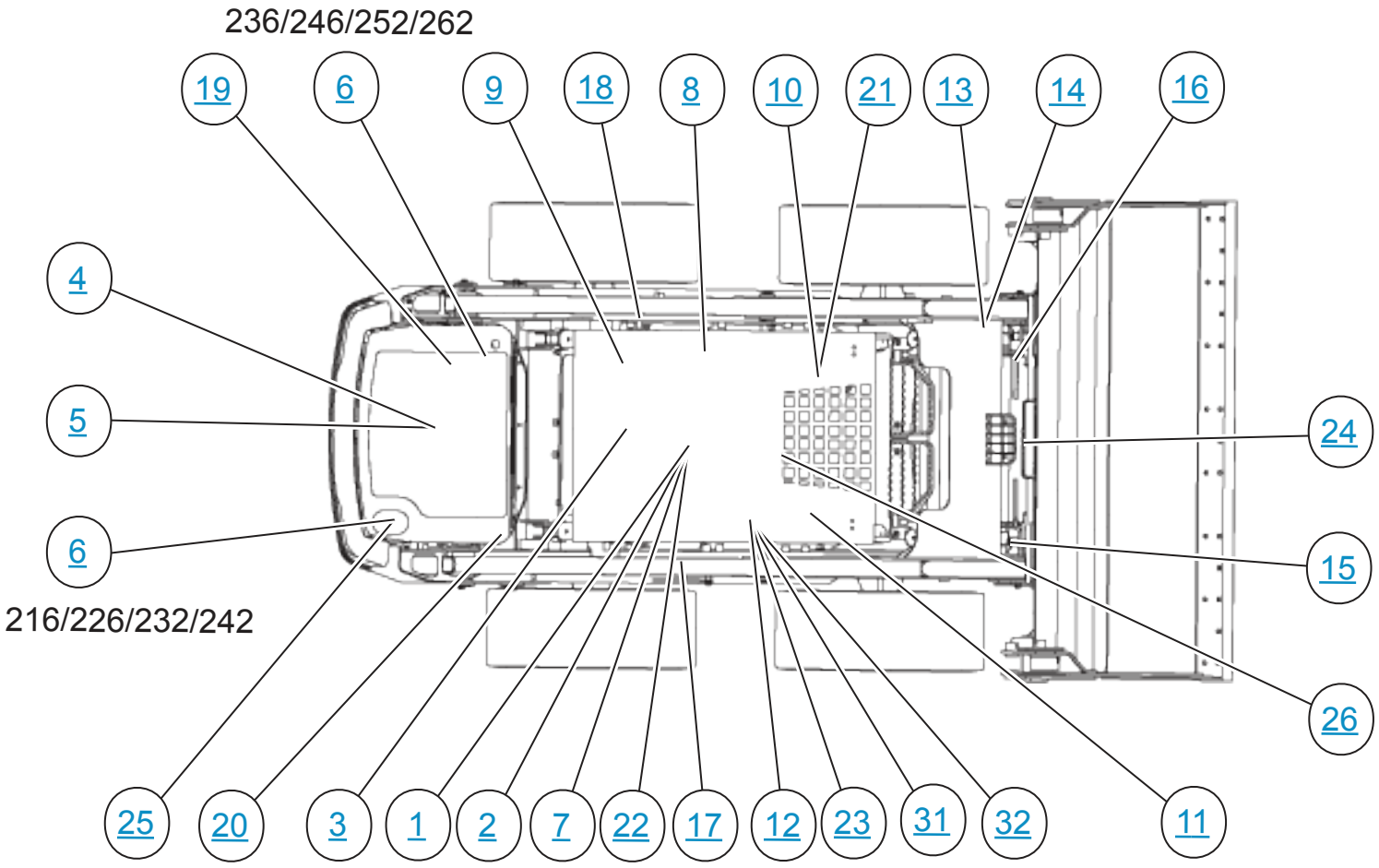
HYDRAULIC CIRCUIT COLOR DESCRIPTIONS
PUMP OUTPUT (LEFT HYDROSTATIC)
PUMP OUTPUT (RIGHT HYDROSTATIC)
PUMP OUTPUT (IMPLEMENT SUPPLY)
PUMP OUTPUT (CHARGE SUPPLY)
SUPPLY LINE
DRAIN / RETURN LINE
DRIVE PILOT CONTROL CIRCUIT
IMPLEMENT PILOT CONTROL CIRCUIT
COUPLER CYLINDER CONTROL CICUIT
LIFT CYLINDER CONTROL CIRCUIT
TILT CYLINDER CONTROL CIRCUIT
AUXILIARY TOOL CONTROL CIRCUIT
PARKING BRAKE CONTROL CIRCUIT
TWO SPEED CONTROL CIRCUIT

LINE PATTERNS	
———	Pressure Line
- - - - -	Pilot / Load Sensing Pressure
.....	Drain / Return Lines
— — —	Component Group
— — — —	Attachment
- - - - -	Air Line
CALLOUTS	
◇	Taps (Pressure, Sampling,Sensor) by letter

THIS SCHEMATIC IS FOR THE 216B, 216B2, 226B, 226B2, 232B, 232B2, 236B, 236B2, 242B, 242B2, 252B, 252B2, AND 262B SKID STEER LOADER
PART NUMBER: 218-6462, CHANGE: 11. VERSION: -
Components are shown installed on a fully operable machine with the key and engine off and transmission shifter in neutral.
Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations

MACHINE COMPONENT LOCATIONS

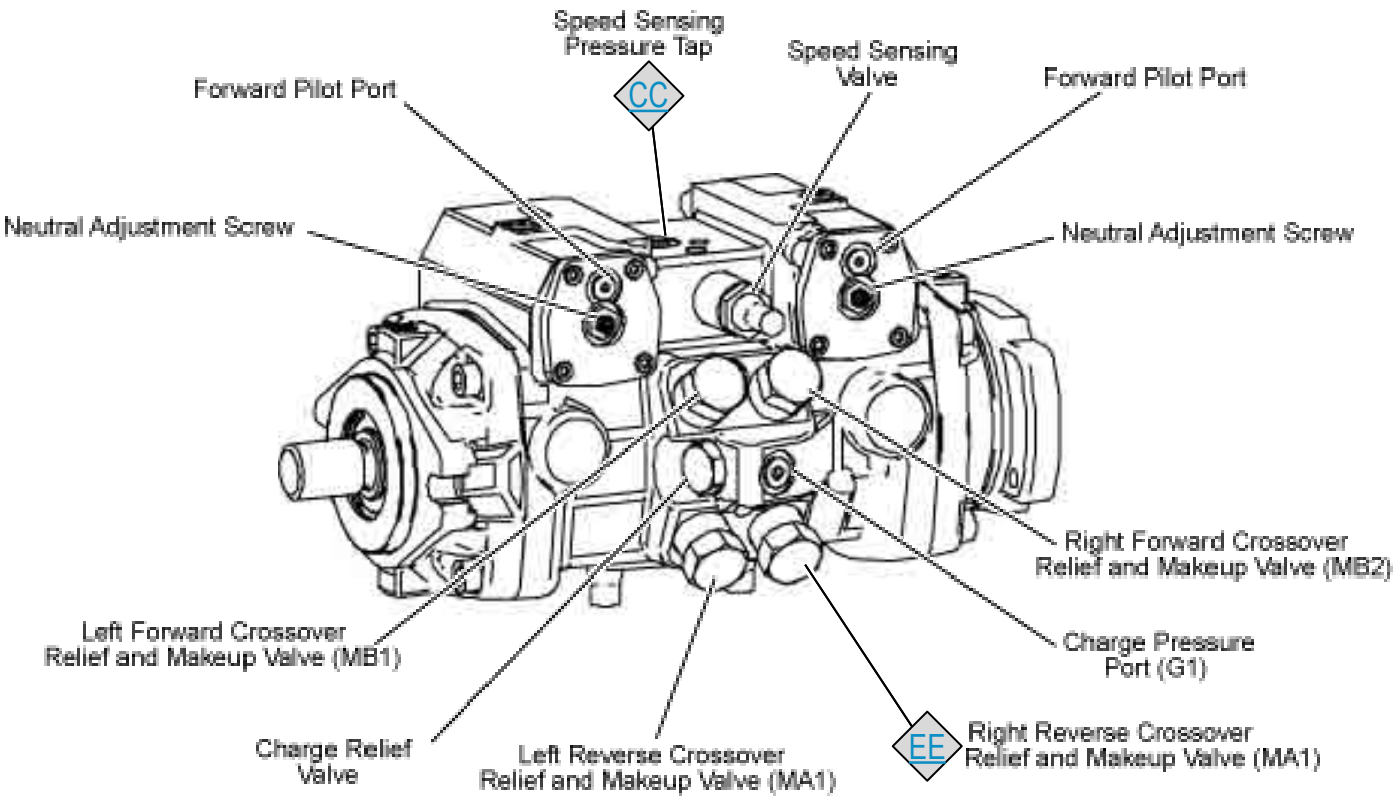


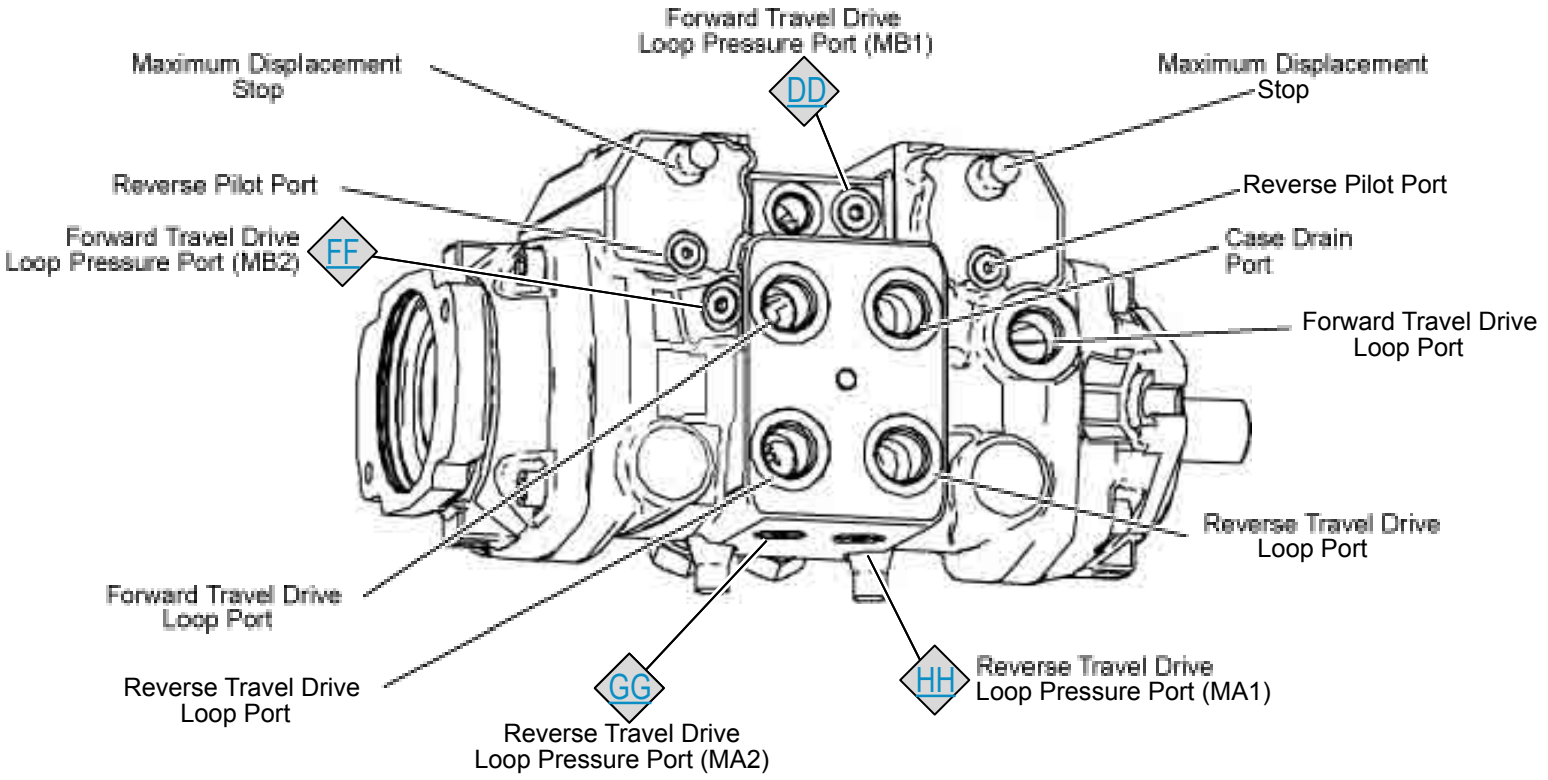


HYDRAULIC FAN MOTOR

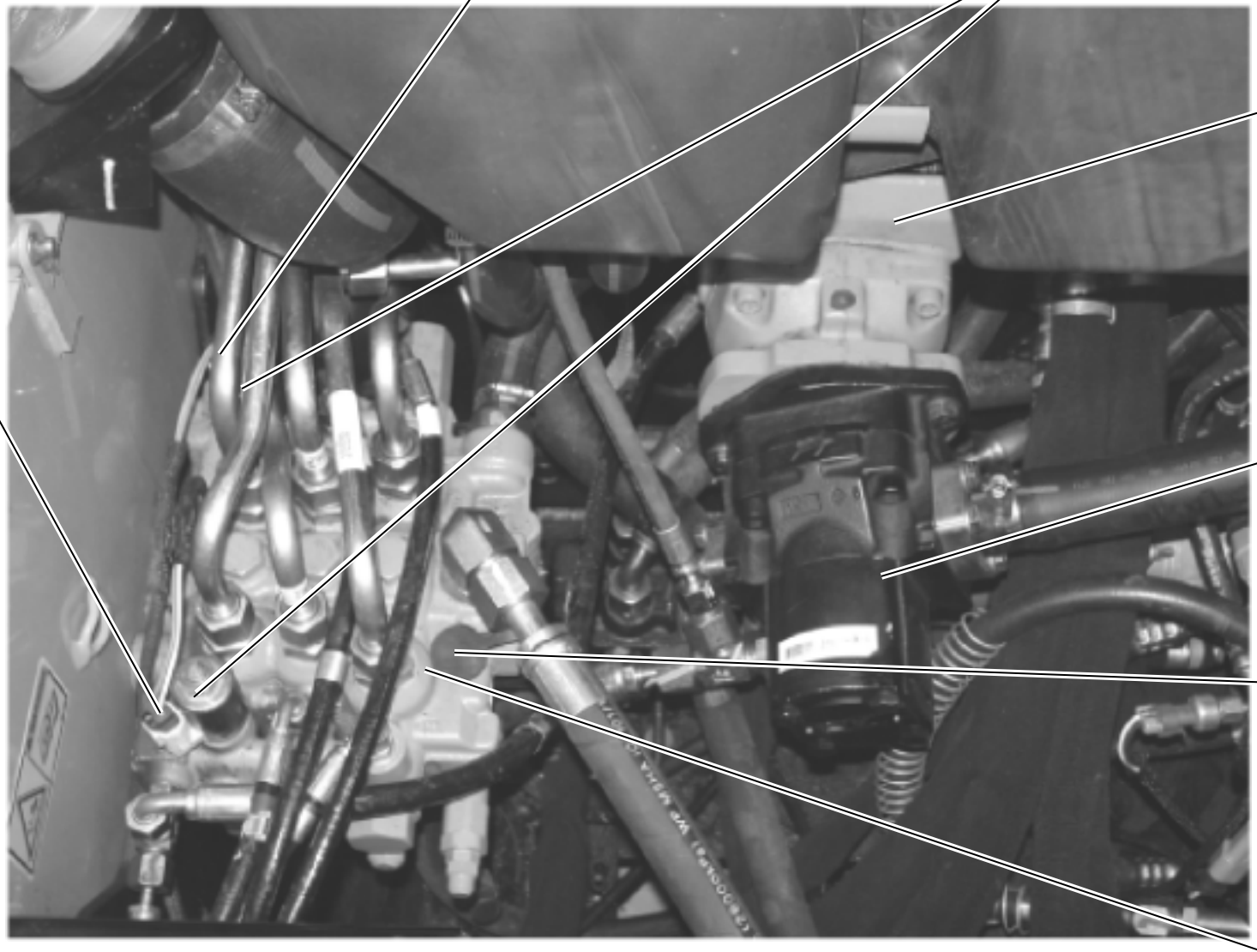


HYDROSTATIC PUMP

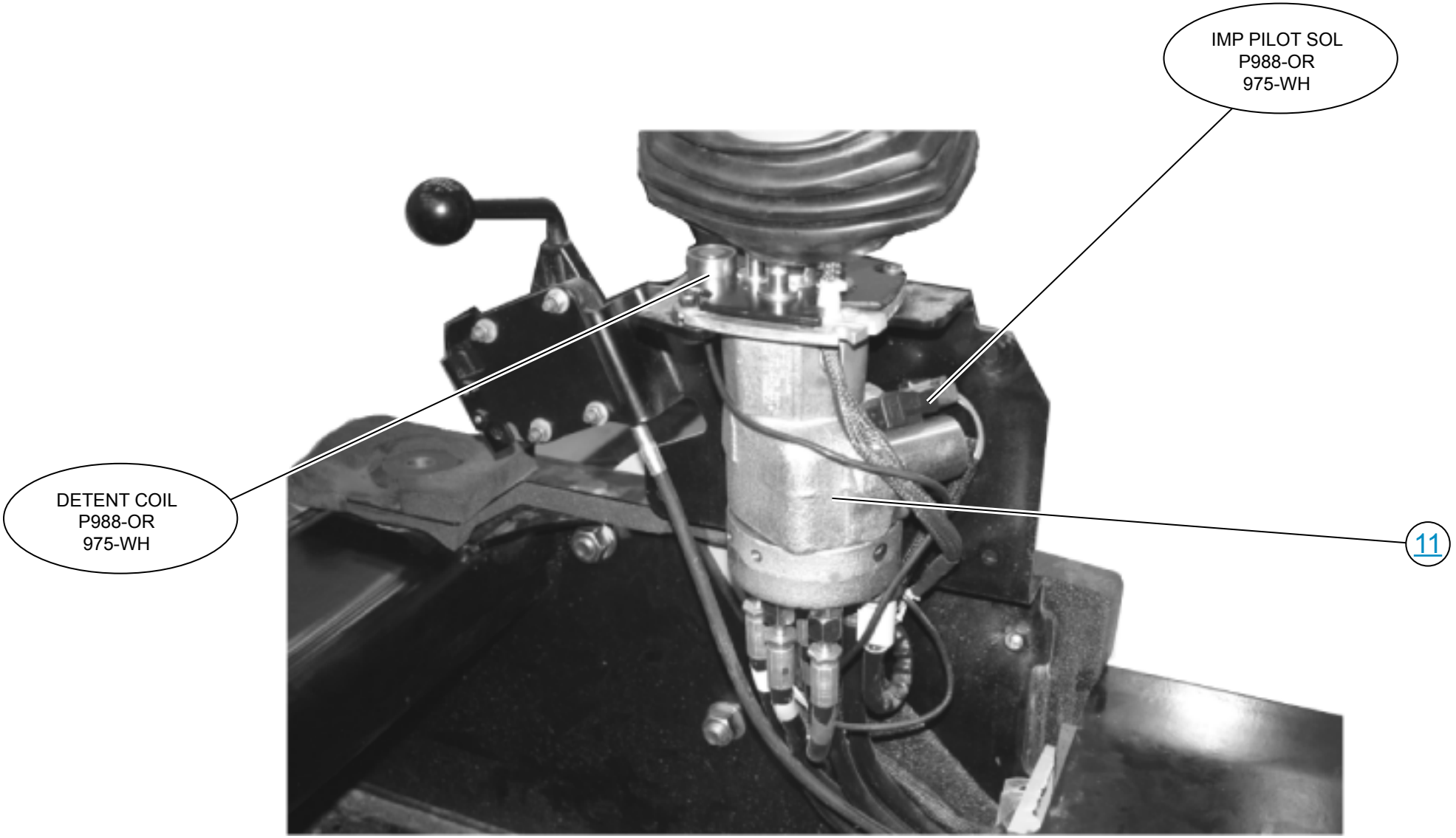




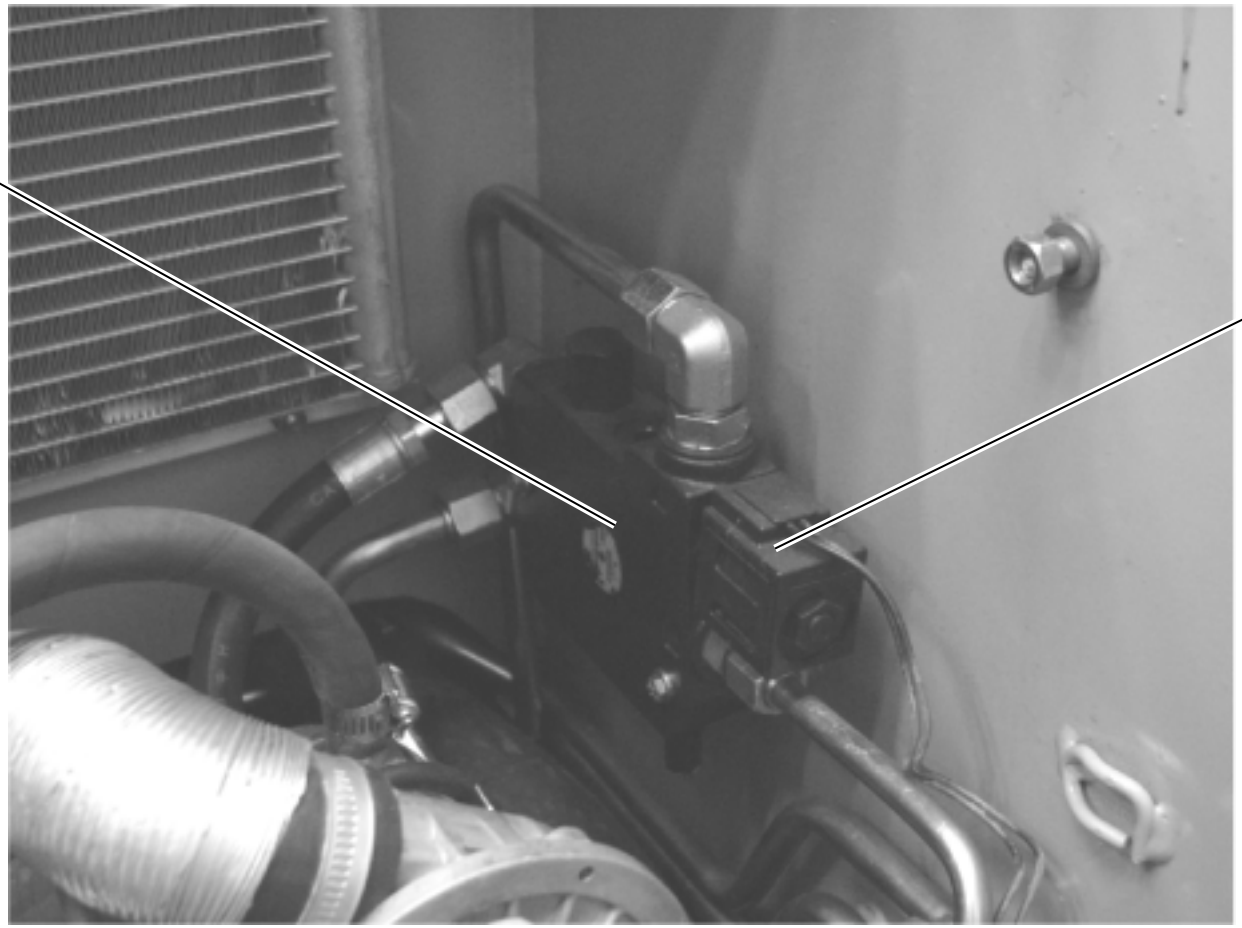
IMPLEMENT, CHARGE AND HYDROSTATIC PUMPS



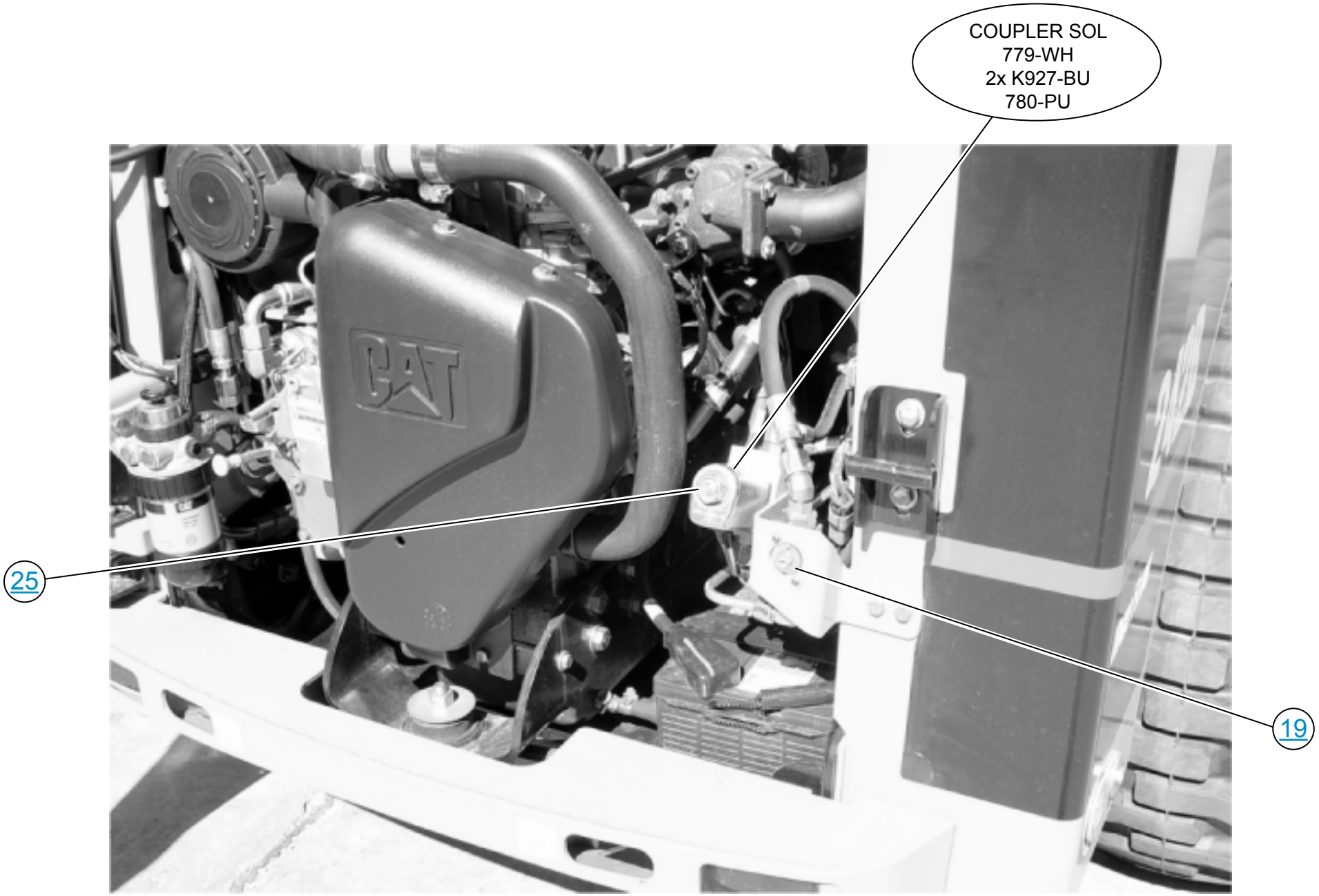
IMPLEMENT PILOT VALVE



INLINE SELF - LEVEL VALVE - RAISE



MANUAL LOWER BALL AND QUICK COUPLER VALVES (FOR 216B, 226B, 232B, AND 242B)



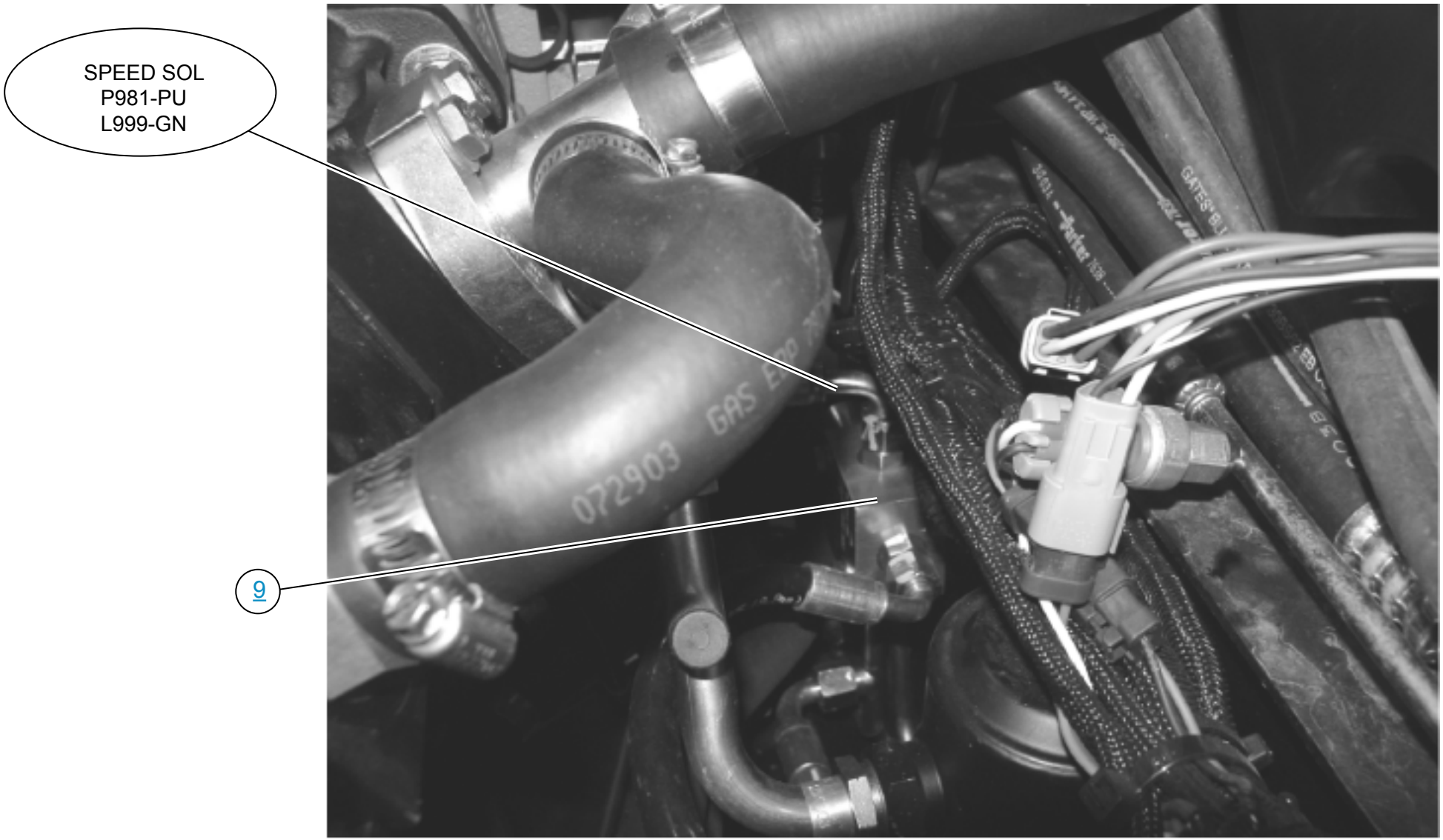
MANUAL LOWER BALL AND QUICK COUPLER VALVES (FOR 236B, 246B, 252B, AND 262B)



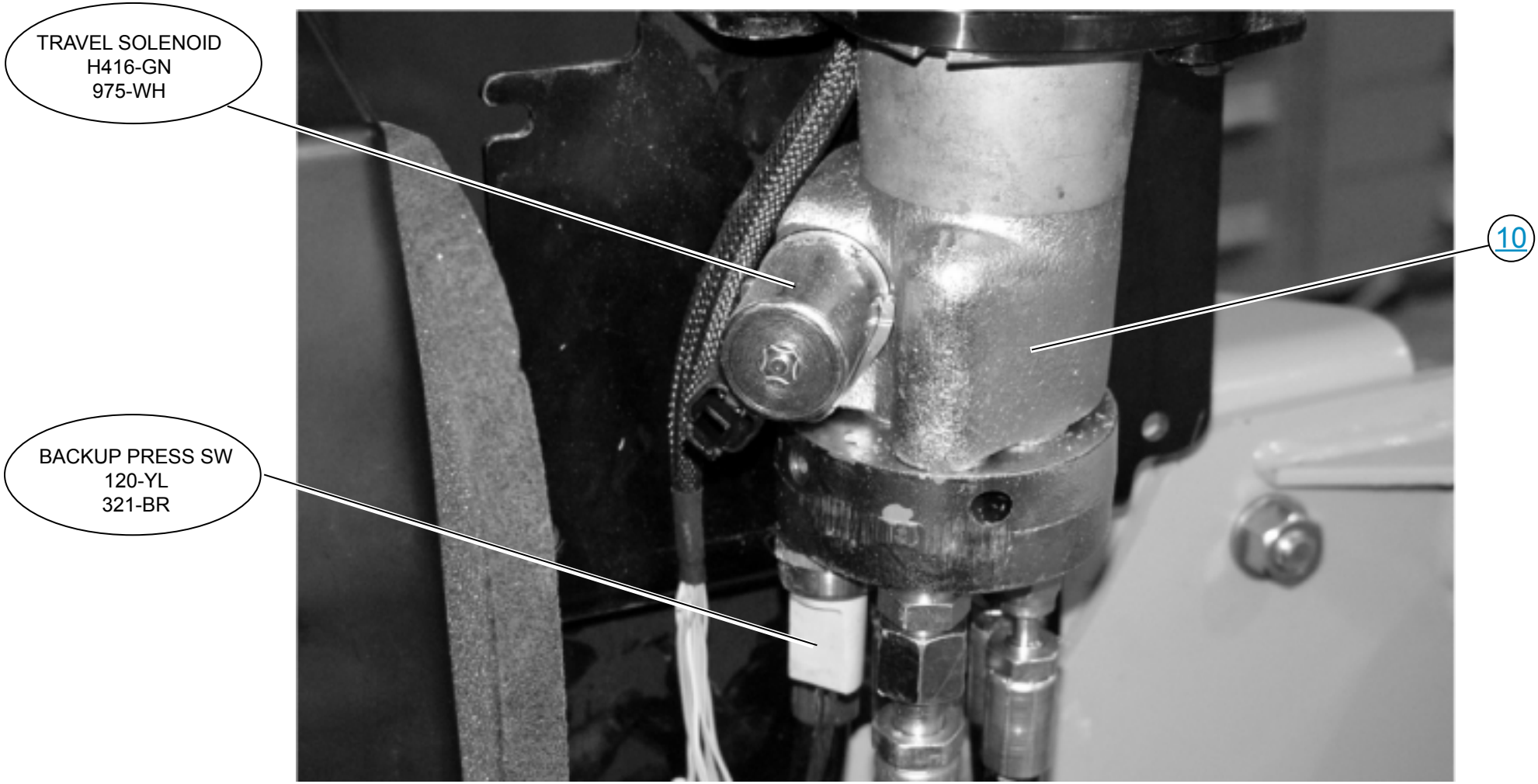
MOTOR GP - A/C



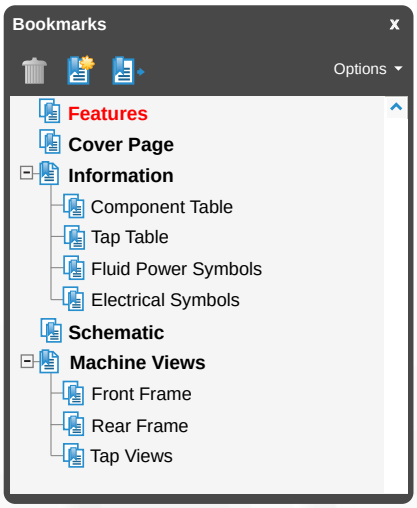
SINGLE SPEED VALVE



TRAVEL PILOT VALVE



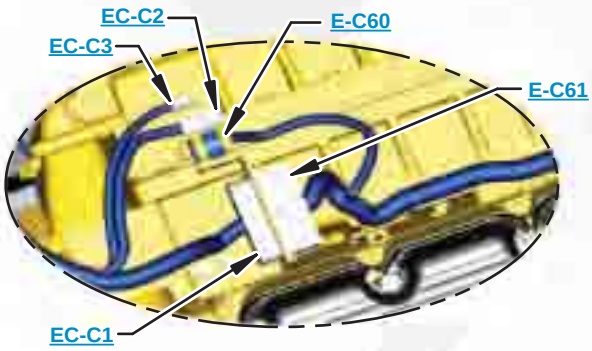
INTERACTIVE SCHEMATIC



The Bookmarks panel will allow you to quickly navigate to points of interest.

This document is best viewed at a screen resolution of 1024 X 768.

To set your screen resolution do the following:
RIGHT CLICK on the **DESKTOP**.
Select **PROPERTIES**.
CLICK the **SETTINGS TAB**.
MOVE THE SLIDER under **SCREEN RESOLUTION** until it shows **1024 X 768**.
CLICK OK to apply the resolution.



Click on any text that is BLUE and underlined. These are hyperlinks that can be used to navigate the schematic and machine views.

VIEW ALL CALLOUTS

When only one callout is showing on a machine view this button will make all of the callouts visible. This button is located in the top right corner of every machine view page.

HOTKEYS (Keyboard Shortcuts)		
	FUNCTION	**KEYS**
	Zoom In	**“CTRL” / “+”**
	Zoom Out	**“CTRL” / “-”**
	Fit to Page	**“CTRL” / “0” (zero)**
	Hand Tool	**“SPACEBAR” (hold down)**
	Find	**“CTRL” / “F”**



KENR8654-02
July 2009

Schematic

216B2, 226B2, 232B2, 236B2 , 242B2, and 252B2 Skid Steer Loader
247B2 and 257B2 Multi-Terrain Loader
Electrical System

MJH12175-UP
SCH2825-UP
SLK8300-UP
MTL5700-UP
RLL7700-UP
BXM4775-UP
HEN8070-UP
SCP5410-UP

Volume 1 of 2: Engine and Platform

Volume 2 of 2: Cab and Attachments

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Printed in U.S.A.

COMPONENT LOCATION
Volume 1 of 2 - ENGINE AND PLATFORM

Component	Schematic Location	Machine Location
Alarm - Backup	C-13	16
Alternator (A)	C-7	14
Alternator (B)	I-10	33
Battery (A)	A-8	11
Battery (B)	G-11	13
Breaker - Main (A)	B-9	45
Breaker - Main (B)	H-12	45
Breaker - Roading (A)	B-9	45
Breaker - Roading (B)	H-12	44
Coil - Ferrite Asy.	C-2	19
Control - Auxiliary Hydraulic Control	F-1	47
Control - Operator Interlock	H-1	48
Diode - Block (A)	B-7	15
Fuses - Block 1	G-5	6
Fuses - Block 2 (Work Tools)	G-7	6
Glow Plugs (A)	A-7	15
Glow Plugs (B)	G-10	15
Ground - Engine Stud (A)	B-7	49
Ground - Engine Stud (B)	H-10	49
Ground - Lower Frame	I-15	21
Ground - Lower Platform	D-4	39
Ground - Upper Frame	I-15	21
Ground - Upper Frame Stud (A)	C-12	51
Ground - Upper Frame Stud (B)	F-15	11
Handle - 1 SW - LH	I-1	20
Handle - 2 SW - LH	H-2	20
Handle - 2 SW - RH	D-1	19
Handle - 2 SW - RH	E-2	19
Handle - 3 SW / Roller - RH	D-2	19
Handle - 5 SW - LH	I-2	20
Horn - Forward (A)	F-12	51
Horn - Forward (B)	H-15	52
Lamp - License	C-15	16
Lamp - Signal Group	C-15	16
Lamp - Stop/Tail - LH Attachment	C-14	18
Lamp - Stop/Tail - RH Attachment	B-14	17
Motor - Fuel Prime Pump (B)	E-15	11
Motor - Starter (A)	A-9	10
Motor - Starter (B)	G-12	50
Motor - Water Pump	I-8	25
Relay - (C-) Fuse Block 2	G-8	6
Relay - (C+) Fuse Block 2	H-8	6
Relay - (C+/C-) Fuse Block 2	H-8	6
Relay - (C1) Fuse Block 2	G-8	6
Relay - (C2) Fuse Block 2	G-8	6
Relay - Boost Flow (A)	E-6	6
Relay - Cold Start (A)	D-5	45
Relay - Cold Start (B)	I-10	45
Relay - Fuel Pump	D-14	11
Relay - Lockout (248,268,Boost Flow)	B-6	7

Component	Schematic Location	Machine Location
Relay - Main Power A (A)	E-12	44
Relay - Main Power A (B)	G-15	44
Relay - Main Power B (A)	E-12	45
Relay - Main Power B (B)	G-15	44
Relay - Main Power C (A)	E-12	45
Relay - Main Power C (B)	G-15	44
Relay - Main Power D (A)	D-12	45
Relay - Main Power D (B)	G-15	44
Relay - Start (A)	D-7	45
Relay - Start (B)	I-10	45
Resistor - DMML Alternator (A)	C-7	14
Sender - Fuel Level (A)	F-12	12
Sender - Fuel Level (B)	H-15	46
Socket - Power +12 Volts	F-5	6
Solenoid - (C-) High Flow (A)	E-5	8
Solenoid - (C+) High Flow (A)	E-5	8
Solenoid - A1	E-7	8
Solenoid - A2	E-7	8
Solenoid - Boost Flow (A)	E-5	8
Solenoid - Cold Start Pump (B)	G-10	14
Solenoid - Continuous Flow	D-5	8
Solenoid - Fuel Shutdown (A)	B-7	33
Solenoid - Fuel Shutdown (B)	H-10	14
Solenoid - Impl Pilot (248,268,High Flow)	A-5	19
Solenoid - Implement Pilot	C-2	19
Solenoid - Parking Brake	D-4	39
Solenoid - Quick Coupler (A)	B-12	11
Solenoid - Quick Coupler (B)	E-15	53
Solenoid - Transmission	H-3	20
Solenoid - Two Speed (B)	E-5	39
Solenoid - Valve Grp DVTR ARC MTL (B) 248 High Flow	F-15	52
Solenoid - Valve Grp DVTR XR XRMTL (A)	B-12	52
Solenoid - Valve Grp DVTR XR XRMTL (B) 268 High Flow	F-15	52
Stud - Power (A)	C-9	45
Stud - Power (B)	H-12	44
Switch - Air Filter Indicator (A)	B-12	45
Switch - Air Filter Indicator (B)	E-15	44
Switch - Backup Pressure	H-3	20
Switch - Cold Start Thermo Temp (B)	G-10	14
Switch - Engine Coolant Temperature (A)	B-7	14
Switch - Engine Coolant Temperature (B)	H-10	33
Switch - Engine Oil Pressure (A)	B-7	33
Switch - Engine Oil Pressure (B)	H-10	14
Switch - High Flow (248,268)	A-4	19
Switch - Hydraulic Filter Bypass (A)	D-12	13
Switch - Hydraulic Filter Bypass (B)	F-15	54
Switch - Hydraulic Oil Temp (A)	F-12	51
Switch - Hydraulic Oil Temp (B)	I-14	51

(A) = 216B / 226 / 232 / 242 / 247 / 257

(B) = 236B / 246 / 248 / 252 / 262 / 267 / 268 / 277 / 287

COMPONENT LOCATION
Volume 2 of 2 - CAB AND ATTACHMENT

Component	Schematic Location	Machine Location
Action Lamp Group - LH (COSA)	G-13	1
Action Lamp Group - LH (NACD)	F-9	1
Action Lamp Group - RH (COSA)	E-13	2
Action Lamp Group - RH (NACD)	E-9	2
Beacon And Beacon Socket (COSA)	D-13	36
Beacon And Beacon Socket (NACD)	E-9	36
Bottle - Washer	I-7	43
Coil - Ferrite Asy. (MSS)	G-3	21
Coil - MSS Exciter (COSA)	F-13	1
Coil - MSS Exciter (NACD)	F-9	1
Control - Machine Security System	H-1	21
Diode - Valve Group Remote Control	E-1	56
Flasher (COSA)	F-15	34
Ground - Cab (COSA)	H-15	34
Ground - Cab (NACD)	H-11	34
Hour Meter (COSA)	G-13	1
Hour Meter (NACD)	G-9	1
Indicator - Fuel Level (COSA)	E-13	2
Indicator - Fuel Level (NACD)	E-9	2
Lamp - Dome (COSA)	E-13	2
Lamp - Dome (NACD)	E-9	2
Lamp - Flood - LH (COSA)	I-12	1
Lamp - Flood - LH (NACD)	I-8	1
Lamp - Flood - RH (COSA)	B-12	2
Lamp - Flood - RH (NACD)	B-8	2
Lamp - Head Turn - LH (Atch)	I-1	1
Lamp - Head Turn - RH (Atch)	I-1	2
Lamp - Rear Flood - LH (COSA)	I-15	3
Lamp - Rear Flood - LH (NACD)	I-11	3
Lamp - Rear Flood - RH (COSA)	E-15	4
Lamp - Rear Flood - RH (NACD)	E-11	4
Motor - Condenser Fan 1 & 2	D-4	23
Motor - Dbl Blower (Heater)	G-6	20
Motor - Dbl Blower (HVAC)	E-6	20
Motor - Front Wiper	I-5	27
Relay - Compressor HVAC	E-6	20
Relay - Condenser Fan	E-6	20
Relay - Key Switch (Heater)	G-6	20
Relay - Key Switch (HVAC)	F-6	20
Relay - Stop Lamp	H-4	55
Solenoid - HVAC Compressor Clutch	E-4	9
Solenoid - Valve Gp RC1	E-1	56
Solenoid - Valve Gp RC2	E-2	56
Switch - Armrest (COSA)	C-15	24
Switch - Armrest (NACD)	C-11	24
Switch - Auto Leveler (COSA)	H-12	1
Switch - Auto Leveler (NACD)	H-8	1
Switch - AUX Hydraulic Mode (COSA)	F-12	1
Switch - AUX Hydraulic Mode (NACD)	F-8	1
Switch - AUX Pressure Release (COSA)	H-12	1
Switch - AUX Pressure Release (NACD)	H-8	1
Switch - Beacon (COSA)	E-12	2
Switch - Cold Start (COSA)	G-12	1
Switch - Cold Start (NACD)	G-8	1
Switch - Fan On/Off/On (Heater)	G-7	20
Switch - Fan On/Off/On (HVAC)	E-7	20
Switch - Front Working Lamp (COSA)	C-12	2
Switch - Front Working Lamp (NACD)	C-8	2
Switch - Hazard (COSA)	E-12	2
Switch - HVAC Refrigerant Pressure	E-4	43
Switch - Hydraulic Lockout (COSA)	E-12	2
Switch - Hydraulic Lockout (Door)	H-5	57
Switch - Hydraulic Lockout (NACD)	D-8	2
Switch - Hydraulic Quick Coupler (COSA)	G-12	1
Switch - Hydraulic Quick Coupler (NACD)	G-8	1
Switch - Key Start (COSA)	F-13	1
Switch - Key Start (NACD)	F-9	1
Switch - Mode Off/On (HVAC)	D-7	20
Switch - Parking Brake (COSA)	F-12	1
Switch - Parking Brake (NACD)	F-8	1
Switch - Rear Working Lamp (COSA)	C-12	2
Switch - Rear Working Lamp (NACD)	C-8	2
Switch - Roading Lamps (COSA)	D-12	2
Switch - Seat (COSA)	C-15	22
Switch - Seat (NACD)	C-11	22
Switch - Stop Pressure 1	G-4	55
Switch - Stop Pressure 2	G-4	55
Switch - Tool Power (COSA)	H-12	1
Switch - Tool Power (NACD)	H-8	1
Switch - Turn Signal (COSA)	D-12	2
Switch - Wiper / Washer	I-5	27
Thermostat (HVAC)	E-7	20

CONNECTOR LOCATION
Volume 1 of 2 - ENGINE AND PLATFORM

Connector Number	Schematic Location	Machine Location
CONN 1	B-12 , E-14	56
CONN 2	B-13 , B-14 , B-15	18
CONN 3	C-13 , C-14	13
CONN 4	C-12 , C-14	52
CONN 5	B-12 , D-14	46
CONN 6	H-14	55
CONN 8	B-10 , D-13	34
CONN 9	C-10 , E-13	34
CONN 10	E-13	34
CONN 11	C-10 , F-13	51
CONN 12	D-10 , F-13	51
CONN 13	E-10 , G-13	51
CONN 14	E-10 , H-13	51
CONN 15	F-10 , H-13	51
CONN 16	H-9 , I-13	12
CONN 17	F-12	44
CONN 19	I-12	45
CONN 20	F-9	51
CONN 21	C-9	51
CONN 22	G-9	13
CONN 23	I-9	14
CONN 25	I-8	7
CONN 26 TOOL	I-7	40
CONN 27	A-6 , D-4	7
CONN 28	B-6 , D-6	7
CONN 29	D-6	39
CONN 30	E-6 , E-7	6
CONN 31 SERVICE	F-5	19
CONN 32	B-5	19
CONN 33	B-4 , D-2	19

The connectors shown in this chart are for harness to harness connectors. Connectors that join a harness to a component are generally located at or near the component. See the Component Location Chart.

CONNECTOR LOCATION
Volume 2 of 2 - CAB AND ATTACHMENT

Connector Number	Schematic Location	Machine Location
CONN 4	I-3 , I-4	13
CONN 5	G-5	55
CONN 8	G-3	34
CONN 9	F-15	34
CONN 11	G-15 , G-11	34
CONN 12	G-15 , G-11	34
CONN 20	H-6 , F-6	42
CONN 24	E-3	13
CONN 34	H-15 , H-11 , H-3	34
CONN 35	I-7 , I-8, I-13	1
CONN 36	I-3	13
CONN 37	I-6	43
CONN 38	E-4	9

The connectors shown in this chart are for harness to harness connectors. Connectors that join a harness to a component are generally located at or near the component. See the Component Location Chart.

CID / MID / FMI

Component Identifiers (CID[1]) Module Identifier (MID[2]) Auxiliary Hydraulic Control (MID No. 106)	
CID	**Component**
0070	Parking Brake Switch
0168	Voltage Fault
0598	Two Speed Motor Solenoid
1180	Auxiliary Hydraulic Solenoid #1
1181	Auxiliary Hydraulic Solenoid #2
1184	Auxiliary Hydraulic Solenoid Supply
1187	Continuous Flow Switch
1188	Operator Interlock Override Switch
1189	Auxiliary Hydraulics Lever
1190	Arm Bar / Seat Switch
1694	Two Speed Motor Solenoid Supply
1695	Two Speed Switch
1931	High Pressure / High Flow Solenoid
1935	Auxiliary Hydraulic Flow Selector Switch
1939	Auxiliary Hydraulic High Flow Supply
1940	Auxiliary Hydraulic High Flow Diverter Solenoid
1942	High Pressure Tool Detection Switch

[1] The CID is a diagnostic code that indicates which circuit is faulty.

[2] The MID is a diagnostic code that indicates which electronic control module

Failure Mode Identifiers (FMI)[1]	
FMI No.	**Failure Description**
0	Data valid but above normal operational range.
1	Data valid but below normal operational range.
2	Data erratic, intermittent, or incorrect.
3	Voltage above normal or shorted high.
4	Voltage below normal or shorted low.
5	Current below normal or open circuit.
6	Current above normal or grounded circuit.
7	Mechanical system not responding properly.
8	Abnormal frequency, pulse width, or period.
9	Abnormal update.
10	Abnormal rate of change.
11	Failure mode not identifiable.
12	Bad device or component.
13	Out of calibration.
14	Parameter failures.
15	Parameter failures.
16	Parameter not available.
17	Module not responding.
18	Sensor supply fault.
19	Condition not met.
20	Parameter failures.

[1]The FMI is a diagnostic code that indicates what type of failure has occurred.

SPECIFICATIONS AND RELATED MANUALS
Volume 1 of 2 - ENGINE AND PLATFORM

Engine & Platform Off Machine Switch Specification				
Part No.	**Function**	**Actuate**	**Deactuate**	**Contact Position**
134-0404	Hydraulic Filter Bypass Switch	275.8 to 303.4 kPa (40 to 44 psi)	206.8 kPa MIN (30 psi MIN)	Normally Open
192-0836	Backup Pressure Switch	517.0 + 41.4, - 68.9 kPa (75.0 + 6.0, -10.0 psi)	386.1 + 41.4, - 68.9 kPa (56.0 + 6.0, -10.0 psi)	Normally Open
224-0744	High Flow Pressure Switch	375.9 + 37.9, - 58.6 kPa (54.5 + 5.5, -8.5 psi)	263 kPa MIN (38.1 psi MIN)	Normally Closed
236-1872	Hydraulic Oil Temperature Switch	102 ± 3°C (215.6 ± 5.4°F)	90°C MIN (194°F MIN)	Normally Open

Engine & Platform Resistor, Sender and Solenoid Specifications			
Part No.	**Component Description**		**Resistance (Ohms)[1]**
233-7128	Solenoid:	Quick Coupler	6.36 ± 0.4
172-0970	Solenoid:	Detent Valve	9.4
185-4254	Solenoid:	A1 & A2 Continuous Flow (High Flow XPS)	2.2 ± 0.2
195-9700	Solenoid:	C+ & C- (High Flow XPS) Implement Pilot Parking Brake Transmission	10 ± 0.5
216-0610	Solenoid:	Two Speed	2.2 ± 0.2
224-7782	Sender:	Fuel (287 / 267)	Empty: 240 - 245 Full: 28 - 33
224-8545	Sender:	Fuel (267 / 277)	Empty: 240 - 245 Full: 28 - 33
231-2105	Sender:	Fuel (216B / 226 / 232B / 242)	Empty: 240 - 250 Full: 28 - 33
231-2106	Sender:	Fuel (247 / 257)	Empty: 240 - 250 Full: 28 - 33
224-8544	Sender:	Fuel (236 / 246 / 252 / 262 / 248 / 268)	Empty: 240 - 250 Full: 28 - 33
238-9397	Resistor:	DMML ALT	120.0 ± 6.0

[1] At room temperature unless otherwise noted.

Related Electrical Service Manuals	
Title	**Form Number**
K3A Alternator: 239-0772	SENR5841
R2.7KW Electric Starting Motor: 143-0539	SENR3828
Auxiliary Hydraulic Control system:	RENR2893
Operator Interlock Control:	RENR2864

SPECIFICATIONS AND RELATED MANUALS
Volume 2 of 2 - CAB AND ATTACHMENT

Attachment & Cab Off Machine Switch Specification				
Part No.	**Function**	**Actuate**	**Deactuate**	**Contact Position**
184-1564	Stop Pressure 1 & 2	375.9 +37.9, -58.6 kPa (54.5 + 5.5, -8.5 psi)	263 kPa (38.2 psi)	Normally Closed[2]
236-6923	A/C Refrigerant Pressure	275 to 1750 kPa[1] (40 to 255 psi)	- - - -	Normally Open[2]

[1] With increasing pressure the closed condition can be maintained up to 2800 kpa (405 psi), with decreasing pressure the closed condition can be maintained down to 170 kpa (25psi).

[2] Contact position at the contacts of the harness connector.

Resistor, Sender and Solenoid Specifications		
Part No.	**Component Description**	**Resistance (Ohms)[1]**
212-3350	Solenoid: Remote Control 1	3.2 ± 0.22
215-3272	Solenoid: Remote Control 2	4.0 ± 0.28
231-6287	Solenoid: A/C Compressor	10.5

[1] At room temperature unless otherwise noted.

Related Electrical Service Manuals	
Title	**Form Number**
K3A Alternator: 239-0772	SENR5841
R2.7KW Electric Starting Motor: 143-0539	SENR3828
Auxiliary Hydraulic Control system:	RENR2893
Operator Interlock Control:	RENR2864

WIRE DESCRIPTION
Page 1 of 2

Wire Number	Wire Color	Description
Power Circuits		
101	RD	Bat (+) / Main Breaker
102	RD	Roading Breaker / Stop Lamp Relay / Roading Lamp SW / Stop Pressure SW / Flasher
105	RD	Key Start SW / AUX Bleed Off SW
109	RD	Alt Output (+) / Start Relay / Cold Start Relay / Roading Breaker / Main Power Relay A - D
110	GN	PWR Fuel Shut Off
111	YL	Main Power Relay Output D
112	PU	Main Power Relay Output A-C
114	RD	LH Handle Forward Horn SW
117	YL	QCPLR Auto Level
118	GY	Power Wiper Washer
119	PK	Power Radio
120	YL	Power Backup Alarm
122	BU	Misc. Power
123	WH	High Flow SW / Fuel Level Ind / Action Lamp
124	RD	Heater & HVAC Key SW Relay
125	RD	HVAC Condenser Fan Relay
126	PK	Operator Interlock Control
127	OR	Cold Start SW
128	PK	AUX Hyd Control / AUX Bleed Off SW
134	YL	Front Working Lamp SW
135	BU	Rear Working Lamp SW
144	GN	Beacon SW / Beacon Socket
145	BU	Power Socket + 12 Volts
180	GN	Jumper Demand Fan
Ground Circuits		
200	BK	Main Chassis
201	BK	Operator Interlock Control / Park Brake SW
202	BK	Armrest SW
203	BK	AUX Hyd Control / High Flow SW Implement Lockout SW / LH & RH Handle / Machine Security System / Detent Valve
Basic Machine Circuits		
304	WH	Starter Relay / Starter
306	GN	Operator Interlock Control / Machine Security System
307	OR	Key Start SW / Operator Interlock Control
308	YL	Key Start SW / Alternator / Res DMML Alt / Machine Security System Control
321	BR	Back Up Pressure SW / Back Up Alarm
322	GY	LH Handle Forward Horn SW / Horn Jumper
327	PK	Fuel Pump PRM
A309	GY	Fuel Shutdown Solenoid / Diode Block
A346	BU	Start Relay / Machine Security System Cont
A347	GN	Main Power Relay Coil A - D
Monitoring Circuits		
403	GN	Alternator (R) Term. / Hour Meter / Machine Security System Control

Wire Number	Wire Color	Description
Lighting Circuits		
608	GN	Rear Work Lamp SW / Rear LH & RH Floods
610	OR	Front Work Lamp SW / LH & RH Floods
614	PU	Panel Switch Lamps
617	BR	LH Stop Tail Lamp / LH Head Turn Lamp/ Signal Lamp Group / License Lamp
618	YL	RH Stop Tail Lamp / RH Head Turn Lamp
619	GN	Roading Lamp SW / LH & RH Head Turn Lamp
674	BU	Operator Interlock Control / Action Lamp Group
676	PU	Operator Interlock Control / Action Lamp Group
Control Circuits		
779	WH	Hyd Quick Coupler SW / Quick Coupler Sol Valve
780	PU	Hyd Quick Coupler SW / Quick Coupler Sol Valve
781	PK	LH Handle / 2 Speed Trigger SW
782	GY	LH Handle / Work Tool C1 SW
A751	YL	Power Tools Switch
A752	BR	Power Tools Switch / Water Pump
F766	WH	Lockout Relay / Detent Valve / Optr Interlock Cont
F780	PK	Operator Interlock Control / AUX Hyd Control / Park Brake SW
G798	PU	Main Power Relay A-D / Machine Security System
H746	YL	Solenoid Demand Fan (+)
H747	BR	Solenoid Demand Fan (-)
H758	BR	Work Tool (C+) Relay / (C+) Solenoid
H759	OR	Work Tool (C-) Relay / (C-) Solenoid
H791	GN	RH Handle WKTL (C+) SW / Relay (C+) Coil
H792	BR	RH Handle WKTL C1 SW / Relay (C-) Coil
J764	BR	Temp Sensor Ground
M732	OR	Start Relay / Machine Security System Control
M733	PK	Tool Connector / Work Tool Relay (C+/C-) Output
R732	BR	Hydraulic Temp. Sensor
X734	GY	LOC Code IP, Bit 2
877	YL	Cold Start Relay / Glow Plugs
F846	PU	RH Action Lamp Group / Machine Security System
G848	GN	RH Action Lamp Group / Machine Security System
944	OR	Cat Data Link (+)
945	BR	Cat Data Link (-)
961	BR	OVRD Switch
975	WH	Operator Interlock Cont / Transmission Solenoid / Implement Pilot Solenoid
A958	WH	Operator Interlock Cont / Park Brake Solenoid
E917	WH	Implement Lockout SW
E918	GN	Implement Lockout SW / Operator Interlock Cont / AUX Hydraulic Control
F905	YL	Auto Leveler SW / Valve DVTR ARC MTL 248 HF
G969	YL	Park Brake Sol / Operator Interlock Control
G982	PK	Implement Lockout SW / AUX Hyd Control
G983	GN	Armrest SW / Seat SW
G984	PK	Armrest SW / Operator Interlock Control / AUX Hydraulic Control
G985	PU	Seat SW / Operator Interlock Control / AUX Hydraulic Control
K927	BU	Hyd Quick Coupler SW / Quick Coupler Solenoid

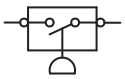
WIRE DESCRIPTION

Wire Number	Wire Color	Description
Monitoring Circuits		
404	YL	LH Action Lamp Gp / Hyd Oil Temperature SW
405	GY	LH Action Lamp Gp / AUX Bleedoff SW / Engine Oil Pressure SW
406	PU	LH Action Lamp Gp / Engine Cool Temp SW
436	OR	LH Action Lamp Gp / Hydraulic Filter Bypass SW
439	YL	RH Action Lamp GP / Implement Lockout SW
440	BR	RH Action Lamp GP / Air Filter Indicator
447	PK	RH Action Lamp GP / Fuel Level Ind / Fuel Sender
C444	YL	RH Action Lamp GP / Alternator / Res DMML Alt
C457	BU	Stop Pressure SW 1
C460	BU	Tool Connector / Jumper
G465	PK	Cold Start Pump / Cold Start Thermo SW
H416	GN	Transmission Solenoid / Operator Interlock Control
Accessory Circuits		
500	BR	Wiper Washer SW / Front Wiper Motor
501	GN	Wiper Washer SW / Front Wiper Motor
506	PU	Wiper Washer SW / Washer Bottle
513	OR	A/C Compressor Relay Output / A/C Comp Sol
514	PU	A/C Condenser Fan Motor Relay Output / Fans
536	WH	Turn Signal SW / Hazard SW
537	GN	Turn Signal SW / Hazard SW / Flasher
549	PK	RH Handle / Work Tool Trigger SW
567	WH	A/C Pressure SW / Compressor Relay Coil
A571	PU	Tool Connector / Spare Relay Fuse Block 1
C576	BU	Stop Lamp Relay / Stop Pressure SW 1
Lighting Circuits		
603	PK	Beacon Socket / Beacon SW
604	OR	Stop Lamp Relay / RH & LH Stop Tail Lamp / Signal Lamp Group
605	YL	Turn Signal SW / LH Stop Tail lamp / LH Head Turn Lamp / Signal Lamp Group
606	GY	Turn Signal SW / RH Stop Tail lamp / RH Head Turn Lamp / Signal Lamp Group

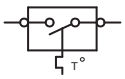
Wire Number	Wire Color	Description
Control Circuits		
L987	WH	Cold Start Relay / Cold Start SW
L998	OR	A1 & A2 Solenoid / AUX Hydraulic Control
L999	GN	Two Speed Solenoid / AUX Hydraulic Control
M901	YL	RH Action Lamp Interlock Override / AUX Hyd Cont
M904	OR	LOC Code IP, Bit 0
M905	WH	LOC Code IP, Bit 1
M906	BU	RC 2 Valve Group Solenoid / Diode
M907	GY	RC 1 Valve Group Solenoid / Diode
N957	PK	RXD - COMM # 1
N960	OR	TXD - COMM # 1
N979	GN	Signal GND - COMM # 1
P978	GN	A1 Solenoid / AUX Hydraulic Control
P979	YL	A2 Solenoid / AUX Hydraulic Control
P980	OR	Flow Control Sol / AUX Hydraulic Control
P981	PU	Two Speed Solenoid / AUX Hydraulic Control / High Flow Relay / RH Action Lamp
P982	BU	LH Handle 2 Speed Trigger SW / AUX Hyd Control
P983	GN	High Flow SW / AUX Hydraulic Control
P984	YL	Work Tool Relay (C+/C-) Output / AUX Hyd Cont
P986	PU	RH Handle Work Tool A2 SW / AUX Hyd Cont
P987	GN	AUX Bleed Off SW / AUX Hydraulic Control
P988	OR	Lockout Relay / IMP Pilot Sol / Optr Interlock Cont
P991	PK	High Flow SW / AUX Hydraulic Control
P993	OR	LH Handle Cont Flow SW / AUX Hydraulic Control
P994	BU	RH Handle Roller Power / AUX Hydraulic Control
P996	GN	RH Handle Roller Signal / AUX Hydraulic Control
P997	BR	RH Handle Roller Ground / AUX Hydraulic Control
R995	BU	Coolant Temp. Sensor
T901	YL	Ferrite Coil / Machine Security System Control
T902	PK	MSS Exciter Coil / Machine Security System Cont
Y905	YL	High Flow Relay / High Flow Solenoid
Y952	YL	Demand Fan Speed Sensor

HARNESS and WIRE
Electrical Schematic Symbols

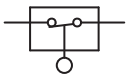
Symbols



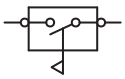
Pressure Symbol



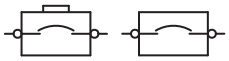
Temperature Symbol



Level Symbol



Flow Symbol

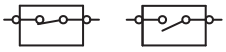


Circuit Breaker Symbol

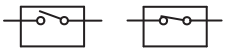
Symbols and Definitions



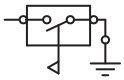
Fuse: A component in an electrical circuit that will open the circuit if too much current flows through it.



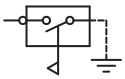
Switch (Normally Open): A switch that will close at a specified point (temp, press, etc.). The circle indicates that the component has screw terminals and a wire can be disconnected from it.



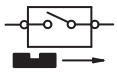
Switch (Normally Closed): A switch that will open at a specified point (temp, press, etc.). No circle indicates that the wire cannot be disconnected from the component.



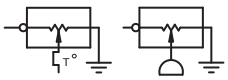
Ground (Wired): This indicates that the component is connected to a grounded wire. The grounded wire is fastened to the machine.



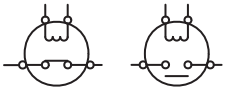
Ground (Case): This indicates that the component does not have a wire connected to ground. It is grounded by being fastened to the machine.



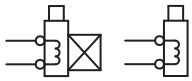
Reed Switch: A switch whose contacts are controlled by a magnet. A magnet closes the contacts of a normally open reed switch; it opens the contacts of a normally closed reed switch.



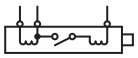
Sender: A component that is used with a temperature or pressure gauge. The sender measures the temperature or pressure. Its resistance changes to give an indication to the gauge of the temperature or pressure.



Relay (Magnetic Switch): A relay is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close the switch part of the relay.



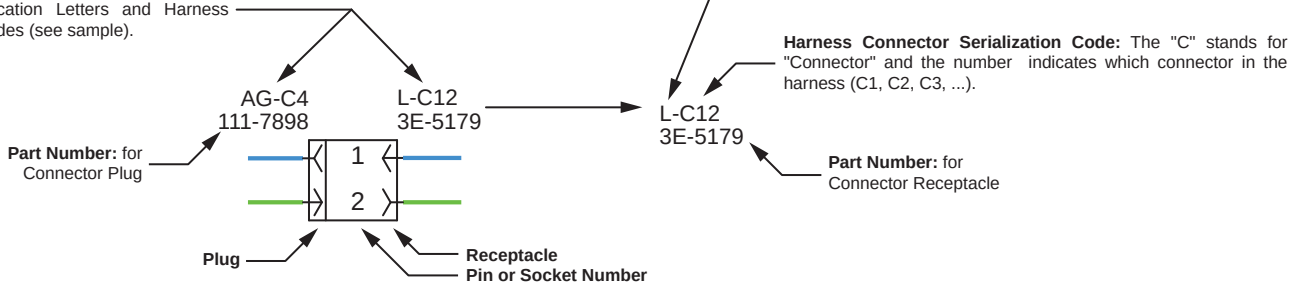
Solenoid: A solenoid is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close a valve or move a piece of metal that can do work.

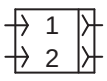


Magnetic Latch Solenoid: A magnetic latch solenoid is an electrical component that is activated by electricity and held latched by a permanent magnet. It has two coils (latch and unlatch) that make electromagnet when current flows through them. It also has an internal switch that places the latch coil circuit open at the time the coil latches.

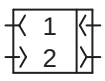
Harness and Wire Symbols

Wire, Cable, or Harness Assembly Identification: Includes Harness Identification Letters and Harness Connector Serialization Codes (see sample).

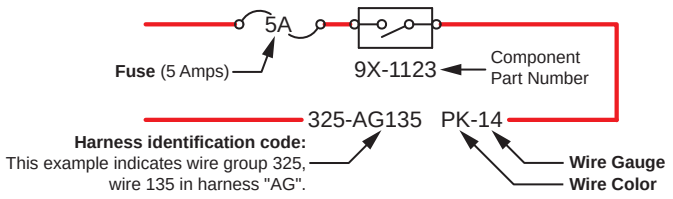


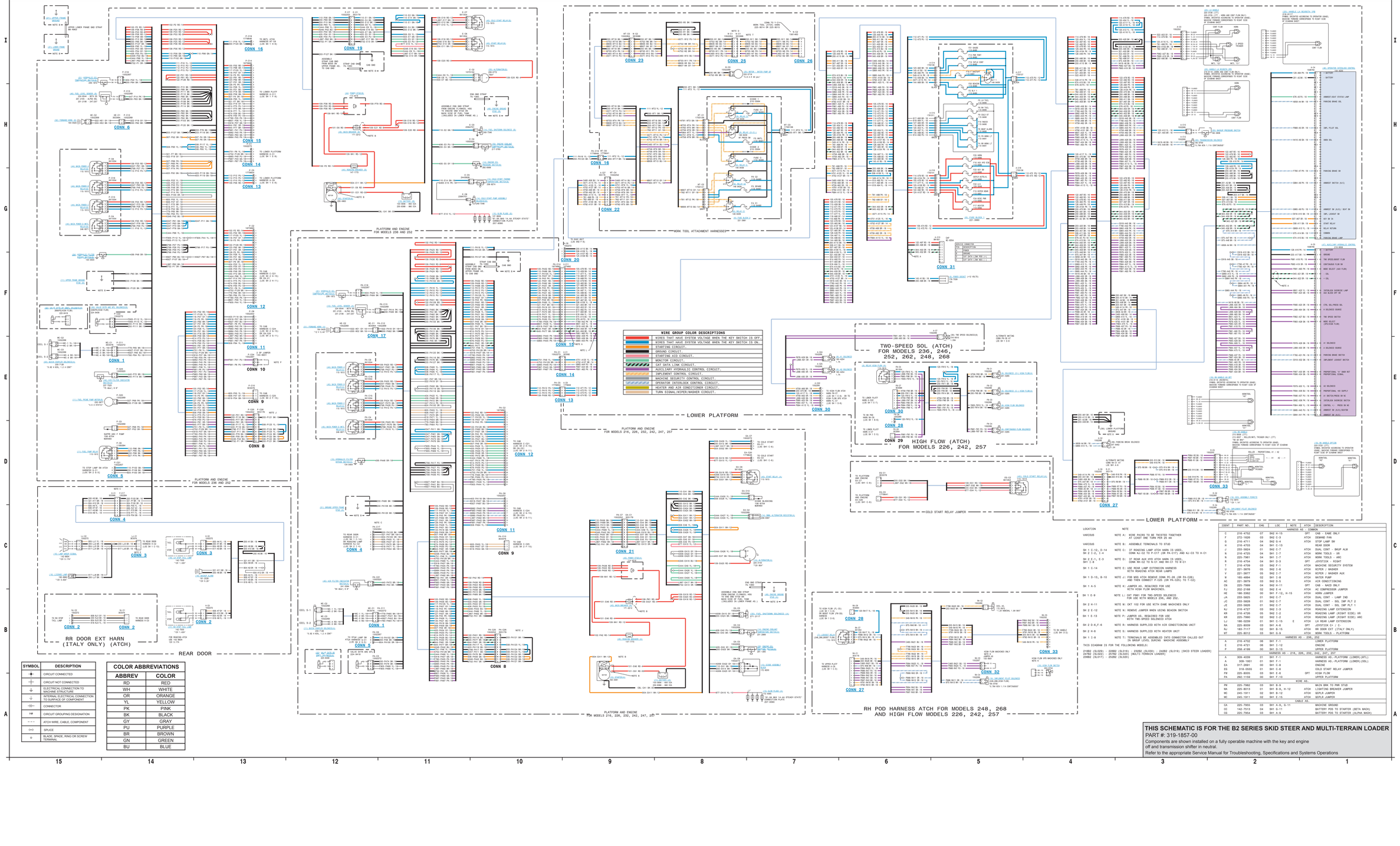


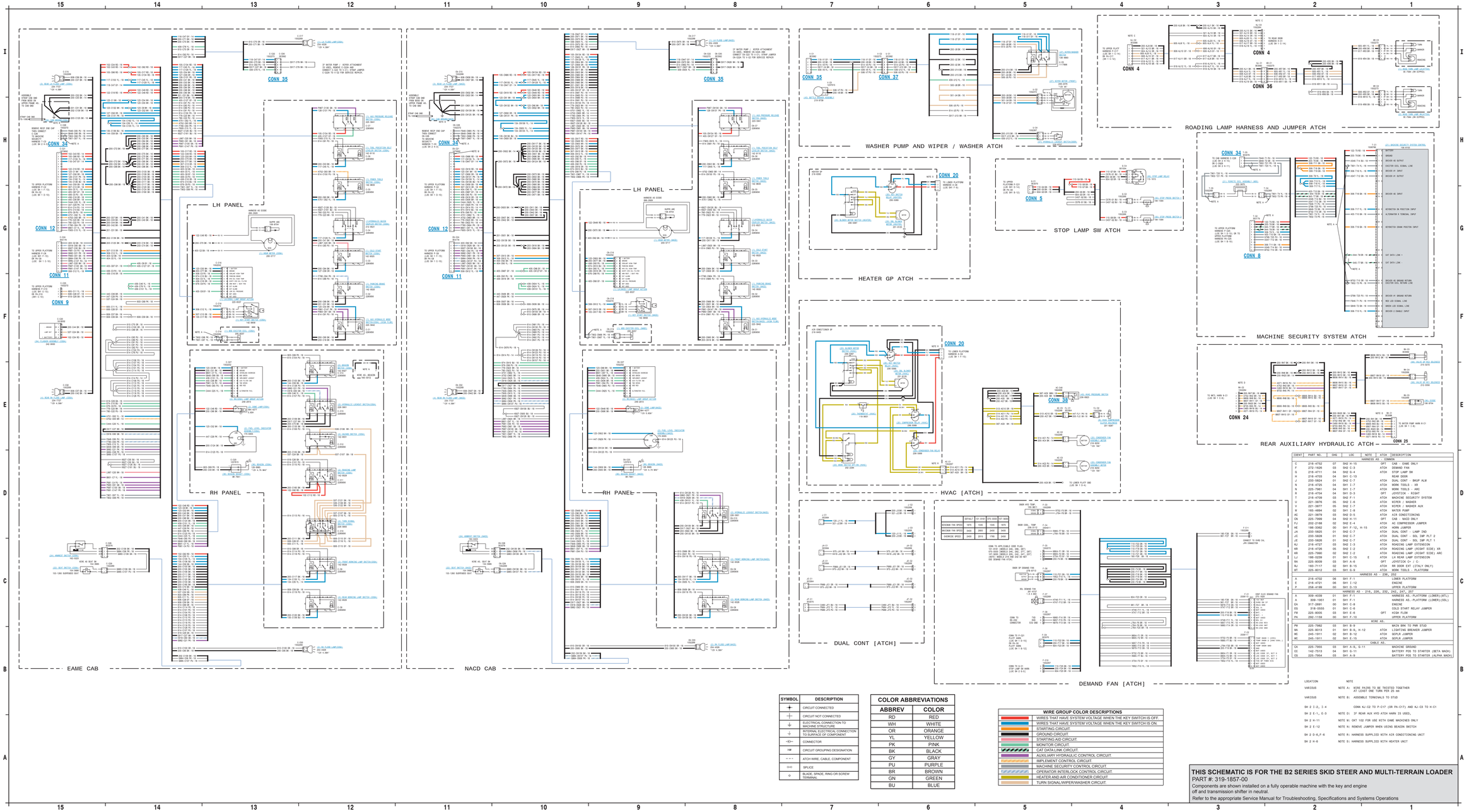
Deutsch connector: Typical representation of a Deutsch connector. The plug contains all sockets and the receptacle contains all pins.



Sure-Seal connector: Typical representation of a Sure-Seal connector. The plug and receptacle contain both pins and sockets.




PLATFORM AND ENGINE FOR MODELS 256 AND 252
PLATFORM AND ENGINE FOR MODELS 216, 226, 232, 242, 247, 257
LOWER PLATFORM
WORK TOOL ATTACHMENT HARNESS
TWO-SPEED SOL (ATCH) FOR MODELS 236, 246, 252, 262, 248, 268
HIGH FLOW (ATCH) FOR MODELS 226, 242, 257
REAR DOOR
RR DOOR EXT HARN (ITALY ONLY) (ATCH)
RH POD HARNESS ATCH FOR MODELS 248, 268 AND HIGH FLOW MODELS 226, 242, 257
WIRE GROUP COLOR DESCRIPTIONS
WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS OFF.
WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS ON.
STARTING CIRCUIT.
GROUND CIRCUIT.
STARTING AID CIRCUIT.
MONITOR CIRCUIT.
CAT DATA LINK CIRCUIT.
AUXILIARY HYDRAULIC CONTROL CIRCUIT.
IMPLEMENT CONTROL CIRCUIT.
MACHINE SECURITY CONTROL CIRCUIT.
OPERATOR INTERLOCK CONTROL CIRCUIT.
HEATER AND AIR CONDITIONER CIRCUIT.
TURN SIGNAL/WIPER/WASHER CIRCUIT.
SYMBOL DESCRIPTION
CIRCUIT CONNECTED
CIRCUIT NOT CONNECTED
ELECTRICAL CONNECTION TO MACHINE STRUCTURE
INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT
CONNECTOR
HW CIRCUIT GROUPING DESIGNATION
ATCH WIRE, CABLE, COMPONENT
SPLICE
BLADE, SPADE, RING OR SCREW TERMINAL
COLOR ABBREVIATIONS
ABBREV COLOR
RD RED
WH WHITE
OR ORANGE
YL YELLOW
PK PINK
BK BLACK
GY GRAY
PU PURPLE
BR BROWN
GN GREEN
BU BLUE
LOCATION NOTE
VARIOUS NOTE A: WIRE PAIRS TO BE TWISTED TOGETHER AT LEAST ONE TURN PER 25 MM
VARIOUS NOTE B: ASSEMBLE TERMINALS TO STUD
SH 1 C-12, D-14 NOTE C: IF ROADING LAMP ATCH HARN IS USED, CONN KJ-C2 TO P-C7 (OR P4-C37) AND KJ-C3 TO H-C1
SH 2 E-2, E-4
SH 2 E-1, E-3 NOTE D: IF REAR AUX HYD ATCH HARN IS USED, CONN RH-C2 TO K-C1 AND RH-C1 TO K-C1
SH 1 C-14 NOTE E: USE REAR LAMP EXTENSION HARNESS WITH MACHINE LAMPS
SH 1 D-13, B-10 NOTE J: FOR 985 ATCH REMOVE CONN PC-26 (OR PA-C26) AND THEN CONNECT P-C25 (OR PA-C25) TO T-C22)
SH 1 A-5 NOTE K: JUMPER AS, REQUIRED FOR USE WITH HIGH FLOW MACHINES.
SH 1 E-9 NOTE L: CKT P98 FOR TWO-SPEED SOLENOID FOR USE WITH MODELS 236, AND 252.
SH 2 H-11 NOTE M: CKT 102 FOR USE WITH EDM MACHINES ONLY
SH 2 E-12 NOTE N: REMOVE JUMPER WHEN USING BEACON SWITCH
SH 1 E-13 NOTE P: JUMPER AS, REQUIRED FOR USE WITH TWO-SPEED SOLENOID ATCH
SH 2 D-6,F-6 NOTE R: HARNESS SUPPLIED WITH AIR CONDITIONING UNIT
SH 2 H-6 NOTE S: HARNESS SUPPLIED WITH HEATER UNIT
SH 1 I-8 NOTE T: TERMINALS BE ASSEMBLED INTO CONNECTOR CALLED OUT ON GROUP LEVEL DURING MACHINE ASSEMBLY
THIS DIAGRAM IS FOR THE FOLLOWING MODELS:
216B2 (SL029) - 226B2 (SL016) - 232B2 (SL030) - 242B2 (SL019) (9410 STEER LOADER)
247B2 (SL022) - 257B2 (SL025) (MULTI-TERRAIN LOADER)
IDENT PART NO. CHG LOC NOTE ATCH DESCRIPTION
HARNESS AS - COMMON
C 216-4752 07 SH2 H-15 OPT CAB - EAME ONLY
F 272-1626 03 SH2 C-3 ATCH DEMAND FAN
G 216-4711 04 SH2 G-4 ATCH STOP LAMP SW
H 216-4703 04 SH1 C-13 REAR DOOR
J 230-5824 01 SH2 C-7 ATCH DUAL CONT - SKGP ALM
N 216-4725 04 SH1 I-7 ATCH WORK TOOLS - XR
N 225-7961 04 SH1 I-7 ATCH WORK TOOLS - ARC
R 216-4704 04 SH1 D-3 OPT JOYSTICK - RIGHT
T 216-4709 03 SH2 F-1 ATCH MACHINE SECURITY SYSTEM
U 221-3875 05 SH2 I-6 ATCH WIPER / WASHER
V 221-3877 05 SH2 I-7 ATCH WIPER / WASHER AUX
W 165-4894 02 SH1 I-8 ATCH WATER PUMP
AC 221-3879 03 SH2 D-5 ATCH AIR CONDITIONING
EN 225-7999 04 SH2 E-4 ATCH CAB - RADIO ONLY
FJ 202-2158 02 SH2 E-4 ATCH AC COMPRESSOR JUMPER
HJ 202-2159 02 SH2 H-12, H-15 ATCH HEATER
JA 230-5825 01 SH2 E-7 ATCH DUAL CONT - LAMP IND
JC 230-5828 01 SH2 C-7 ATCH DUAL CONT - SOL SW PLT 1
JE 230-5826 01 SH2 E-7 ATCH DUAL CONT - SOL SW PLT 2
KJ 216-4727 03 SH2 I-3 ATCH ROADING LAMP EXTENSION
KR 216-4728 05 SH2 I-2 ATCH ROADING LAMP (RIGHT SIDE) XR
KR 225-7990 02 SH2 I-2 ATCH ROADING LAMP (RIGHT SIDE) ARC
LJ 186-0239 01 SH1 C-15 E ATCH REAR LAMP EXTENSION
RA 225-8009 03 SH1 A-6 OPT JOYSTICK C+ / C-
RJ 183-7117 02 SH1 E-15 ATCH RR DOOR EXT (ITALY ONLY)
WT 225-8012 03 SH1 G-9 ATCH WORK TOOLS - PLATFORM
HARNESS AS - 216, 252
A 216-4702 06 SH1 F-1 LOWER PLATFORM
E 216-4721 06 SH1 I-12 ENGINE
P 258-4199 00 SH1 D-13 UPPER PLATFORM
HARNESS AS - 216, 226, 232, 242, 247, 257
A 309-4039 01 SH1 F-1 HARNESS AS.-PLATFORM (LOWER)(MTL)
A 309-1951 01 SH1 F-1 HARNESS AS.-PLATFORM (LOWER)(SSL)
EA 317-2691 00 SH1 C-8 ENGINE
EG 318-0555 01 SH1 C-8 COLD START RELAY JUMPER
FW 225-8005 03 SH1 E-6 OPT HIGH FLOW
PA 252-1159 00 SH1 F-10 UPPER PLATFORM
WIRE AS.-
PR 225-7982 03 SH1 B-9 MAIN BRK TO PWR STUD
MA 225-8013 01 SH1 B-9, H-12 ATCH LIGHTING BREAKER JUMPER
MC 245-1911 02 SH1 E-15 ATCH QCPLR JUMPER
MC 245-1911 02 SH1 E-15 ATCH QCPLR JUMPER
CABLE AS.-
TA 225-7955 03 SH1 A-9, G-11 MACHINE GROUND
CC 142-7513 04 SH1 A-11 BATTERY POS TO STARTER (BETA MACH)
CS 225-7954 03 SH1 A-9 BATTERY POS TO STARTER (ALPHA MACH)
THIS SCHEMATIC IS FOR THE B2 SERIES SKID STEER AND MULTI-TERRAIN LOADER
PART #: 319-1857-00
Components are shown installed on a fully operable machine with the key and engine off and transmission shifter in neutral.
Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations



IDENT	PART NO.	CHG	LOC	NOTE	ATCH	DESCRIPTION
HARNESS AS - COMMON						
C	216-4752	07	SH2 H-15		OPT	CAB - EAME ONLY
F	272-1626	03	SH2 C-3		ATCH	DEMAND FAN
G	216-4711	04	SH1 G-4		ATCH	STOP LAMP SW
H	216-4703	04	SH1 C-13		ATCH	REAR DOOR
J	233-5824	01	SH2 C-7		ATCH	DUAL CONT - BKUP ALM
N	216-4725	04	SH1 I-7		ATCH	WORK TOOLS - XR
R	225-7961	04	SH1 I-7		ATCH	WORK TOOLS - ARC
R	216-4704	04	SH1 D-3		OPT	JOYSTICK - RIGHT
T	216-4709	03	SH2 F-1		ATCH	MAGNUM SECURITY SYSTEM
U	221-3676	05	SH2 I-6		ATCH	WIPER / WASHER
V	221-3677	05	SH2 I-7		ATCH	WIPER / WASHER AUX
W	165-4894	02	SH1 I-8		ATCH	WATER PUMP
AC	221-3679	03	SH2 D-5		ATCH	AIR CONDITIONING
CN	225-7999	04	SH2 H-11		OPT	CAB - NACD ONLY
FJ	202-2166	02	SH2 E-4		ATCH	AC CONDENSOR JUMPER
HE	186-3362	00	SH1 F-12; H-15		ATCH	HORN JUMPER
JA	233-5825	01	SH2 C-7		ATCH	DUAL CONT - LAMP IND
JC	233-5826	01	SH2 C-7		ATCH	DUAL CONT - SOL 1&R PLT 2
JJ	233-5827	01	SH2 C-7		ATCH	DUAL CONT - SOL 1&R PLT 1
KJ	216-4727	03	SH2 I-3		ATCH	ROADING LAMP EXTENSION
KR	216-4726	05	SH2 I-2		ATCH	ROADING LAMP (RIGHT SIDE) XR
KS	225-7960	02	SH2 I-2		ATCH	ROADING LAMP (RIGHT SIDE) ARC
LJ	186-0239	01	SH1 C-15	E	ATCH	LH REAR LAMP EXTENSION
RA	225-9008	03	SH1 A-5		OPT	JOYSTICK C+ / C-
RJ	183-7117	02	SH1 B-15		ATCH	RR DOOR EXT (STALY ONLY)
WT	225-8012	03	SH1 G-5		ATCH	WORK TOOLS - PLATFORM
HARNESS AS - 236, 252						
A	216-4702	06	SH1 F-1			LOWER PLATFORM
E	216-4721	06	SH1 I-12			ENGINE
F	258-4199	00	SH1 D-13			UPPER PLATFORM
HARNESS AS - 216, 225, 252, 242, 247, 257						
A	309-4039	01	SH1 F-1			HARNESS AS-,PLATFORM (LOWER)(STL)
A	309-1951	01	SH1 F-1			HARNESS AS-,PLATFORM (LOWER)(SSL)
EA	317-2681	00	SH1 C-8			ENGINE
ES	318-0555	01	SH1 C-6			COLD START RELAY JUMPER
FB	225-8005	03	SH1 F-6		OPT	HIGH FLOW
PA	292-1159	00	SH1 F-10			UPPER PLATFORM
WIRE AS-						
PW	225-7982	03	SH1 B-9			MAIN BRK TO PWR STUD
WA	225-8073	01	SH1 B-9, H-12		ATCH	LIGHTING BREAKER JUMPER
WC	245-1911	02	SH1 B-12		ATCH	GCPLR JUMPER
WC	245-1911	02	SH1 E-15		ATCH	GCPLR JUMPER
CABLE AS-						
GA	225-7955	03	SH1 A-9, G-11			MACHINE GROUND
CC	142-7513	04	SH1 G-11			BATTERY POS TO STARTER (BETA MACH)
CG	225-7954	05	SH1 A-9			BATTERY POS TO STARTER (ALPHA MACH)

SYMBOL	DESCRIPTION
	CIRCUIT CONNECTED
	CIRCUIT NOT CONNECTED
	ELECTRICAL CONNECTION TO MACHINE STRUCTURE
	INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT
	CONNECTOR
	CIRCUIT GROUPING DESIGNATION
	ATCH WIRE, CABLE, COMPONENT
	SPLICE
	BLADE, SPADE, RING OR SCREW TERMINAL

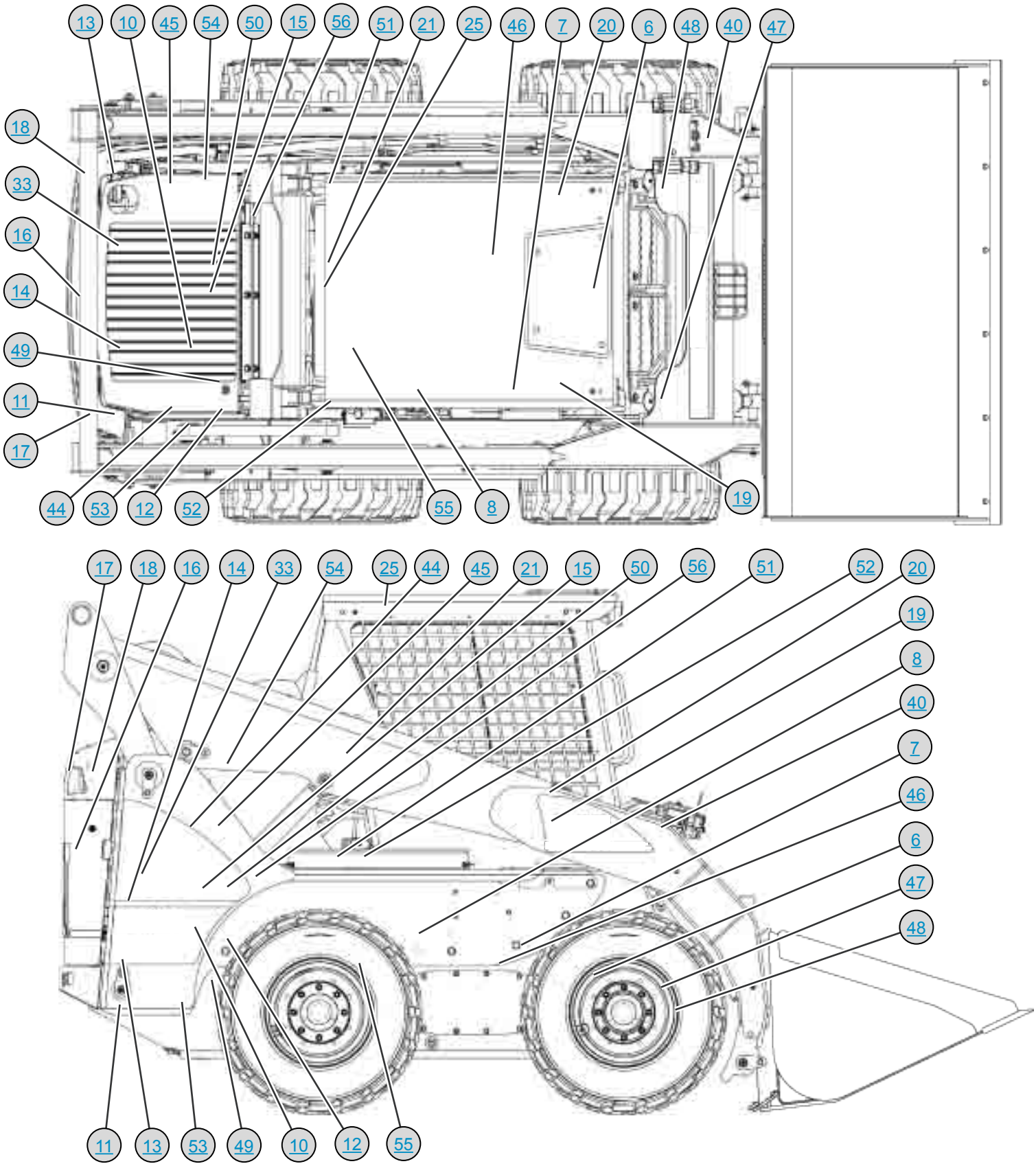
COLOR ABBREVIATIONS	
ABBREV	COLOR
RD	RED
WH	WHITE
OR	ORANGE
YL	YELLOW
PK	PINK
BK	BLACK
GY	GRAY
PU	PURPLE
BR	BROWN
GN	GREEN
BU	BLUE

WIRE GROUP COLOR DESCRIPTIONS	
	WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS OFF.
	WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS ON.
	STARTING CIRCUIT.
	GROUND CIRCUIT.
	STARTING AID CIRCUIT.
	MONITOR CIRCUIT.
	CAT DATA LINK CIRCUIT.
	AUXILIARY HYDRAULIC CONTROL CIRCUIT.
	IMPLEMENT CONTROL CIRCUIT.
	MACHINE SECURITY CONTROL CIRCUIT.
	OPERATOR INTERLOCK CONTROL CIRCUIT.
	HEATER AND AIR CONDITIONER CIRCUIT.
	TURN SIGNAL/WIPER/WASHER CIRCUIT.

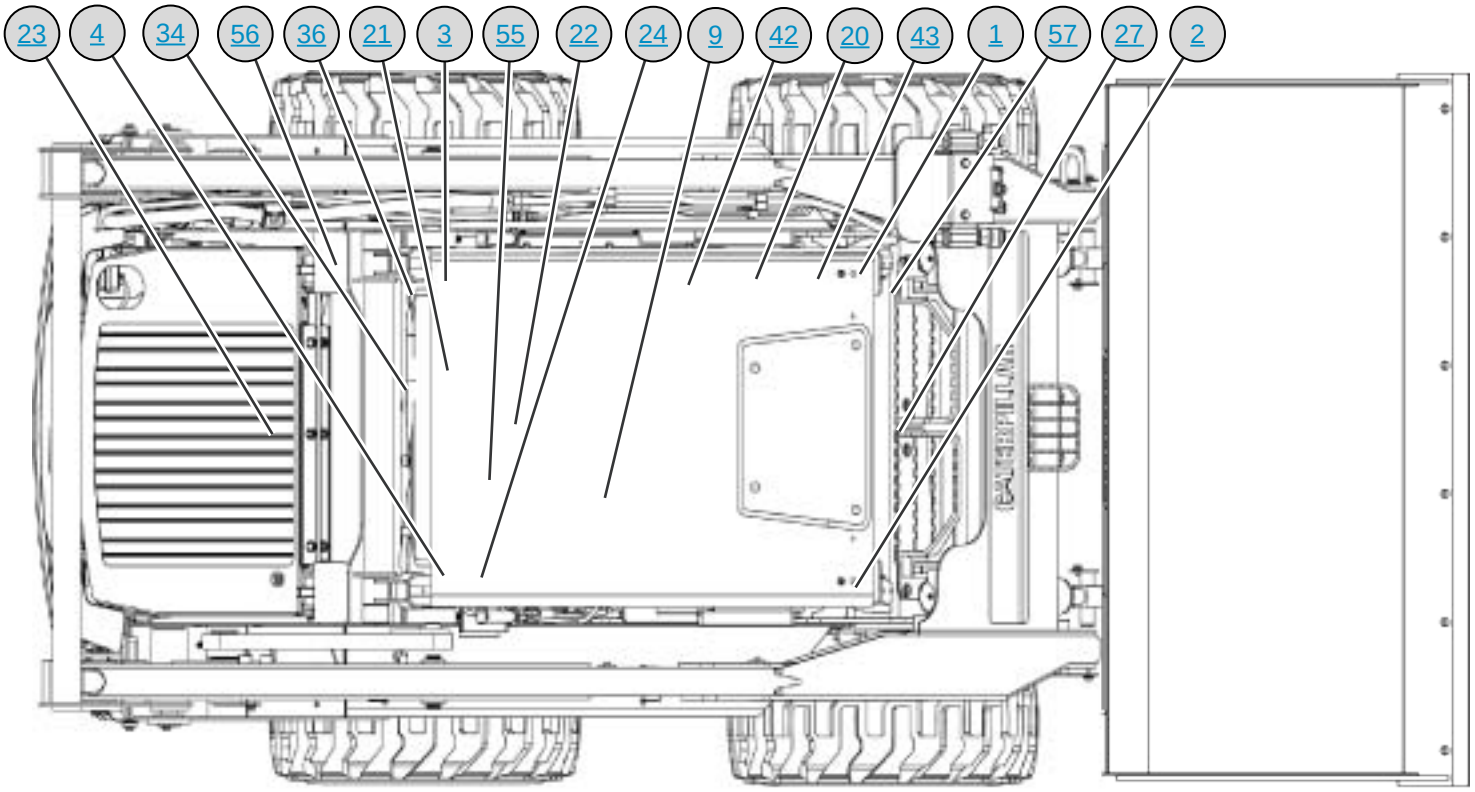
LOCATION	NOTE
VARIOUS	NOTE A: WIRE PAIRS TO BE TWISTED TOGETHER AT LEAST ONE TURN PER 25 MM
VARIOUS	NOTE B: ASSEMBLE TERMINALS TO STUD
SH 2 I-2, I-4	CONN KJ-C2 TO P-C17 (OR PA-C17) AND KJ-C3 TO H-C1
SH 2 E-1, E-3	NOTE D: IF REAR AUX HYD ATCH HARN IS USED,
SH 2 H-11	NOTE H: DXT 102 FOR USE WITH EAME MACHINES ONLY
SH 2 E-12	NOTE N: REMOVE JUMPER WHEN USING BEACON SWITCH
SH 2 D-8,F-6	NOTE R: HARNESS SUPPLIED WITH AIR CONDITIONING UNIT
SH 2 H-6	NOTE S: HARNESS SUPPLIED WITH HEATER UNIT

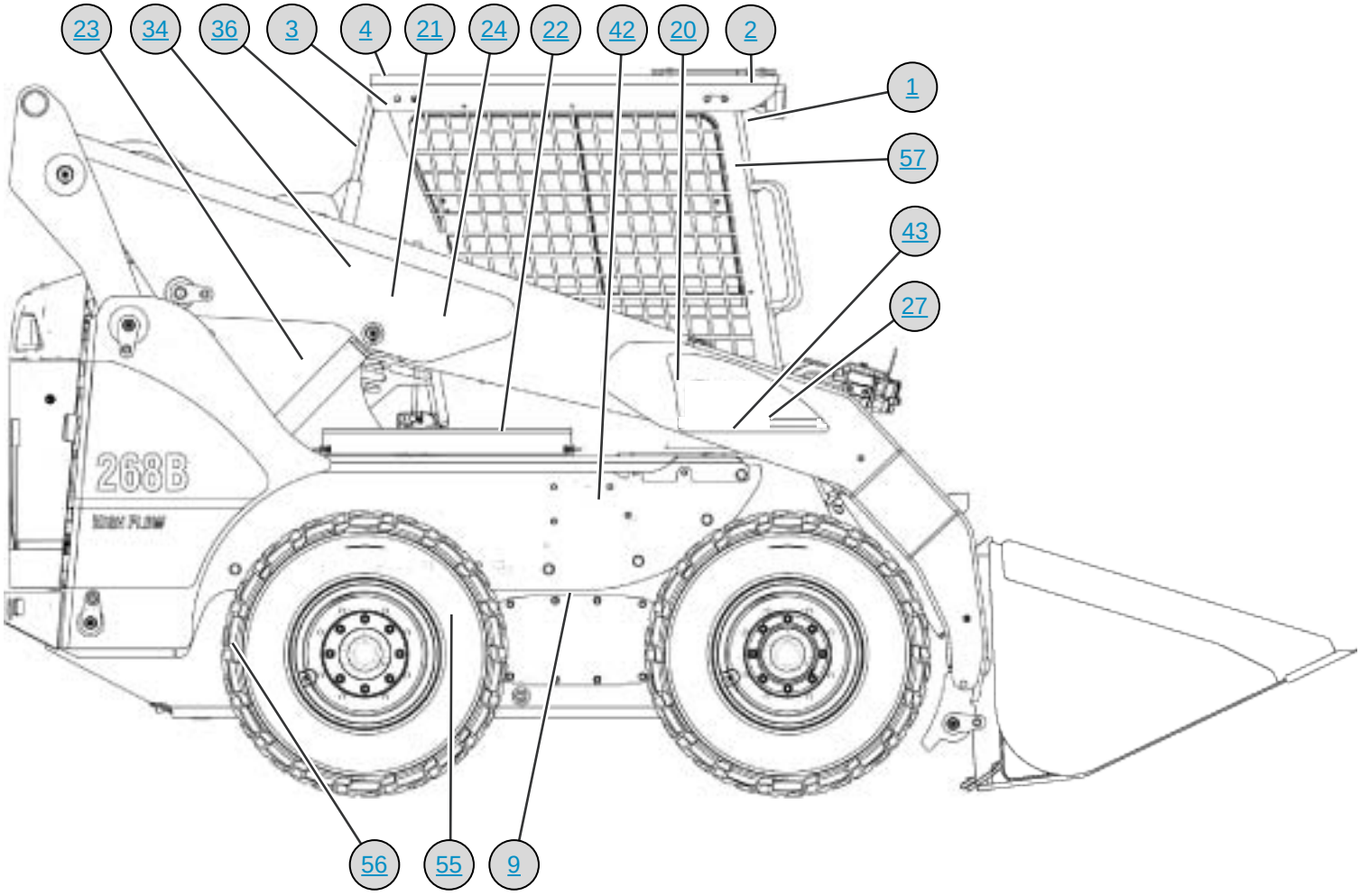
THIS SCHEMATIC IS FOR THE B2 SERIES SKID STEER AND MULTI-TERRAIN LOADER
PART #: 319-1857-00
Components are shown installed on a fully operable machine with the key and engine off and transmission shifter in neutral.
Refer to the appropriate Service Manual for Troubleshooting, Specifications and Systems Operations

MACHINE HARNESS CONNECTOR AND COMPONENT LOCATIONS

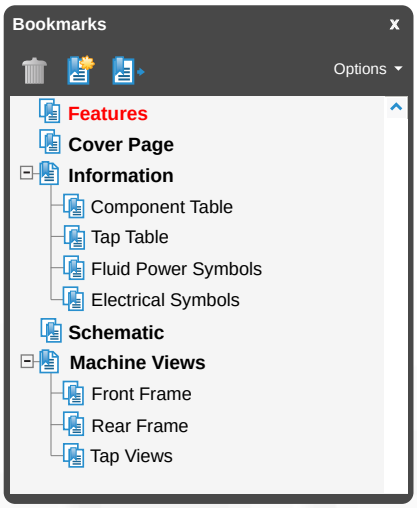


MACHINE HARNESS CONNECTOR AND COMPONENT LOCATIONS





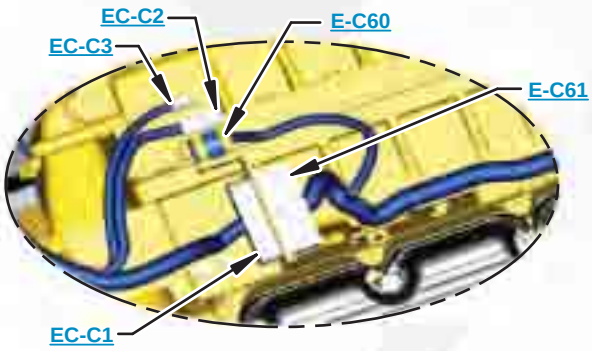
INTERACTIVE SCHEMATIC



The Bookmarks panel will allow you to quickly navigate to points of interest.

This document is best viewed at a screen resolution of 1024 X 768.

To set your screen resolution do the following:
RIGHT CLICK on the **DESKTOP**.
Select **PROPERTIES**.
CLICK the **SETTINGS TAB**.
MOVE THE SLIDER under **SCREEN RESOLUTION** until it shows **1024 X 768**.
CLICK OK to apply the resolution.



Click on any text that is BLUE and underlined. These are hyperlinks that can be used to navigate the schematic and machine views.

VIEW ALL CALLOUTS

When only one callout is showing on a machine view this button will make all of the callouts visible. This button is located in the top right corner of every machine view page.

HOTKEYS (Keyboard Shortcuts)		
	FUNCTION	**KEYS**
	Zoom In	**“CTRL” / “+”**
	Zoom Out	**“CTRL” / “-”**
	Fit to Page	**“CTRL” / “0” (zero)**
	Hand Tool	**“SPACEBAR” (hold down)**
	Find	**“CTRL” / “F”**



CATERPILLAR®

RENR6419-05
January 2010

Schematic

Skid Steer Loaders:
216B, 216B2, 226B, 226B2, 232B, 232B2, 236B, 236B2, 242B, 242B2, 246B, 248B, 252B, 252B2, 262B, 268B

Multi Terrain Loaders:
247B, 247B2, 257B, 257B2, 267B, 277B, 287B

Electrical System

216B: RLL1-6799	**232B2: SCH2475-2824**	**246B: PAT1-UP**	**252B2: SCP4600-5409**	**268B: LBA1-UP**
216B2: RLL6800-7699	**236B: HEN1-6749**	**247B: MTL1-5074**	**257B: SLK1-7299**	**277B: MDH1-UP**
226B: MJH1-10574	**236B2: HEN6750-8069**	**247B2: MTL5075-5699**	**257B2: SLK7300-8299**	**287B: ZSA1-UP**
226B2: MJH10575-12174	**242B: BXM1-4224**	**248B: SCL1-UP**	**262B: PDT1-UP**	
232B: SCH1-2474	**242B2: BXM4225-4774**	**252B: SCP1-4599**	**267B: CYC1-UP**	

Volume 1 of 2: Engine & Chassis
Volume 2 of 2: Cab

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COMPONENT LOCATION
Volume 1 of 2 - ENGINE & CHASSIS

Component	Schematic Location	Machine Location
Alarm - Backup	C-14	16
Alternator (A)	C-8	14
Alternator (B)	I-10	33
Battery (A)	A-8	11
Battery (B)	G-11	13
Breaker - Main (A)	B-9	45
Breaker - Main (B)	H-12	45
Breaker - Roading (A)	B-9	45
Breaker - Roading (B)	G-12	44
Coil - Ferrite Asy.	C-2	19
Control - Auxiliary Hydraulic Control	F-1	47
Control - Operator Interlock	H-1	48
Diode - Block (A)	B-8	15
Diode - Fuel Pump (Arc Suppression)	D-15	11
Fuses - Block 1	G-5	6
Fuses - Block 2 (Work Tools)	G-8	6
Glow Plugs (A)	A-7	15
Glow Plugs (B)	G-10	15
Ground - Engine Stud (A)	B-7	49
Ground - Engine Stud (B)	H-10	49
Ground - Lower Frame	I-15	21
Ground - Lower Platform	D-4	39
Ground - Upper Frame	I-15	21
Ground - Upper Frame Stud (A)	C-12	51
Ground - Upper Frame Stud (B)	F-15	11
Handle - 1 SW - LH	I-1	20
Handle - 2 SW - LH	H-2	20
Handle - 2 SW - RH	D-1	19
Handle - 2 SW - RH	D-2	19
Handle - 3 SW / Roller - RH	D-2	19
Handle - 5 SW - LH	I-2	20
Horn - Forward (A)	F-12	51
Horn - Forward (B)	H-15	52
Lamp - License	C-15	16
Lamp - Signal Group	C-15	16
Lamp - Stop/Tail - LH Attachment	C-14	18
Lamp - Stop/Tail - RH Attachment	B-14	17
Motor - Fuel Prime Pump (B)	E-15	11
Motor - Starter (A)	A-9	10
Motor - Starter (B)	G-12	50
Motor - Water Pump	I-8	25
Relay - (C-) Fuse Block 2	H-8	6
Relay - (C+) Fuse Block 2	H-8	6
Relay - (C+/C-) Fuse Block 2	H-8	6
Relay - (C1) Fuse Block 2	G-8	6
Relay - (C2) Fuse Block 2	G-8	6
Relay - Boost Flow (A)	E-6	6
Relay - Cold Start (A)	D-8	45
Relay - Cold Start (B)	I-10	45
Relay - Fuel Pump	D-15	11
Relay - Lockout (248,268,Boost Flow)	B-6	7
Relay - Main Power A (A)	E-12	44
Relay - Main Power A (B)	G-15	44
Relay - Main Power B (A)	E-12	45
Relay - Main Power B (B)	G-15	44
Relay - Main Power C (A)	E-12	45
Relay - Main Power C (B)	G-15	44
Relay - Main Power D (A)	D-12	45
Relay - Main Power D (B)	G-15	44
Relay - Start (A)	D-8	45
Relay - Start (B)	I-10	45
Resistor - DMML Alternator (A)	C-7	14
Sender - Fuel Level (A)	F-12	12
Sender - Fuel Level (B)	H-15	46
Socket - Power +12 Volts	F-5	6
Solenoid - (C-) High Flow (A)	E-5	8
Solenoid - (C-) High Flow (B)	D-5	8
Solenoid - (C+) High Flow (A)	E-5	8
Solenoid - (C+) High Flow (B)	D-5	8
Solenoid - A1	E-7	8
Solenoid - A2	E-7	8
Solenoid - Boost Flow (A)	E-5	8
Solenoid - Cold Start Pump (B)	G-10	14
Solenoid - Continuous Flow (A)	D-5	8
Solenoid - Continuous Flow (B)	C-5	8
Solenoid - Detent Valve (248,268, High Flow)	D-5	19
Solenoid - Fuel Shutdown (A)	B-8	33
Solenoid - Fuel Shutdown (B)	H-10	14
Solenoid - Impl Pilot (248,268,High Flow)	A-5	19
Solenoid - Implement Pilot	C-2	19
Solenoid - Parking Brake	D-4	39
Solenoid - Quick Coupler (A)	B-12	11
Solenoid - Quick Coupler (B)	E-15	53
Solenoid - Transmission	H-3	20
Solenoid - Two Speed (B)	E-5	39
Solenoid - Valve Grp DVTR ARC MTL (B) 248 High Flow	F-15	52
Solenoid - Valve Grp DVTR XR XRMTL (A)	B-12	52
Solenoid - Valve Grp DVTR XR XRMTL (B) 268 High Flow	F-15	52
Stud - Power (A)	C-9	45
Stud - Power (B)	H-12	44
Switch - Air Filter Indicator (A)	B-12	45
Switch - Air Filter Indicator (B)	E-15	44
Switch - Backup Pressure	H-3	20
Switch - Cold Start Thermo Temp (B)	G-10	14
Switch - Engine Coolant Temperature (A)	B-8	14
Switch - Engine Coolant Temperature (B)	H-10	33
Switch - Engine Oil Pressure (A)	B-8	33
Switch - Engine Oil Pressure (B)	H-10	14
Switch - High Flow (248,268)	A-4	19
Switch - Hydraulic Filter Bypass (A)	D-12	13
Switch - Hydraulic Filter Bypass (B)	F-15	54
Switch - Hydraulic Oil Temp (A)	F-12	51
Switch - Hydraulic Oil Temp (B)	H-15	51

(A) = 216B / 226 / 232 / 242 / 247 / 257

(B) = 236B / 246 / 248 / 252 / 262 / 267 / 268 / 277 / 287

COMPONENT LOCATION
Volume 2 of 2 - CAB

Component	Schematic Location	Machine Location
Action Lamp Group - LH (COSA)	F-13	1
Action Lamp Group - LH (NACD)	E-9	1
Action Lamp Group - RH (COSA)	E-13	2
Action Lamp Group - RH (NACD)	F-9	2
Beacon And Beacon Socket (COSA)	D-13	36
Beacon And Beacon Socket (NACD)	D-9	36
Bottle - Washer	I-7	43
Coil - Ferrite Asy. (MSS)	G-3	21
Coil - MSS Exciter (COSA)	F-13	1
Coil - MSS Exciter (NACD)	F-9	1
Control - Machine Security System	H-1	21
Diode - Valve Group Remote Control	E-1	56
Flasher (COSA)	F-15	34
Ground - Cab (COSA)	H-15	34
Ground - Cab (NACD)	H-11	34
Hour Meter (COSA)	G-13	1
Hour Meter (NACD)	G-9	1
Indicator - Fuel Level (COSA)	E-13	2
Indicator - Fuel Level (NACD)	E-9	2
Lamp - Dome (COSA)	E-13	2
Lamp - Dome (NACD)	E-9	2
Lamp - Flood - LH (COSA)	I-12	1
Lamp - Flood - LH (NACD)	I-8	1
Lamp - Flood - RH (COSA)	B-12	2
Lamp - Flood - RH (NACD)	B-8	2
Lamp - Head Turn - LH (Atch)	I-1	1
Lamp - Head Turn - RH (Atch)	I-1	2
Lamp - Rear Flood - LH (COSA)	I-15	3
Lamp - Rear Flood - LH (NACD)	I-11	3
Lamp - Rear Flood - RH (COSA)	E-15	4
Lamp - Rear Flood - RH (NACD)	E-11	4
Motor - Condenser Fan 1 & 2	D-4	23
Motor - Dbl Blower (Heater)	G-6	20
Motor - Dbl Blower (HVAC)	E-6	20
Motor - Front Wiper	I-5	27
Relay - Compressor HVAC	E-6	20
Relay - Condenser Fan	E-6	20
Relay - Key Switch (Heater)	G-6	20
Relay - Key Switch (HVAC)	F-6	20
Relay - Stop Lamp	H-4	55
Solenoid - HVAC Compressor Clutch	E-4	9
Solenoid - Valve Gp RC1	E-1	56
Solenoid - Valve Gp RC2	E-1	56
Switch - Armrest (COSA)	C-15	24
Switch - Armrest (NACD)	C-11	24
Switch - Auto Leveler (COSA)	H-12	1
Switch - Auto Leveler (NACD)	H-8	1
Switch - AUX Hydraulic Mode (COSA)	F-12	1
Switch - AUX Hydraulic Mode (NACD)	F-8	1
Switch - AUX Pressure Release (COSA)	H-12	1
Switch - AUX Pressure Release (NACD)	H-8	1
Switch - Beacon (COSA)	E-12	2
Switch - Cold Start (COSA)	G-12	1
Switch - Cold Start (NACD)	G-8	1
Switch - Fan On/Off/On (Heater)	G-7	20
Switch - Fan On/Off/On (HVAC)	E-7	20
Switch - Front Working Lamp (COSA)	C-12	2
Switch - Front Working Lamp (NACD)	C-8	2
Switch - Hazard (COSA)	E-12	2
Switch - HVAC Refrigerant Pressure	E-4	43
Switch - Hydraulic Lockout (COSA)	E-12	2
Switch - Hydraulic Lockout (Door)	H-5	57
Switch - Hydraulic Lockout (NACD)	D-8	2
Switch - Hydraulic Quick Coupler (COSA)	G-12	1
Switch - Hydraulic Quick Coupler (NACD)	G-8	1
Switch - Key Start (COSA)	F-13	1
Switch - Key Start (NACD)	F-9	1
Switch - Mode Off/On (HVAC)	D-7	20
Switch - Parking Brake (COSA)	F-12	1
Switch - Parking Brake (NACD)	F-8	1
Switch - Rear Working Lamp (COSA)	C-12	2
Switch - Rear Working Lamp (NACD)	C-8	2
Switch - Roading Lamps (COSA)	D-12	2
Switch - Seat (COSA)	C-15	22
Switch - Seat (NACD)	C-11	22
Switch - Stop Pressure 1	G-4	55
Switch - Stop Pressure 2	G-4	55
Switch - Tool Power (COSA)	H-12	1
Switch - Tool Power (NACD)	H-8	1
Switch - Turn Signal (COSA)	D-12	2
Switch - Wiper / Washer	I-5	27
Thermostat (HVAC)	E-7	20

CONNECTOR LOCATION
Volume 1 of 2 - ENGINE & CHASSIS

Connector Number	Schematic Location	Machine Location
CONN 1	B-12, E-14	56
CONN 2	B-14, B-15	18
CONN 3	C-14	13
CONN 4	C-12, C-14	52
CONN 5	B-12, D-14	46
CONN 6	H-14	55
CONN 7	H-14	34
CONN 8	B-10, D-13	34
CONN 9	C-10, E-13	34
CONN 10	E-13	34
CONN 11	C-10, F-13	51
CONN 12	D-10, F-13	51
CONN 13	E-10, G-13	51
CONN 14	E-10, G-13	51
CONN 15	E-10, H-13	51
CONN 16	H-9, I-13	12
CONN 17	F-12	44
CONN 18	F-12	51
CONN 19	I-12	45
CONN 20	F-10	51
CONN 21	C-9	51
CONN 22	G-9	13
CONN 23	I-9	14
CONN 24	C-8	13
CONN 25	I-8	7
CONN 26 TOOL	I-7	40
CONN 27	A-6, D-4	7
CONN 28	B-6, D-6	7
CONN 29	D-6	39
CONN 30	D-6, E-6	6
CONN 31 SERVICE	F-5	19
CONN 32	B-5	19
CONN 33	B-4, D-2	19

The connectors shown in this chart are for harness to harness connectors. Connectors that join a harness to a component are generally located at or near the component. See the Component Location Chart.

CONNECTOR LOCATION
Volume 2 of 2 - CAB

Connector Number	Schematic Location	Machine Location
CONN 4	I-3, I-4	13
CONN 5	G-5	55
CONN 8	G-3	34
CONN 9	F-15	34
CONN 11	G-15, G-11	34
CONN 12	H-15, H-11	34
CONN 20	G-6, F-6	42
CONN 24	E-3	13
CONN 34	H-15, H-11, H-3	34
CONN 35	I-7, I-8, I-13	1
CONN 36	I-3	13
CONN 37	I-6	43
CONN 38	E-4	9

The connectors shown in this chart are for harness to harness connectors. Connectors that join a harness to a component are generally located at or near the component. See the Component Location Chart.

CID / MID / FMI
Volume 1 of 2 - ENGINE & CHASSIS

Component Identifiers (CID[1]) Module Identifier (MID[2])	
Auxiliary Hydraulic Control (MID No. 106)	
CID	**Component**
0070	Parking Brake Switch
0168	Voltage Fault
0598	Two Speed Motor Solenoid
1180	Auxiliary Hydraulic Solenoid #1
1181	Auxiliary Hydraulic Solenoid #2
1184	Auxiliary Hydraulic Solenoid Supply
1187	Continuous Flow Switch
1188	Operator Interlock Override Switch
1189	Auxiliary Hydraulics Lever
1190	Arm Bar / Seat Switch
1694	Two Speed Motor Solenoid Supply
1695	Two Speed Switch
1931	High Pressure / High Flow Solenoid
1935	Auxiliary Hydraulic Flow Selector Switch
1939	Auxiliary Hydraulic High Flow Supply
1940	Auxiliary Hydraulic High Flow Diverter Solenoid
1942	High Pressure Tool Detection Switch

[1] The CID is a diagnostic code that indicates which circuit is faulty.

[2] The MID is a diagnostic code that indicates which electronic control module

Failure Mode Identifiers (FMI)[1]	
FMI No.	**Failure Description**
0	Data valid but above normal operational range.
1	Data valid but below normal operational range.
2	Data erratic, intermittent, or incorrect.
3	Voltage above normal or shorted high.
4	Voltage below normal or shorted low.
5	Current below normal or open circuit.
6	Current above normal or grounded circuit.
7	Mechanical system not responding properly.
8	Abnormal frequency, pulse width, or period.
9	Abnormal update.
10	Abnormal rate of change.
11	Failure mode not identifiable.
12	Bad device or component.
13	Out of calibration.
14	Parameter failures.
15	Parameter failures.
16	Parameter not available.
17	Module not responding.
18	Sensor supply fault.
19	Condition not met.
20	Parameter failures.

[1]The FMI is a diagnostic code that indicates what type of failure has occurred.

CID / MID / FMI
Volume 2 of 2 - CAB

Component Identifiers (CID[1]) Module Identifier (MID[2]) Auxiliary Hydraulic Control (MID No. 106)	
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[1]The FMI is a diagnostic code that indicates what type of failure has occurred.

SPECIFICATIONS AND RELATED MANUALS
Volume 1 of 2 - ENGINE & CHASSIS

Engine & Platform Off Machine Switch Specification				
Part No.	**Function**	**Actuate**	**Deactuate**	**Contact Position**
134-0404	Hydraulic Filter Bypass Switch	275.8 to 303.4 kPa (40 to 44 psi)	206.8 kPa MIN (30 psi MIN)	Normally Open
192-0836	Backup Pressure Switch	517.0 + 41.4, - 68.9 kPa (75.0 + 6.0, -10.0 psi)	386.1 + 41.4, - 68.9 kPa (56.0 + 6.0, -10.0 psi)	Normally Open
224-0744	High Flow Pressure Switch	375.9 + 37.9, - 58.6 kPa (54.5 + 5.5, -8.5 psi)	263 kPa MIN (38.1 psi MIN)	Normally Closed
236-1872	Hydraulic Oil Temperature Switch	102 ± 3°C (215.6 ± 5.4°F)	90°C MIN (194°F MIN)	Normally Open

Engine & Platform Resistor, Sender and Solenoid Specifications			
Part No.	**Component Description**		**Resistance (Ohms)[1]**
233-7128	Solenoid:	Quick Coupler	6.36 ± 0.4
172-0970	Solenoid:	Detent Valve	9.4
185-4254	Solenoid:	A1 & A2 Continuous Flow (High Flow XPS)	2.2 ± 0.2
195-9700	Solenoid:	C+ & C- (High Flow XPS) Implement Pilot Parking Brake Transmission	10 ± 0.5
216-0610	Solenoid:	Two Speed	2.2 ± 0.2
224-7782	Sender:	Fuel (287 / 267)	Empty: 240 - 245 Full: 28 - 33
224-8545	Sender:	Fuel (267 / 277)	Empty: 240 - 245 Full: 28 - 33
231-2105	Sender:	Fuel (216B / 226 / 232B / 242)	Empty: 240 - 250 Full: 28 - 33
231-2106	Sender:	Fuel (247 / 257)	Empty: 240 - 250 Full: 28 - 33
224-8544	Sender:	Fuel (236 / 246 / 252 / 262 / 248 / 268)	Empty: 240 - 250 Full: 28 - 33
238-9397	Resistor:	DMML ALT	120.0 ± 6.0

[1] At room temperature unless otherwise noted.

Related Electrical Service Manuals	
Title	**Form Number**
K3A Alternator: 239-0772	SENR5841
R2.7KW Electric Starting Motor: 143-0539	SENR3828
Auxiliary Hydraulic Control system:	RENR2893
Operator Interlock Control:	RENR2864

SPECIFICATIONS AND RELATED MANUALS
Volume 2 of 2 - CAB

Attachment & Cab Off Machine Switch Specification				
Part No.	**Function**	**Actuate**	**Deactuate**	**Contact Position**
184-1564	Stop Pressure 1 & 2	375.9 +37.9, -58.6 kPa (54.5 + 5.5, -8.5 psi)	263 kPa (38.2 psi)	Normally Closed[2]
236-6923	A/C Refrigerant Pressure	275 to 1750 kPa[1] (40 to 255 psi)	- - - -	Normally Open[2]

[1] With increasing pressure the closed condition can be maintained up to 2800 kpa (405 psi), with decreasing pressure the closed condition can be maintained down to 170 kpa (25psi).

[2] Contact position at the contacts of the harness connector.

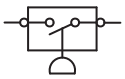
Resistor, Sender and Solenoid Specifications		
Part No.	**Component Description**	**Resistance (Ohms)[1]**
212-3350	Solenoid: Remote Control 1	3.2 ± 0.22
215-3272	Solenoid: Remote Control 2	4.0 ± 0.28
231-6287	Solenoid: A/C Compressor	10.5

[1] At room temperature unless otherwise noted.

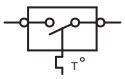
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Operator Interlock Control:	RENR2864

HARNESS and WIRE
Electrical Schematic Symbols

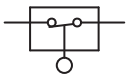
Symbols



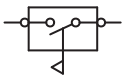
Pressure Symbol



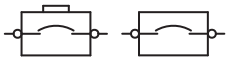
Temperature Symbol



Level Symbol



Flow Symbol

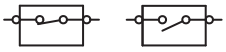


Circuit Breaker Symbol

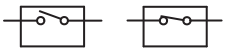
Symbols and Definitions



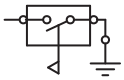
Fuse: A component in an electrical circuit that will open the circuit if too much current flows through it.



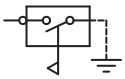
Switch (Normally Open): A switch that will close at a specified point (temp, press, etc.). The circle indicates that the component has screw terminals and a wire can be disconnected from it.



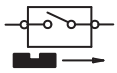
Switch (Normally Closed): A switch that will open at a specified point (temp, press, etc.). No circle indicates that the wire cannot be disconnected from the component.



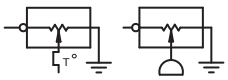
Ground (Wired): This indicates that the component is connected to a grounded wire. The grounded wire is fastened to the machine.



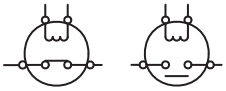
Ground (Case): This indicates that the component does not have a wire connected to ground. It is grounded by being fastened to the machine.



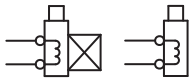
Reed Switch: A switch whose contacts are controlled by a magnet. A magnet closes the contacts of a normally open reed switch; it opens the contacts of a normally closed reed switch.



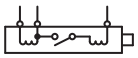
Sender: A component that is used with a temperature or pressure gauge. The sender measures the temperature or pressure. Its resistance changes to give an indication to the gauge of the temperature or pressure.



Relay (Magnetic Switch): A relay is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close the switch part of the relay.



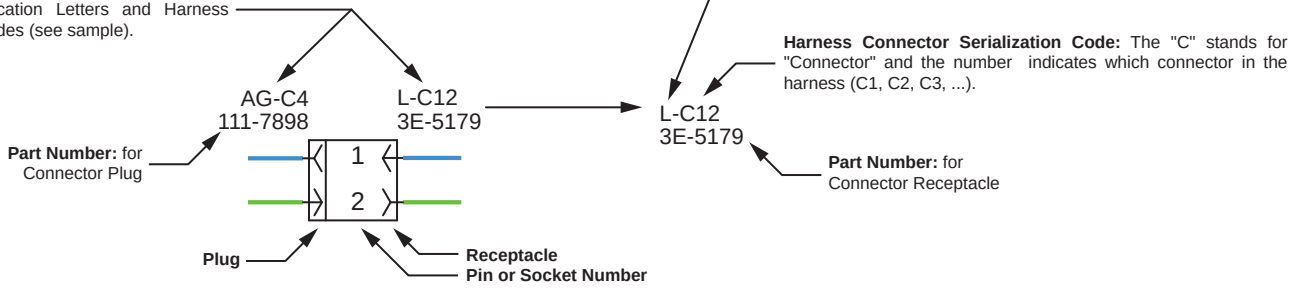
Solenoid: A solenoid is an electrical component that is activated by electricity. It has a coil that makes an electromagnet when current flows through it. The electromagnet can open or close a valve or move a piece of metal that can do work.

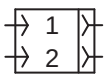


Magnetic Latch Solenoid: A magnetic latch solenoid is an electrical component that is activated by electricity and held latched by a permanent magnet. It has two coils (latch and unlatch) that make electromagnet when current flows through them. It also has an internal switch that places the latch coil circuit open at the time the coil latches.

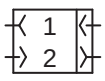
Harness and Wire Symbols

Wire, Cable, or Harness Assembly Identification: Includes Harness Identification Letters and Harness Connector Serialization Codes (see sample).

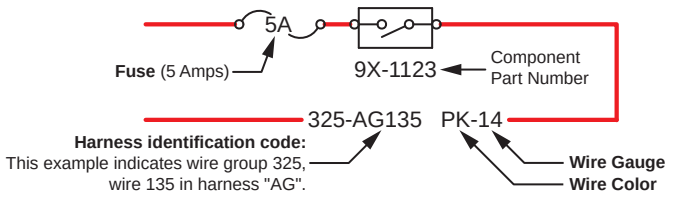




Deutsch connector: Typical representation of a Deutsch connector. The plug contains all sockets and the receptacle contains all pins.



Sure-Seal connector: Typical representation of a Sure-Seal connector. The plug and receptacle contain both pins and sockets.



PLATFORM AND ENGINE
FOR MODELS 236, 246, 248,
252, 262, 267, 268, 277, 287

WORK TOOL ATTACHMENT HARNESSES

TWO-SPEED SOL (ATCH)
FOR MODELS 236, 246,
252, 262, 248, 268

HIGH FLOW (ATCH)
FOR MODELS 226, 242, 257

HIGH FLOW XPS (ATCH)
FOR MODELS 248, 268

LOWER PLATFORM

PLATFORM AND ENGINE
FOR MODELS 216, 226,
232, 242, 247, 257

LOWER PLATFORM

PLATFORM AND ENGINE
FOR MODELS 216, 226,
232, 242, 247, 257

RR DOOR EXT HARN
(ITALY ONLY) (ATCH)

REAR DOOR

RH POD HARNESS ATCH FOR MODELS 248, 268
AND HIGH FLOW MODELS 226, 242, 257, 287

WIRE GROUP COLOR DESCRIPTIONS

- WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS OFF.
- WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS ON.
- STARTING CIRCUIT.
- GROUND CIRCUIT.
- STARTING AID CIRCUIT.
- MONITOR CIRCUIT.
- AUX. HYDRAULIC CONTROL CIRCUIT.
- IMPLEMENT CONTROL CIRCUIT.
- MACHINE SECURITY CONTROL CIRCUIT.
- OPERATOR INTERLOCK CONTROL CIRCUIT.
- HEATER AND AIR CONDITIONER CIRCUIT.
- TURN SIGNAL/WIPER/WASHER CIRCUIT.

ABBREV	COLOR
RD	RED
WH	WHITE
OR	ORANGE
YL	YELLOW
PK	PINK
BK	BLACK
GN	GREEN
PU	PURPLE
BR	BROWN
GY	GRAY
BU	BLUE

SYMBOL	DESCRIPTION
	BLADE, SPADE, RING, OR SCREW TERMINAL
	SPLICE
	CIRCUIT NOT CONNECTED
	ELECTRICAL CONNECTION TO MACHINE STRUCTURE
	INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT
	CONNECTOR
	ATCH WIRE, CABLE & COMPONENT
	CIRCUIT GROUPING DESIGNATION

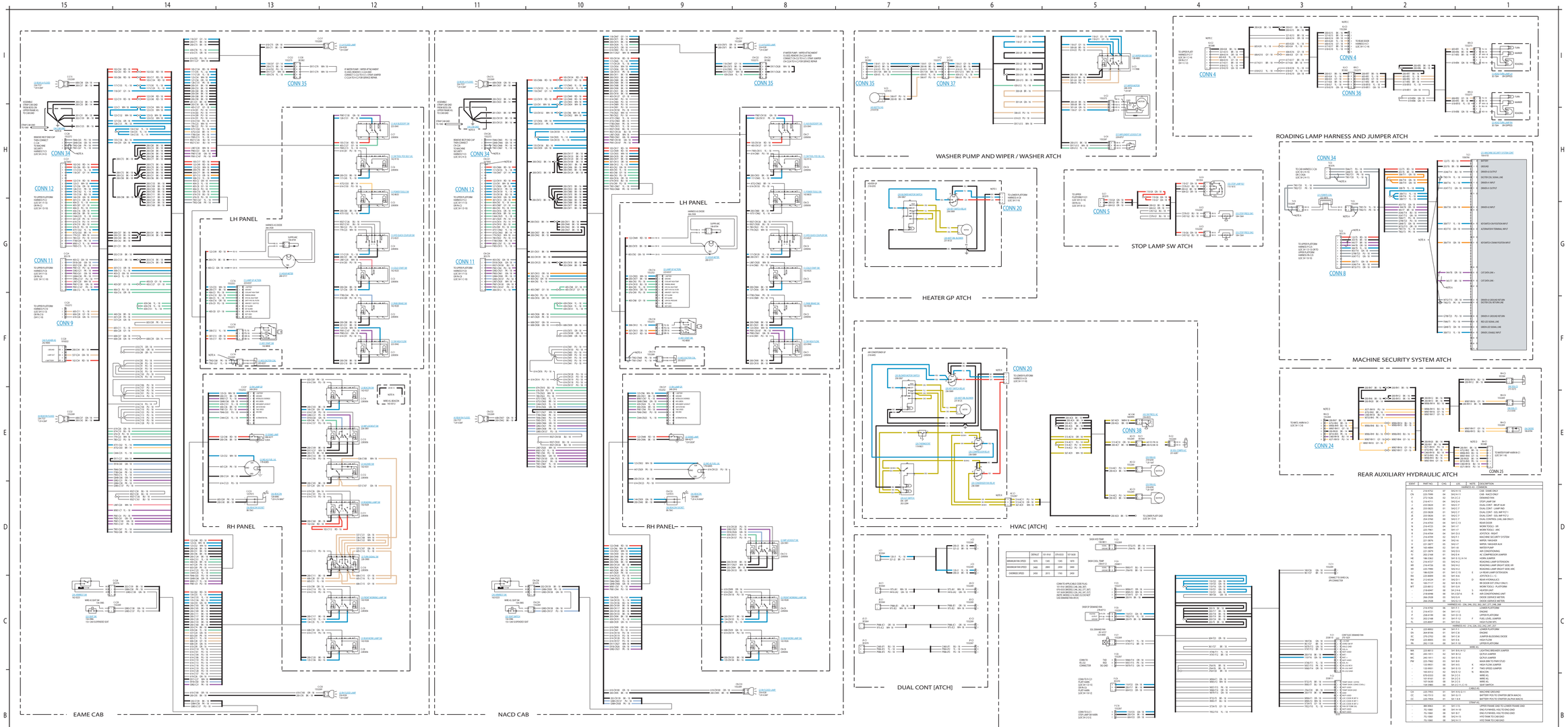
ZONE	PART NO.	CTVL	QTY	NOTE	DESCRIPTION
C	216-4752	07	SHQ 44-15		CAB - GAME ONLY
CN	220-7599	04	SHQ 44-11		CAB - NACS ONLY
F	372-1626	02	SH 2-C-2		DEMAND FAN
G	372-1627	02	SH 2-C-2		DUAL CONT - GAME
J	233-5824	01	SHQ 2-C-7		DUAL CONT - DELP ALM
JN	233-5825	01	SHQ 2-C-7		DUAL CONT - LAMP ISO
JC	233-5826	01	SHQ 2-C-7		DUAL CONT - SOL MIR PLT 1
JB	233-5827	01	SHQ 2-C-7		DUAL CONT - SOL MIR PLT 2
JK	233-5828	01	SHQ 2-C-7		DUAL CONT - TWO SPD (ENG PRO C)
H	216-4753	04	SHQ 17-C-12		REAR DOOR
N	216-4725	04	SHQ 17		WORK TOOLS - MI
P	216-4726	04	SHQ 17-2		WORK TOOLS - HI
R	216-4704	04	SHQ 17-3		JOYSTICK - RIGHT
T	216-4709	02	SHQ 2-11		MACHINE SECURITY SYSTEM
U	221-3076	04	SHQ 2-15		WIPER / WASHER
V	221-3877	05	SHQ 2-7		WIPER / WASHER AUX
W	221-3878	05	SHQ 2-7		AIR CONDITIONING
AC	221-3879	05	SHQ 2-5		AIR CONDITIONING
FJ	202-2168	01	SHQ 2-4		AC COMPRESSOR JUMPER
FK	202-2169	01	SHQ 2-4		AC CLUTCH
KJ	216-4727	03	SHQ 2-7		ROADING LAMP EXTENSION
KB	216-4726	05	SHQ 44-2		ROADING LAMP (RIGHT SIDE) AR
KB	220-7598	02	SHQ 44-2		ROADING LAMP (RIGHT SIDE) ARUC
LJ	186-8259	03	SH 1-4-5L	E	LH REAR LAMP EXTENSION
LK	216-4728	03	SH 1-4-5L		LH REAR LAMP
RH	213-8234	04	SHQ 2-7		REAR DOOR
RJ	183-7117	02	SH 1-4-5		RR DOOR KIT (ITALY ONLY)
RK	183-7118	02	SH 1-4-5		RR DOOR KIT - PLATFORM
-	216-4731	04	SHQ 2-7		ENGINE
-	216-6848	06	SH 2-GP-6-4	R	AIR CONDITIONING UNIT
-	266-2528	03	SHQ 2-13		DOOR OPEN (3 MOTS)
-	266-2858	03	SHQ 2-13		DOOR CLOSED (3 MOTS)
A	216-4732	04	SHQ 2-C-7		HARNESS TO - 216, 226, 232, 247
A	216-4721	04	SHQ 1-C-2		ENGINE
A	216-4722	04	SHQ 2-C-7		PLATFORM
AJ	233-5788	01	SHQ 2-C-7		FUEL LEVEL JUMPER
AL	233-8897	01	SHQ 2-C-6		HIGH FLOW XPS
-	-	-	HARNESS TO - 216, 226, 232, 247		
A	220-8892	04	SHQ 1-C-1		LOWER PLATFORM
AC	220-8893	04	SHQ 1-C-1		ENGINE
GC	276-2705	04	SHQ 1-C-8		JUMPER BLOCK TO DIODE
FM	220-8895	02	SHQ 2-C-6		HIGH FLOW
PA	292-1128	04	SHQ 2-C-6		UPPER PLATFORM
-	-	-	HARNESS TO - 216, 226, 232, 247		
WA	220-8913	01	SHQ 18-C-9-12		LIGHTING BREAKER JUMPER
WC	240-1913	01	SHQ 18-C-12		QUICK JUMPER
WC	240-1911	02	SHQ 18-C-15		QUICK JUMPER
PW	133-9931	01	SHQ 2-C-6		HIGH FLOW JUMPER STUD
-	133-9931	00	SHQ 18-C-6	A	HIGH FLOW JUMPER
-	133-9931	00	SHQ 2-13	F	TWO SPEED JUMPER
-	133-9931	00	SHQ 2-C-6		HIGH FLOW
-	370-0333	00	SH 1-C-2-5	F	WIRE #2
-	161-9161	01	SH 2-C-5		WIRE #1
-	161-9162	01	SH 2-C-5		WIRE #4
-	134-2985	00	SH 2-C-5		SUIT SWITCH
-	-	-	CABLE KIT		
CA	220-7593	01	SHQ 4-5L-5-C-11		MACHINE GROUND
CC	142-7913	02	SHQ 5-C-11		BATTERY POS TO STARTER (BETA MACH)
CJ	133-7954	01	SHQ 5-C-8		BATTERY POS TO STARTER (HITACHI MACH)
-	-	-	ITEMS KIT		
-	466-4963	01	SHQ 1-19		UPPER FRAME GND TO LOWER FRAME GND
-	70-1585	00	SHQ 44-15		ENG TO PANEL HYD TACHO GND
-	70-1585	00	SHQ 44-2		ENG TO PANEL HYD TACHO GND
-	70-1585	00	SHQ 44-15		HYD TANK TO CAB GND
-	70-1585	00	SHQ 44-11		HYD TANK TO CAB GND

TWO ENGINES STATIC E-SERIES
GRD STEER AND VALVE TUNING LOCATION ENGINES ONLY

TWO ENGINES STATIC F/G/J/L/M/N/P/Q MODELS

2 MB SLEWS - 2 MB SLEW - 2 SLEW SLEWS - 3 MB SLEW 3 MB SWD STEER 2 MOTOR
4 MB SLEW - 2 TB SLEW SWD STEER TRAVEL 2 MOTOR
2 MB SLEW - 3 MB SLEW - 3 MB SLEW - 2 SLEW SLEW - 3 MB SLEW SLEW SWD STEER 2 MOTOR
2 MB SLEW - 3 MB SLEW - 3 MB SLEW - 2 SLEW SLEW - 3 MB SLEW SLEW SWD STEER 2 MOTOR

COMPONENTS ARE SHOWN IN FULLY DE-STROKED MACHINE WITH
THE KEY AND ENGINE OFF AND THE TRANSMISSION SHIFTER IN NEUTRAL
AND DOOR OPEN.



WIRE GROUP COLOR DESCRIPTIONS
WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS OFF.
WIRES THAT HAVE SYSTEM VOLTAGE WHEN THE KEY SWITCH IS ON.
STARTING CIRCUIT.
GROUND CIRCUIT.
STARTING AID CIRCUIT.
MONITOR CIRCUIT.
AUX. HYDRAULIC CONTROL CIRCUIT.
IMPLEMENT CONTROL CIRCUIT.
MACHINE SECURITY CONTROL CIRCUIT.
OPERATOR INTERLOCK CONTROL CIRCUIT.
HEATER AND AIR CONDITIONER CIRCUIT.
TURN SIGNAL/WIPER/WASHER CIRCUIT.

SYMBOL	DESCRIPTION
	BLADE, SPADE, RING, OR SCREW TERMINAL
	SPLICE
	CIRCUIT NOT CONNECTED
	ELECTRICAL CONNECTION TO MACHINE STRUCTURE
	INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT
	CONNECTOR
	ATCH WIRE, CABLE & COMPONENT
	CIRCUIT GROUPING DESIGNATION

ABBREV	COLOR
RD	RED
WH	WHITE
OR	ORANGE
YL	YELLOW
PK	PINK
GN	GLADE
BU	BLUE
PU	PURPLE
BN	BROWN
GY	GREY
BU	BLUE

THIS DIAGRAM IS FOR THE 8 SERIES
900/7550 AND MULTI-TERRAIN LOADERS 216-6423 ONLY

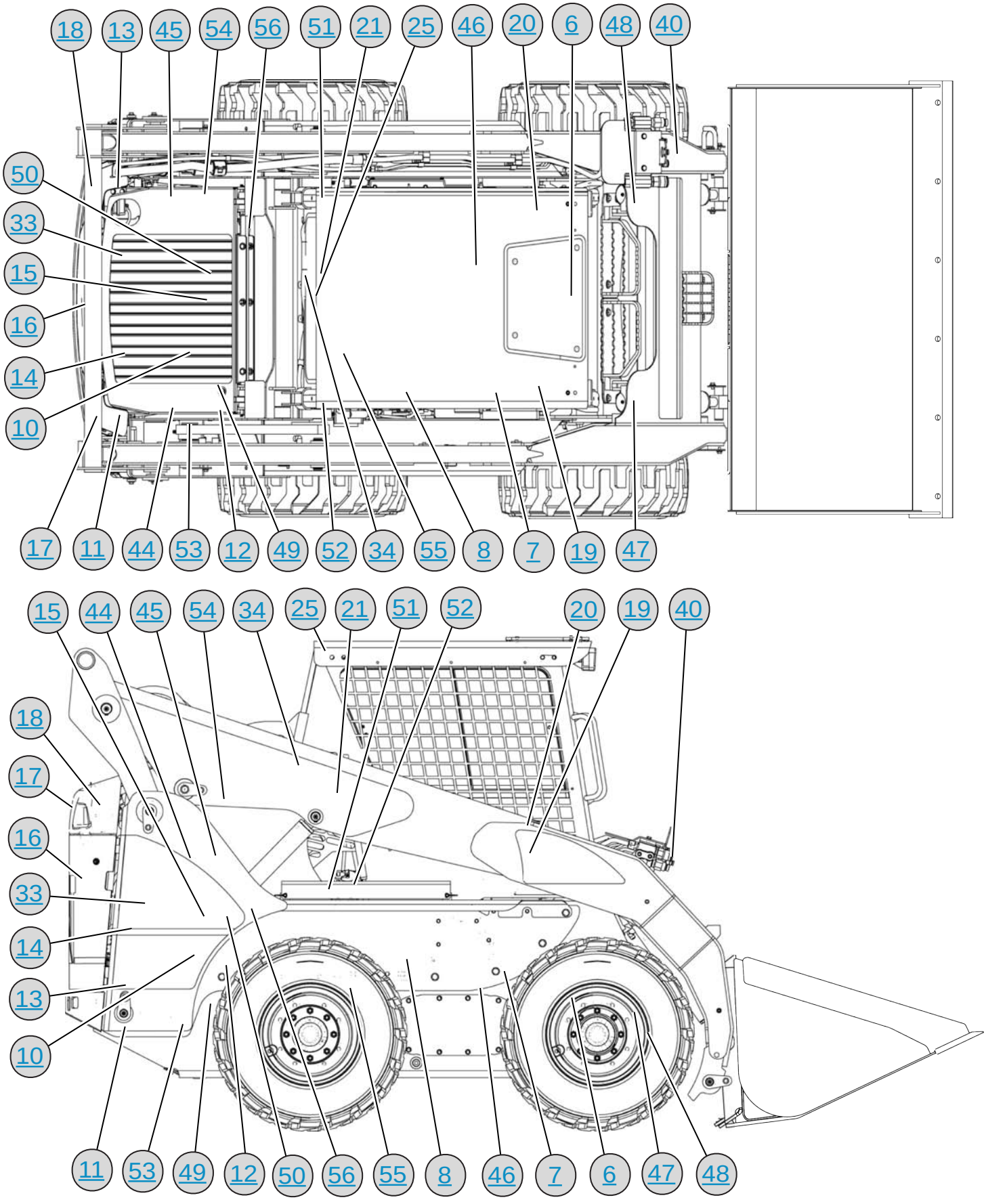
THIS DIAGRAM IS FOR THE FOLLOWING MODELS:
216-7535 - 216R-7535 - 216R-TL0150 - 242R-TL0150 (SKID STEER LOADER)
247R-TL0125 - 257R-TL0125 (MULTI-TERRAIN LOADER)
236R-TL0175 - 246R-TL0150 - 246R-TL0175 - 252R-TL0265 - 262R-TL0265 (SKID STEER LOADER)
267R-TL0245 - 277R-TL0255 - 287R-TL0265 (MULTI-TERRAIN LOADER)

COMPONENTS ARE SHOWN INSTALLED ON A FULLY OPERABLE MACHINE WITH THE KEY ON (ENGINE OFF AND THE TRANSMISSION SHIFTER IN NEUTRAL AND DOOR OPEN.

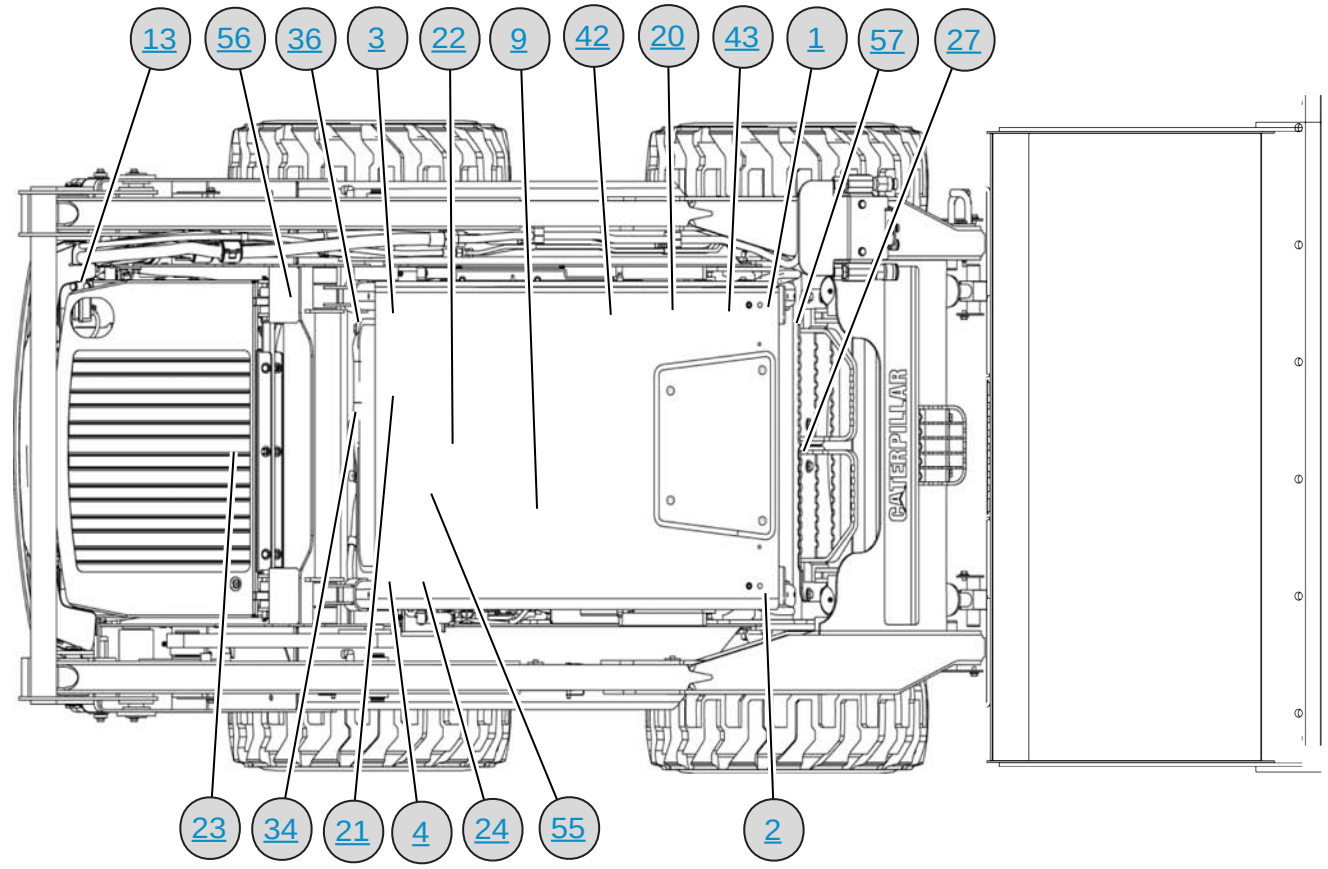
IDENT	PART NO.	CNO	LOC	NOTE	DESCRIPTION
					HARNESS #1 CONNECTS
C	216-4752	01	SHO-H-11		CAB - WIRE ONLY
CN	220-7999	04	SHO-H-11		CAB - MACO ONLY
F	272-1626	02	SH-2 C-2		DEMAND FAN
G	216-6171	04	SHO-G-4		STOP LAMP SW
J	233-5836	01	SHO-C-7		DUAL CONT - BKUP AUX
JC	233-5836	01	SHO-C-7		DUAL CONT - AUX, MP
JC	233-5838	01	SHO-C-7		DUAL CONT - SOL MP PLT 1
JE	233-5836	01	SHO-C-7		DUAL CONT - SOL MP PLT 2
K	216-4755	04	SHO-G-4		HEATER GP (216, 246 ONLY)
M	216-6783	04	SHO-G-4		REAR DOOR
N	216-4725	04	SHO-I-7		WORK TOOLS - KR
N	233-7561	01	SHO-I-7		WORK TOOLS - ARC
R	216-4764	04	SHO-D-3		JOYSTICK - RIGHT
S	216-4763	04	SHO-I-6		MACHINE SECURITY SYSTEM
U	221-5676	04	SHO-I-6		WIPER / WASHER
V	221-5877	05	SHO-I-7		WIPER / WASHER ALX
W	221-5878	05	SHO-I-7		WORK TOOLS - ARC
AC	221-5879	05	SHO-D-4		AIR CONDITIONING
FJ	200-2168	01	SHO-E-4		AC COMPRESSOR JUMPER
HJ	198-2362	01	SHO-C-12, H-14		HORN JUMPER
KJ	216-4727	03	SHO-H-2		ROADING LAMP EXTENSION
KJ	216-4727	03	SHO-H-2		ROADING LAMP JUMPER - 5M
KR	220-7980	02	SHO-H-2		ROADING LAMP HEIGHT SERV ARC
LJ	186-5239	01	SHO-C-10,	E	LH REAR LAMP EXTENSION
RK	233-8859	04	SHO-H-6		JOYSTICK K.D.C.
RM	213-4534	01	SHO-D-7,	D	REAR HYDRAULICS
WT	233-8812	01	SHO-I-6		WORK TOOLS - PLATFORM ONLY
WT	233-8812	01	SHO-I-6		WORK TOOLS - PLATFORM
-	218-6947	04	SH 2-H-6	S	HEATER UNIT
-	218-6948	04	SH 2-H-6	S	HEATER MOUNTING UNIT
-	266-2528	03	SHO-D-8		DIODE (SERVICE METER)
-	266-2528	03	SHO-D-13		DIODE (SERVICE METER)
					HARNESS #2 - 216, 246, 252, 262, 277, 287
E	216-4753	04	SH-1 F-1		ENGINE PLATFORM
E	216-4757	04	SH-1 F-12		ENGINE
P	258-6199	04	SH-1 D-13		UPPER PLATFORM
FJ	202-2168	01	SH-1 F-12	F	FUEL LEVEL JUMPER
FL	233-8859	04	SH-1 F-12		FUEL LEVEL SENDER
					HARNESS #3 - 216, 236, 242, 247, 257, 267, 277
A	220-8892	04	SH-1 F-1		ENGINE PLATFORM
EA	204-8106	01	SH-1 E-8		ENGINE
EC	216-2762	04	SH-1 E-8		JUMPER BLOCKING DIODE
EJ	216-2762	04	SH-1 E-8		ENGINE JUMPER
PA	242-5108	04	SH-1 F-8		UPPER PLATFORM
					WIRE
WA	233-8813	01	SH1-B-9, H-14		LIGHTING BREAKER JUMPER
WC	245-1911	02	SH1-B-12		OUTLK JUMPER
WC	245-1911	02	SH1-B-15		OUTLK JUMPER
PW	233-7962	01	SH1-B-9		MAIN BRK TO PWR STUD
-	133-8951	00	SH1-B-5	R	HIGH FLOW JUMPER
-	133-8951	00	SH1-B-5	R	HIGH FLOW JUMPER
-	190-0312	02	SH2-F-12	N	BEACON
-	670-0333	00	SH 2-C-5		WIRE #5
-	670-0333	00	SH 2-C-5		WIRE #5
-	107-5638	00	SH 2-C-5		WIRE #5
-	104-3985	00	SH 2-C-7, C-13		SEAT SWITCH
					CABLE
CA	182-7003	02	SH1-B-8, D-11		MACHINE GROUND
CC	142-7013	02	SH1-G-11		BATTERY POS TO STARTER (BETA MACH)
CJ	233-7954	01	SH1-B-8		BATTERY POS TO STARTER (ALPHA MACH)
					STRAP
-	380-9963	01	SH1-F-11		UPPER FRAME GND TO LOWER FRAME GND
-	751-1980	00	SH1-H-10		ENG FLYWHSG, HSG TO ENG GND
-	751-1980	00	SH1-B-7		ENG FLYWHSG, HSG TO ENG GND
-	751-1980	00	SH1-H-11		HYD TANK TO CAB GND
-	751-1980	00	SH2-H-11		HYD TANK TO CAB GND

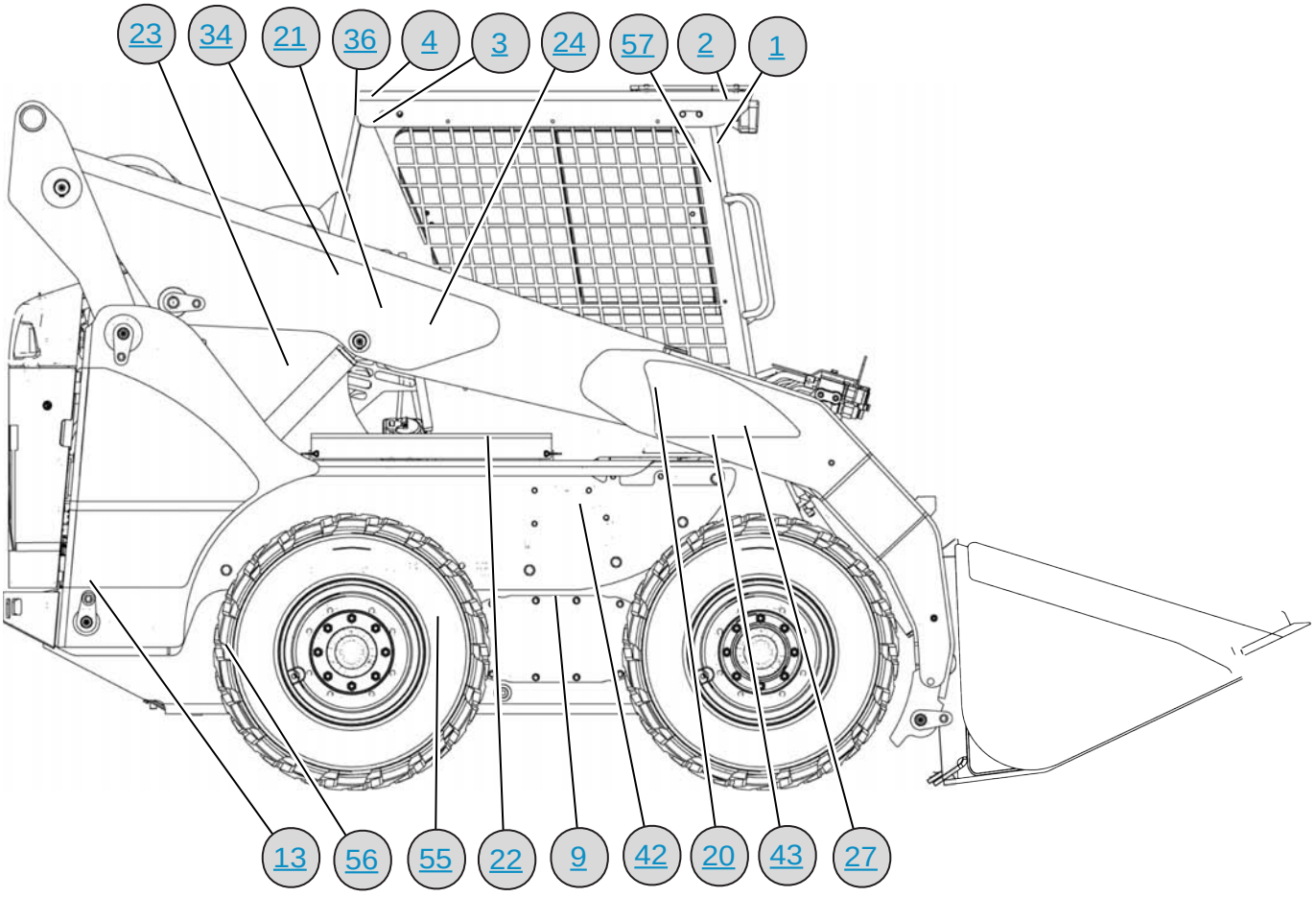
LOCATION	NOTE
VARIOUS	NOTE A - WIRE PAIRS TO BE TWISTED TOGETHER AT LEAST ONE TURN PER 25 mm
VARIOUS	NOTE B - ASSEMBLE TERMINALS TO STUD
SH 1 B-12, C-12, SH 2 B-1, F-14	NOTE C - IF ROADING LAMP KITS# 6 HARN IS USED, CONN #2 C2 TO P-217, CONN #6 C15 AND #6 C2 TO P-C1
SH 2-D-1, E-8-1	NOTE D - IF REAR AUX HYD #7 HARN IS USED, CONN #4 C2 TO #2 C1 AND #4 C1 TO #2 C1
SH 1-C-14	NOTE E - IF 216 ROADING LAMP HARNESS WITH ROADING #5 IS #5 HARNESS
SH 1-F-12	NOTE F - USE FUEL LEVEL SENDER EXTENSION HARNESS ONLY ON 261, 271, OR 281 MACHINES
SH 1-D-13, B-10	NOTE J - FOR MTL #7 OR #9 HARN (CONN PC 24 OR PA-C24) AND THEN CONNECT P-C24 OR PA-C23 TO P-C2
SH 1-A-5	NOTE K - JUMPER #2 REQUIRED FOR USE WITH TWO SPEED SOLENOID FOR HIGH FLOW OPT. MACHINES REMOVE JUMPER #2 AND CONNECT PRESSURE SWITCH TO P-C1 AND P-C2
SH 1-E-8	NOTE L - CUT ONLY FOR TWO SPEED SOLENOID FOR 236 WITH MODELS 246, 246, 252, 262, 267, 277, 287, AND 288
SH 2-H-11	NOTE M - CUT 102 FOR USE WITH ENAB MACHINES ONLY
SH 2-F-12	NOTE N - REMOVE JUMPER WHEN USING BEACON SWITCH
SH 1-E-13	NOTE O - JUMPER #2 REQUIRED FOR USE WITH TWO SPEED SOLENOID #OH
SH 2-D-F-6	NOTE R - HARNESS SUPPLIED WITH AIR CONDITIONING UNIT.
SH 2-H-6	NOTE S - HARNESS SUPPLIED WITH HEATER UNIT
SH 1-I-8	NOTE T - ASSEMBLE TERMINALS INTO CONNECTOR CAVITIES CALLED OUT IN GROUP LEVEL DURING MACHINE ASSEMBLY

MACHINE HARNESS CONNECTOR AND COMPONENT LOCATIONS 1



MACHINE HARNESS CONNECTOR AND COMPONENT LOCATIONS 2





Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02558839

Air Inlet and Exhaust System

SMCS - 1050

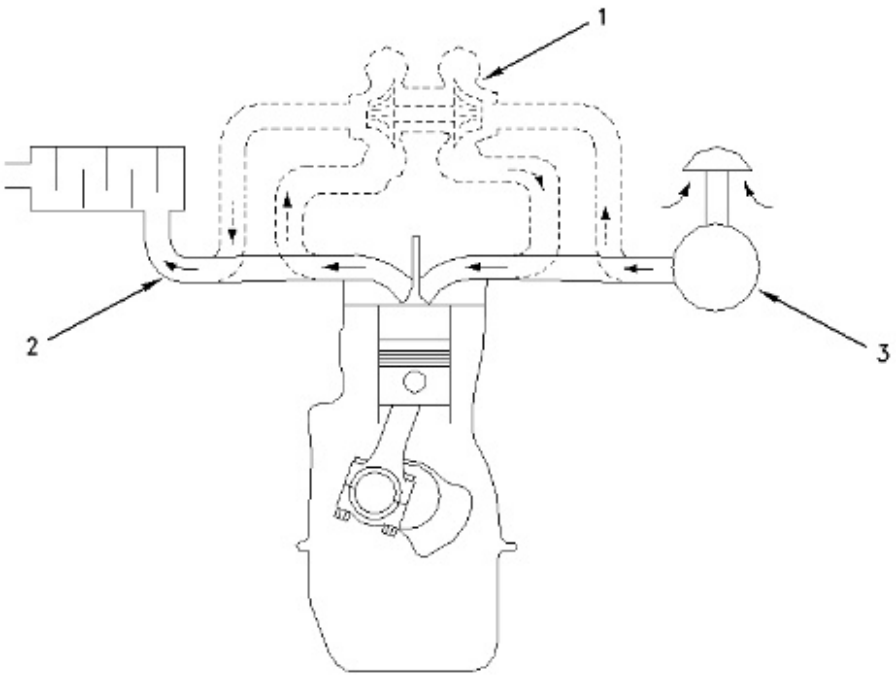


Illustration 1 g00987178

Flow diagram of the air inlet and exhaust system

(1) Turbocharger

(2) Exhaust

(3) Air inlet

The components of the air inlet and exhaust system control the quality of air and the amount of air that is available for combustion.

Naturally aspirated engines pull outside air through air inlet (3) of an air cleaner directly into the inlet manifold. The air flows through the inlet manifold which directs an even distribution of the air to each engine cylinder. The air is pulled into the engine cylinder during the intake stroke of the piston. Fuel is mixed with the air in the engine cylinders during the compression stroke. After the fuel combustion occurs in the engine cylinder, the exhaust gases flow directly to the outside air through exhaust (2) .

Turbocharged engines pull outside air through air inlet (3) of an air cleaner into the air inlet of turbocharger (1). The suction is caused by the turbocharger compressor wheel. Then, the turbocharger compressor wheel compresses the air. The air flows through the inlet manifold which directs an even distribution of the air to each engine cylinder. The air is pulled into the engine cylinder during the intake stroke of the piston. Fuel is mixed with the air in the engine cylinders during the compression stroke. After the fuel combustion occurs in the engine cylinder, the exhaust gases flow to the exhaust manifold. The exhaust gases from the exhaust manifold enter the turbine side of the turbocharger in order to turn the turbocharger turbine wheel. The turbine wheel is connected to the same shaft that drives the compressor wheel. Exhaust gases from the turbocharger pass through the exhaust outlet and to exhaust (2) .

Each piston makes four strokes for one complete cycle in two revolutions of the crankshaft.

1. Intake

   During the intake stroke, the piston moves down and air is drawn into the cylinder through the open inlet valve.

2. Compression

   During the compression stroke, the valves are closed and the piston moves up in the cylinder in order to compress the air. As the air is compressed, the temperature increases. As the piston nears the top of the stroke, fuel is injected into the combustion chamber on top of the piston. The fuel mixes with the hot compressed air in order to cause combustion.

3. Power

   During the power stroke, the valves are closed as the forces from combustion push the piston and connecting rod down turning the crankshaft.

4. Exhaust

   During the exhaust stroke, the inertial force of the turning flywheel helps continue the rotation of the crankshaft in order to push up the piston in the cylinder. This action forces the burned gases out of the exhaust valve. This completes the four strokes of the piston.

Turbocharger (if equipped)

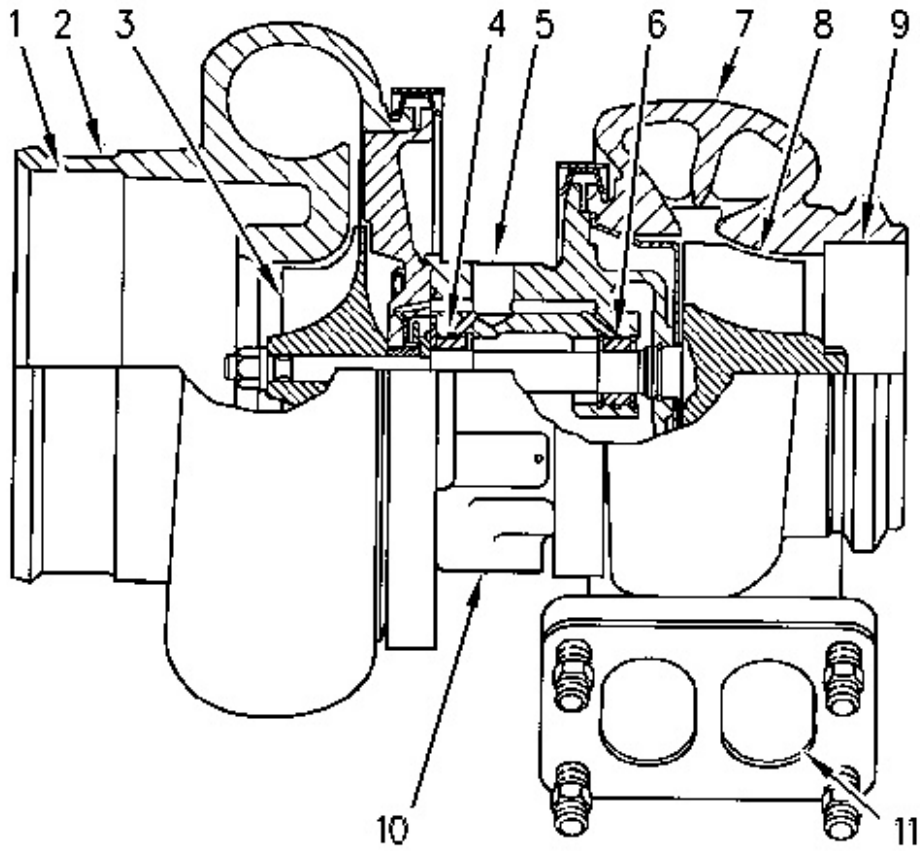


Illustration 2 g00302786

Components of a turbocharger (typical example)

(1) Air inlet

(2) Compressor housing

(3) Compressor wheel

(4) Bearing

(5) Oil inlet port

(6) Bearing

(7) Turbine housing

(8) Turbine wheel

(9) Exhaust outlet

(10) Oil outlet port

(11) Exhaust inlet

The turbocharger is mounted on the exhaust manifold. All the exhaust gases from the engine go through the turbocharger. The exhaust gases enter turbine housing (7) through exhaust inlet (11). The exhaust gases then push the blades of turbine wheel (8). The turbine wheel is connected by a shaft to compressor wheel (3) .

When the load on the engine increases, more fuel is injected into the cylinders. The combustion of this additional fuel produces more exhaust gases. The additional exhaust gases cause the turbine and

the compressor wheels of the turbocharger to turn faster. As the compressor wheel turns faster, more air is forced into the cylinders. The increased flow of air gives the engine more power by allowing the engine to burn the additional fuel with greater efficiency.

Bearings (4) and (6) for the turbocharger use engine oil under pressure for lubrication and cooling. The oil comes in through oil inlet port (5). The oil then goes through passages in the center section in order to lubricate the bearings. This oil also cools the bearings. Oil from the turbocharger passes through oil outlet port (10) in the bottom of the center section. The oil then returns to the engine oil pan.

Valve System Components

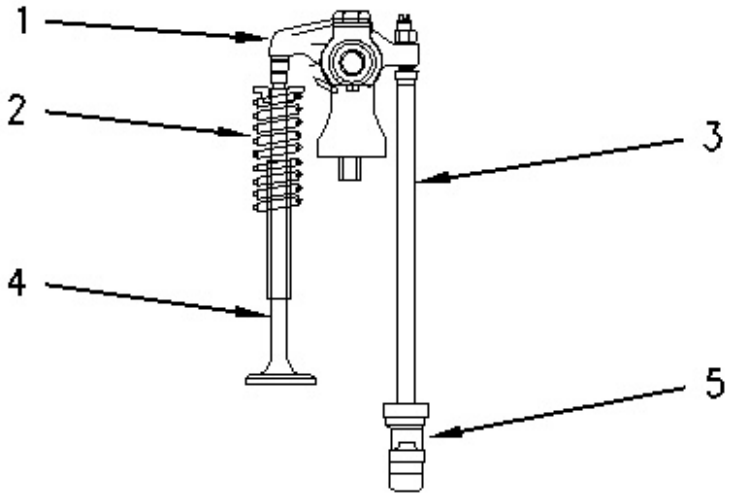


Illustration 3 g00986774

Valve system components

(1) Rocker arm

(2) Valve spring

(3) Pushrod

(4) Valve

(5) Lifter

The valve system components control the flow of inlet air into the cylinders during engine operation. The valve system components also control the flow of exhaust gases out of the cylinders during engine operation.

The crankshaft gear drives the camshaft gear through an upper idler gear. The camshaft must be timed to the crankshaft in order to get the correct relationship between the piston movement and the valve movement.

The camshaft has two camshaft lobes for each cylinder. The lobes operate the inlet and exhaust valves. Each cylinder has one inlet valve and one exhaust valve. As the camshaft rotates, the lobes cause lifter (5) to move pushrod (3) up and down. Upward movement of the pushrod against rocker arm (1) results in downward movement (opening) of valve (4). Valve spring (2) closes the valves when the lifters move down.

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C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02727442

Air Inlet and Exhaust System

SMCS - 1050

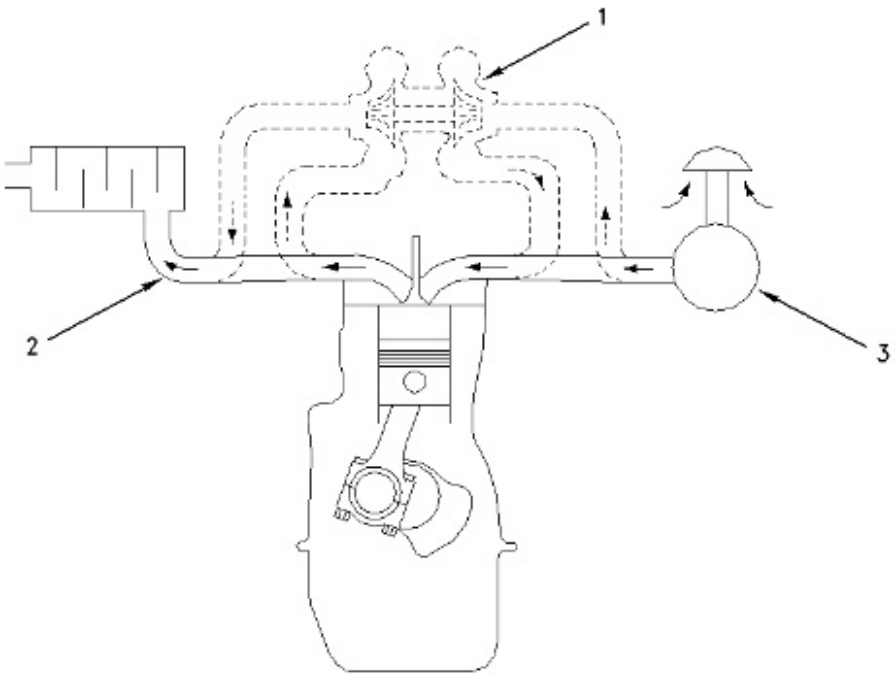


Illustration 1 g00987178

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Turbocharger (if equipped)

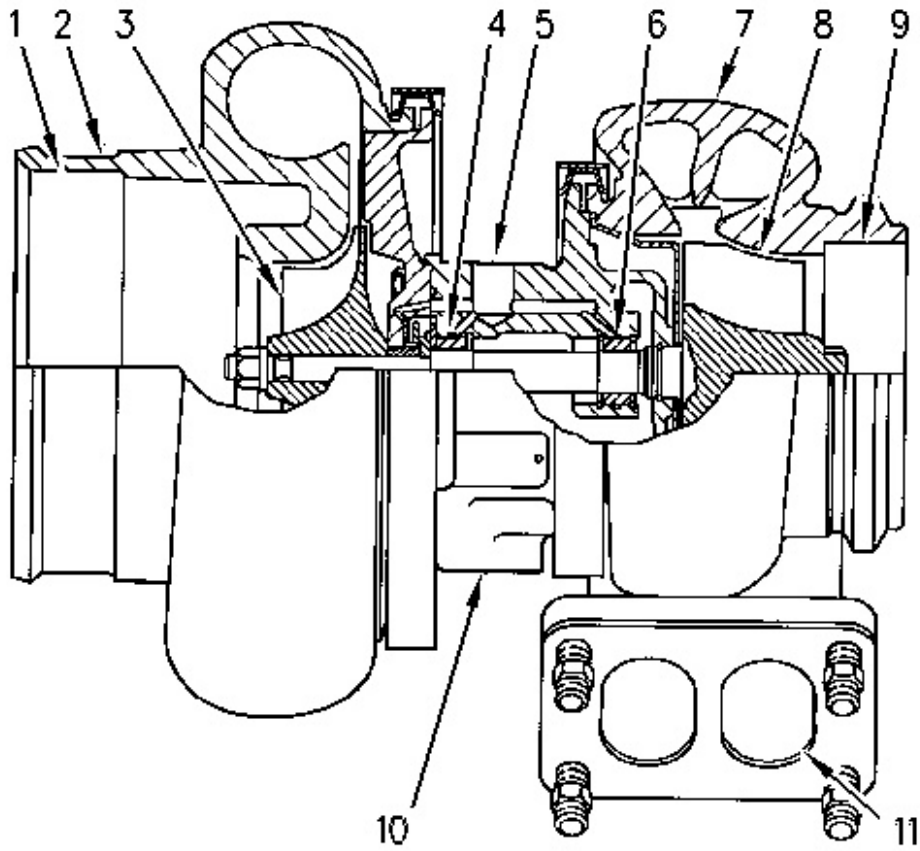


Illustration 2 g00302786

Components of a turbocharger (typical example)

(1) Air inlet

(2) Compressor housing

(3) Compressor wheel

(4) Bearing

(5) Oil inlet port

(6) Bearing

(7) Turbine housing

(8) Turbine wheel

(9) Exhaust outlet

(10) Oil outlet port

(11) Exhaust inlet

The turbocharger is mounted on the exhaust manifold. All the exhaust gases from the engine go through the turbocharger. The exhaust gases enter turbine housing (7) through exhaust inlet (11). The exhaust gases then push the blades of turbine wheel (8). The turbine wheel is connected by a shaft to compressor wheel (3) .

When the load on the engine increases, more fuel is injected into the cylinders. The combustion of this additional fuel produces more exhaust gases. The additional exhaust gases cause the turbine and

the compressor wheels of the turbocharger to turn faster. As the compressor wheel turns faster, more air is forced into the cylinders. The increased flow of air gives the engine more power by allowing the engine to burn the additional fuel with greater efficiency.

Bearings (4) and (6) for the turbocharger use engine oil under pressure for lubrication and cooling. The oil comes in through oil inlet port (5). The oil then goes through passages in the center section in order to lubricate the bearings. This oil also cools the bearings. Oil from the turbocharger passes through oil outlet port (10) in the bottom of the center section. The oil then returns to the engine oil pan.

Valve System Components

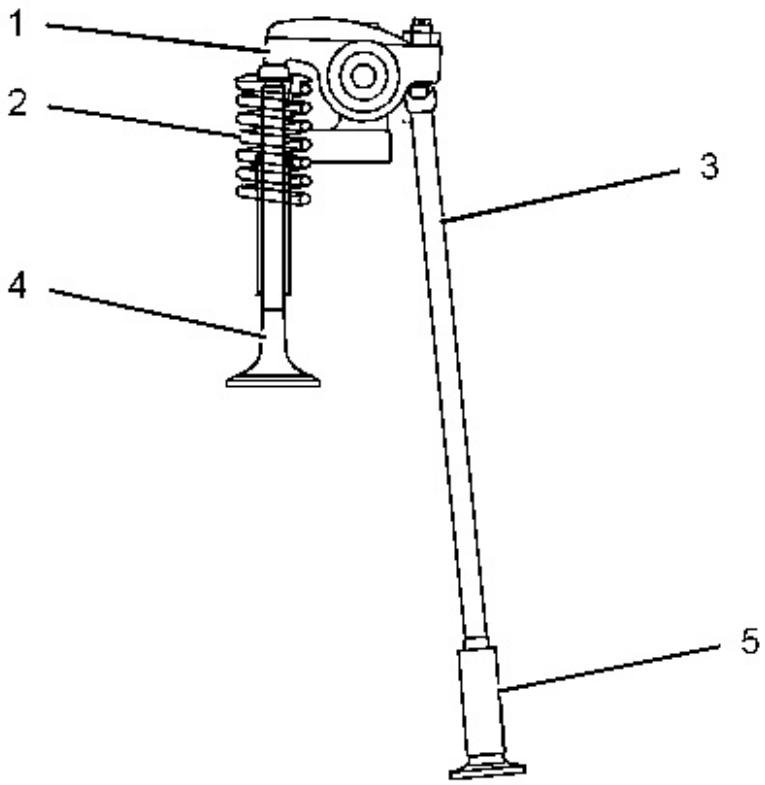


Illustration 3 g01367972

Valve system components

(1) Rocker arm

(2) Valve spring

(3) Pushrod

(4) Valve

(5) Lifter

The valve system components control the flow of inlet air into the cylinders during engine operation. The valve system components also control the flow of exhaust gases out of the cylinders during engine operation.

The crankshaft gear drives the camshaft gear through an upper idler gear. The camshaft must be timed to the crankshaft in order to get the correct relationship between the piston movement and the valve movement.

The camshaft has two camshaft lobes for each cylinder. The lobes operate the inlet and exhaust valves. Each cylinder has one inlet valve and one exhaust valve. As the camshaft rotates, the lobes cause lifter (5) to move pushrod (3) up and down. Upward movement of the pushrod against rocker arm (1) results in downward movement (opening) of valve (4). Valve spring (2) closes the valves when the lifters move down.

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02281171

Air Inlet and Exhaust System - Inspect

SMCS - 1050-040

Do a general visual inspection of the air inlet and exhaust system. Make sure that there are no signs of leaks in the system.

There will be a reduction in the performance of the engine if there is a restriction or there is a leak in the air inlet system or the exhaust system.

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

1. Inspect the engine air cleaner inlet and ducting in order to ensure that the passageway is not blocked or collapsed.
2. Inspect the engine air cleaner element. Replace a dirty element with a clean element.
3. Check for dirt tracks on the clean side of the engine air cleaner element. If dirt tracks are observed, contaminants are flowing past the element.

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i05182893

Turbocharger - Inspect

SMCS - 1052-040

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Introduction

Before you begin inspection of the turbocharger, be sure that the inlet air restriction is within the specifications for your engine. Be sure that the exhaust system restriction is within the specifications for your engine. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".

The condition of the turbocharger will have definite effects on engine performance. Use the following inspections and procedures to determine the condition of the turbocharger.

- Inspection of the compressor wheel and the compressor housing
- Inspection of the turbine wheel and the turbine housing

Required Tools

Table 1

Tools Needed		
Part Number	**Part Name**	**Qty**
6V-3075	Dial Indicator	1

Check Procedure

Inspection of the Compressor Wheel and the Compressor Housing

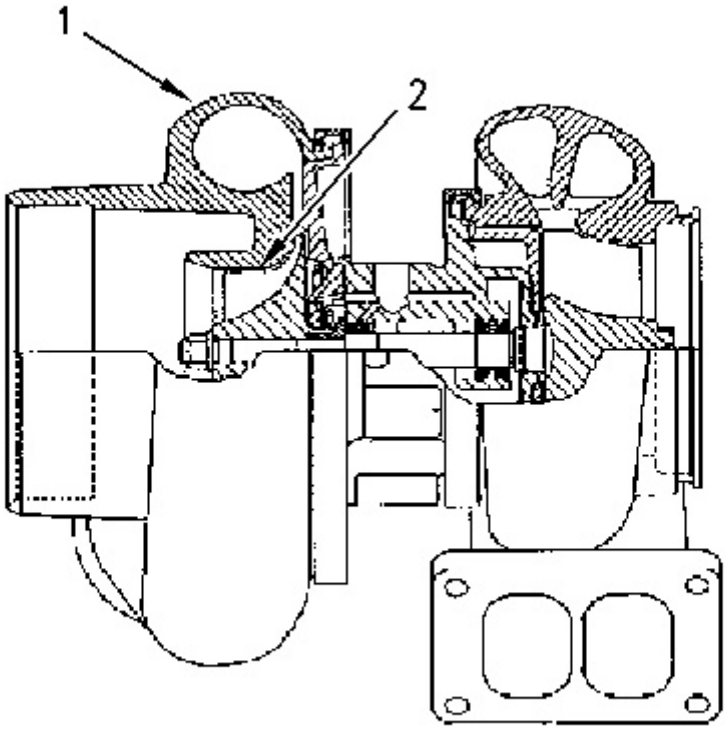


Illustration 1 g00922408

Typical example of a turbocharger

(1) Compressor housing

(2) Compressor wheel

1. Remove the air cleaner from the compressor inlet.
2. Inspect compressor wheel (2) for damage from a foreign object. If there is damage, determine the source of the foreign object. As required, clean the inlet system and repair the intake system. Replace the turbocharger. If there is no damage, go to Step 3.
3. Clean compressor wheel (2) and compressor housing (1) if you find buildup of foreign material. If there is no buildup of foreign material, go to Step 4.
4. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways. The assembly should turn freely. Compressor wheel (2) should not rub compressor housing (1). The turbocharger must be replaced if the compressor wheel rubs the compressor housing. If there is no rubbing or scraping, go to Step 5.
5. Inspect compressor wheel (2) and compressor housing (1) for oil leakage.
    a. Check the oil level in the crankcase. If the oil level is too high, adjust the oil level.
    b. Inspect the air cleaner element for restriction. If restriction is found, correct the problem.

c. Inspect the engine crankcase breather. Clean the breather or replace the breather if the breather is plugged.

d. Remove the oil drain tube. Inspect the oil drain hole and the oil drain tube for oil sludge. Inspect the area between the bearings of the rotating assembly shaft. If necessary, clean the rotating assembly shaft, the oil drain hole, and the oil drain tube.

e. If Steps a through e did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

Inspection of the Turbine Wheel and the Turbine Housing

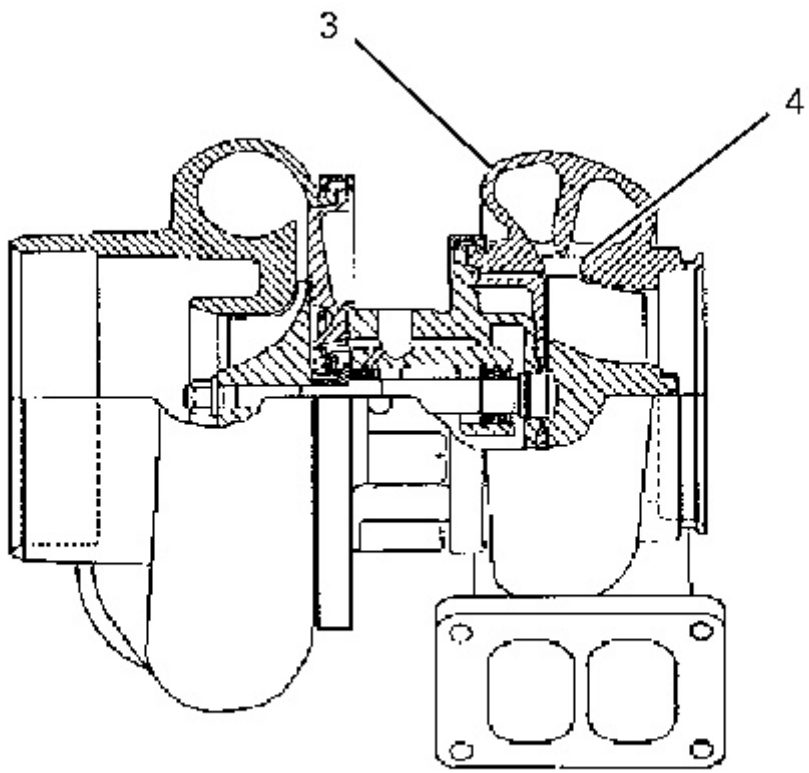


Illustration 2 g01283779

Typical example of a turbocharger

(3) Turbine housing

(4) Turbine wheel

1. Remove the air piping from the turbine housing.

2. Inspect turbine wheel (4) for damage by a foreign object. If there is damage, determine the source of the foreign object. Replace the turbocharger. If there is no damage, go to the next Step.

3. Clean turbine wheel (4) and turbine housing (3) if you find buildup of carbon or foreign material. If there is no buildup of carbon or foreign material, go to the next Step.

4. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways. The assembly should turn freely. Turbine wheel (4) should not rub turbine housing (3). Replace the turbocharger if the turbine wheel rubs the turbine housing. If there is no rubbing or scraping, go to the next Step.

5. Inspect turbine wheel (4) and turbine housing (3) for oil leakage and oil coking. Some oil coking may be cleaned. Heavy oil coking may require replacement of the turbocharger. If the oil is coming from the turbocharger center housing go to the next Steps.

    a. Remove the oil drain tube. Inspect the oil drain hole and the oil drain tube for oil sludge. Inspect the area between the bearings of the rotating assembly shaft. If necessary, clean the rotating assembly shaft, the oil drain hole, and the oil drain tube.

    b. If crankcase pressure is high, or if the oil drain is restricted, pressure in the center housing may be greater than the pressure of turbine housing (3). Oil flow may be forced in the wrong direction and the oil may not drain. Check the crankcase pressure and correct any problems.

    c. If the oil drain tube is damaged, replace the oil drain tube.

    d. Check the routing of the oil drain tube. Eliminate any sharp restrictive bends. Make sure that the oil drain tube is not too close to the engine exhaust manifold.

    e. If Steps a through e did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

Inspection of the Wastegate (If Equipped)

The wastegate controls the amount of exhaust gas that is allowed to bypass the turbine side of the turbocharger. This valve then controls the rpm of the turbocharger.

When the engine operates in conditions of low boost (lug), a spring presses against a diaphragm in the canister. The actuating rod will move and the wastegate will close. Then, the turbocharger can operate at maximum performance.

When the boost pressure increases against the diaphragm in the canister, the wastegate will open. The rpm of the turbocharger becomes limited. The rpm limitation occurs because a portion of the exhaust gases bypass the turbine wheel of the turbocharger.

The following levels of boost pressure indicate a problem with the wastegate:

- Too high at full load conditions
- Too low at all lug conditions

The boost pressure controls the maximum rpm of the turbocharger, because the boost pressure controls the position of the wastegate. The following factors also affect the maximum rpm of the turbocharger:

- The engine rating

- The horsepower demand on the engine
- The high idle rpm
- Inlet air restriction
- Exhaust system restriction

Check the Wastegate for Proper Operation

Note: The turbocharger is a nonserviceable item. The pressure for the wastegate can be checked, but not adjusted.

1. Remove the heat shield from the turbocharger. Remove the guard for the wastegate.
2. Remove the boost line from the wastegate. Connect an air supply to the wastegate that can be adjusted accurately.
3. Fasten a dial indicator to the turbocharger so that the end of the actuator rod is in contact with the dial indicator. This will measure axial movement of the actuator rod.
4. Slowly apply air pressure to the wastegate so that the actuator rod moves the correct value. The air pressure should be at the correct test pressure. Ensure that the dial indicator returns to zero when the air pressure is released. Repeat the test several times. This will ensure that an accurate reading is obtained. Refer to Specifications, "Turbocharger" for the correct values for the movement of the actuator rod and the test pressure.
5. If the operation of the wastegate is incorrect then the turbocharger must be renewed.

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i02478555

Exhaust Temperature - Test

SMCS - 1088-081

Measure the Exhaust Temperature

Table 1

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	164-3310	Laser Infrared Thermometer	1

When the engine runs at low idle, the temperature of an exhaust manifold port can indicate the condition of a fuel injection nozzle.

A low temperature indicates that no fuel is flowing to the cylinder. An inoperative fuel injection nozzle or a problem with the fuel injection pump could cause this low temperature.

A very high temperature can indicate that too much fuel is flowing to the cylinder. A malfunctioning fuel injection nozzle could cause this very high temperature.

Use Tooling (A) in order to check the exhaust temperature at the exhaust outlet for each cylinder.

Compare the temperature readings for each exhaust outlet. Investigate any difference in the temperature readings.

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i02281171

Air Inlet and Exhaust System - Inspect

SMCS - 1050-040

Do a general visual inspection of the air inlet and exhaust system. Make sure that there are no signs of leaks in the system.

There will be a reduction in the performance of the engine if there is a restriction or there is a leak in the air inlet system or the exhaust system.

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

1. Inspect the engine air cleaner inlet and ducting in order to ensure that the passageway is not blocked or collapsed.
2. Inspect the engine air cleaner element. Replace a dirty element with a clean element.
3. Check for dirt tracks on the clean side of the engine air cleaner element. If dirt tracks are observed, contaminants are flowing past the element.

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i05182893

Turbocharger - Inspect

SMCS - 1052-040

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Introduction

Before you begin inspection of the turbocharger, be sure that the inlet air restriction is within the specifications for your engine. Be sure that the exhaust system restriction is within the specifications for your engine. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".

The condition of the turbocharger will have definite effects on engine performance. Use the following inspections and procedures to determine the condition of the turbocharger.

- Inspection of the compressor wheel and the compressor housing
- Inspection of the turbine wheel and the turbine housing

Required Tools

Table 1

Tools Needed		
Part Number	**Part Name**	**Qty**
6V-3075	Dial Indicator	1

Check Procedure

Inspection of the Compressor Wheel and the Compressor Housing

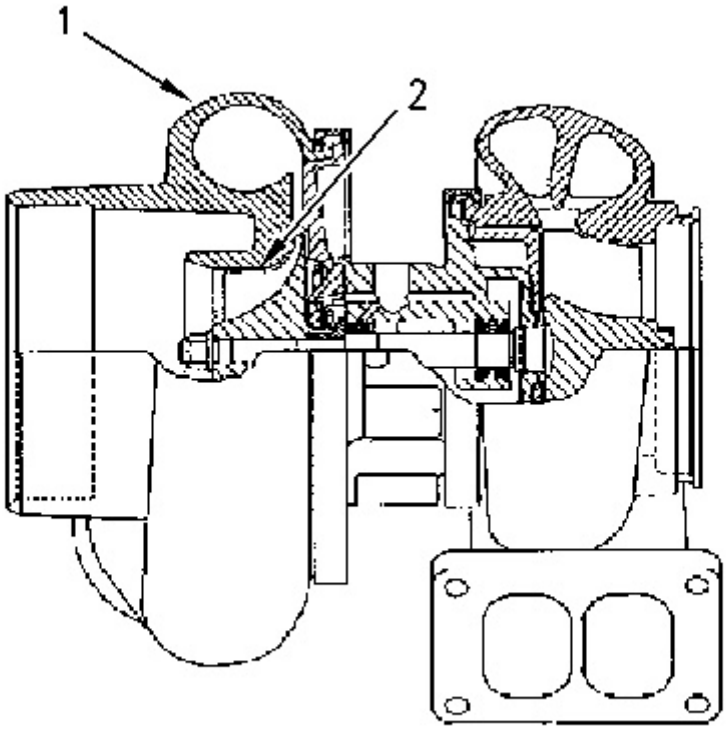


Illustration 1 g00922408

Typical example of a turbocharger

(1) Compressor housing

(2) Compressor wheel

1. Remove the air cleaner from the compressor inlet.
2. Inspect compressor wheel (2) for damage from a foreign object. If there is damage, determine the source of the foreign object. As required, clean the inlet system and repair the intake system. Replace the turbocharger. If there is no damage, go to Step 3.
3. Clean compressor wheel (2) and compressor housing (1) if you find buildup of foreign material. If there is no buildup of foreign material, go to Step 4.
4. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways. The assembly should turn freely. Compressor wheel (2) should not rub compressor housing (1). The turbocharger must be replaced if the compressor wheel rubs the compressor housing. If there is no rubbing or scraping, go to Step 5.
5. Inspect compressor wheel (2) and compressor housing (1) for oil leakage.
    a. Check the oil level in the crankcase. If the oil level is too high, adjust the oil level.
    b. Inspect the air cleaner element for restriction. If restriction is found, correct the problem.

c. Inspect the engine crankcase breather. Clean the breather or replace the breather if the breather is plugged.

d. Remove the oil drain tube. Inspect the oil drain hole and the oil drain tube for oil sludge. Inspect the area between the bearings of the rotating assembly shaft. If necessary, clean the rotating assembly shaft, the oil drain hole, and the oil drain tube.

e. If Steps a through e did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

Inspection of the Turbine Wheel and the Turbine Housing

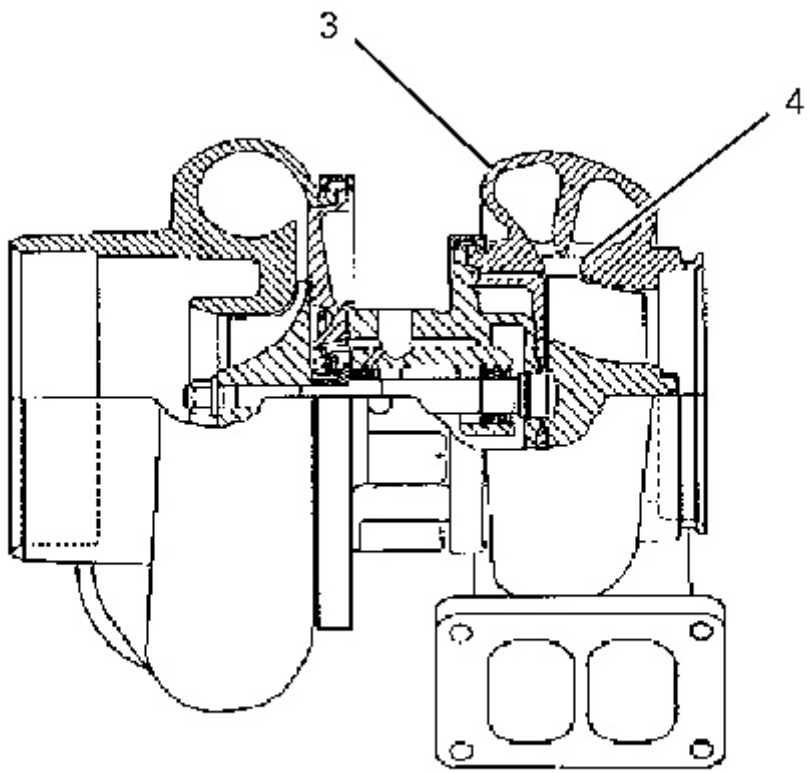


Illustration 2 g01283779

Typical example of a turbocharger

(3) Turbine housing

(4) Turbine wheel

1. Remove the air piping from the turbine housing.

2. Inspect turbine wheel (4) for damage by a foreign object. If there is damage, determine the source of the foreign object. Replace the turbocharger. If there is no damage, go to the next Step.

3. Clean turbine wheel (4) and turbine housing (3) if you find buildup of carbon or foreign material. If there is no buildup of carbon or foreign material, go to the next Step.

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5. Inspect turbine wheel (4) and turbine housing (3) for oil leakage and oil coking. Some oil coking may be cleaned. Heavy oil coking may require replacement of the turbocharger. If the oil is coming from the turbocharger center housing go to the next Steps.

    a. Remove the oil drain tube. Inspect the oil drain hole and the oil drain tube for oil sludge. Inspect the area between the bearings of the rotating assembly shaft. If necessary, clean the rotating assembly shaft, the oil drain hole, and the oil drain tube.

    b. If crankcase pressure is high, or if the oil drain is restricted, pressure in the center housing may be greater than the pressure of turbine housing (3). Oil flow may be forced in the wrong direction and the oil may not drain. Check the crankcase pressure and correct any problems.

    c. If the oil drain tube is damaged, replace the oil drain tube.

    d. Check the routing of the oil drain tube. Eliminate any sharp restrictive bends. Make sure that the oil drain tube is not too close to the engine exhaust manifold.

    e. If Steps a through e did not reveal the source of the oil leakage, the turbocharger has internal damage. Replace the turbocharger.

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- The engine rating

- The horsepower demand on the engine
- The high idle rpm
- Inlet air restriction
- Exhaust system restriction

Check the Wastegate for Proper Operation

Note: The turbocharger is a nonserviceable item. The pressure for the wastegate can be checked, but not adjusted.

1. Remove the heat shield from the turbocharger. Remove the guard for the wastegate.
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3. Fasten a dial indicator to the turbocharger so that the end of the actuator rod is in contact with the dial indicator. This will measure axial movement of the actuator rod.
4. Slowly apply air pressure to the wastegate so that the actuator rod moves the correct value. The air pressure should be at the correct test pressure. Ensure that the dial indicator returns to zero when the air pressure is released. Repeat the test several times. This will ensure that an accurate reading is obtained. Refer to Specifications, "Turbocharger" for the correct values for the movement of the actuator rod and the test pressure.
5. If the operation of the wastegate is incorrect then the turbocharger must be renewed.

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i02478555

Exhaust Temperature - Test

SMCS - 1088-081

Measure the Exhaust Temperature

Table 1

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	164-3310	Laser Infrared Thermometer	1

When the engine runs at low idle, the temperature of an exhaust manifold port can indicate the condition of a fuel injection nozzle.

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Compare the temperature readings for each exhaust outlet. Investigate any difference in the temperature readings.

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02667975

Air Cleaner - Remove and Install

SMCS - 1051-010

Removal Procedure

1. Tilt the radiator. Refer to Operation and Maintenance Manual, "Radiator Tilting".

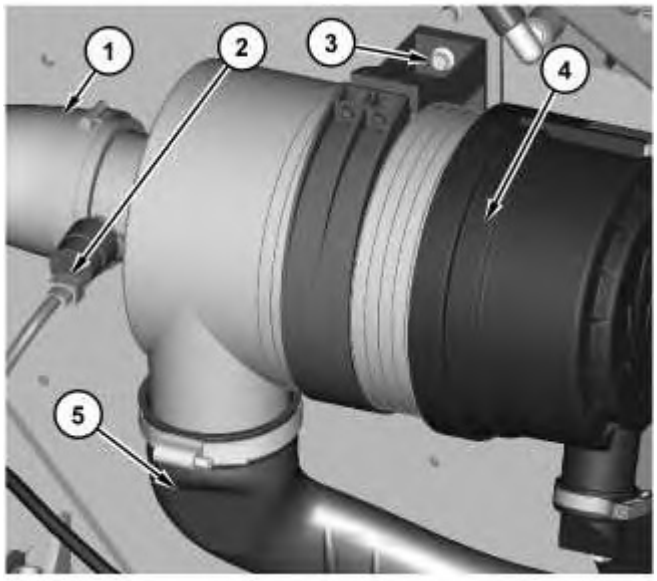


Illustration 1 g01340815

2. Disconnect harness assembly (2). Disconnect hoses (1) and (5). Remove bolts (3) and air cleaner (4) .

Installation Procedure

1. Tilt the radiator. Refer to Operation and Maintenance Manual, "Radiator Tilting".

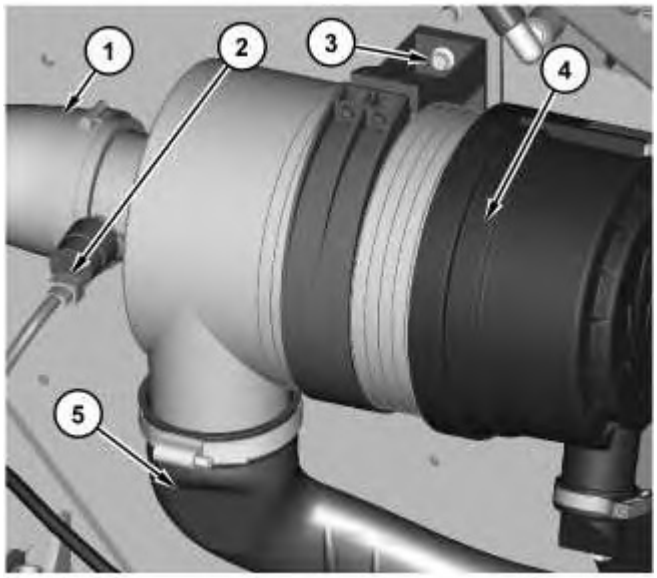


Illustration 2 g01340815

2. Position air cleaner (4) and install bolts (3). Connect hoses (1) and (5). Connect harness assembly (2) .
3. Tilt the radiator back to the original position. Refer to Operation and Maintenance Manual, "Radiator Tilting".

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i02667975

Air Cleaner - Remove and Install

SMCS - 1051-010

Removal Procedure

1. Tilt the radiator. Refer to Operation and Maintenance Manual, "Radiator Tilting".

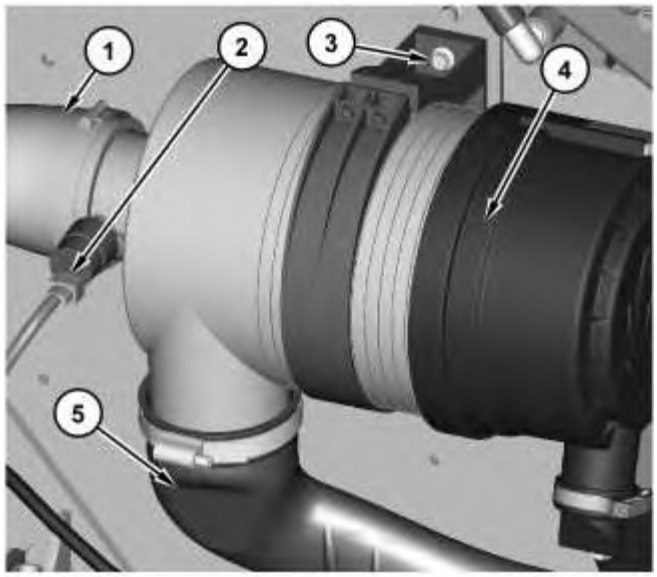


Illustration 1 g01340815

2. Disconnect harness assembly (2). Disconnect hoses (1) and (5). Remove bolts (3) and air cleaner (4) .

Installation Procedure

1. Tilt the radiator. Refer to Operation and Maintenance Manual, "Radiator Tilting".

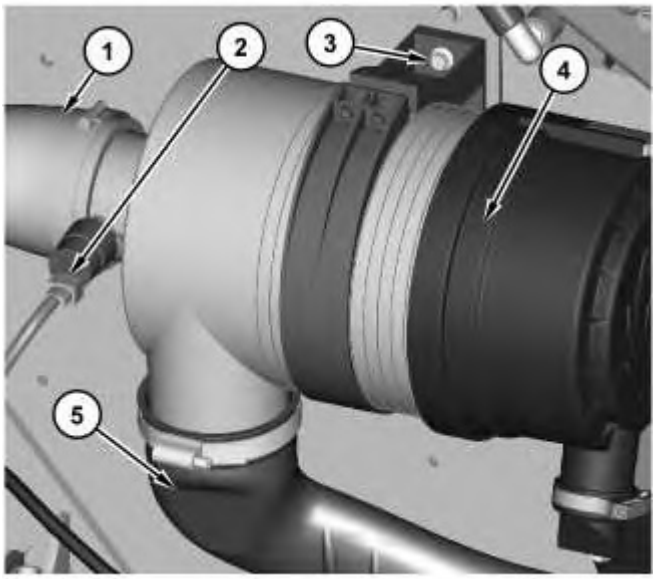


Illustration 2 g01340815

2. Position air cleaner (4) and install bolts (3). Connect hoses (1) and (5). Connect harness assembly (2) .
3. Tilt the radiator back to the original position. Refer to Operation and Maintenance Manual, "Radiator Tilting".

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i02003443

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. Remove the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

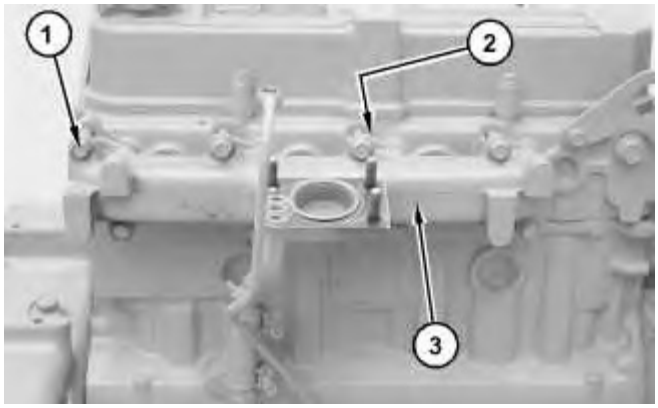


Illustration 1 g01036153

1. Remove bolts (1). Remove exhaust manifold (3) and gasket (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

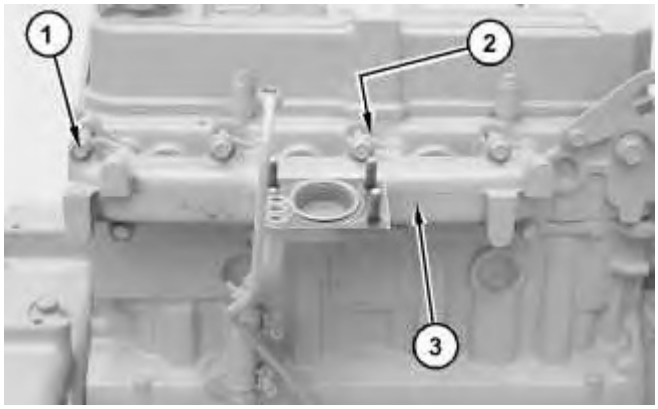


Illustration 2 g01036153

1. Install gasket (2) and exhaust manifold (3). Install bolts (1). Tighten the bolts, beginning at the center of the exhaust manifold and working toward the ends, to the following torque:

   Naturally aspirated engines ... 15 to 22 N·m (11 to 16 lb ft)

   Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

End By: Install the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Install".

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i02003443

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. Remove the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

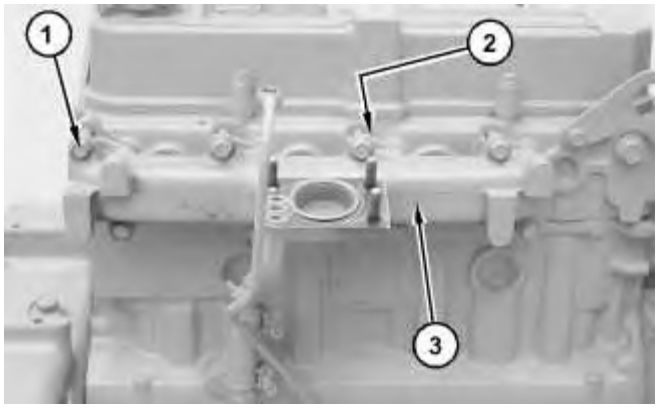


Illustration 1 g01036153

1. Remove bolts (1). Remove exhaust manifold (3) and gasket (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

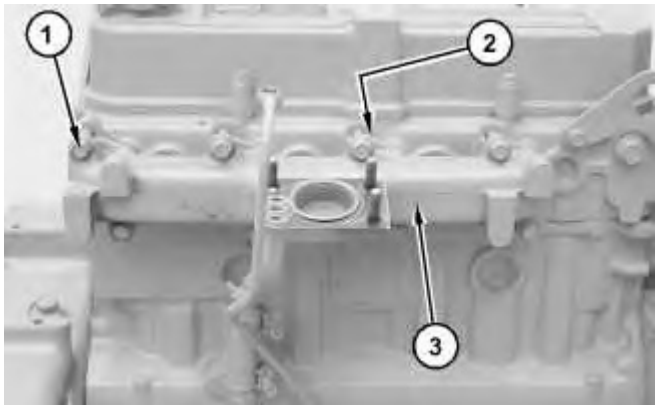


Illustration 2 g01036153

1. Install gasket (2) and exhaust manifold (3). Install bolts (1). Tighten the bolts, beginning at the center of the exhaust manifold and working toward the ends, to the following torque:

   Naturally aspirated engines ... 15 to 22 N·m (11 to 16 lb ft)

   Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

End By: Install the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Install".

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i02638747

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. If the engine is equipped with a turbocharger, remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

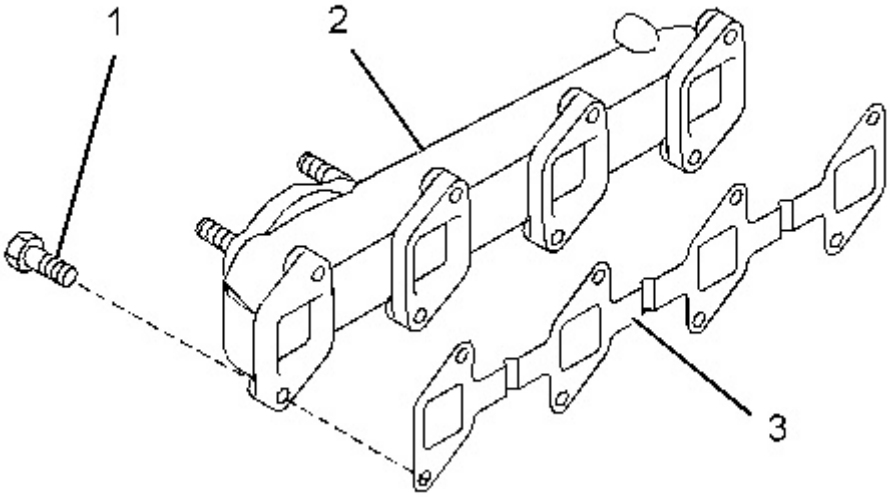


Illustration 1 g01333088

Exhaust manifold from a naturally aspirated engine

1. Loosen bolts (1) .

   Note: In order to prevent distortion of the exhaust manifold, Loosen the outer bolts first.

2. Remove bolts (1) and remove exhaust manifold (2) from the cylinder head.
3. Remove gasket (3) .

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud (M8 x 1.25 by 100 mm)	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the exhaust manifold is clean and free from damage. Clean the joint surface of the cylinder head.

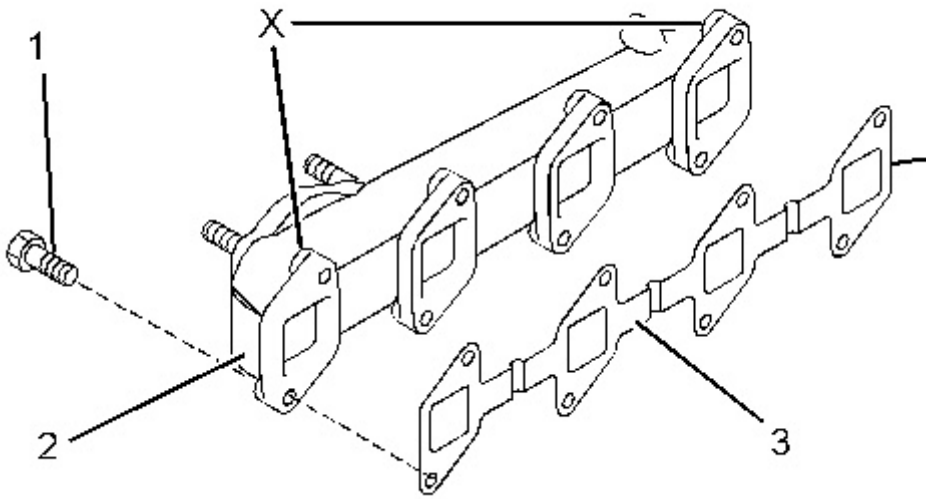


Illustration 2 g01333101

Exhaust manifold from a naturally aspirated engine

2. Install Tooling (A) to the cylinder head in positions (X) .
3. Position a new exhaust manifold gasket (3) onto Tooling (A) .

   Note: Ensure that the exhaust manifold gasket is correctly oriented.
4. Align exhaust manifold (2) with Tooling (A). Install the exhaust manifold to the cylinder head.
5. Install bolts (1) finger tight.
6. Remove Tooling (A). Install the remaining bolts (1) finger tight.
7. Tighten bolts (1) to a torque of 30 N·m (22 lb ft).

   Note: Tighten the center bolts first.

End By: If the engine is equipped with a turbocharger, install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01892688

Exhaust Manifold

SMCS - 1059

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

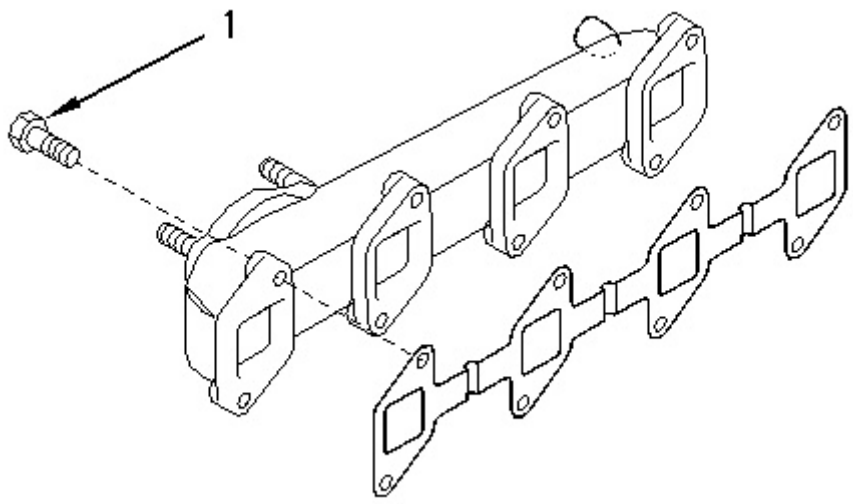


Illustration 1 g00985166

(1) Bolt

Tighten the exhaust manifold bolts to the following torque.

Naturally aspirated engines ... 15 to 22 N·m (11 to 16 lb ft)
Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

Maximum warpage of the flange for the exhaust manifold ... 0.20 mm (0.008 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697374

Exhaust Manifold

SMCS - 1059

S/N - -

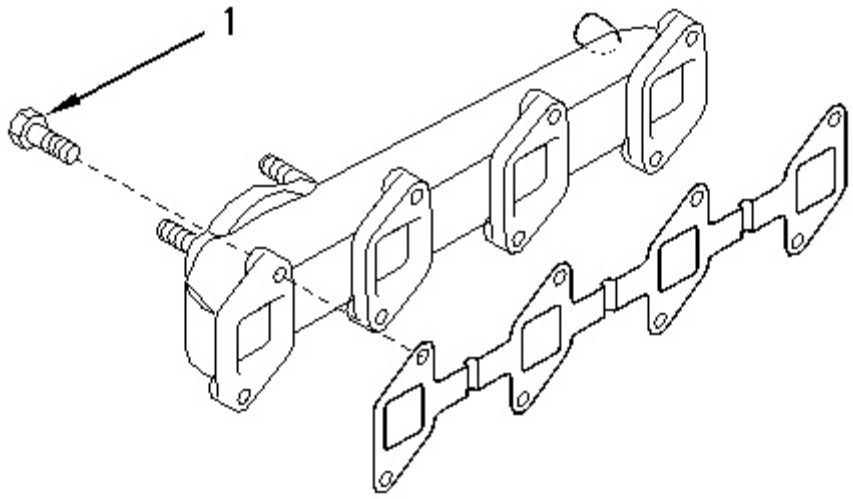


Illustration 1 g00985166

(1) Bolt

Tighten the exhaust manifold bolts to the following torque.

Naturally aspirated engines ... 28 to 33 N·m (21 to 24 lb ft)
Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

Maximum warpage of the flange for the exhaust manifold ... 0.20 mm (0.008 inch)

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i02003443

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. Remove the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

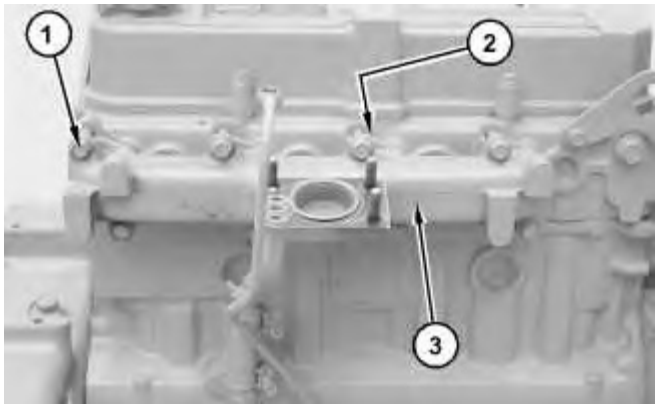


Illustration 1 g01036153

1. Remove bolts (1). Remove exhaust manifold (3) and gasket (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

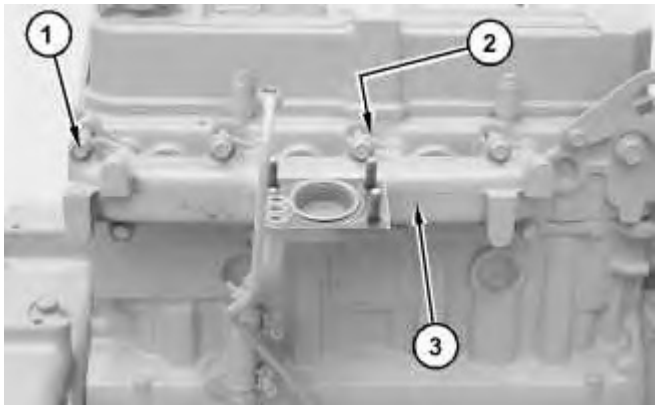


Illustration 2 g01036153

1. Install gasket (2) and exhaust manifold (3). Install bolts (1). Tighten the bolts, beginning at the center of the exhaust manifold and working toward the ends, to the following torque:

   Naturally aspirated engines ... 15 to 22 N·m (11 to 16 lb ft)

   Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

End By: Install the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Install".

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i02003443

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. Remove the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

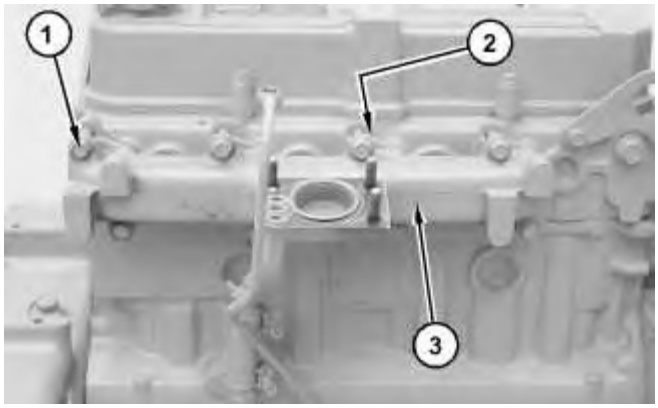


Illustration 1 g01036153

1. Remove bolts (1). Remove exhaust manifold (3) and gasket (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

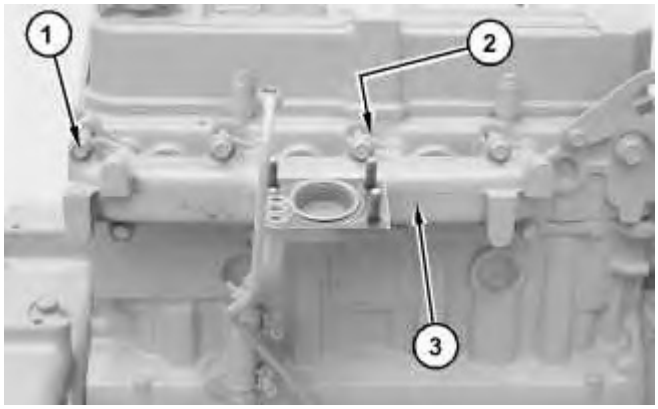


Illustration 2 g01036153

1. Install gasket (2) and exhaust manifold (3). Install bolts (1). Tighten the bolts, beginning at the center of the exhaust manifold and working toward the ends, to the following torque:

   Naturally aspirated engines ... 15 to 22 N·m (11 to 16 lb ft)

   Turbocharged engines ... 28 to 33 N·m (21 to 24 lb ft)

End By: Install the turbocharger, if equipped. Refer to Disassembly and Assembly, "Turbocharger - Install".

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i02638747

Exhaust Manifold - Remove and Install

SMCS - 1059-010

Removal Procedure

Start By:

A. If the engine is equipped with a turbocharger, remove the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove".

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

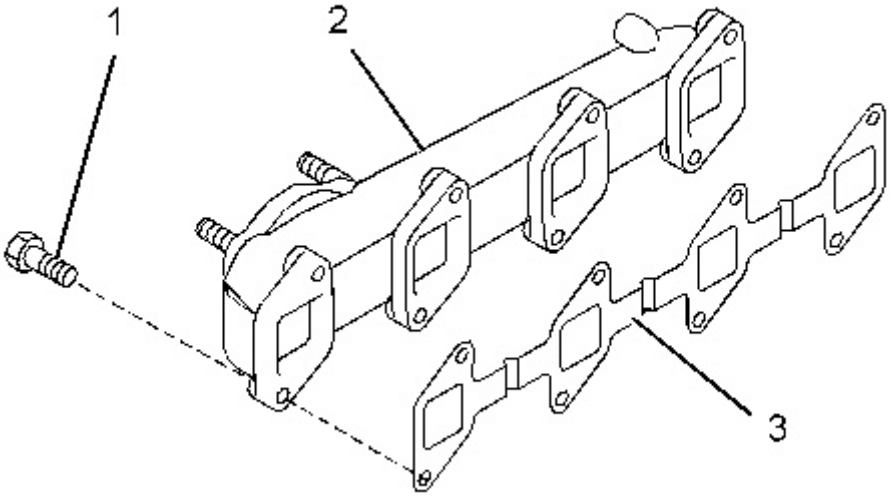


Illustration 1 g01333088

Exhaust manifold from a naturally aspirated engine

1. Loosen bolts (1) .

   Note: In order to prevent distortion of the exhaust manifold, Loosen the outer bolts first.

2. Remove bolts (1) and remove exhaust manifold (2) from the cylinder head.
3. Remove gasket (3) .

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud (M8 x 1.25 by 100 mm)	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the exhaust manifold is clean and free from damage. Clean the joint surface of the cylinder head.

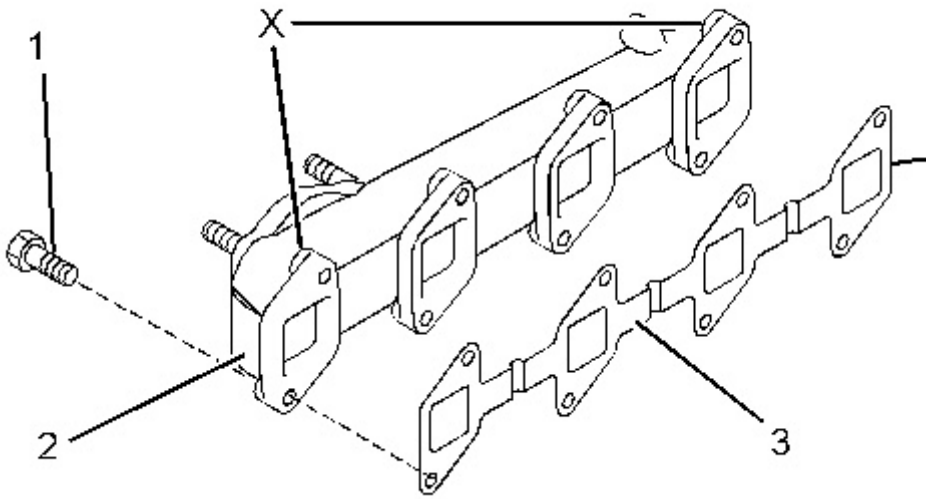


Illustration 2 g01333101

Exhaust manifold from a naturally aspirated engine

2. Install Tooling (A) to the cylinder head in positions (X) .
3. Position a new exhaust manifold gasket (3) onto Tooling (A) .

   Note: Ensure that the exhaust manifold gasket is correctly oriented.
4. Align exhaust manifold (2) with Tooling (A). Install the exhaust manifold to the cylinder head.
5. Install bolts (1) finger tight.
6. Remove Tooling (A). Install the remaining bolts (1) finger tight.
7. Tighten bolts (1) to a torque of 30 N·m (22 lb ft).

   Note: Tighten the center bolts first.

End By: If the engine is equipped with a turbocharger, install the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Install".

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i02001104

Inlet Manifold - Remove

SMCS - 1058-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7087	Tapered Cap/Plug	1
	9U-7089	Tapered Cap/Plug	1

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

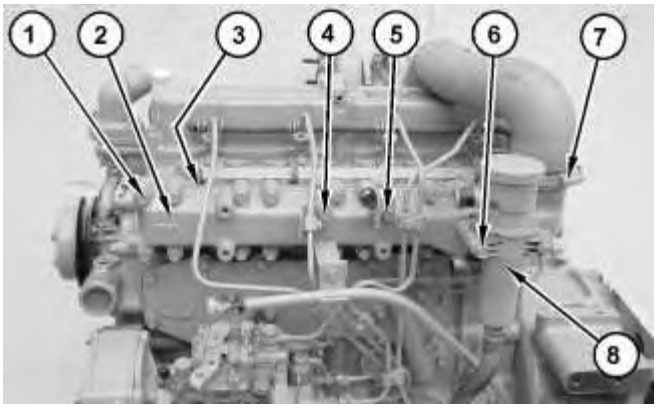


Illustration 1 g01035474

1. Remove bolts (6) and position crankcase breather (8) out of the way. Loosen clamp (7) and disconnect the hose assembly. Remove bolts (4) and (5). Remove bolts (1). Remove inlet manifold (2) and gasket (3) .

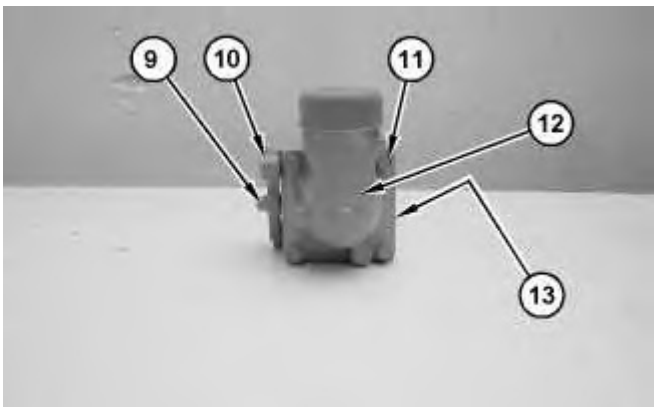


Illustration 2 g01035495

2. Remove bolt (9) and bracket (10). Remove bolts (11). Remove elbow assembly (12) and gasket (13) .

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i02001241

Inlet Manifold - Install

SMCS - 1058-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

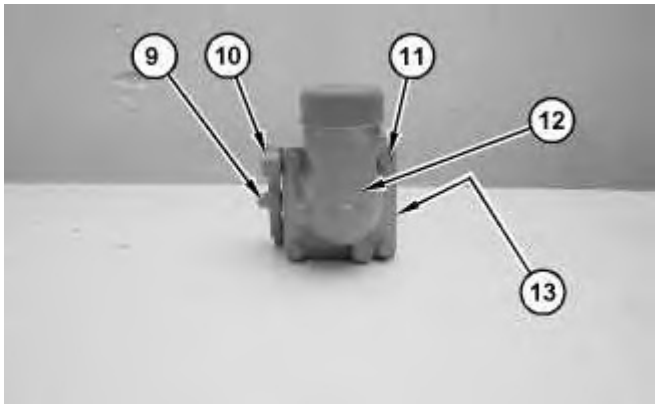


Illustration 1 g01035495

1. Install gasket (13) and elbow assembly (12). Install bolts (11). Install bracket (10) and bolt (9) .

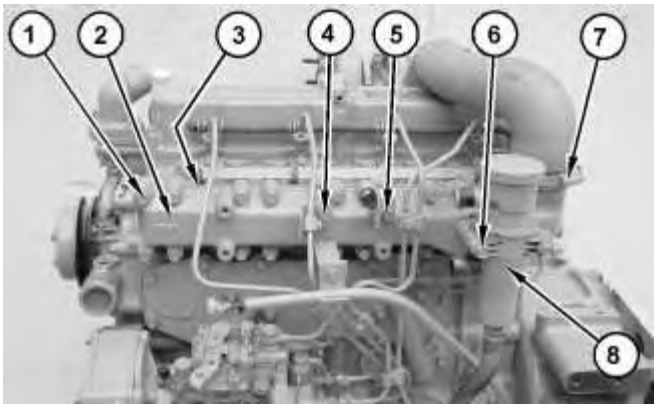


Illustration 2 g01035474

2. Install gasket (3) and position inlet manifold (2). Install bolts (1). Install bolts (4) and (5). Connect the hose assembly and tighten clamp (7). Position crankcase breather (8) and install bolts (6) .

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i02001104

Inlet Manifold - Remove

SMCS - 1058-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7087	Tapered Cap/Plug	1
	9U-7089	Tapered Cap/Plug	1

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

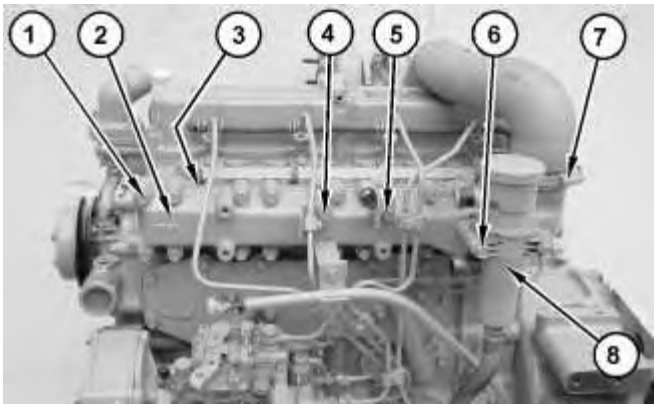


Illustration 1 g01035474

1. Remove bolts (6) and position crankcase breather (8) out of the way. Loosen clamp (7) and disconnect the hose assembly. Remove bolts (4) and (5). Remove bolts (1). Remove inlet manifold (2) and gasket (3) .

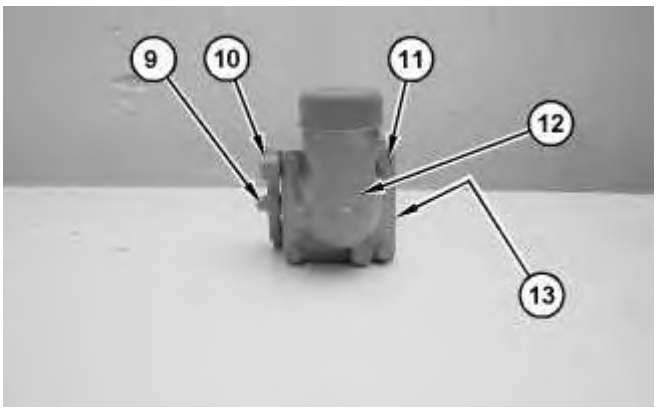


Illustration 2 g01035495

2. Remove bolt (9) and bracket (10). Remove bolts (11). Remove elbow assembly (12) and gasket (13) .

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i02001241

Inlet Manifold - Install

SMCS - 1058-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

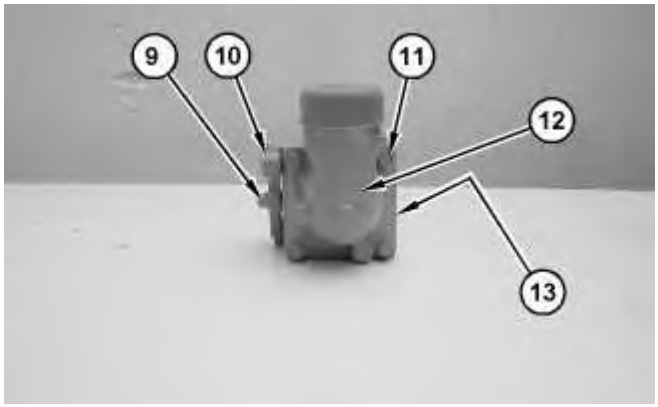


Illustration 1 g01035495

1. Install gasket (13) and elbow assembly (12). Install bolts (11). Install bracket (10) and bolt (9) .

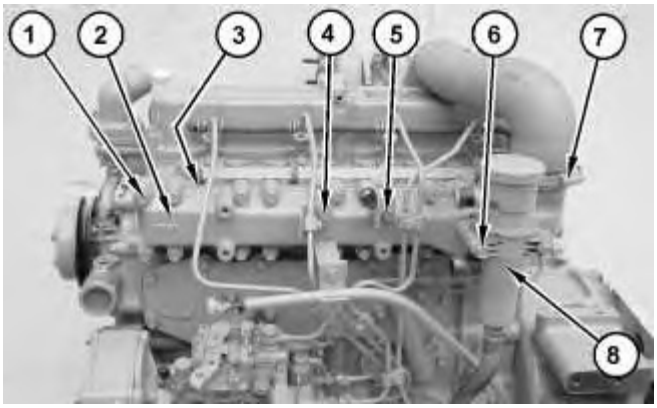


Illustration 2 g01035474

2. Install gasket (3) and position inlet manifold (2). Install bolts (1). Install bolts (4) and (5). Connect the hose assembly and tighten clamp (7). Position crankcase breather (8) and install bolts (6) .

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638751

Inlet Manifold - Remove and Install

SMCS - 1058-010

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

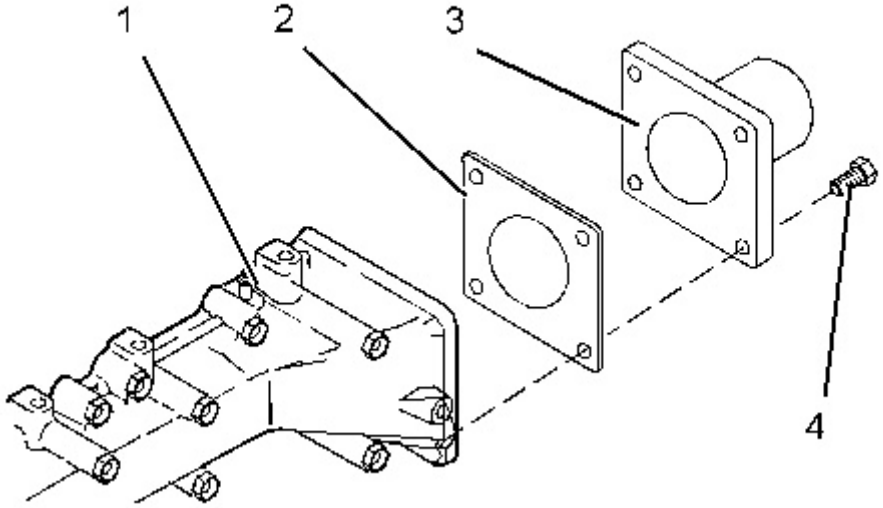


Illustration 1 g01333458

Typical example

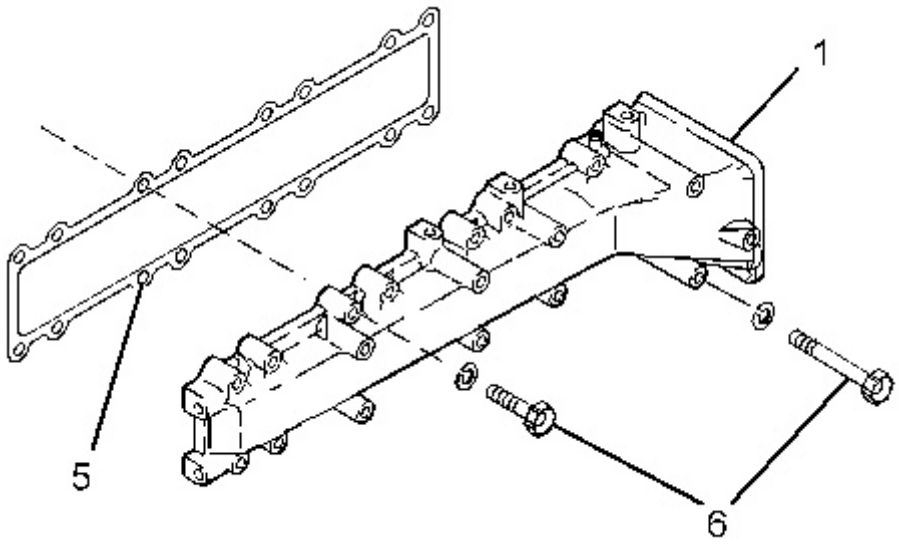


Illustration 2 g01333457

Typical example

1. Loosen the hose clamps and disconnect the air hose (not shown) from connection (3) .
2. For naturally aspirated engines, disconnect the hose for the crankcase breather (not shown) from inlet manifold (1) .

For turbocharged engines, remove the bolt that secures the hose for the crankcase breather (not shown) from the inlet manifold (1) .

3. Remove bolts (6) from inlet manifold (1). Note the position of any brackets that are retained by the bolts for installation.
4. Remove inlet manifold (1) and gasket (5) from the cylinder head.
5. If necessary, remove bolts (4) and remove connection (3) from inlet manifold (1). Remove gasket (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all mating surfaces are clean and free from debris.

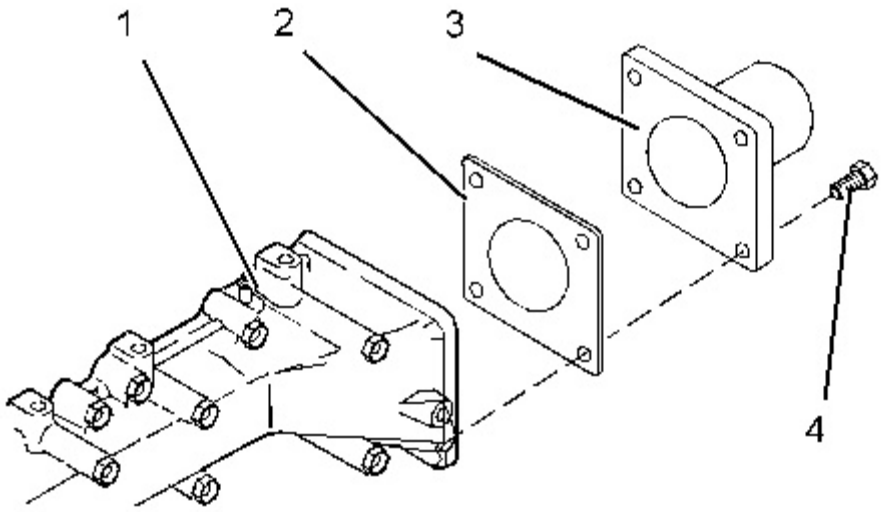


Illustration 3 g01333458

Typical example

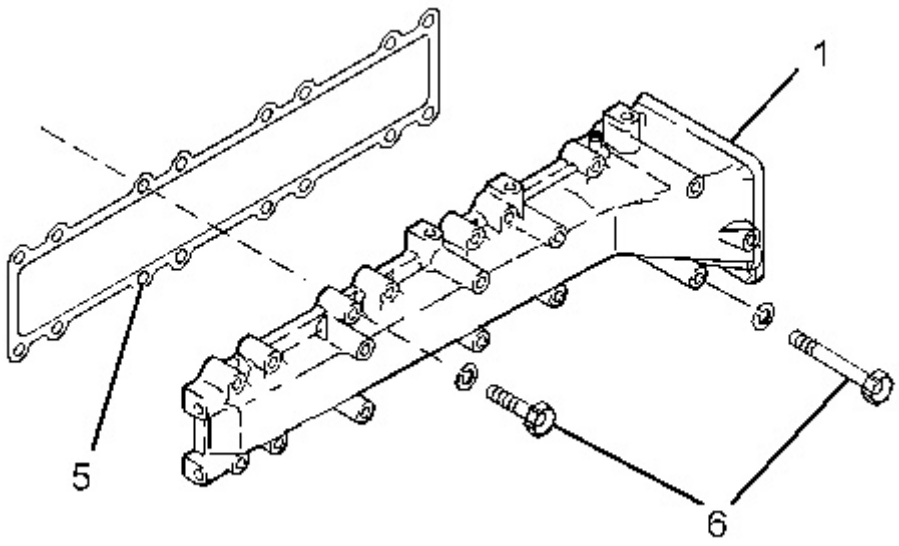


Illustration 4 g01333457

Typical example

2. If necessary, position a new gasket (2) and connection (3) onto inlet manifold (1). Install bolts (4). Tighten the bolts to a torque of 11 N·m (97 lb in).

   Note: Ensure correct orientation of the connection.

3. Place a new gasket (5) in position on inlet manifold (1) .

4. Position inlet manifold (1) on the cylinder head.

5. Install bolts (6). Ensure that bolts of different lengths are installed in the correct positions. Also ensure that any brackets that are retained by the bolts are installed in the correct positions.

6. Tighten bolts (6) to a torque of 18 N·m (13 lb ft).

7. For naturally aspirated engines, connect the hose for the crankcase breather (not shown) to inlet manifold (1) .

   For turbocharged engines, install the bolt that secures the hose for the crankcase breather (not shown) to the inlet manifold (1). Tighten the bolt to a torque of 11 N·m (97 lb in).

8. Connect the air hose (not shown) to connection (3) and tighten the hose clamps securely.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and install".

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02014368

Muffler - Remove and Install

SMCS - 1062-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

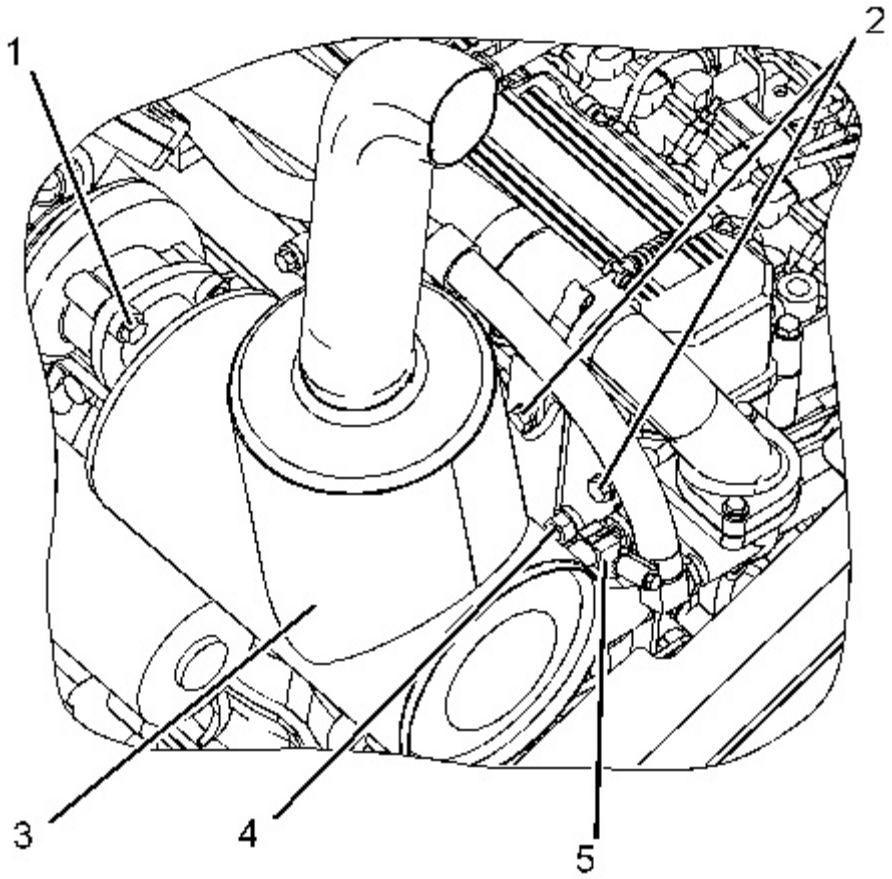


Illustration 1 g01041430

1. Remove bolts (1). Disconnect harness assembly (5). Remove bolts (2). Remove nut (4). Remove muffler (3) .

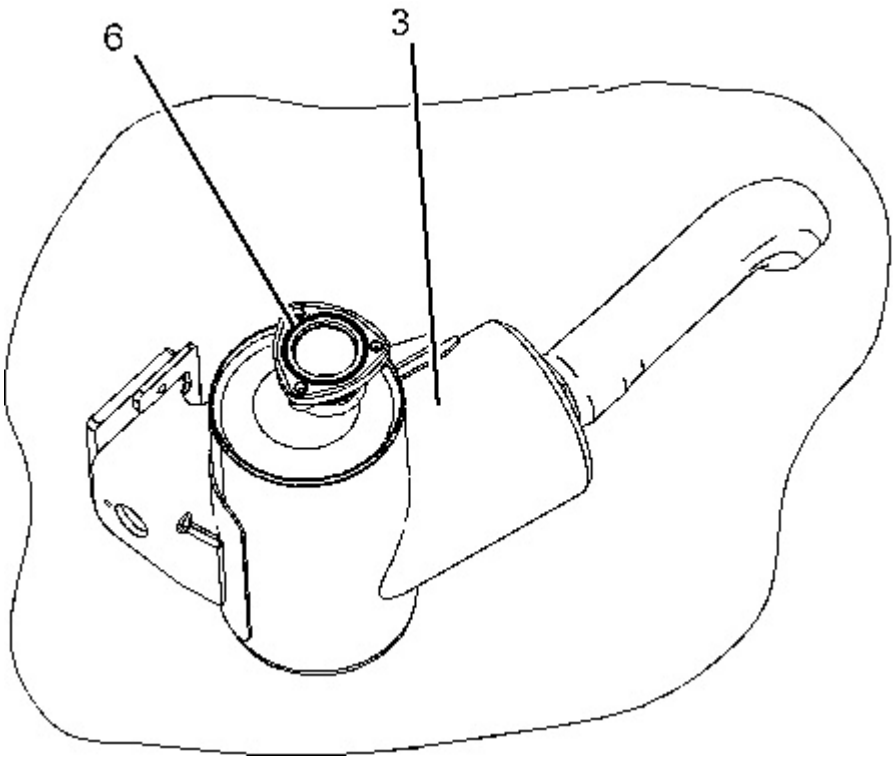


Illustration 2 g01041438

2. Remove gasket (6) from muffler (3). Note the orientation of the gasket for installation purposes.

Installation Procedure

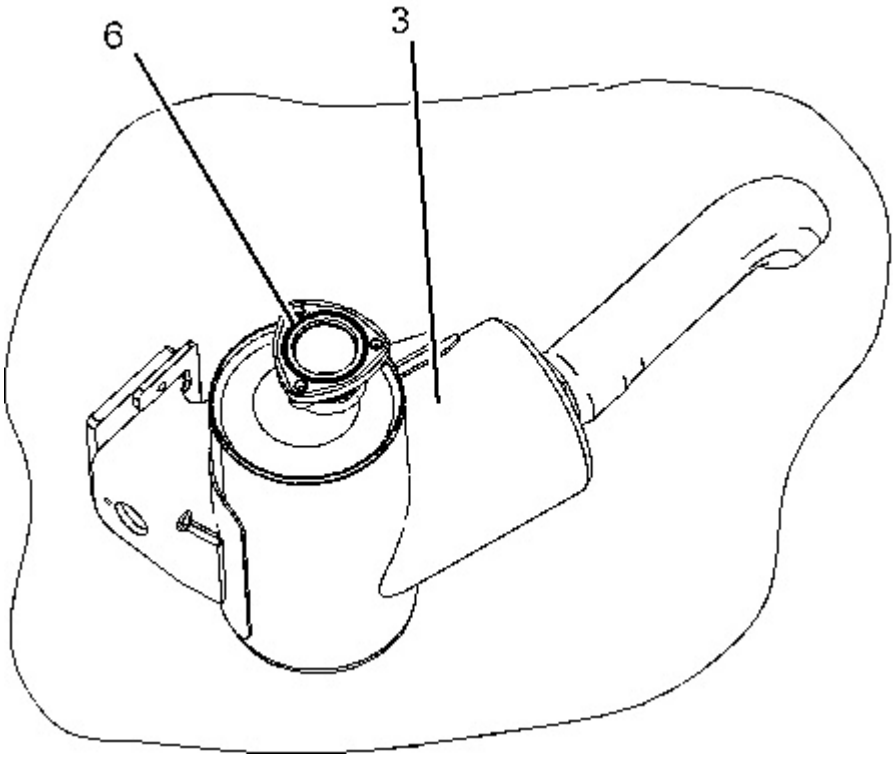


Illustration 3 g01041438

1. Install gasket (6) onto muffler (3). Note the orientation of the gasket.

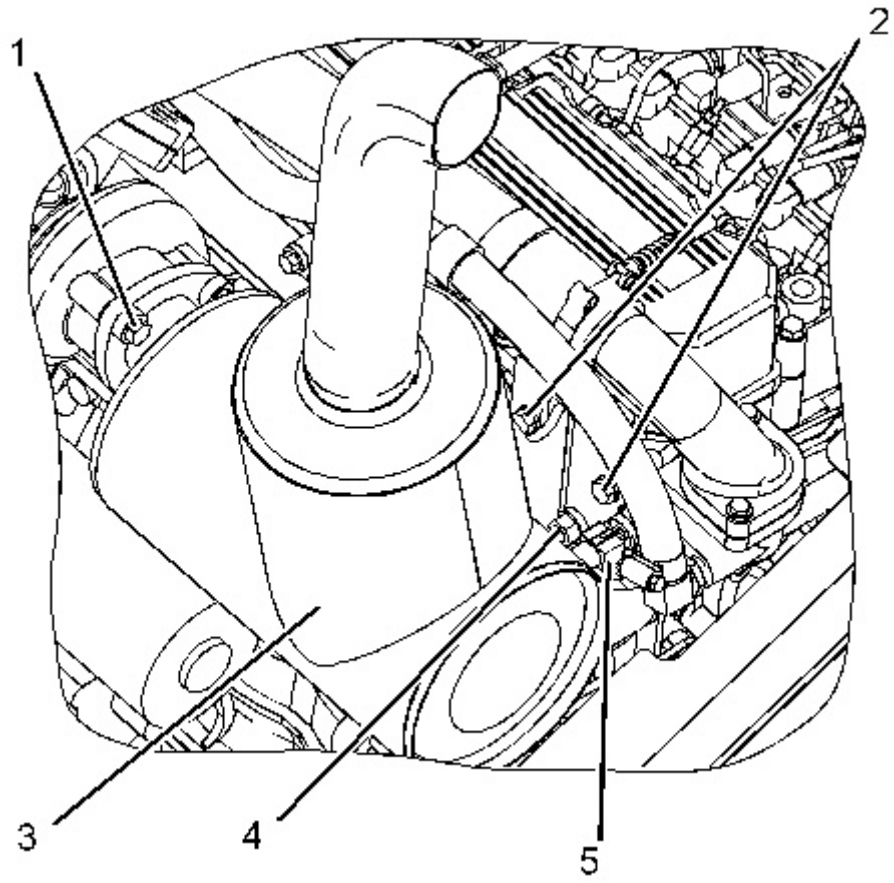


Illustration 4 g01041430

2. Install muffler (3). Install bolts (1). Install nut (4). Install bolts (2). Connect harness assembly (5).

   Note: Bolts (1) need to be installed first in order to properly seal gasket (6) .

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i02014368

Muffler - Remove and Install

SMCS - 1062-010

Removal Procedure

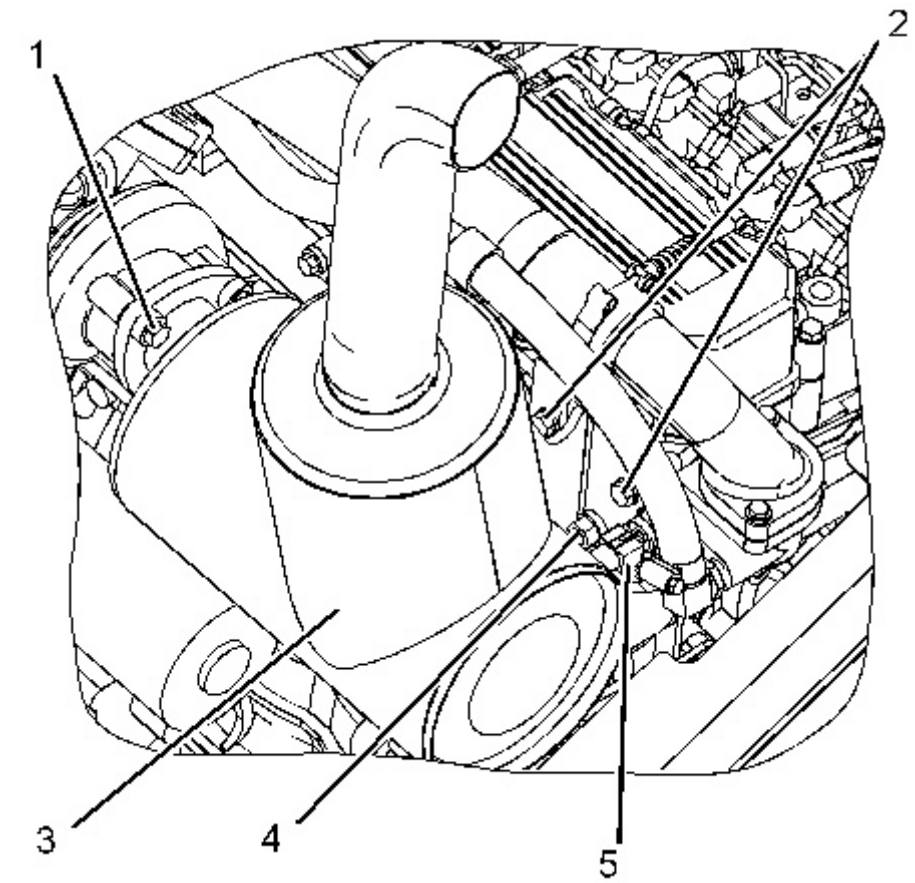


Illustration 1 g01041430

1. Remove bolts (1). Disconnect harness assembly (5). Remove bolts (2). Remove nut (4). Remove muffler (3) .

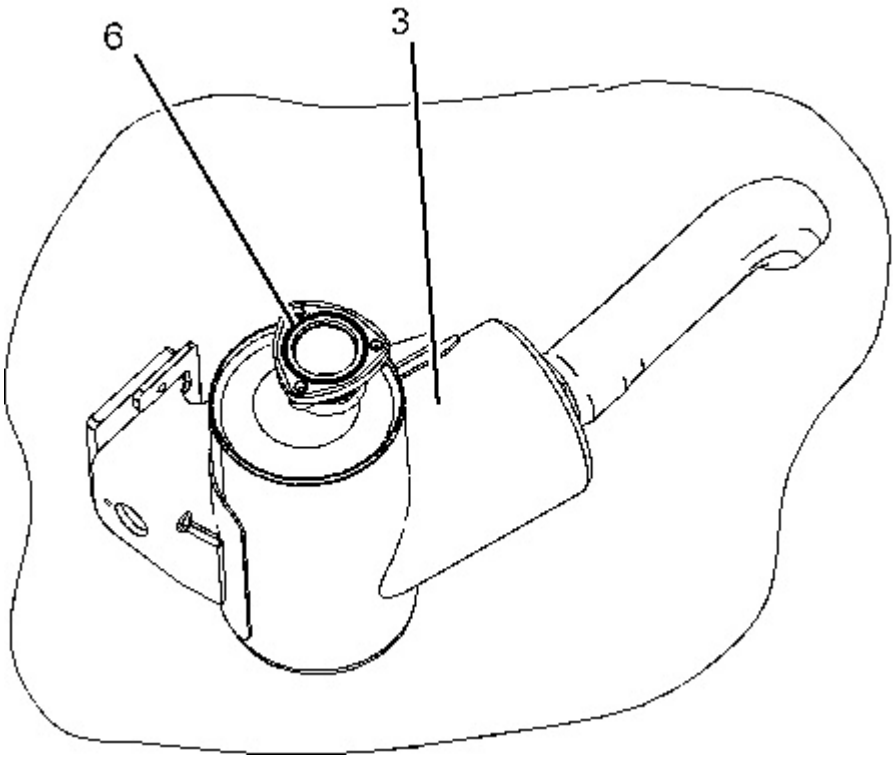


Illustration 2 g01041438

2. Remove gasket (6) from muffler (3). Note the orientation of the gasket for installation purposes.

Installation Procedure

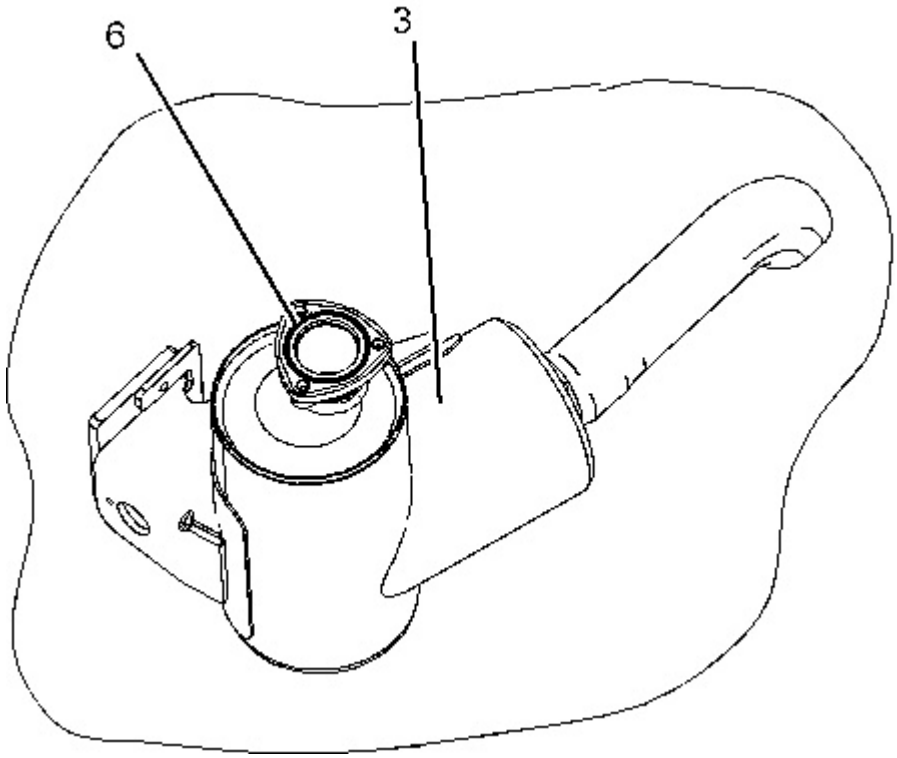


Illustration 3 g01041438

1. Install gasket (6) onto muffler (3). Note the orientation of the gasket.

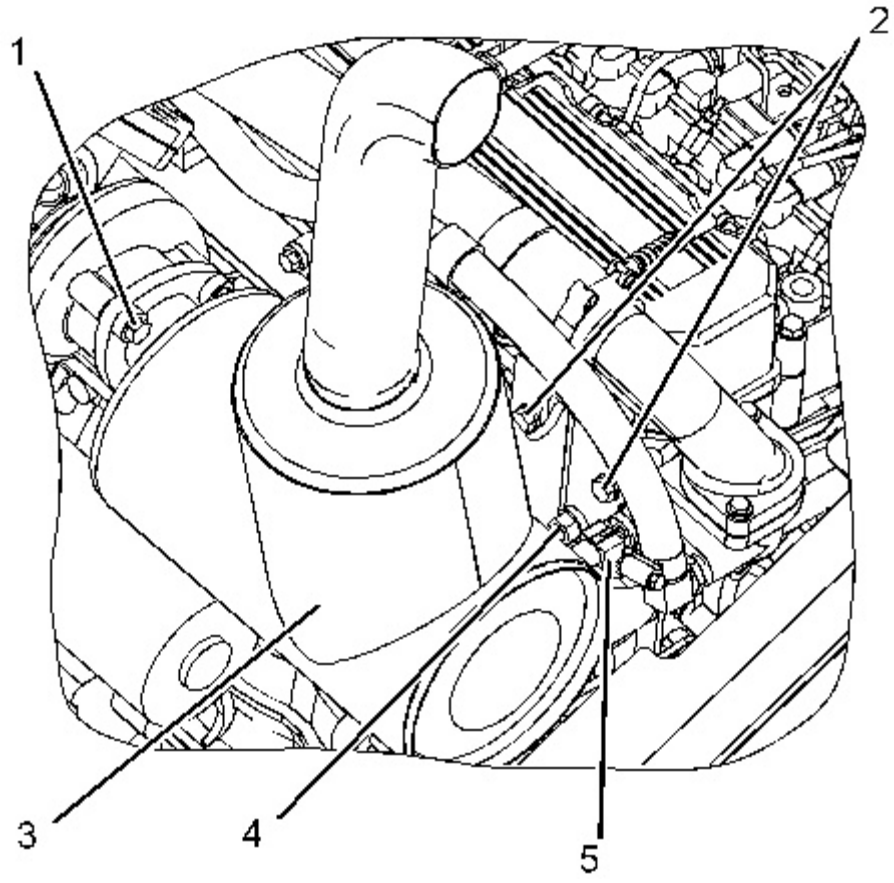


Illustration 4 g01041430

2. Install muffler (3). Install bolts (1). Install nut (4). Install bolts (2). Connect harness assembly (5).

   Note: Bolts (1) need to be installed first in order to properly seal gasket (6) .

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001252

Turbocharger - Remove

SMCS - 1052-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7089	Tapered Cap/Plug	1
	9U-7090	Tapered Cap/Plug	1
	9U-7070	Tapered Cap/Plug	1
	9U-7087	Tapered Cap/Plug	4

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

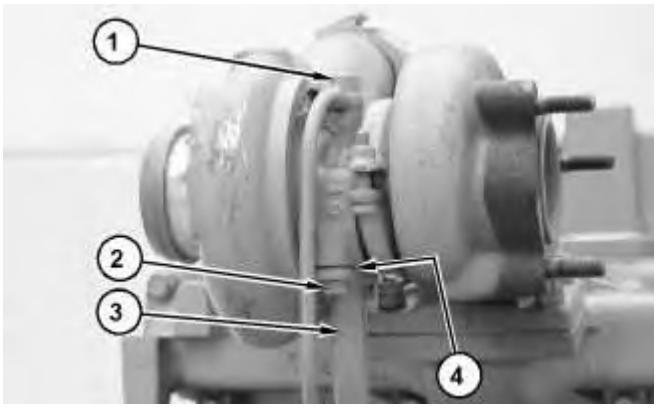


Illustration 1 g01035595

1. Remove bolt (1). Remove bolts (2). Disconnect tube assembly (3) and remove gasket (4) .

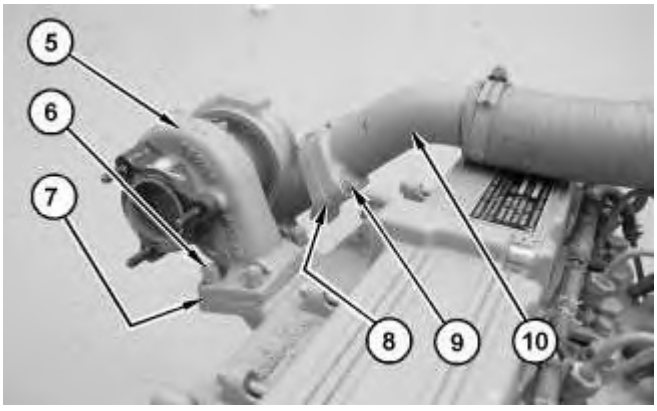


Illustration 2 g01035597

2. Remove bolts (9). Disconnect elbow assembly (10) and remove gasket (8). Remove nuts (6). Remove turbocharger (5) and gasket (7) .

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i02001310

Turbocharger - Install

SMCS - 1052-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

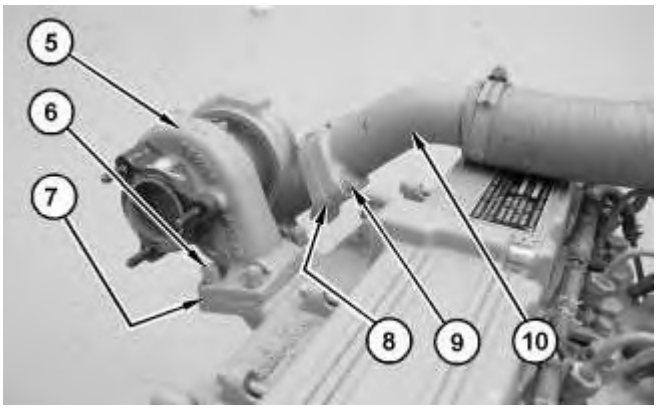


Illustration 1 g01035597

1. Install gasket (7) and position turbocharger (5). Apply Tooling (A) to nuts (6). Install nuts (6). Install gasket (8) and connect elbow assembly (10). Install bolts (9) .

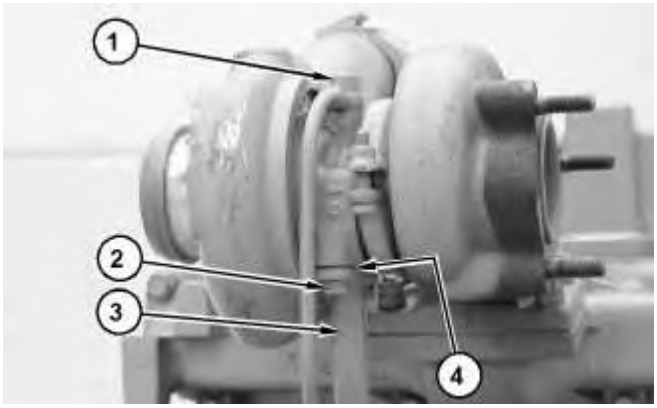


Illustration 2 g01035595

2. Install gasket (4) and connect tube assembly (3). Install bolts (2). Install bolt (1) .

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i02001252

Turbocharger - Remove

SMCS - 1052-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7089	Tapered Cap/Plug	1
	9U-7090	Tapered Cap/Plug	1
	9U-7070	Tapered Cap/Plug	1
	9U-7087	Tapered Cap/Plug	4

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

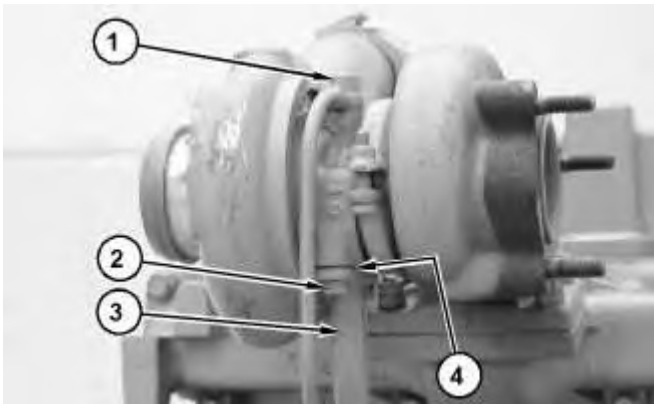


Illustration 1 g01035595

1. Remove bolt (1). Remove bolts (2). Disconnect tube assembly (3) and remove gasket (4) .

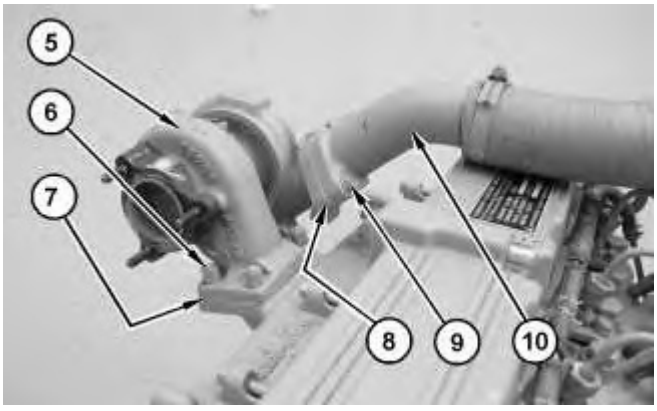


Illustration 2 g01035597

2. Remove bolts (9). Disconnect elbow assembly (10) and remove gasket (8). Remove nuts (6). Remove turbocharger (5) and gasket (7) .

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i02001310

Turbocharger - Install

SMCS - 1052-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

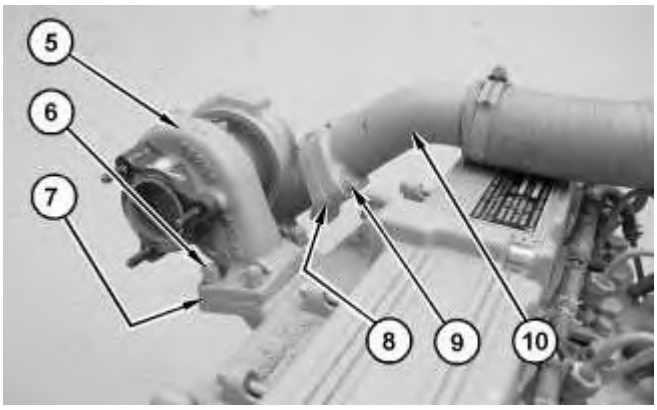


Illustration 1 g01035597

1. Install gasket (7) and position turbocharger (5). Apply Tooling (A) to nuts (6). Install nuts (6). Install gasket (8) and connect elbow assembly (10). Install bolts (9) .

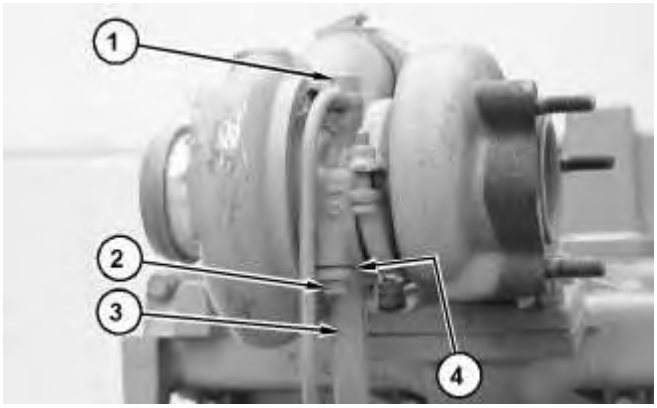


Illustration 2 g01035595

2. Install gasket (4) and connect tube assembly (3). Install bolts (2). Install bolt (1) .

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638723

Turbocharger - Remove

SMCS - 1052-011

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

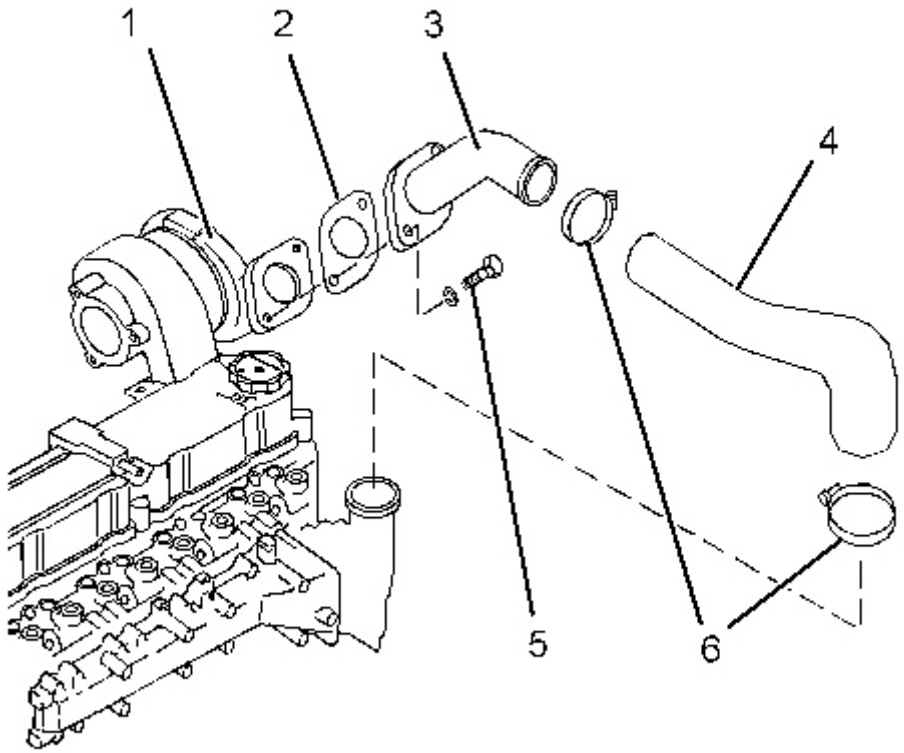


Illustration 1 g01336694

Typical example

1. Loosen hose clamps (6) and remove hose (4). Plug the connection on the inlet manifold with a suitable plug.
2. Remove bolts (5) and remove air pipe (3) from turbocharger (1). Remove gasket (2) .
3. Plug the opening in the inlet manifold and the opening in the turbocharger with suitable plugs.

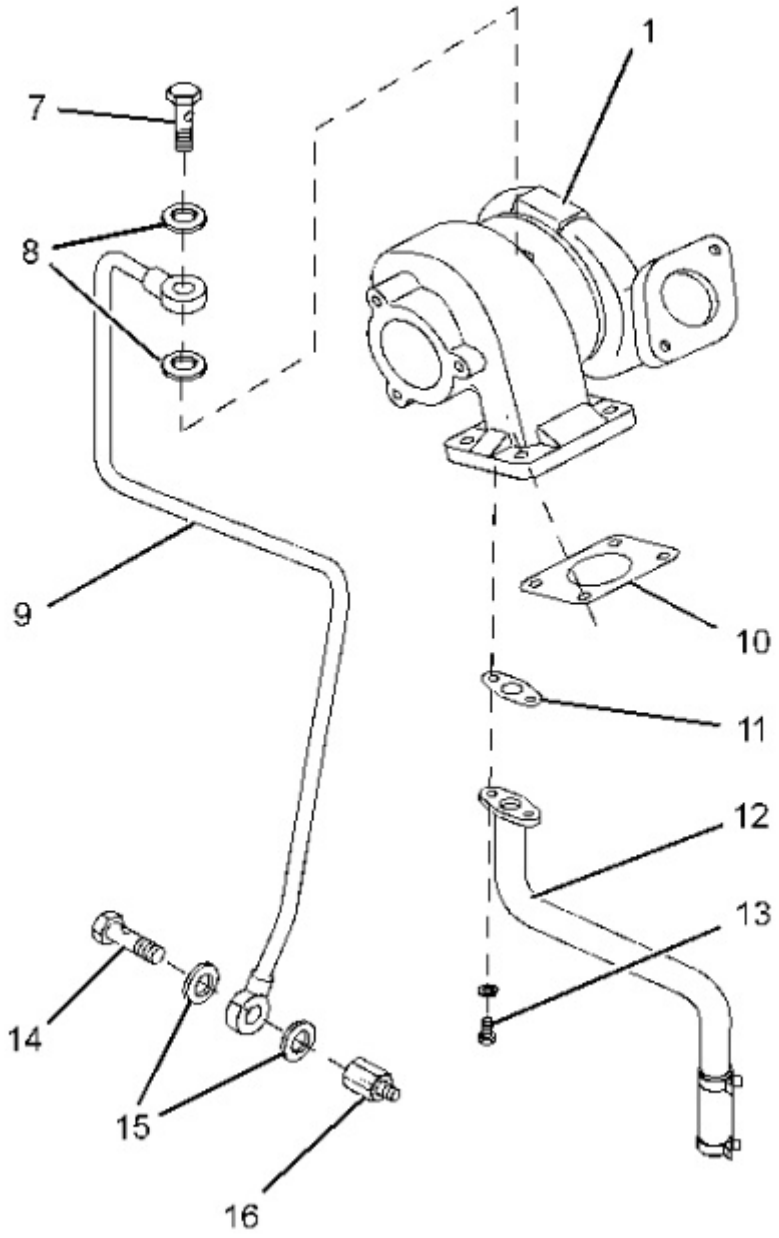


Illustration 2 g01336699

Typical example

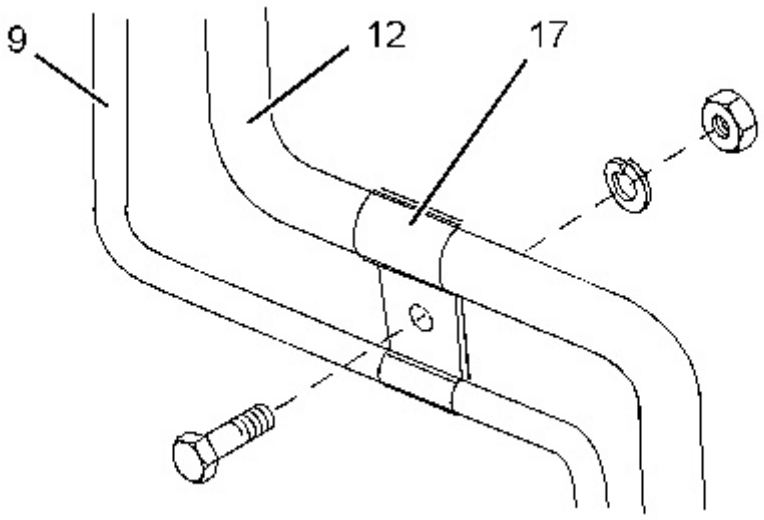


Illustration 3 g01337174

4. Follow Steps 4.a through 4.c in order to remove tube assembly (9) for the oil feed.

    a. Remove tube clamp (17) that secures tube assembly (9) to tube assembly (12). Note the position of the clamp.

    b. Remove banjo bolt (14) and sealing washers (15). Disconnect tube assembly (9) from adapter (16) in the cylinder block.

    Note: Do not allow adapter (16) to turn in the cylinder block when the banjo bolt is loosened. Use two wrenches in order to disconnect the tube assembly.

    c. Remove banjo bolt (7) and sealing washers (8). Remove tube assembly (9) from turbocharger (1) .

5. Follow Steps 5 through 5.c in order to remove the tube assembly (12) for the oil drain.

    a. Remove bolts (13). Disconnect tube assembly (12) from turbocharger (1) .

    b. Remove joint (11) .

    c. If necessary, loosen the hose clips and remove tube assembly (12) from the adapter in the cylinder block.

6. Remove the double nuts (not shown) that secure turbocharger (1) to the exhaust manifold.

7. Remove turbocharger (1) from the exhaust manifold. Remove gasket (10) .

8. Plug the oil supply and the oil drain ports in the turbocharger and in the cylinder block with suitable plugs.

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i02638738

Turbocharger - Install

SMCS - 1052-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3931	Anti-Seize Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the turbocharger is clean and free from damage. Inspect the turbocharger for wear. Refer to Systems Operation, Testing and Adjusting, "Turbocharger - Inspect" for more information. If the turbocharger is worn, the complete turbocharger must be replaced.

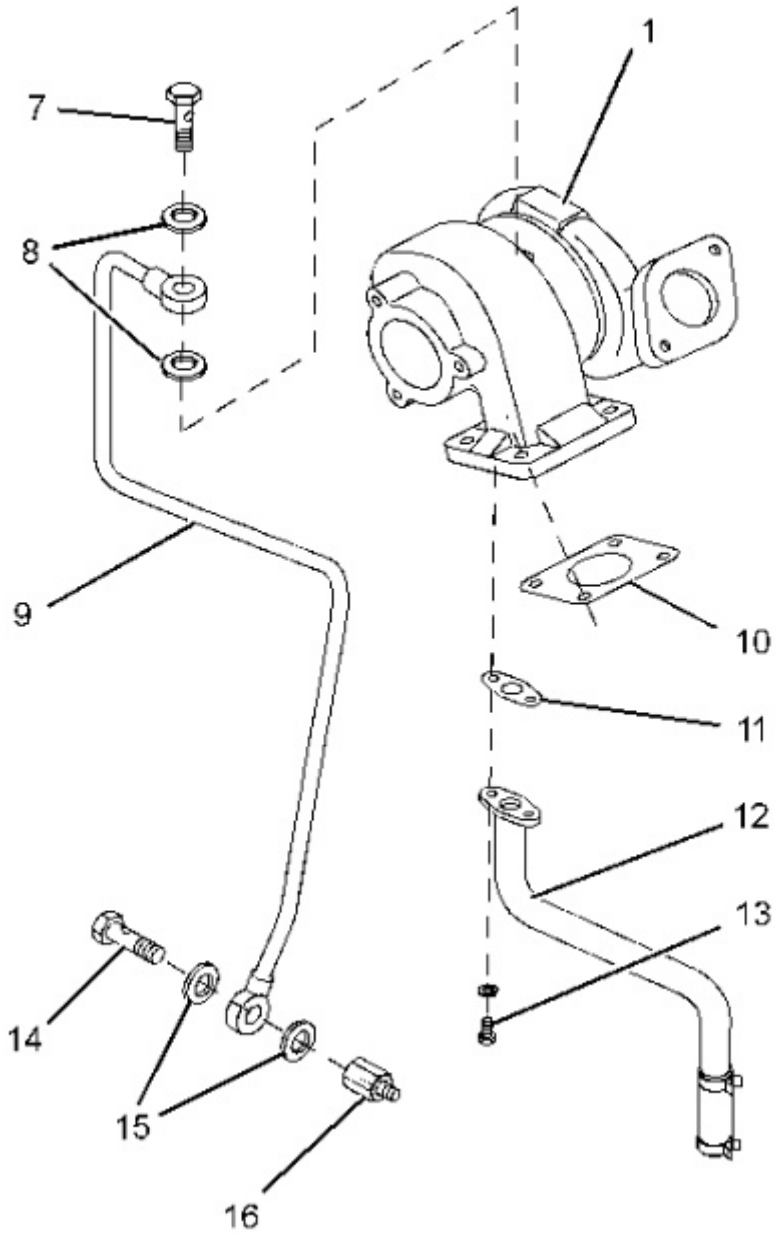


Illustration 1 g01336699

Typical example

2. Clean the mating surface of the exhaust manifold. Install a new gasket (10) over the studs. Apply Tooling (A) to the studs.
3. Position turbocharger (1) onto the exhaust manifold and install the double nuts. Tighten the nuts to a torque of 18 N·m (13 lb ft).

   Note: Do not allow the lower nuts to turn when the upper nuts are tightened.
4. Ensure that tube assemblies (9) and (12) are clean and free from damage. If necessary, replace the tube assemblies.

5. Remove the plugs from the ports in the turbocharger and from the cylinder block.

6. If necessary, install the lower end of tube assembly (12) to the adapter in the cylinder block. Position a new joint (11) onto tube assembly (12). Connect the tube assembly to turbocharger (1) and install bolts (13). Tighten the bolts to a torque of 9 N·m (80 lb in). If necessary, tighten the hose clips.

7. Lubricate the bearings of turbocharger (1) with clean engine oil through the oil inlet port. Rotate the shaft of the turbocharger in order to distribute the lubricant.

8. Install new sealing washers (8) and banjo bolt (7) to tube assembly (9). Position tube assembly (9) onto turbocharger (1). Tighten the banjo bolt finger tight. Install new sealing washers (15) and banjo bolt (14) to tube assembly (9). Connect the tube assembly to adapter (16) in the cylinder block.

9. Tighten banjo bolts (7) and (14) to a torque of 16 N·m (12 lb ft).

   Note: Do not allow adapter (16) to turn in the cylinder block.

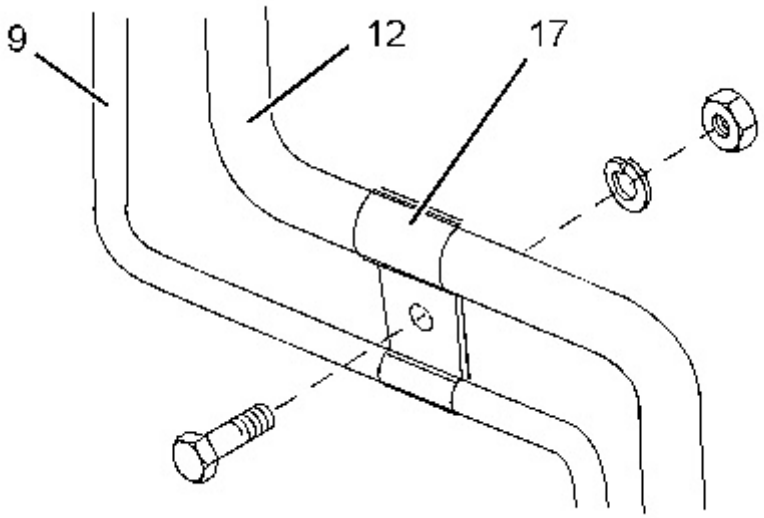


Illustration 2 g01337174

10. Install clamp (17) to tube assemblies (9) and (12). Tighten the fasteners securely.

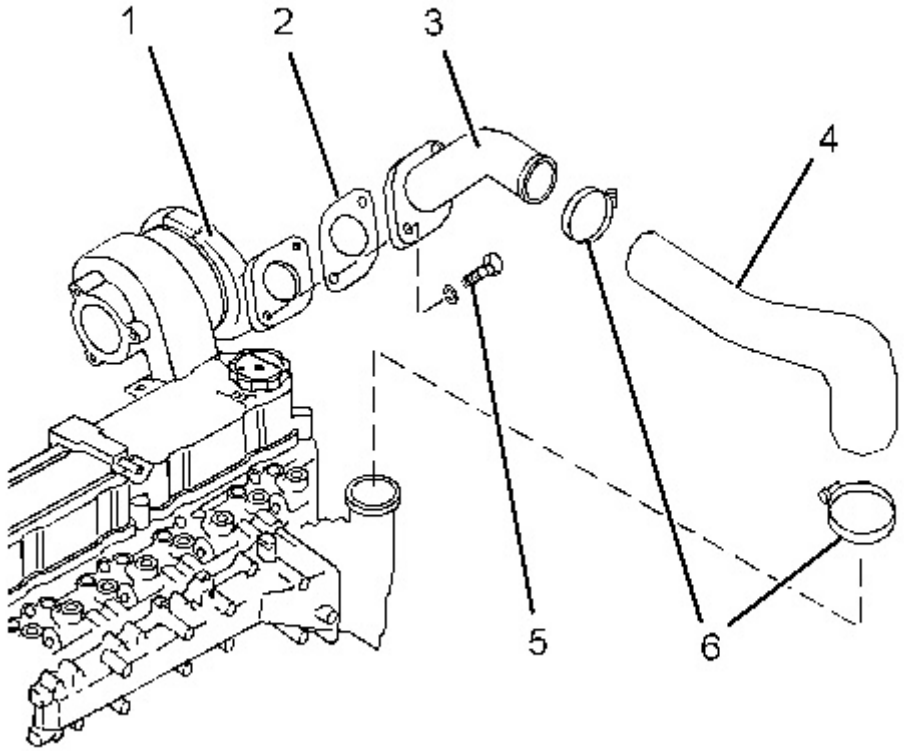


Illustration 3 g01336694

Typical example

11. Position a new joint (2) and air pipe (3) onto turbocharger (1). Install bolts (5). Tighten the bolts to a torque of 18 N·m (13 lb ft).

12. Remove the plugs from the connection on the inlet manifold and from the turbocharger. Install hose (4) and tighten hose clamps (6) securely.

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i01892117

Basic Engine

SMCS - 1200

The basic engine components are described in this section.

- Cylinder block
- Cylinder head
- Pistons and connecting rods
- Crankshaft
- Camshaft
- Timing case and gears
- Flywheel and flywheel housing

Cylinder Block

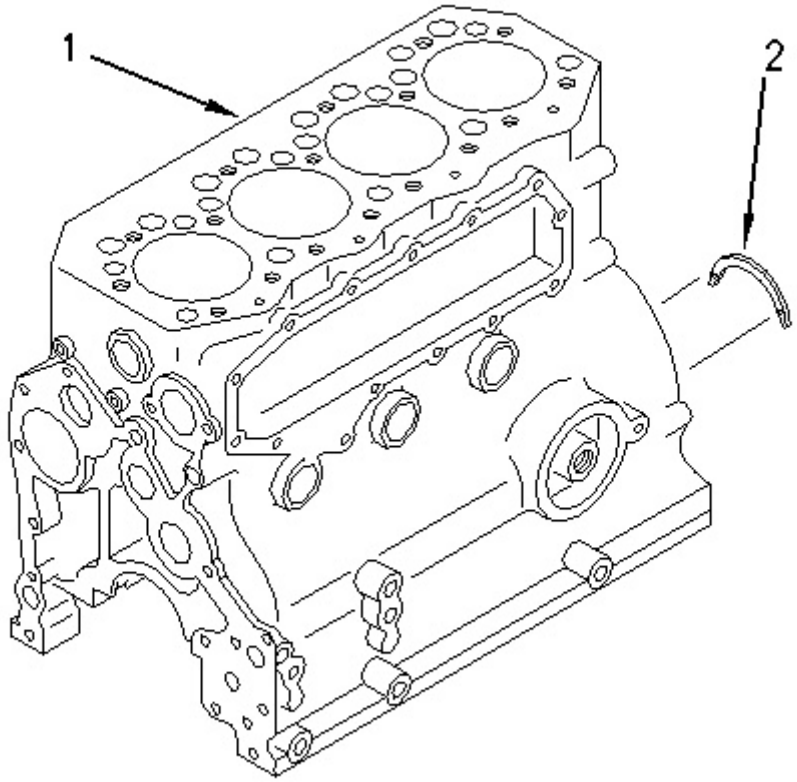


Illustration 1 g00987345

Exploded view of the cylinder block

(1) Cylinder block

(2) Thrust washer

Cylinder block (1) is made of cast iron with an integral crankcase. The four cylinders are arranged in-line. The sides of the block extend below the centerline of the crankshaft in order to provide added strength. The cylinder block provides full support for the length of the cylinder bores. The cylinder sleeves are integral with the cylinder block.

The journals of the camshaft run directly in the bores of the cylinder block. Thrust washer (2) is located at the rear of the block in order to control the end play of the crankshaft.

Cylinder Head

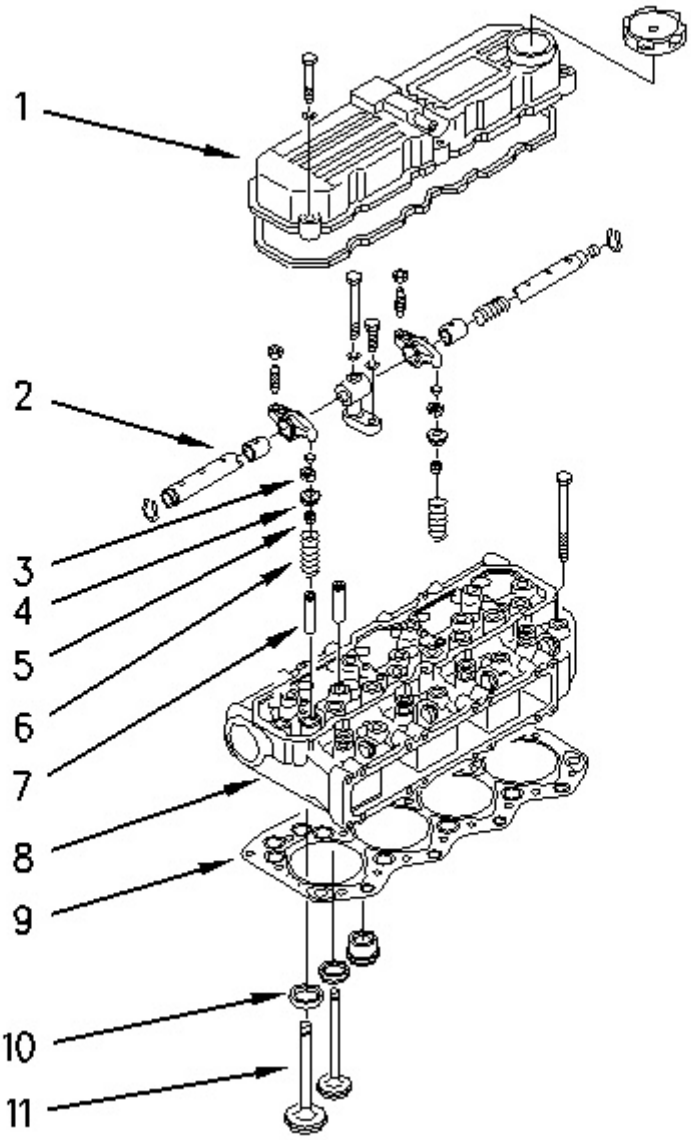


Illustration 2 g00987347

Exploded view of the cylinder head

(1) Valve mechanism cover

(2) Rocker shaft assembly

(3) Valve keepers

(4) Valve spring retainer

(5) Valve seal

(6) Valve spring

(7) Valve guide

(8) Cylinder head

(9) Cylinder head gasket

(10) Valve seat insert

(11) Valve

The cast iron cylinder head (8) is fastened to the top of the cylinder block by seventeen bolts. A cylinder head gasket (9) is used between the engine block and the cylinder head in order to seal combustion gases, coolant, and oil. The inlet and exhaust ports are designed to improve air flow.

The cylinder head assembly has two overhead valves (11) for each cylinder. Each valve is held in place by a single valve spring (6), a valve spring retainer (4), and two valve keepers (3). The cylinder head has steel valve seat inserts (10) for both the inlet and exhaust valves. The valves move in steel valve guides (7). Each valve guide is equipped with a synthetic rubber valve seal (5). The exhaust valve guides have a counterbore in order to prevent seizure of the valve stem that is caused by a buildup of carbon underneath the head of the valve. Both the valve seat inserts and the valve guides can be renewed.

The overhead valves are operated by a rocker shaft assembly (2) that is installed under a valve mechanism cover (1). The forged steel rocker arms are operated by cold drawn pushrods with hardened heads. The rocker shaft is supported by four steel brackets that support the rocker shaft between each pair of valves. The rocker shaft assembly and valve components are lubricated by an oil flow from the hollow rocker shaft. The rocker shaft receives a reduced oil flow from the oil feed of the camshaft.

Valve lash is adjusted by adjustment screws and locknuts at the pushrod end of each rocker arm.

The valve mechanism cover also contains an oil fill cap and breather pipe.

Pistons and Connecting Rods

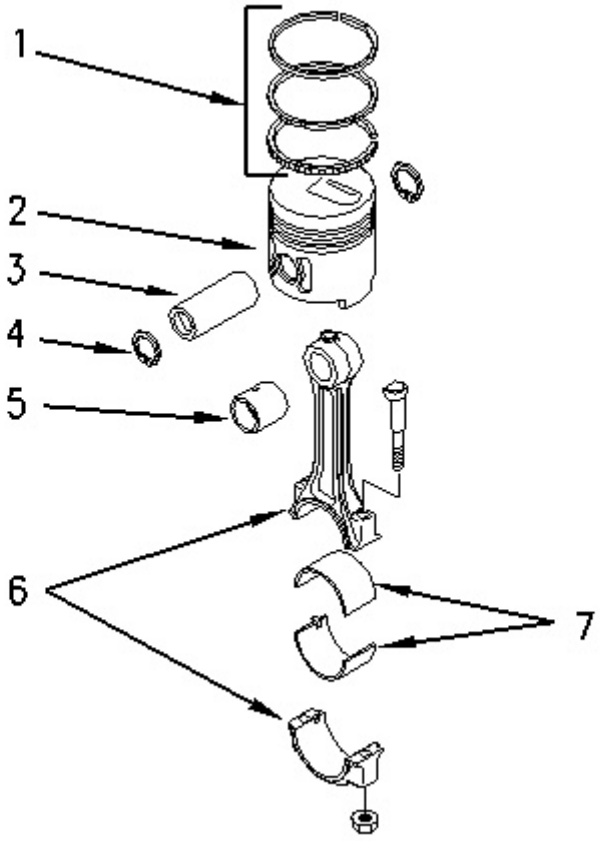


Illustration 3 g00987348

Exploded view of the piston and connecting rod

(1) Piston rings

(2) Piston

(3) Piston pin

(4) Retaining rings

(5) Piston pin bearing

(6) Connecting rod

(7) Connecting rod bearing

Pistons (2) have a combustion chamber in the top of the piston. The piston crater ensures an efficient mix of fuel and air.

Piston rings (1) consist of two compression rings and an oil control ring. The groove in the piston for the top ring has a hard metal insert that reduces wear of the groove. The piston skirt has a layer of graphite in order to improve the wear characteristics. The fully floating piston pin (3) is held in an axial location by retaining rings (4). The piston pin is placed off-center in order to reduce the noise level.

Some engines are equipped with piston cooling jets. The piston cooling jets spray lubricating oil onto the inner surface of the piston in order to cool the piston.

The correct piston height is important in order to ensure that the piston does not contact the cylinder head and that the fuel has efficient combustion. The pistons and connecting rods (6) are matched to each cylinder.

The connecting rod and the connecting rod cap are machined on the surfaces in order to provide a smooth mating surface. The cap is held in position by a pair of bolts with nuts.

Crankshaft

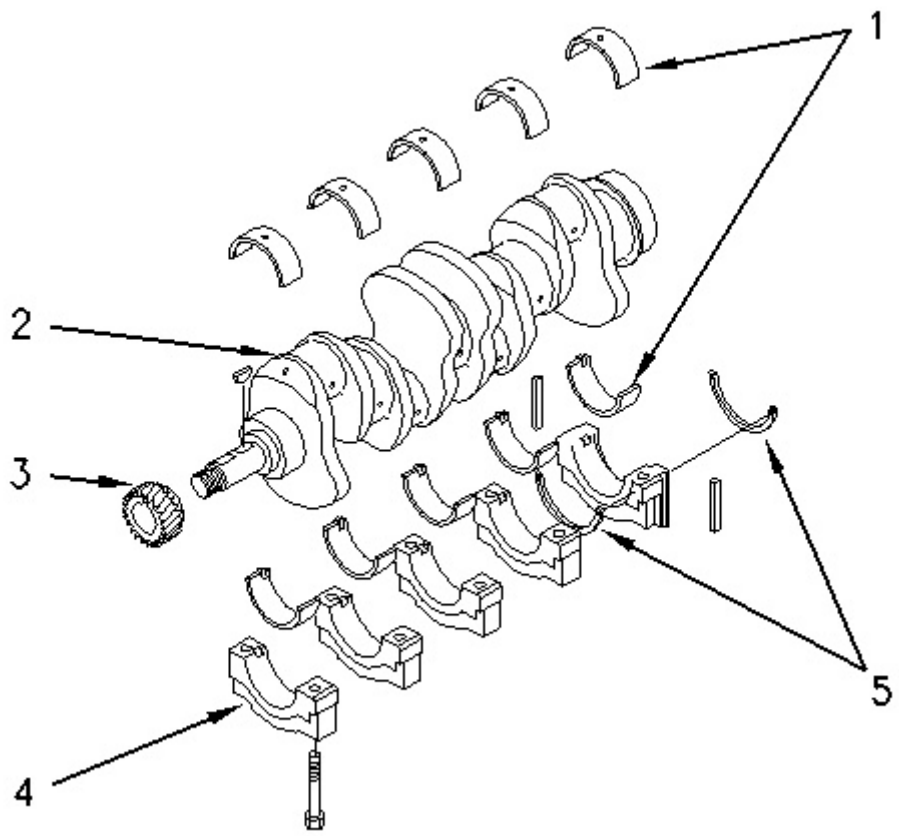


Illustration 4 g00987351

Exploded view of the crankshaft

(1) Main bearings

(2) Crankshaft

(3) Crankshaft gear

(4) Main bearing cap

(5) Thrust washers

Crankshaft (2) is forged from chrome molybdenum steel. The crankshaft has five main bearing journals and four connecting rod bearing journals. The flywheel is attached to the large flange at the rear of the crankshaft.

End play of the crankshaft is controlled by three thrust washers (5). Two thrust washers are located on both sides of the rear main bearing. The third thrust washer is located on the rear face of the cylinder block (Illustration 1).

Main bearings (1) have steel backs with an aluminum and tin bearing material. Main bearing caps (4) are made of cast iron.

Crankshaft gear (3) is held on the tapered shaft of the crankshaft by a pair of woodruff keys. The crankshaft pulley is held in position by a nut on the front of the crankshaft.

Camshaft

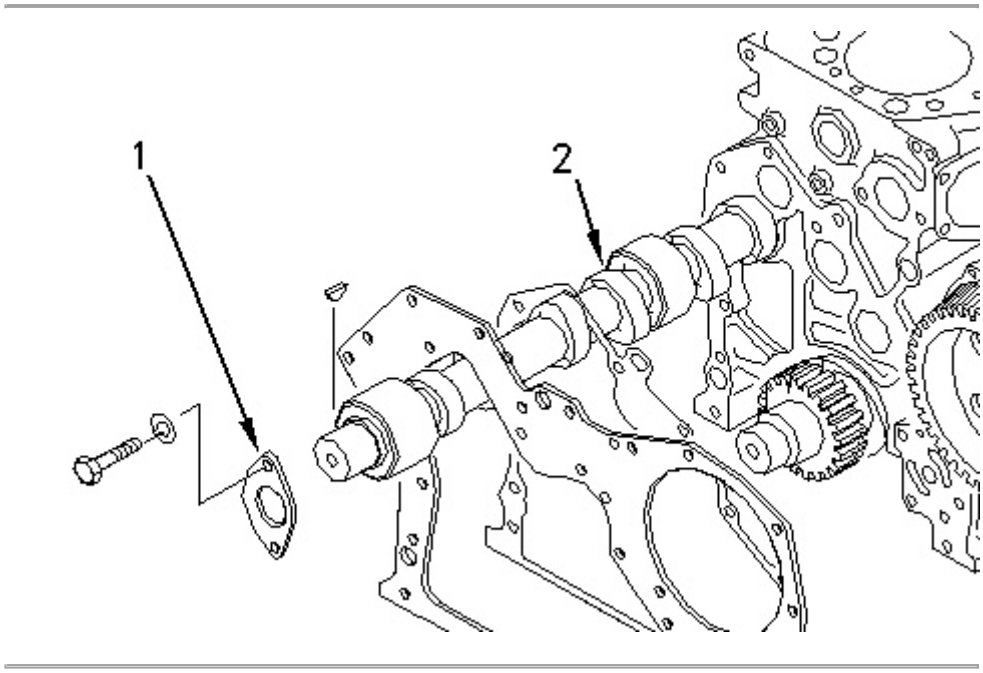


Illustration 5 g00994980

Exploded view of the camshaft

(1) Thrust washer

(2) Camshaft

The engine has a single camshaft (2) that is made of cast iron. The camshaft has four sets of lobes. Each set of lobes controls the movement of the inlet and exhaust valves for each cylinder.

The camshaft is driven at the front end by the camshaft gear. As the camshaft rotates, the camshaft lobes move the valve system components. The valve system components move the cylinder valves.

The camshaft gear must be timed to the crankshaft gear. The relationship between the lobes of the camshaft and the camshaft gear causes the valves in each cylinder to open at the correct time. The camshaft gear is held on the tapered shaft of the camshaft by a woodruff key.

End play of the camshaft is controlled by thrust washer (1) that is mounted in front of the camshaft. The thrust washer is held in place by two bolts in the cylinder block.

Timing Case and Gears

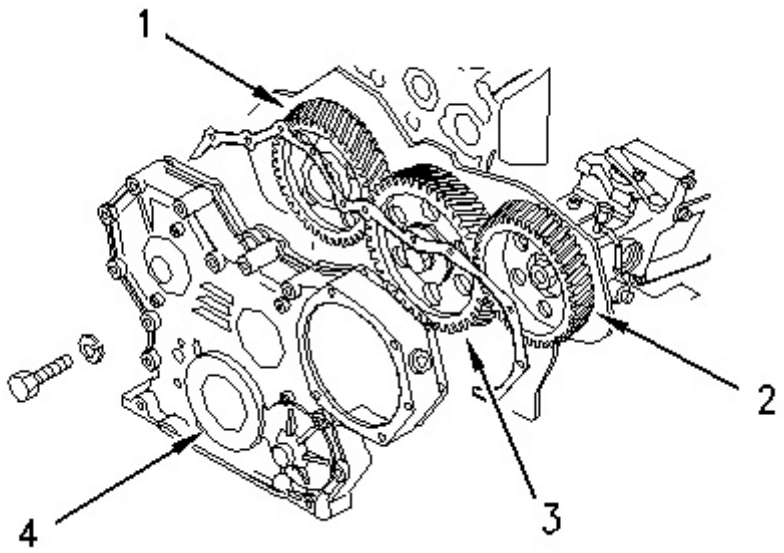


Illustration 6 g00987354

Exploded view of the timing case and gears

(1) Camshaft gear

(2) Fuel injection pump gear

(3) Upper idler gear

(4) Crankshaft front seal

The timing case is constructed of either aluminum or cast iron. The timing case cover contains crankshaft front seal (4) .

The timing gears are made of steel. The crankshaft gear (not shown) drives an upper idler gear (3). The upper idler gear drives camshaft gear (1), fuel injection pump gear (2), and the oil pump gear (not shown).

The camshaft and the fuel injection pump run at half the speed of the crankshaft. The oil pump runs at three quarters of the speed of the crankshaft.

Flywheel and Flywheel Housing

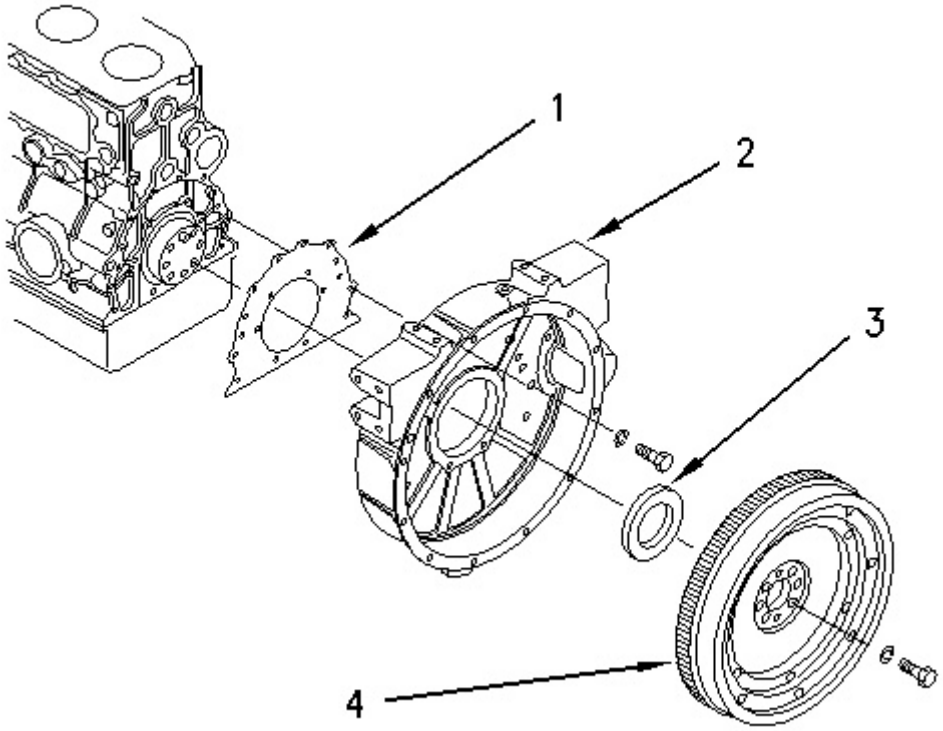


Illustration 7 g00988009

Exploded view of the flywheel and flywheel housing

(1) Gasket

(2) Flywheel housing

(3) Crankshaft rear seal

(4) Flywheel

Flywheel (4) and flywheel housing (2) are made of cast iron. The flywheel housing contains crankshaft rear seal (3) .

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Systems Operation
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01892117

Basic Engine

SMCS - 1200

The basic engine components are described in this section.

- Cylinder block
- Cylinder head
- Pistons and connecting rods
- Crankshaft
- Camshaft
- Timing case and gears
- Flywheel and flywheel housing

Cylinder Block

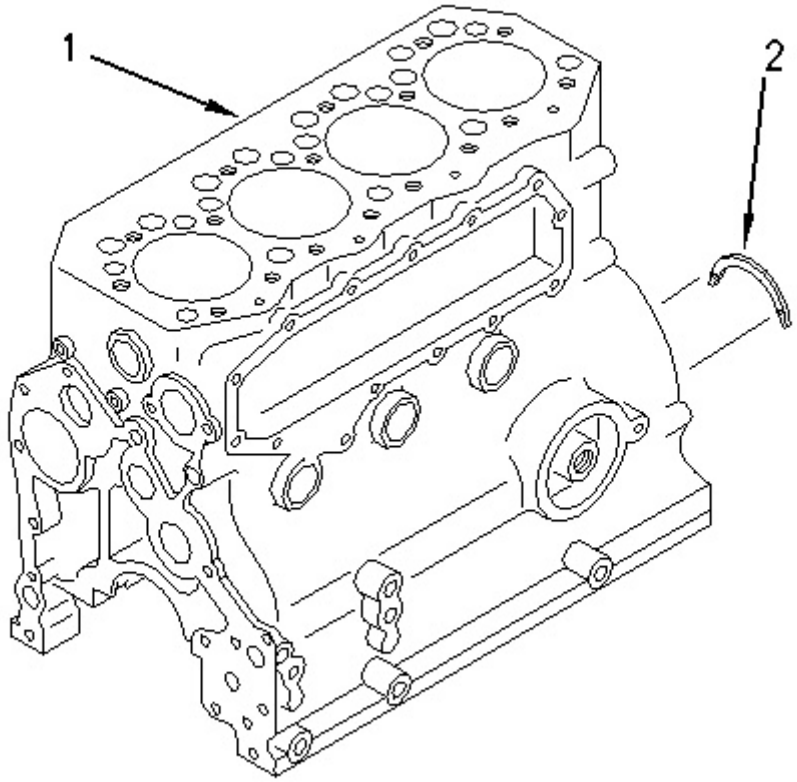


Illustration 1 g00987345

Exploded view of the cylinder block

(1) Cylinder block

(2) Thrust washer

Cylinder block (1) is made of cast iron with an integral crankcase. The four cylinders are arranged in-line. The sides of the block extend below the centerline of the crankshaft in order to provide added strength. The cylinder block provides full support for the length of the cylinder bores. The cylinder sleeves are integral with the cylinder block.

The journals of the camshaft run directly in the bores of the cylinder block. Thrust washer (2) is located at the rear of the block in order to control the end play of the crankshaft.

Cylinder Head

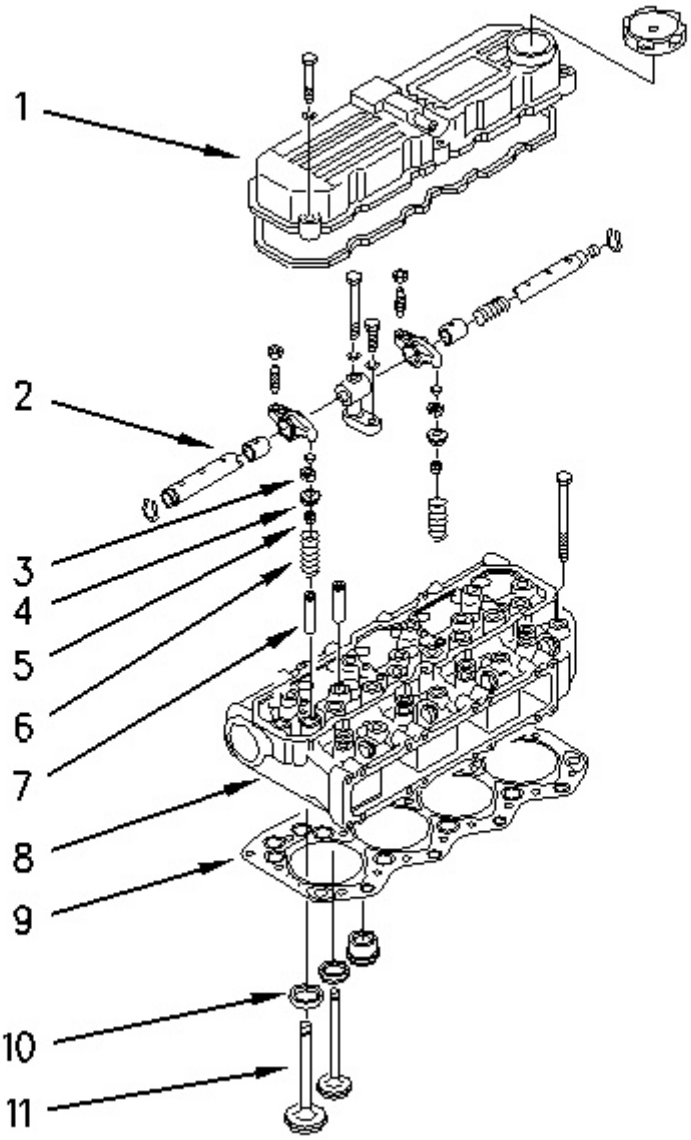


Illustration 2 g00987347

Exploded view of the cylinder head

(1) Valve mechanism cover

(2) Rocker shaft assembly

(3) Valve keepers

(4) Valve spring retainer

(5) Valve seal

(6) Valve spring

(7) Valve guide

(8) Cylinder head

(9) Cylinder head gasket

(10) Valve seat insert

(11) Valve

The cast iron cylinder head (8) is fastened to the top of the cylinder block by seventeen bolts. A cylinder head gasket (9) is used between the engine block and the cylinder head in order to seal combustion gases, coolant, and oil. The inlet and exhaust ports are designed to improve air flow.

The cylinder head assembly has two overhead valves (11) for each cylinder. Each valve is held in place by a single valve spring (6), a valve spring retainer (4), and two valve keepers (3). The cylinder head has steel valve seat inserts (10) for both the inlet and exhaust valves. The valves move in steel valve guides (7). Each valve guide is equipped with a synthetic rubber valve seal (5). The exhaust valve guides have a counterbore in order to prevent seizure of the valve stem that is caused by a buildup of carbon underneath the head of the valve. Both the valve seat inserts and the valve guides can be renewed.

The overhead valves are operated by a rocker shaft assembly (2) that is installed under a valve mechanism cover (1). The forged steel rocker arms are operated by cold drawn pushrods with hardened heads. The rocker shaft is supported by four steel brackets that support the rocker shaft between each pair of valves. The rocker shaft assembly and valve components are lubricated by an oil flow from the hollow rocker shaft. The rocker shaft receives a reduced oil flow from the oil feed of the camshaft.

Valve lash is adjusted by adjustment screws and locknuts at the pushrod end of each rocker arm.

The valve mechanism cover also contains an oil fill cap and breather pipe.

Pistons and Connecting Rods

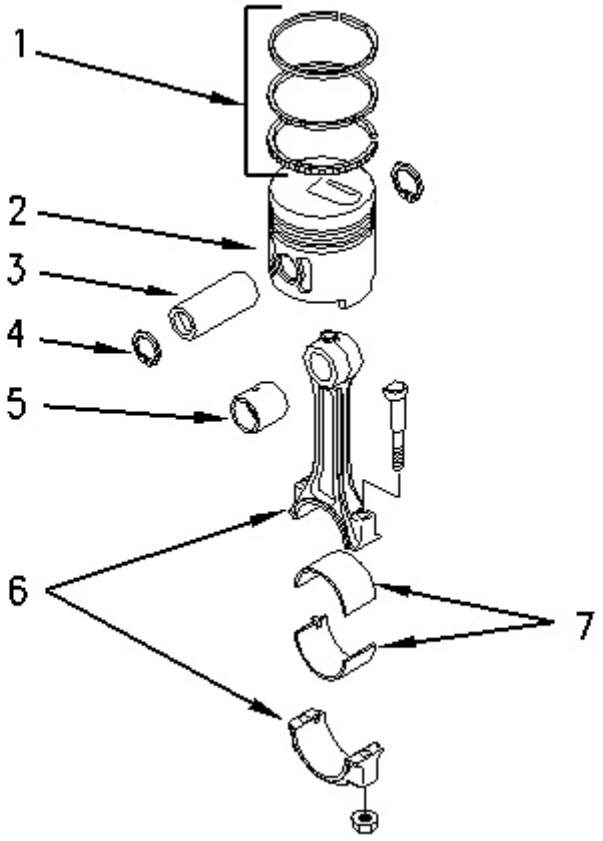


Illustration 3 g00987348

Exploded view of the piston and connecting rod

(1) Piston rings

(2) Piston

(3) Piston pin

(4) Retaining rings

(5) Piston pin bearing

(6) Connecting rod

(7) Connecting rod bearing

Pistons (2) have a combustion chamber in the top of the piston. The piston crater ensures an efficient mix of fuel and air.

Piston rings (1) consist of two compression rings and an oil control ring. The groove in the piston for the top ring has a hard metal insert that reduces wear of the groove. The piston skirt has a layer of graphite in order to improve the wear characteristics. The fully floating piston pin (3) is held in an axial location by retaining rings (4). The piston pin is placed off-center in order to reduce the noise level.

Some engines are equipped with piston cooling jets. The piston cooling jets spray lubricating oil onto the inner surface of the piston in order to cool the piston.

The correct piston height is important in order to ensure that the piston does not contact the cylinder head and that the fuel has efficient combustion. The pistons and connecting rods (6) are matched to each cylinder.

The connecting rod and the connecting rod cap are machined on the surfaces in order to provide a smooth mating surface. The cap is held in position by a pair of bolts with nuts.

Crankshaft

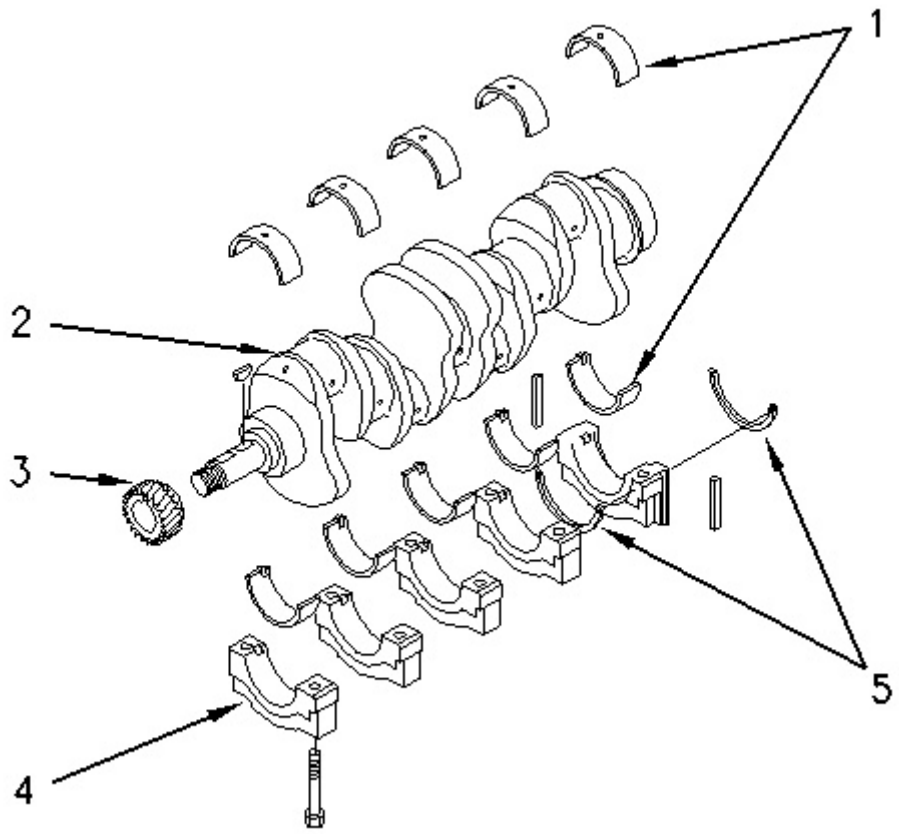


Illustration 4 g00987351

Exploded view of the crankshaft

(1) Main bearings

(2) Crankshaft

(3) Crankshaft gear

(4) Main bearing cap

(5) Thrust washers

Crankshaft (2) is forged from chrome molybdenum steel. The crankshaft has five main bearing journals and four connecting rod bearing journals. The flywheel is attached to the large flange at the rear of the crankshaft.

End play of the crankshaft is controlled by three thrust washers (5). Two thrust washers are located on both sides of the rear main bearing. The third thrust washer is located on the rear face of the cylinder block (Illustration 1).

Main bearings (1) have steel backs with an aluminum and tin bearing material. Main bearing caps (4) are made of cast iron.

Crankshaft gear (3) is held on the tapered shaft of the crankshaft by a pair of woodruff keys. The crankshaft pulley is held in position by a nut on the front of the crankshaft.

Camshaft

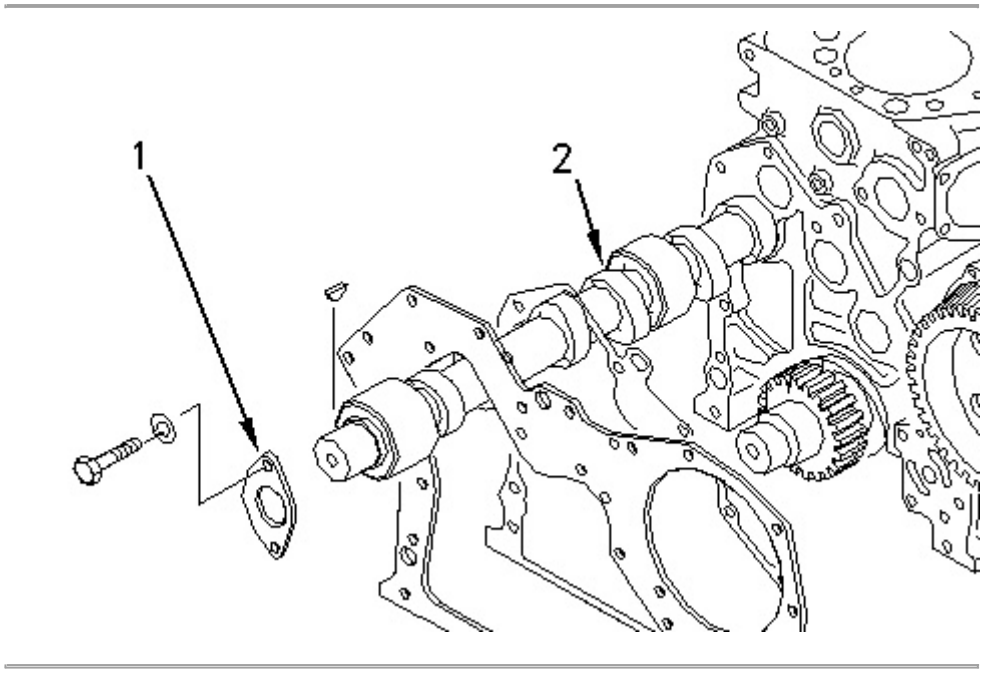


Illustration 5 g00994980

Exploded view of the camshaft

(1) Thrust washer

(2) Camshaft

The engine has a single camshaft (2) that is made of cast iron. The camshaft has four sets of lobes. Each set of lobes controls the movement of the inlet and exhaust valves for each cylinder.

The camshaft is driven at the front end by the camshaft gear. As the camshaft rotates, the camshaft lobes move the valve system components. The valve system components move the cylinder valves.

The camshaft gear must be timed to the crankshaft gear. The relationship between the lobes of the camshaft and the camshaft gear causes the valves in each cylinder to open at the correct time. The camshaft gear is held on the tapered shaft of the camshaft by a woodruff key.

End play of the camshaft is controlled by thrust washer (1) that is mounted in front of the camshaft. The thrust washer is held in place by two bolts in the cylinder block.

Timing Case and Gears

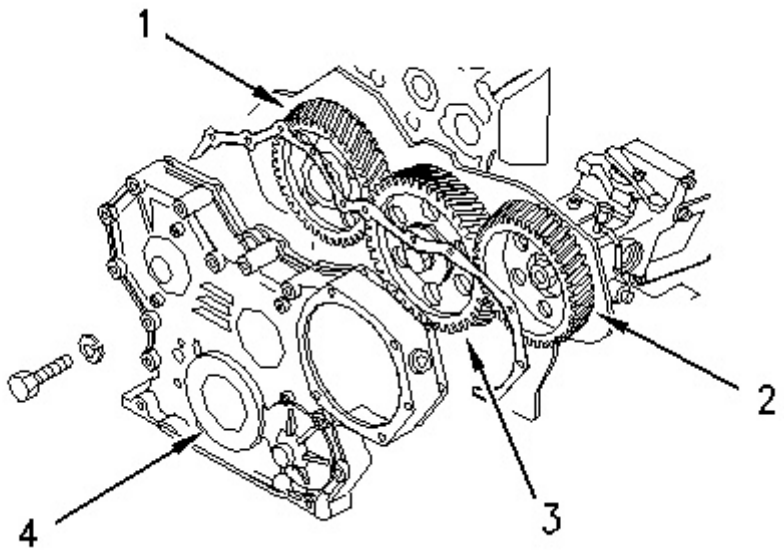


Illustration 6 g00987354

Exploded view of the timing case and gears

(1) Camshaft gear

(2) Fuel injection pump gear

(3) Upper idler gear

(4) Crankshaft front seal

The timing case is constructed of either aluminum or cast iron. The timing case cover contains crankshaft front seal (4) .

The timing gears are made of steel. The crankshaft gear (not shown) drives an upper idler gear (3). The upper idler gear drives camshaft gear (1), fuel injection pump gear (2), and the oil pump gear (not shown).

The camshaft and the fuel injection pump run at half the speed of the crankshaft. The oil pump runs at three quarters of the speed of the crankshaft.

Flywheel and Flywheel Housing

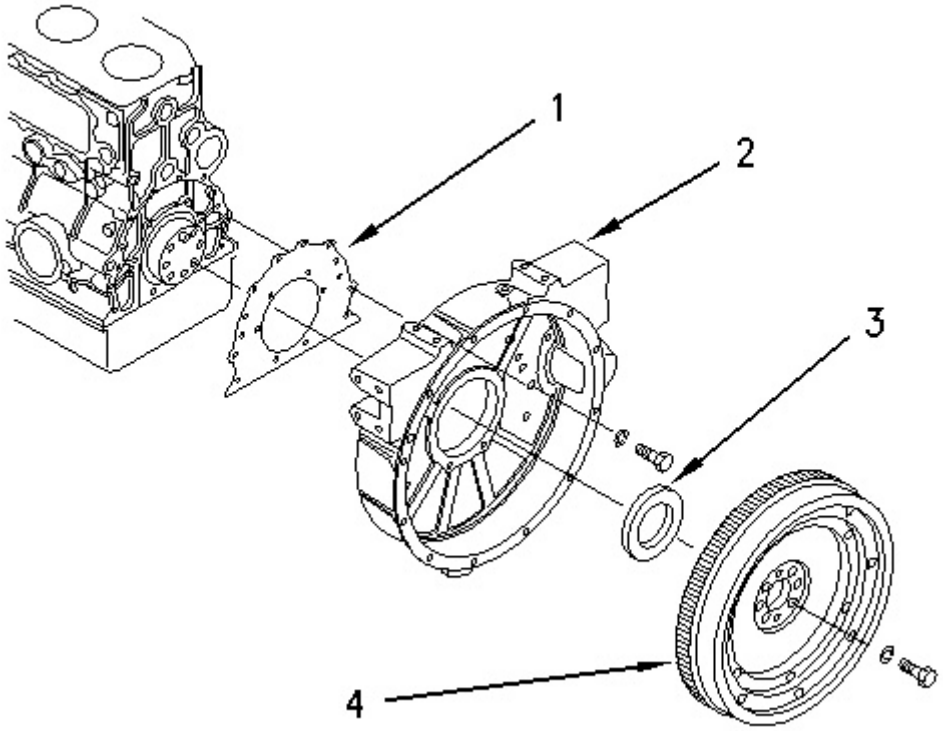


Illustration 7 g00988009

Exploded view of the flywheel and flywheel housing

(1) Gasket

(2) Flywheel housing

(3) Crankshaft rear seal

(4) Flywheel

Flywheel (4) and flywheel housing (2) are made of cast iron. The flywheel housing contains crankshaft rear seal (3) .

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i05192642

Finding Top Center Position for No. 1 Piston

SMCS - 1105-531

Note: Refer to the Disassembly and Assembly for your machine for the removal of components.

Note: A timing mark for top dead center is present on the crankshaft pulley. If the mark cannot be found or if the mark is suspected to be incorrect, refer to the procedure below.

Table 1

Required Tools			
Callout	**Part Number**	**Description**	**Quantity**
A	299-9126	Crankshaft Turning Tool	1

1. Remove the valve mechanism cover from the engine.

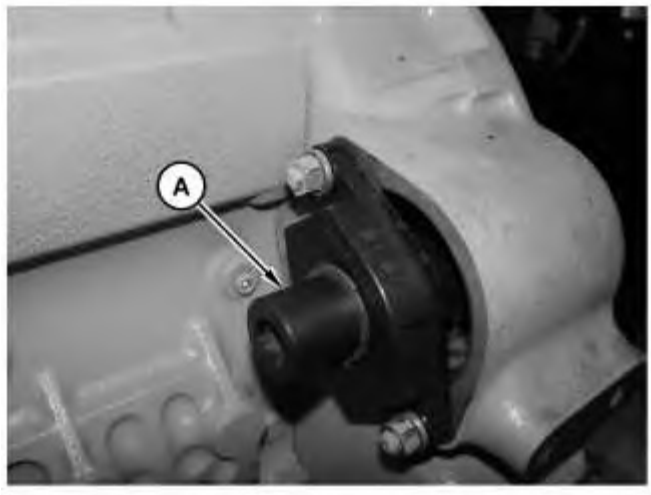


Illustration 1 g01420177

(A) 299-9126 Crankshaft Turning Tool

2. Install Tooling (A) on the engines flywheel housing. Use Tooling (A) in order to rotate the engine. Refer to Illustration 1.

3. Rotate the crankshaft clockwise when you face the front of the engine. Rotate the crankshaft until the pushrod for the inlet valve of the rear cylinder begins to tighten.

4. Rotate the crankshaft further by 1/8 of a turn in a clockwise direction. Insert a suitable lever between the rocker arm and the valve spring cap of the No. 1 inlet valve. Open the inlet valve. Put a spacer that is approximately 5 mm (0.2 inch) thick between the valve stem and the rocker arm.

5. Slowly rotate the crankshaft in a counterclockwise direction until the piston contacts the open valve. Make a temporary mark on the damper or the pulley. The temporary make must align accurately with the tip of the pointer.

6. Rotate the crankshaft in a clockwise direction by 1 degrees or 2 degrees. Remove the spacer that is between the valve stem and the rocker arm. Rotate the crankshaft by 1/4 of a turn in a counterclockwise direction. Put a spacer that is approximately 5 mm (0.2 inch) thick between the valve stem and the rocker lever of the No. 1 inlet valve.

7. Slowly rotate the crankshaft clockwise until the piston contacts the open valve. Make another temporary mark on the damper or the pulley. The temporary mark must align accurately with the tip of the pointer.

8. Make a temporary mark at the center point between the two marks on the damper or the pulley. Remove the other two marks. Rotate the crankshaft by 1/8 of a turn in a counterclockwise direction. Remove the spacer between the valve stem and the rocker arm.

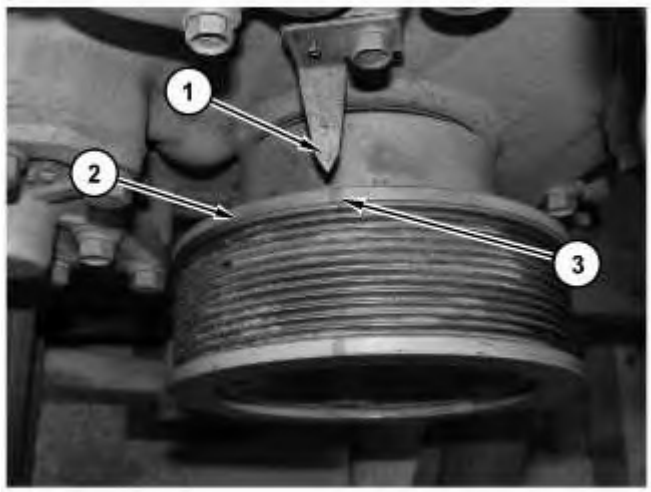


Illustration 2 g01811376

(1) Pointer

(2) Pulley

(3) Top center mark

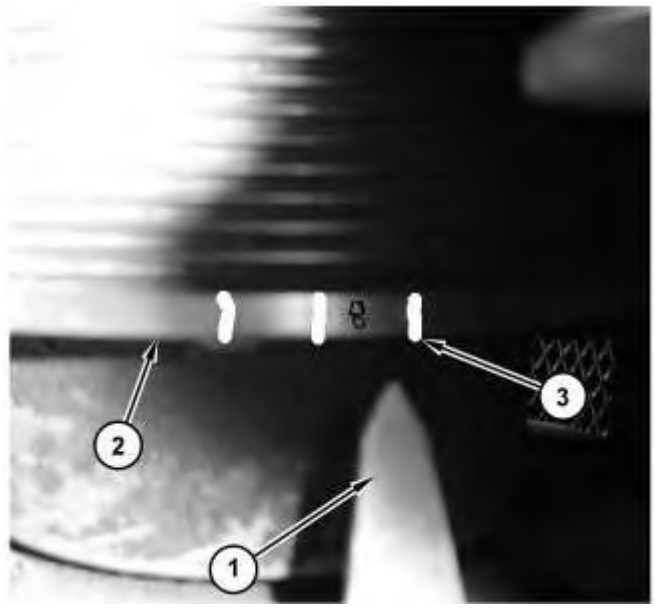


Illustration 3 g01830733

(1) Pointer

(2) Pulley

(3) Top center mark

9. Slowly rotate the crankshaft in a clockwise direction until the mark on the damper of the pulley (2), which was made in Step 8, aligns with the tip of the pointer (1). The No. 1 piston is now at the top center on the compression stroke. Refer to Illustration 2 and Illustration 3.

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02707221

Fuel Injection Nozzle - Test

SMCS - 1254-081

Test the Fuel Injection Nozzles

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-4150	Nozzle Testing Group	1
5P-7448	Adapter	1
6V-2170	Tube Assembly	1
8S-2270	Fuel Collector	1
1U-8857	Extension	1
6V-6068	SAE J-967 Calibration Fluid	1

Perform the following procedures in order to determine if a fuel injection nozzle does not work correctly.

Bench test the fuel injection nozzles at a temperature of 18° to 20 °C (64° to 70 °F).

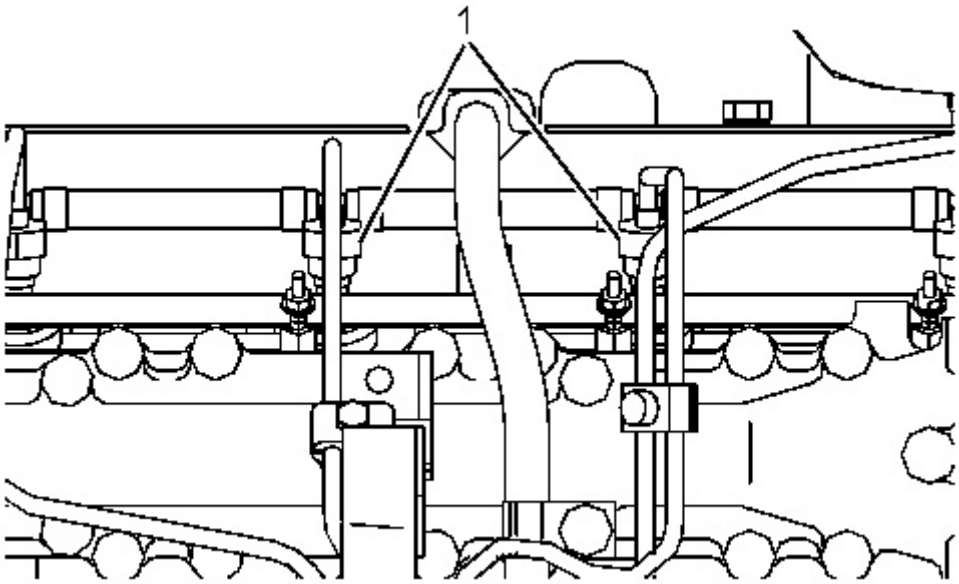


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

1. Run the engine at low idle.
2. Loosen the connection for the high pressure fuel line (1) at the fuel injection nozzle on No. 1 cylinder. Do not loosen the nut more than half of a turn. Listen for the low idle to decrease or become rough. Tighten the nut for the fuel supply line on No. 1 cylinder. Perform this test on each cylinder.
3. The fuel injection nozzle is faulty when the nut for the fuel supply line is loosened and the following events occur:
   - The engine rpm does not decrease.
   - The engine does not idle roughly.
4. Remove the fuel injection nozzle for additional testing.

   Note: If leakage occurs at the nut for the fuel supply line, make sure that fuel supply line and the nut are correctly aligned with the inlet connection of fuel injection nozzle. Do not tighten the nut for the fuel supply line on the high pressure fuel line more than the recommended torque. If the nut is tightened more, the fuel line may become restricted or the threads of the fuel injection nozzle and the nut may be damaged.

Cleaning of the Fuel Injection Nozzles

Before a fuel injection nozzle is tested, remove any loose carbon from the tip of the fuel injection nozzle. Do not use abrasive material or a wire brush in order to clean the nozzle.

The fuel injection nozzle is not a serviceable part. Disassembling or adjusting the nozzle will violate the standards for emissions.

Note: Extra care should be used in handling the fuel injection nozzle in order to prevent damage to the nozzle tip. A scratch or a burr could cause needle leakage or spray distortion. Dirt in the orifices of the nozzle tip can damage engine components. Dirt can also distort the spray pattern of the nozzle.

Pressure Test

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

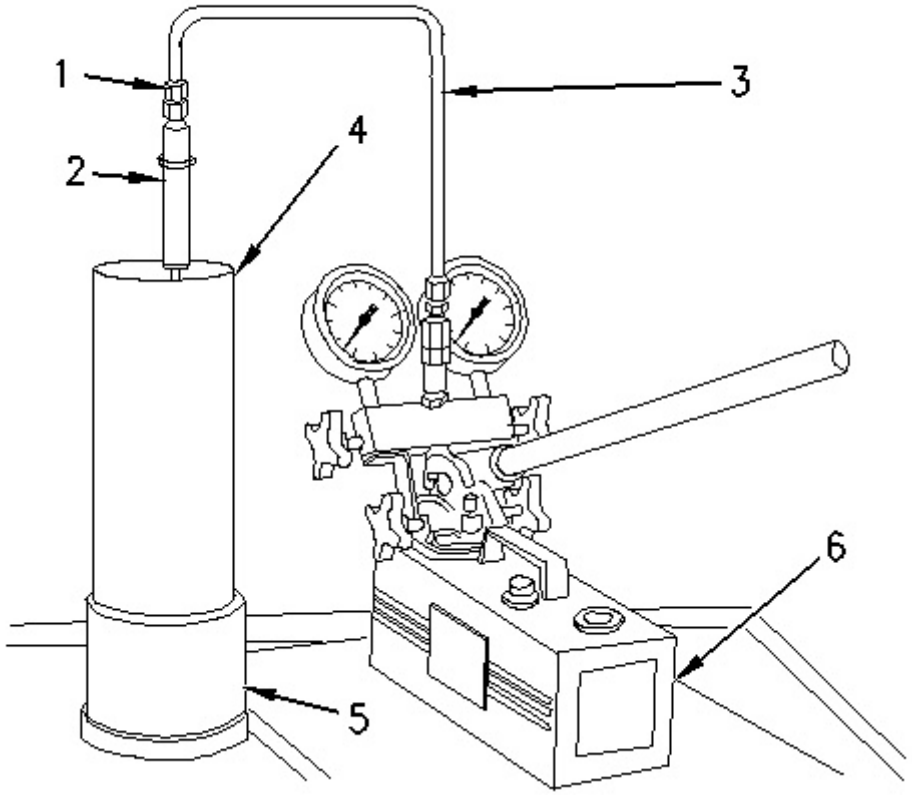


Illustration 2 g00804566

5P-4150 Nozzle Testing Group

(1) 5P-7448 Adapter

(2) Fuel injection nozzle

(3) 6V-2170 Tube assembly

(4) 1U-8857 Extension

(5) 8S-2270 Fuel collector

(6) 8T-5313 Filter

NOTICE

Do not use dirty test fluids when you test fuel injection nozzles. Also, do not test fuel injection nozzles unless you have the correct service tools.The use of dirty test fluids and the use of incorrect service tools will result in damage to fuel injection nozzles.

---

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

   Use clean **6V-6068** Calibration Fluid when the fuel injection nozzles are tested. The calibration fluid is equivalent to SAE J-967 (ISO 4113) oil.

2. Close the gauge protector valve. Close the shutoff valve. Open the pump isolator valve. In order to flush the fuel injection nozzle, operate the nozzle tester for 10 to 15 strokes at a rate of approximately 60 strokes per minute.

3. Open the gauge protector valve. Slowly increase the pressure until the valve in the fuel injection nozzle opens. Note the highest pressure indication on the dial indicator before the pointer moves to 0 kPa (0 psi). This highest pressure indication is the opening pressure of the fuel injection nozzle. The opening pressure is defined when the valve needle is lifted from the valve seat.

4. Refer to Specifications, "Fuel Injection Nozzles" for the correct pressure settings.

   If the opening pressure is not within the range of the setting that is given, the fuel injection nozzle must be replaced.

Back Leakage Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure to about 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

Release the handle. When the pressure begins to decrease, note the time that is required for the pressure to decrease to approximately 0 kPa (0 psi). If the fuel injection nozzle is not faulty, the time will not be less than 5 seconds or more than 45 seconds.

3. When the test in Step 2 is done, look for any leakage from the pressure faces of the holder and the retaining nut of the fuel injection nozzle. If leaks are visible, make sure that the components are tightened to the correct torque. Do not overtighten the components in order to stop the leakage. Instead, a pressure test on the fuel injection nozzle must be conducted. This test may force any foreign particles out of the nozzle. Replace the fuel injection nozzle if there is excessive fuel leakage.

4. If the pressure decreases to 0 kPa (0 psi) in less than 5 seconds, too much fuel is leaking around the valve needle. The valve needle or the fuel injection nozzle must be replaced in order to correct the problem.

Fuel Injection Nozzle and Seat Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure of the nozzle tester to approximately 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

   Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

   A drop of fuel should not form on the tip of the fuel injection nozzle for at least ten seconds. A light dampness is acceptable. If the results of the tests are not acceptable, clean the fuel injection nozzle. After you clean the fuel injection nozzle and the fuel leakage still occurs, the nozzle must be replaced.

Test the Spray Pattern

The pressure adjustment must be correct before the spray pattern is tested.

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

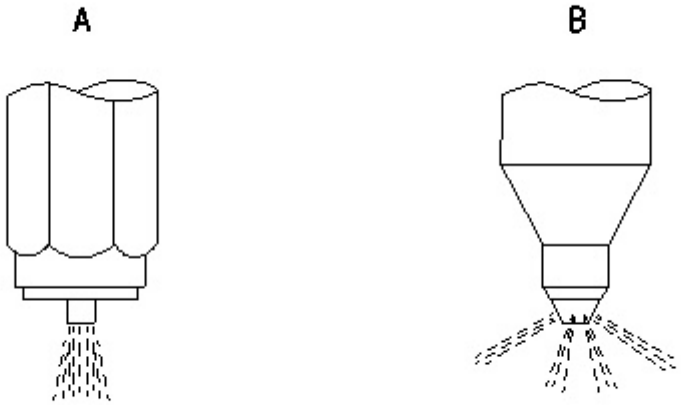


Illustration 3 g01007931

Spray patterns of the fuel injection nozzles

(A) Spray pattern for indirect injection

(B) Spray pattern for direct injection

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Close the gauge protector valve and the shutoff valve. Open the pump isolator valve.

3. Quickly pump the nozzle tester and look at the spray pattern when the fluid begins to flow through the orifices of the fuel injection nozzle.

   The spray, which flows from all of the orifices, must have the same pattern. The fuel injection nozzle is faulty if there is a difference in the vertical patterns or a difference in the horizontal patterns. Refer to the correct spray pattern in Illustration 3.

   Note: Be sure that the gauge protector valve is closed before the fuel injection nozzle is removed from the nozzle tester. Closing the valve will prevent damage to the pressure gauge.

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Testing and Adjusting
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Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i04643912

Engine Crankcase Pressure (Blowby) - Test

SMCS - 1215; 1317

Table 1

Tools Needed		
Part Number	**Part Name**	**Quantity**
348-5430	Multi-Tool Gp	1
285-0900	Blowby Tool Group	1
NETG5049	Software License	1

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than a normal amount of blowby fumes rising from the crankcase breather. The breather can then become restricted in a short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.



Illustration 1 g02709261

348-5430 Multi-Tool Gp

The **348-5430** Multi-Tool Gp , or the **285-0900** Blowby Tool Group is used to check the amount of blowby. Refer to Tool Operating Manual, NEHS1087, " **348-5430** Multi-Tool Gp " for the test procedure for checking the blowby.

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Compression - Test

SMCS - 1215

Table 1

Tools Needed		
Part Number	Part Name	Qty
9U-6274	Compression Test Tool Gp	1

The following conditions can affect the results of the cylinder compression test:

- Battery
- Condition of the starter motor
- Ambient conditions
- Quality of the compression gauge

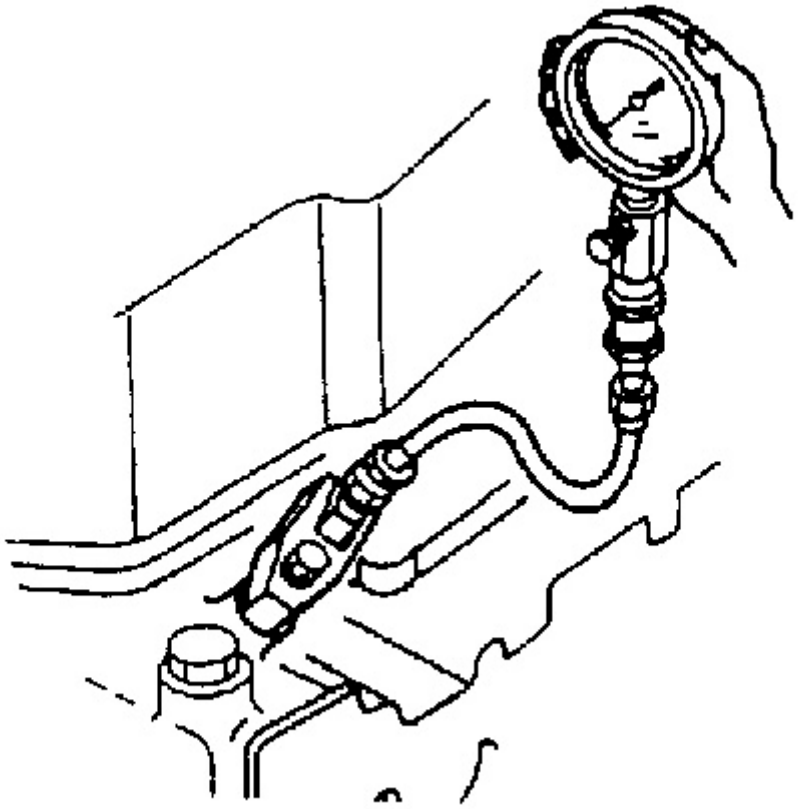


Illustration 1 g00564993

Checking compression of engine

1. Remove the fuel injection nozzle from the cylinder in order to measure the compression for that cylinder.
2. Connect a compression gauge to the cylinder.
3. Disconnect the fuel shutoff solenoid or hold the governor stop lever in the engine stop position.
4. Operate the starter motor and record the pressure on the compression gauge.
5. Repeat for each cylinder.

   Note: Compression tests should only be used to compare pressures between cylinders of an engine. If one or more cylinders vary more than 350 kPa (51 psi) then those cylinders may be damaged.

   Note: The cylinder compression test should not be the only test for determining the condition of an engine.

Table 2

	Standard at Assembly	**Repair Limit**
Compression Pressure [(1)]		

	2940 kPa (427 psi)	2650 kPa (384 psi)

(1) The compression pressure is taken at 300 rpm.

6. Repair procedures must be taken if the compression is lower than the repair limit.

NOTICE

Be sure to measure the compression on all of the cylinders. If all of the cylinders are not checked an improper diagnosis may result. The compression pressure will vary with the change in engine rpm. It is necessary to keep the engine rpm constant for all cylinders when you are taking a compression reading.

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i01895545

Engine Valve Lash - Inspect/Adjust

SMCS - 1102-025

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8H-8581	Feeler Gauge	1

WARNING

To prevent possible injury, do not use the starter to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring valve clearance.

If the valve lash requires adjustment several times in a short period of time, excessive wear exists in a different part of the engine. Repair the problem in order to prevent more damage to the engine.

Not enough valve lash can be the cause of rapid wear of the camshaft and valve lifters. Not enough valve lash can indicate that the seats for the valves are damaged.

Valves become damaged due to the following causes:

- The fuel injection nozzles do not operate correctly.
- Excessive dirt and oil are present on the filters for the air inlet.
- Incorrect fuel settings on the fuel injection pump.
- The load capacity of the engine is frequently exceeded.

Too much valve lash can cause broken valve stems, springs, and spring retainers. Too much valve lash can be an indication of the following problems:

- Worn camshaft and valve lifters
- Worn rocker arms
- Bent pushrods
- Broken socket on the upper end of a pushrod
- Loose adjustment screw for the valve lash

If the camshaft and valve lifters show rapid wear, look for fuel in the lubrication oil or dirty lubrication oil as a possible cause.

Valve Lash Check

The valve lash is measured between the top of the valve stem and the rocker arm lever.

Valve Lash Setting (cold engine)

Inlet valve ... 0.25 mm (0.0098 inch)
Exhaust valve ... 0.25 mm (0.0098 inch)

If the measurement is not within the acceptable clearance, adjustment is necessary. Refer to "Valve Lash Adjustment".

Valve Lash Adjustment

Note: The No. 1 cylinder is at the front of the engine.

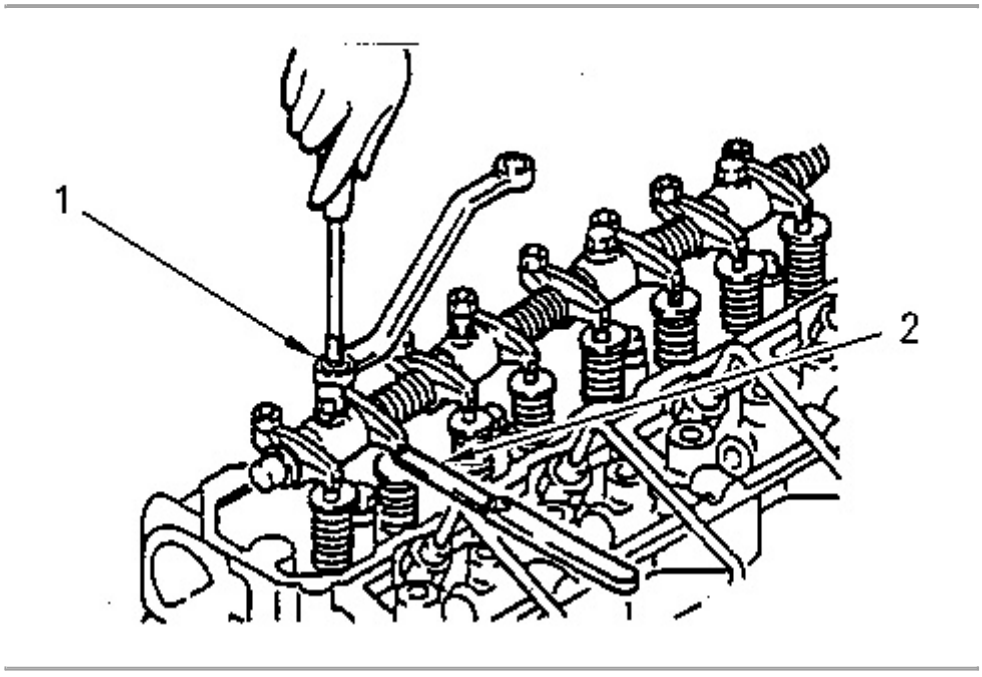


Illustration 1 g00987161

Setting the valve lash

(1) Adjustment screw

(2) Feeler gauge

WARNING

Accidental engine starting can cause injury or death to personnel.

To prevent accidental engine starting, turn the ignition switch to the OFF position and place a do not operate tag at the ignition switch location.

Remove the valve mechanism cover and perform the following procedure in order to adjust the valve lash:

1. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 4 cylinder has opened and the exhaust valve of the No. 4 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 1 cylinder. If necessary, make adjustment.

    a. Loosen the valve adjustment screw locknut that is on adjustment screw (1) .

    b. Place the appropriate feeler gauge (2) between the rocker arm and the valve stem. Turn adjustment screw (1) while the valve adjustment screw locknut is being held from turning. Adjust the valve lash until the correct specification is achieved.

    c. After each adjustment, tighten the valve adjustment screw locknut to the correct torque while adjustment screw (1) is being held from turning.

2. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 2 cylinder has opened and the exhaust valve of the No. 2 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 3 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

3. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 1 cylinder has opened and the exhaust valve of the No. 1 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 4 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

4. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 3 cylinder has opened and the exhaust valve of the No. 3 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 2 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

Note: Lubricate the rocker shaft assembly with clean engine oil after the valves have been adjusted. Lubricate the bearing surfaces on the rocker shaft, the tips of the valves, the pushrod sockets, and the pushrods so that the oil will drain in order to lubricate the lobes of the cam.

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i05182954

Valve Depth - Inspect

SMCS - 1105-040

Introduction

This procedure is intended to give information on inspecting valve depth.

Required Tools

Table 1

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	8T-0455	Liner Projection Tool Group	1

Check Procedure

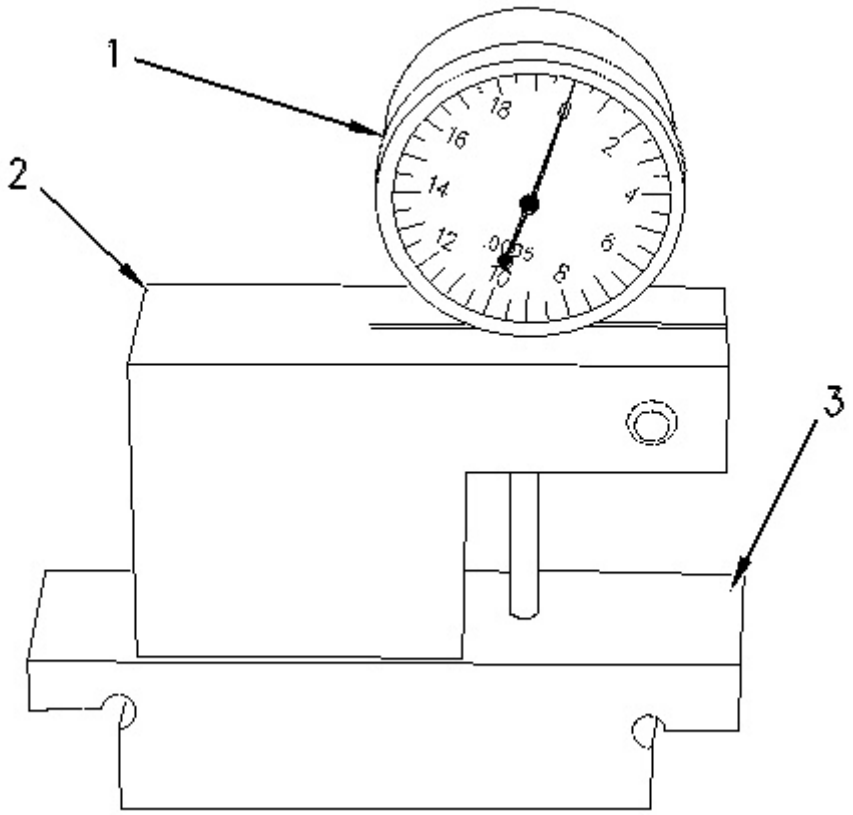


Illustration 1 g00323908

8T-0455 Liner Projection Tool Group

(1) Dial indicator

(2) Gauge body

(3) Gauge block

1. Use Tooling (A) in order to check the depths of the inlet valves and the exhaust valves below the face of the cylinder head. Use gauge block (3) to zero dial indicator (1) .

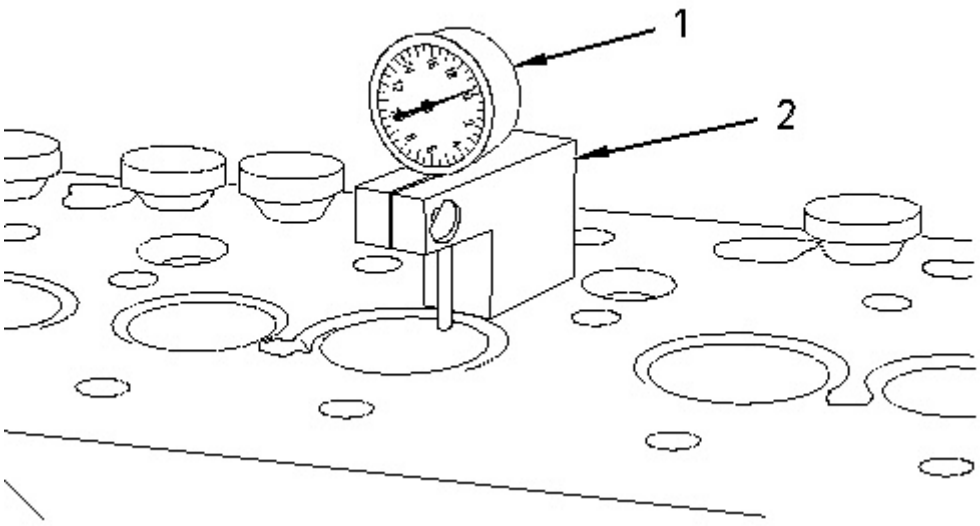


Illustration 2 g00323909

Measurement of the valve depth

(1) Dial indicator

(2) Gauge body

2. Position gauge body (2) and dial indicator (1) in order to measure the valve depth. Measure the depth of the inlet valve and the exhaust valve before the valve springs are removed.

   Refer to Specifications, "Cylinder Head Valves" for the minimum, the maximum, and the service wear limits for the valve depth below the cylinder head face.

   If the valve depth below the cylinder head face exceeds the service limit, use a new valve to check the valve depth. If the valve depth still exceeds the service limit, renew the cylinder head. If the valve depth is within the service limit, renew the valves.

3. Inspect the valves for cracks and other damage. Check that the valve stems for wear. Check that the valve springs are the correct length under the test force. Refer to Specifications, "Cylinder Head Valves" for the dimensions and tolerances of the valves and valve springs.

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i01773333

Valve Guide - Inspect

SMCS - 1104-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Group	1

Perform this test in order to determine if a valve guide should be replaced.

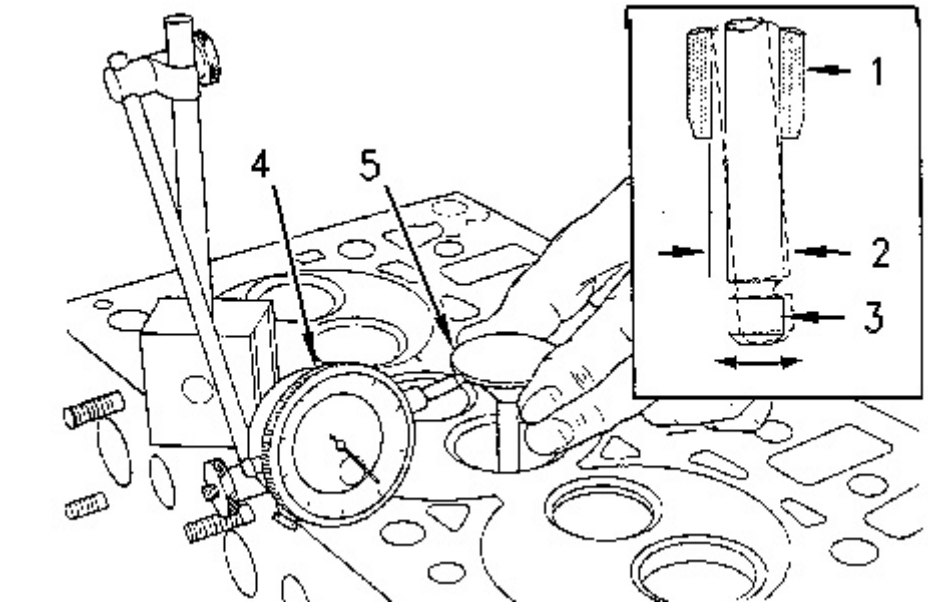


Illustration 1 g00314806

(1) Valve guide

(2) Radial movement of the valve in the valve guide

(3) Valve stem

(4) Dial indicator

(5) Valve head

1. Place a new valve in the valve guide.
2. Place the dial indicator with the magnetic base on the face of the cylinder head.
3. Lift the edge of the valve head to a distance of 15.0 mm (0.60 inch).
4. Move the valve in a radial direction away from the dial indicator. Make sure that the valve moves away from the dial indicator as far as possible. Position the contact point of the dial indicator on the edge of the valve head. Set the position of the needle of the dial indicator to zero.
5. Move the valve in a radial direction toward the dial indicator as far as possible. Note the distance of movement which is indicated on the dial indicator. If the distance is greater than the maximum clearance of the valve in the valve guide, replace the valve guide. Refer to Specifications, "Cylinder Head Valves" for the maximum clearance of the valve in the valve guide.

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Excessive Bearing Wear - Inspect

SMCS - 1203-040; 1211-040; 1219-040

When some components of the engine show bearing wear in a short time, the cause can be a restriction in an oil passage.

An engine oil pressure indicator may show that there is enough oil pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the oil supply to the component. A restriction in an oil supply passage will not allow enough lubrication to reach a component. This will result in early wear.

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i05183361

Piston Ring Groove - Inspect

SMCS - 1214-040

Introduction

This procedure is intended to give information on inspecting piston ring grove. Refer to the Specifications Manual for specifications for this procedure.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8H-8581	Feeler Gauge	1

Inspection Procedure

Inspect the Piston and the Piston Rings

1. Check the piston for wear and other damage.
2. Check that the piston rings are free to move in the grooves and that the rings are not broken.

Inspect the Clearance of the Piston Ring

1. Remove the piston rings and clean the grooves and the piston rings.

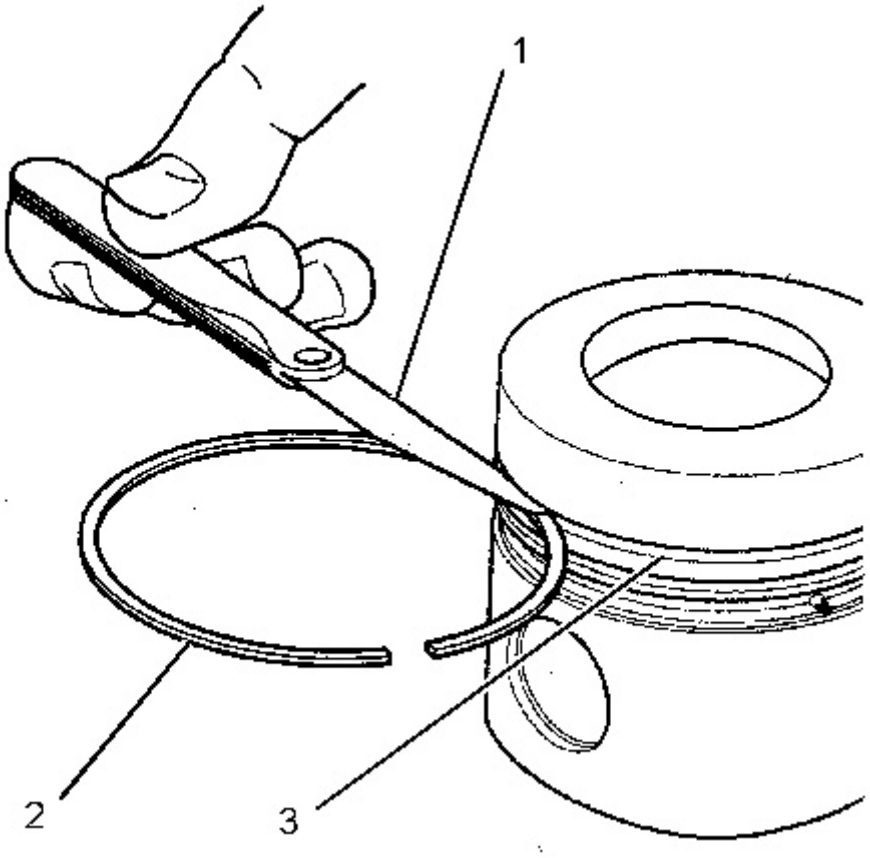


Illustration 1 g01284934

(1) Feeler gauge

(2) Piston ring

(3) Piston grooves

2. Fit new piston rings (2) in the piston grooves (3) .

3. Check the clearance for the piston ring by placing the **8H-8581** Feeler Gauge (1) between piston groove (3) and the top of piston ring (2) . Refer to Specifications, "Piston and Rings" for the dimensions.

   Note: Some pistons have a tapered top groove and the piston ring is wedged. The clearance for the top piston ring cannot be checked by the above method when this occurs.

Inspect the Piston Ring End Gap

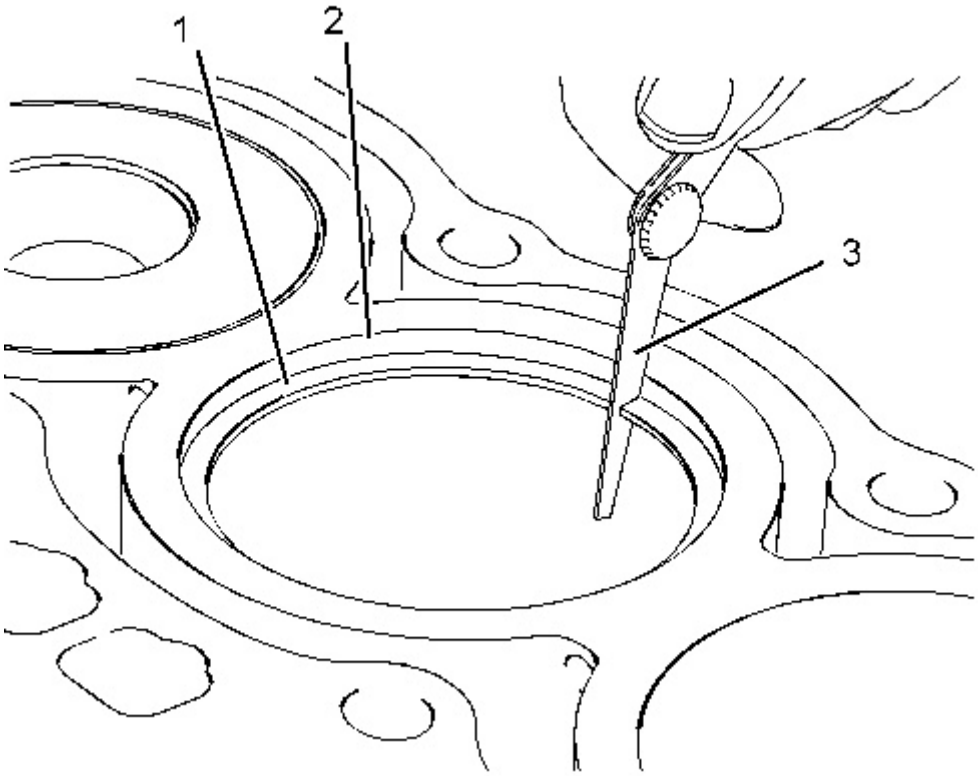


Illustration 2 g01358235

(1) Piston ring

(2) Cylinder ring ridge

(3) Feeler gauge

1. Clean all carbon from the top of the cylinder bores.
2. Place each piston ring (1) in the cylinder bore just below the cylinder ring ridge (2) .
3. Use the **8H-8581** Feeler Gauge (3) to measure piston ring end gap. Refer to Specifications, "Piston and Rings" for the dimensions.

   Note: The coil spring must be removed from the oil control ring before the gap of the oil control ring is measured.

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Connecting Rod - Inspect

SMCS - 1218-040

Inspect the Connecting Rod

1. Inspect the connecting rod for wear or cracking.
2. Inspect the piston pin bearing and the piston pin for wear and other damage. Check the piston pin bearing for a clogged oil hole.

   Note: Be sure that the oil holes of the piston pin bearing and the small end of the connecting rod are lined up.
3. Inspect the connecting rod bolts for stripped threads.

Measure Clearances and End Play

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
5P-2170	Dial Bore Gauge Group	1
8H-8581	Feeler Gauge	1

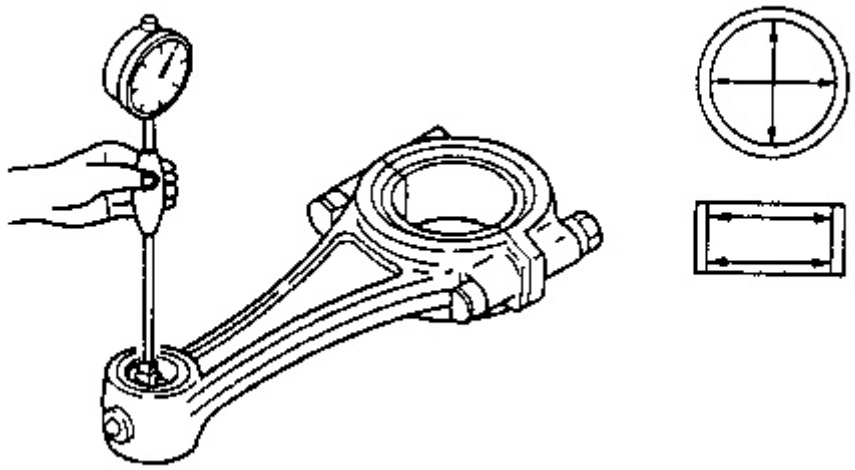


Illustration 1 g00994326

1. Measure the clearance of the piston pin in the piston pin bearing. Refer to Specifications, "Connecting Rod" for clearance dimensions.

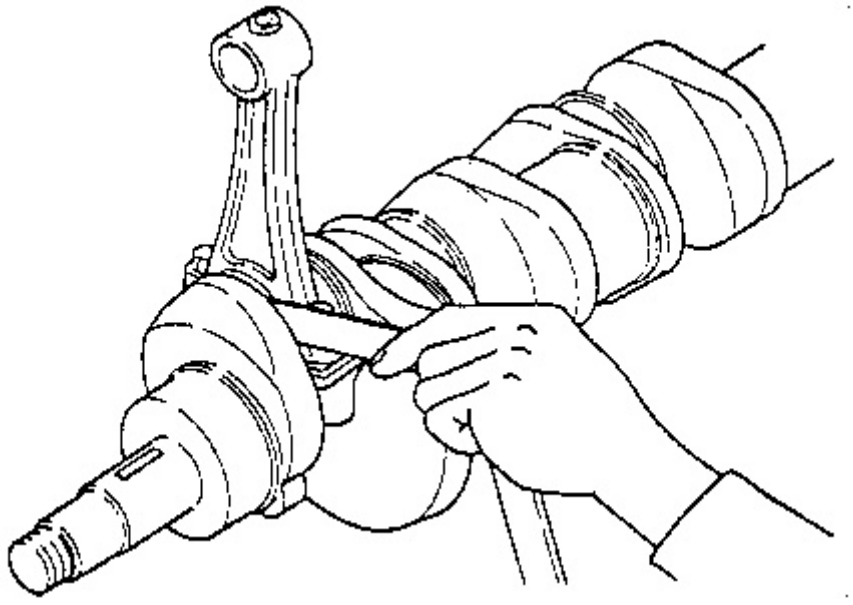


Illustration 2 g00994330

2. Install the connecting rod to the connecting rod journal. Tighten the bolts to the correct torque.
3. Measure the end play. Refer to Specifications, "Connecting Rod" for end play values.
4. If the end play exceeds the service limit, replace the connecting rod.

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i01748770

Connecting Rod Bearings - Inspect

SMCS - 1219-040

Check the connecting rod bearings and the connecting rod bearing journal for wear or other damage.

Connecting rod bearings are available with a smaller inside diameter than the original size bearings. These bearings are for crankshafts that have been ground.

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Main Bearings - Inspect

SMCS - 1203-040

Check the main bearings for wear or other damage. Replace both halves of the bearings and check the condition of the other bearings if a main bearing is worn or damaged.

Main bearings are available with a smaller inside diameter than the original size bearings. These bearings are for main bearing journals that have been ground.

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Cylinder Block - Inspect

SMCS - 1201-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
1P-3537	Dial Bore Gauge Group	1

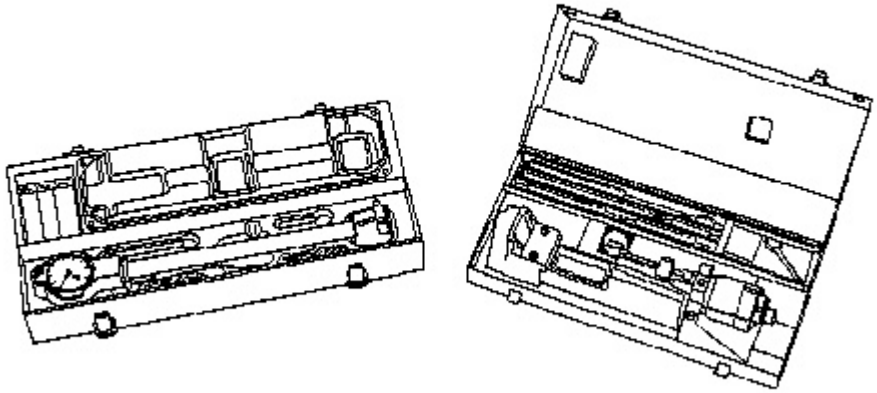


Illustration 1 g00285686

Inspect the top of the cylinder block for cracks and warpage. Refer to the Specifications Module, "Cylinder Block" topic for the tolerances.

Inspect each cylinder bore. There should be no scoring, rust or corrosion. Use a **1P-3537** Dial Bore Gauge Group in order to measure each cylinder bore. Each cylinder bore should be measured

at the top, middle and bottom. Refer to Special Instruction, GMG00981 for the instructions that are needed to use the dial bore gauge.

If the cylinder bores are out of the service limit, the cylinder block must be bored oversize. Refer to the Specifications Module, "Cylinder Block" topic for the tolerances.

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Cylinder Head - Inspect

SMCS - 1100-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8S-6691	Cylinder Head Repair Stand	1
8H-8581	Feeler Gauge	1

1. Remove the cylinder head from the engine.
2. Clean the cylinder head thoroughly. Make sure that the contact surfaces of the cylinder head and the cylinder block are clean, smooth and flat.
3. Inspect the bottom surface of the cylinder head for pitting, corrosion, and cracks. Inspect the area around the valve seat inserts and the holes for the fuel injection nozzles.

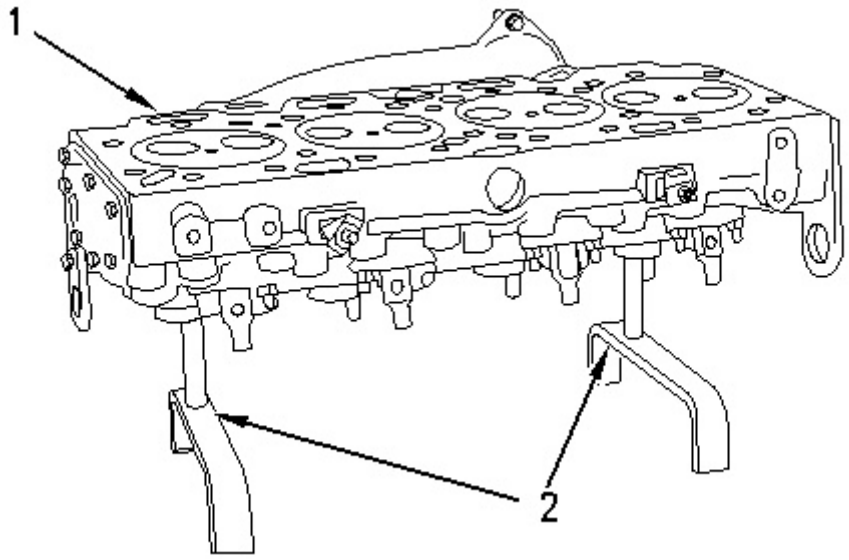


Illustration 1 g00876690

Typical example

(1) Cylinder head

(2) Cylinder head repair stand

4. Place cylinder head (1) on cylinder head repair stand (2) .

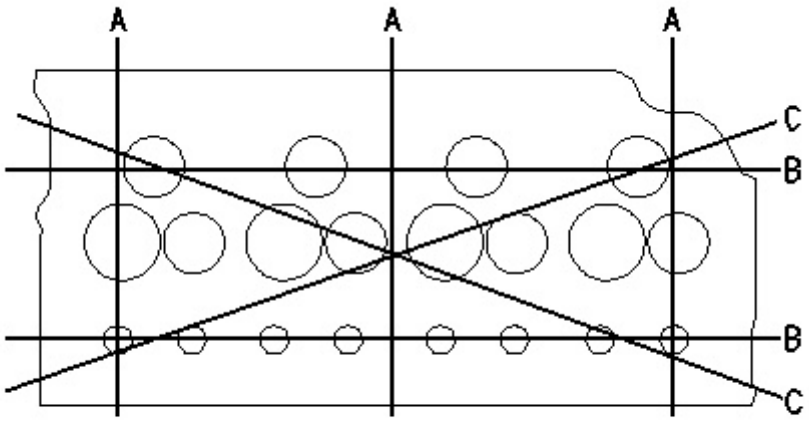


Illustration 2 g00987700

Measuring points on cylinder head

(A) Side to side

(B) End to end

(C) Corner to corner

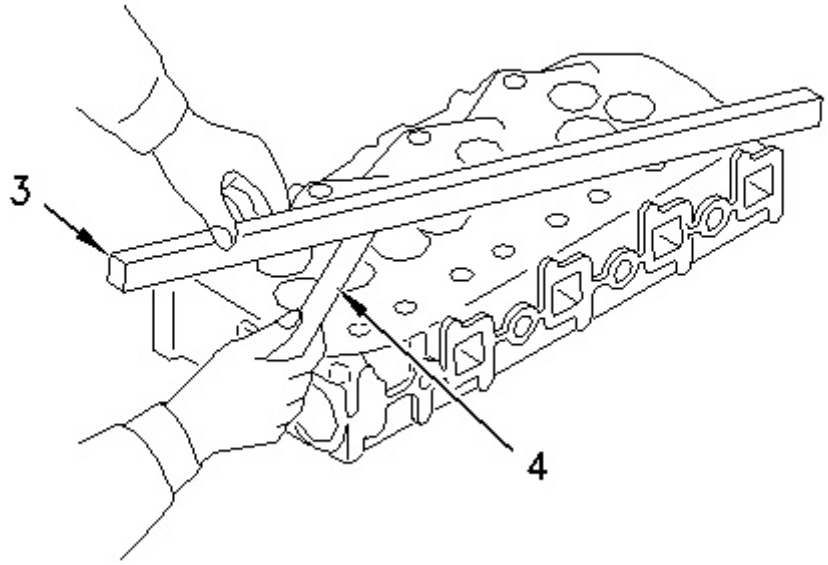


Illustration 3 g00987701

Measuring flatness

(3) Straight edge

(4) Feeler gauge

5. Measure the cylinder head for flatness. Measure the flatness with straight edge (3) and with feeler gauge (4) .
    - Measure the cylinder head from one side to the other side (A) .
    - Measure the cylinder head from one end to the other end (B) .
    - Measure the cylinder head from one corner to the other corner (C) .

    Refer to Specifications, "Cylinder Head" for the requirements of flatness.

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i05183429

Piston Height - Inspect

SMCS - 1214-040

Introduction

If the height of the piston above the top face of the cylinder block is not within the tolerance that is given in Specifications, "Piston and Rings", the piston and the piston pin bearing must be replaced. If any of the following components are replaced or remachined, the piston height above the top face of the cylinder block must be measured:

- Crankshaft
- Cylinder head
- Connecting rod
- Piston pin bearing
- Piston

The correct piston height must be maintained in order to ensure that the engine conforms to the standards for emissions.

Note: The top of the piston should not be machined. If the original piston is installed, be sure that the original piston is assembled to the correct connecting rod and installed in the original cylinder.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-0455	Liner Projection Tool Group	1

Inspection Procedure

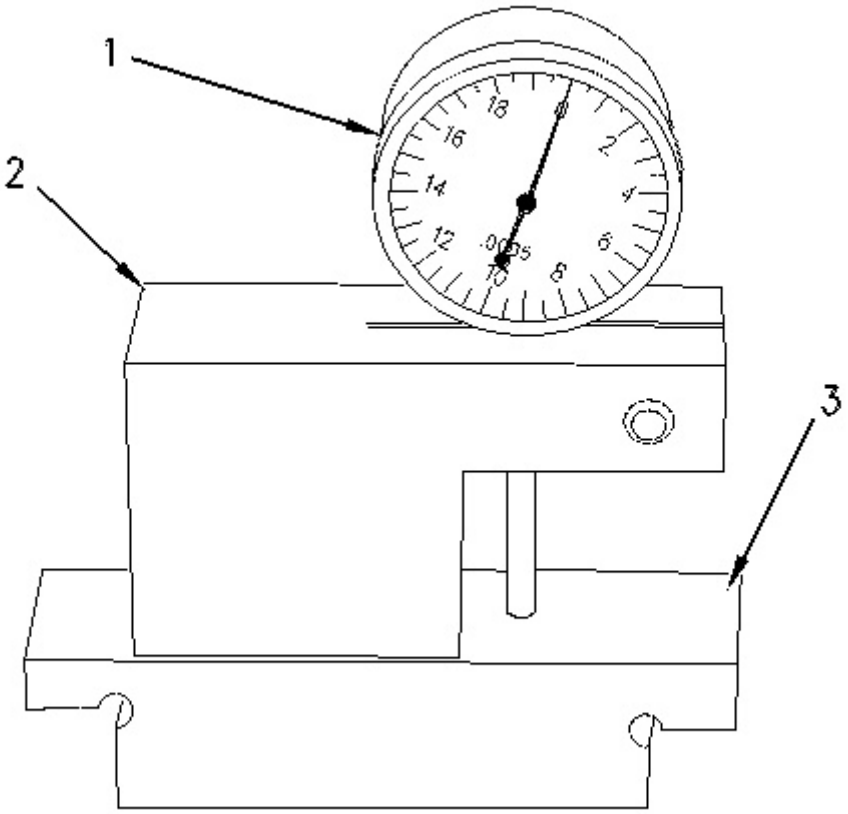


Illustration 1 g00323908

8T-0455 Liner Projection Tool Group

(1) 1P-2403 Dial Indicator

(2) 1P-2402 Gauge Body

(3) 1P-5507 Gauge Block

1. Use the **8T-0455** Liner Projection Tool Group in order to measure the piston height above the top face of the cylinder block. Use the gauge block (3) in order to zero the dial indicator (1) .

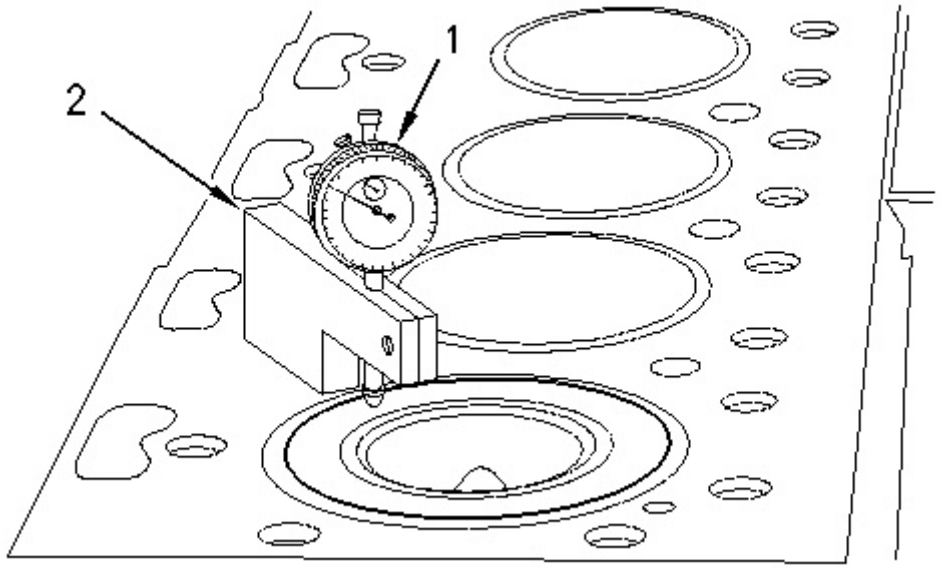


Illustration 2 g00326383

Measurement of the piston height

(1) 1P-2403 Dial Indicator

(2) 1P-2402 Gauge Body

2. Position gauge body (2) and dial indicator (1) in order to measure the piston height above the top face of the cylinder block. Slowly rotate the crankshaft in order to determine when the piston is at the highest position. Record this dimension. Compare this dimension with the dimensions that are given in Specifications, "Piston and Rings".

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Flywheel - Inspect

SMCS - 1156-040

Inspect the Flywheel

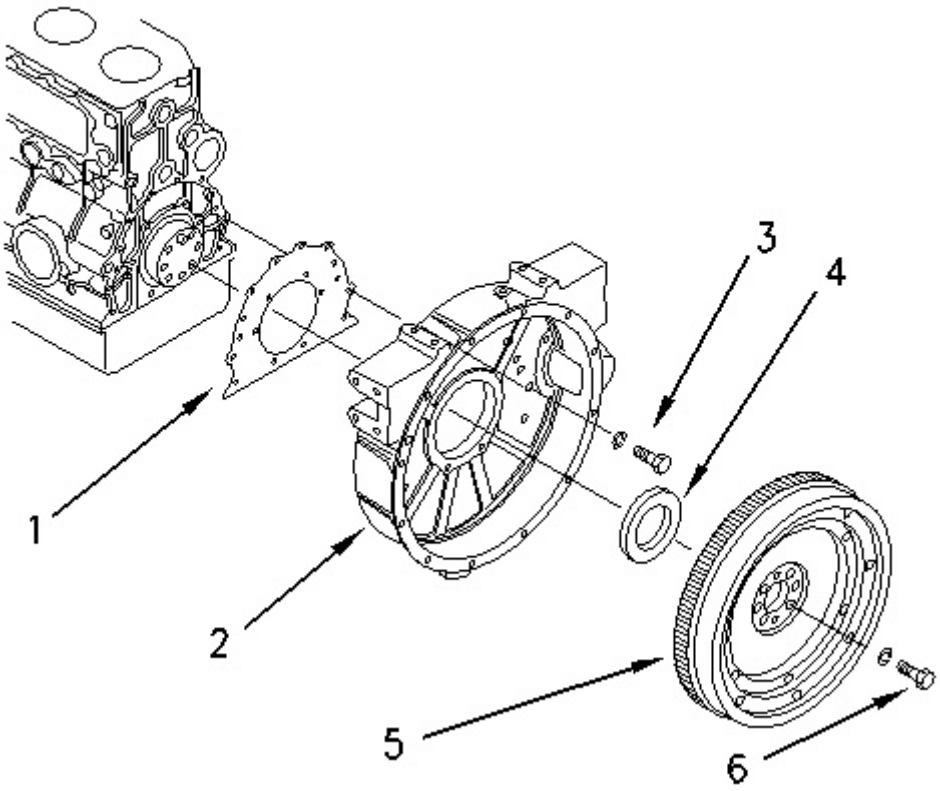


Illustration 1 g00987873

Exploded view of flywheel and flywheel housing

(1) Gasket

(2) Flywheel housing

(3) Bolt

(4) Rear oil seal

(5) Flywheel

(6) Bolt

1. Check for cracks or a damaged dowel hole.
2. Check the ring gear on flywheel (5) for teeth that are worn or damaged.
3. Inspect the flywheel bolts (6) for stripped threads.

Flatness of the Flywheel

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

Note: The flywheel must be removed from the engine in order to check the flatness.

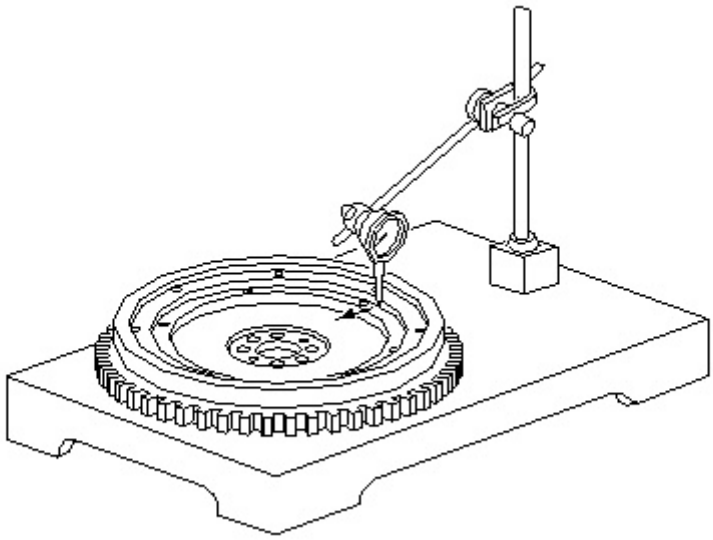


Illustration 2 g00987717

Flatness of flywheel

1. Place the flywheel on a surface plate.
2. Set a dial indicator at one side of the surface plate and move the dial indicator to the opposite side. Refer to Illustration 2.
3. Refer to Specifications, "Flywheel" for the correct values of the flatness.

Face Runout (Radial Eccentricity) of the Flywheel

Table 2

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

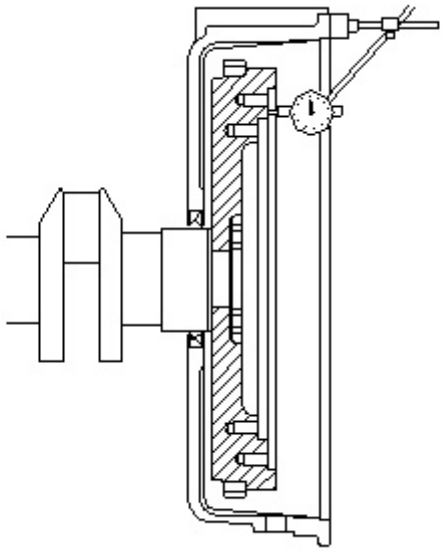


Illustration 3 g00987720

Runout of flywheel

1. Refer to Illustration 3 and install the dial indicator. Always put a force on the crankshaft in the same direction before the dial indicator is read. This will remove any crankshaft end clearance.
2. Set the dial indicator to read 0.0 mm (0.00 inch).
3. Turn the flywheel at intervals of 90 degrees and read the dial indicator.
4. Calculate the difference between the lower measurements and the higher measurements that are performed at all four points. Refer to Specifications, "Flywheel" for the correct values of the runout.

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Flywheel Housing - Inspect

SMCS - 1157-040

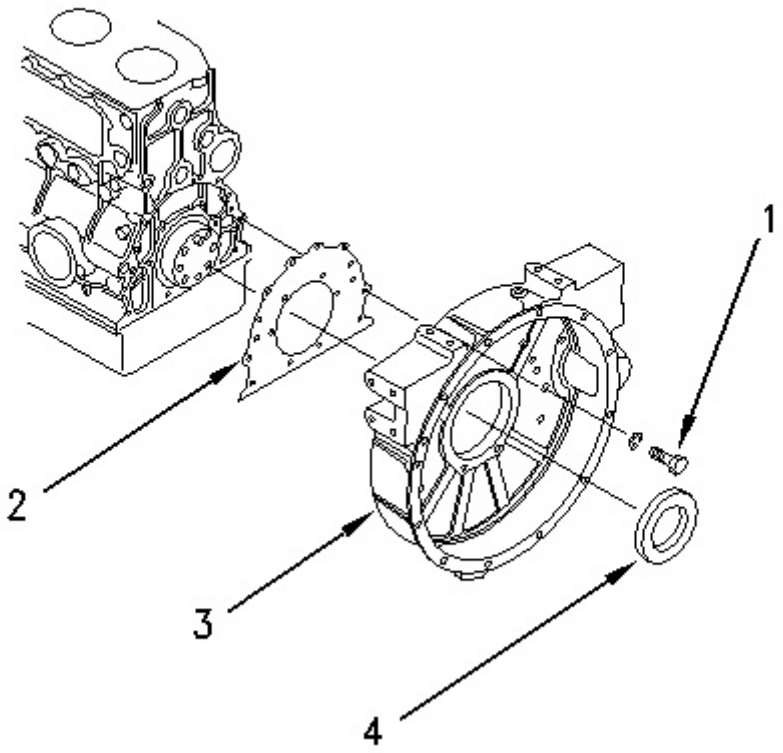


Illustration 1 g00987862

Exploded view of flywheel housing

(1) Bolt

(2) Gasket

(3) Flywheel housing

(4) Rear oil seal

1. Check for cracks or a damaged dowel hole.
2. Inspect bolts (1) that hold the flywheel housing in place for stripped threads.
3. Inspect rear oil seal (4) for leaks or damage.

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Gear Group - Inspect

SMCS - 1206-040

Inspect the Gear Group

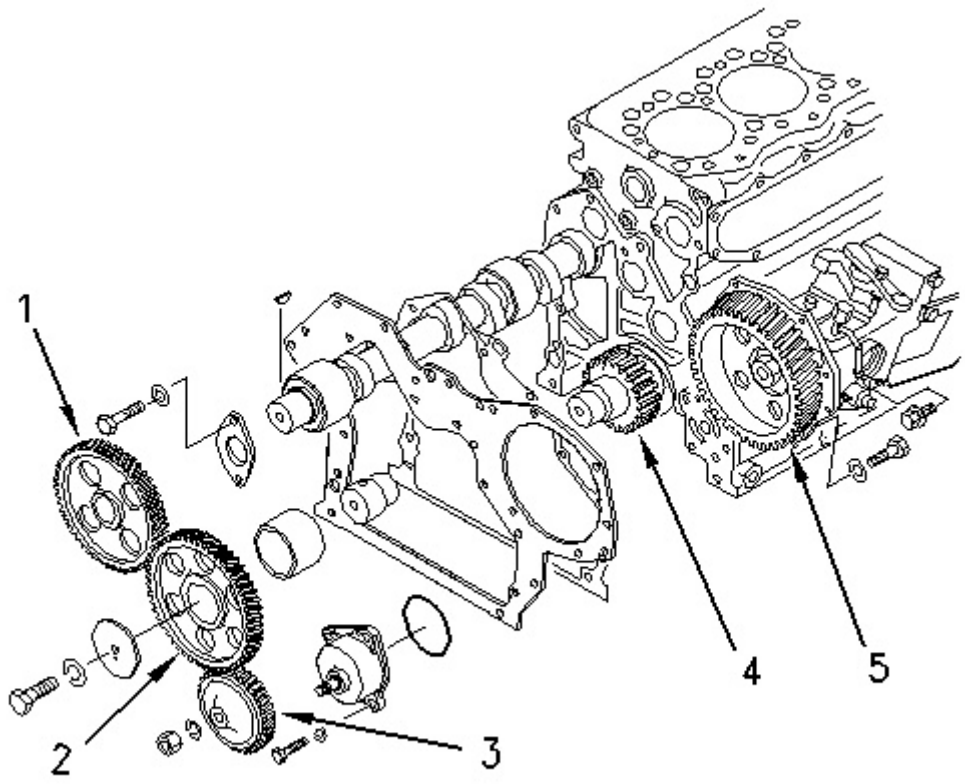


Illustration 1 g00987777

Exploded view of the front timing group

(1) Camshaft gear

(2) Upper idler gear

(3) Oil pump gear

(4) Crankshaft gear

(5) Fuel injection pump gear

Inspect the gears for wear or for damage. If the gears are worn or damaged, use new parts for replacement.

Note: If one or more of the gears need to be removed for repair, refer to Disassembly and Assembly in order to properly remove the gears.

Measure Backlash and End Play

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

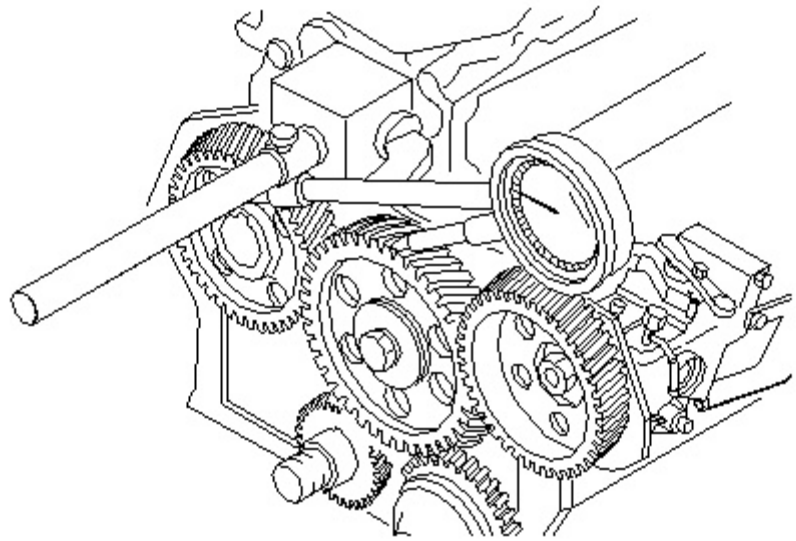


Illustration 2 g00987788

Measuring backlash

1. Install the dial indicator in Illustration 2, as shown.

2. Measure the backlash of the gears. Refer to Specifications, "Gear Group (Front)" for the values of the backlash.

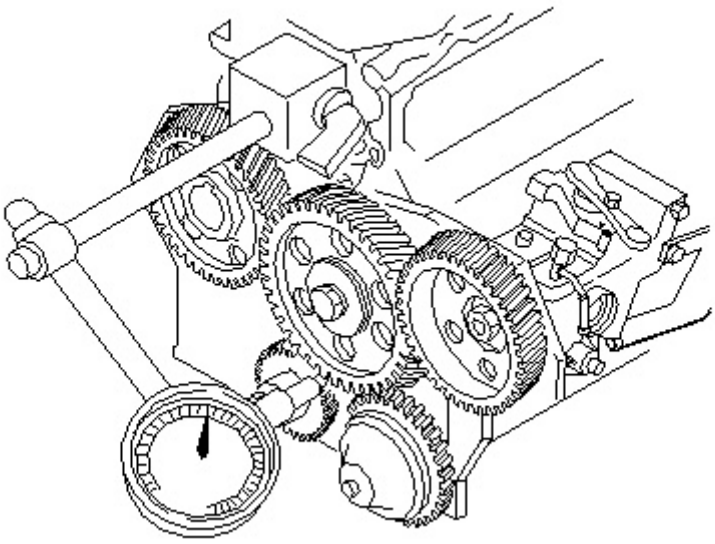


Illustration 3 g00987800

Measuring end play of the idler gear

1. Install the dial indicator in Illustration 3, as shown.
2. Measure the end play of the idler gear. Refer to Specifications, "Gear Group (Front)" for the values of the end play.

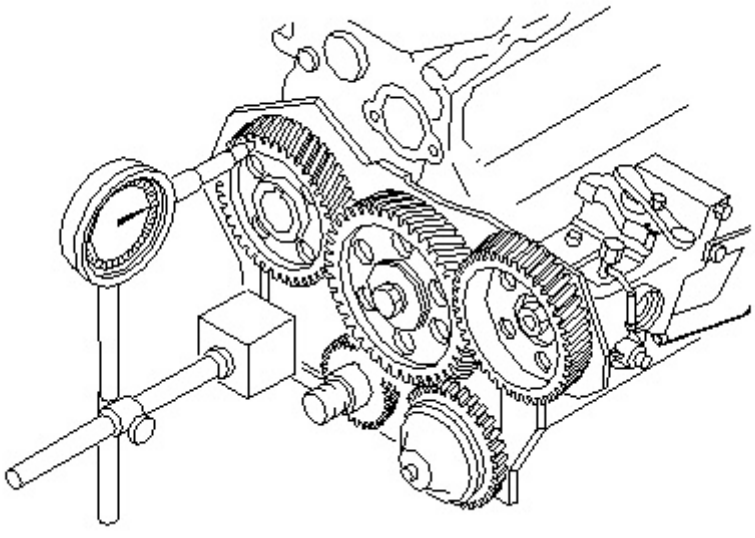


Illustration 4 g00996060

Measuring end play of the camshaft

1. Install the dial indicator in Illustration 4, as shown.
2. Measure the end play of the camshaft. Refer to Specifications, "Camshaft" for the values of the end play.

   Note: The end play is controlled by the camshaft thrust washer. If the end play is not within specifications, replace the thrust washer.

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i02831535

Finding Top Center Position for No. 1 Piston

SMCS - 1105-531

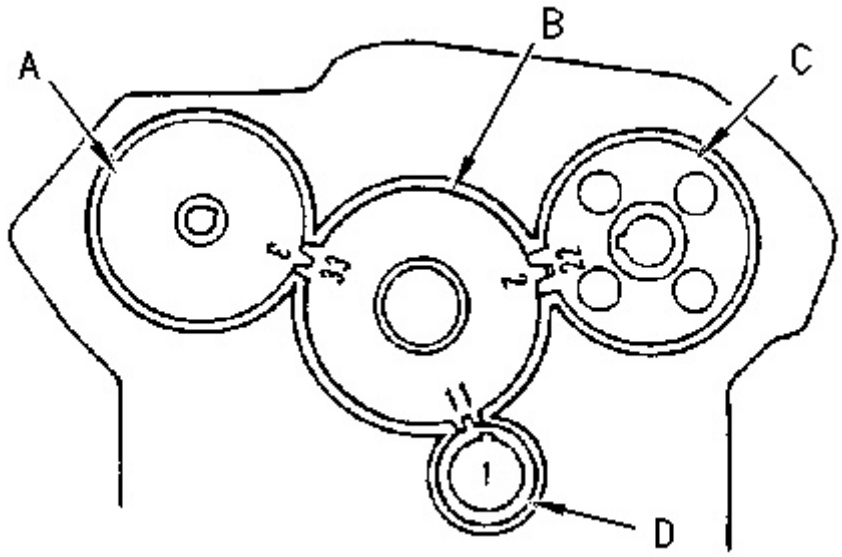


Illustration 1 g00569371

Timing Gears

(A) Fuel injection pump drive gear

(B) Idler gear

(C) Camshaft gear

(D) Crankshaft gear

1. The engine timing gears have a reference mark on each gear. The No. 1 cylinder is at the top center position when these marks are in alignment.

   Note: This engine is not timed with a pin and this engine has an idler gear with an odd number of teeth. Do not rotate the engine if the fuel injection pump is removed. The gears

must be aligned by using the timing marks once the front housing is removed. Mark the teeth with a paint stick. Reinstall the fuel injection pump by meshing the marked teeth.

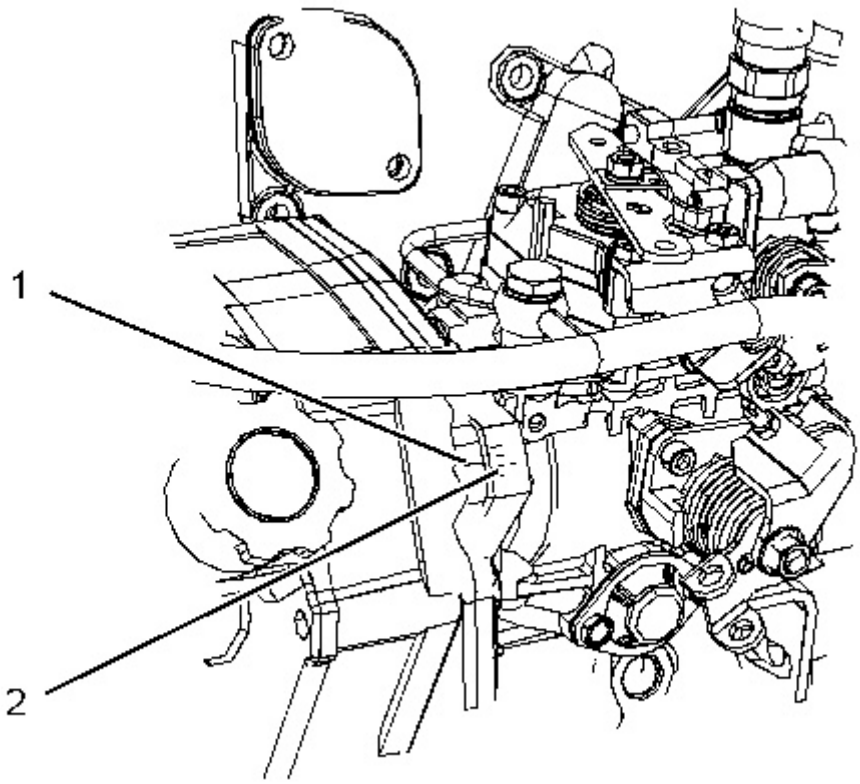


Illustration 2 g01412325

Fuel Injection Pump Timing Mark

(1) Timing marks

(2) Timing marks

2. Timing marks (1) and (2) on the fuel injection pump indicate the pump position relative to the timing gear. Each mark on the scale represents a change in timing of six degrees.
3. Turn the crankshaft until the No. 1 piston is approximately 60 degrees BTC on the compression stroke.

   Note: Check the valve lash with the No. 1 cylinder at the top center position. This ensures that the cylinder is on the compression stroke and that the cylinder is not on the exhaust stroke.

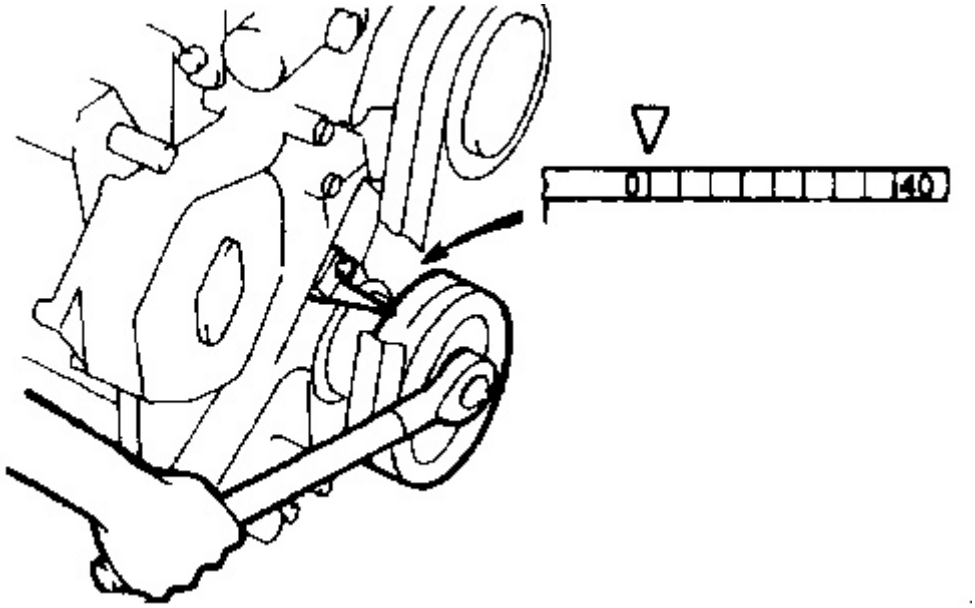


Illustration 3 g00565561

Crankshaft Pulley Timing Marks

4. The crankshaft pulley contains a scale that has a range of 0 degrees to 40 degrees. Each mark on the scale represents a 5 degree crankshaft rotation.

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i02707221

Fuel Injection Nozzle - Test

SMCS - 1254-081

Test the Fuel Injection Nozzles

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-4150	Nozzle Testing Group	1
5P-7448	Adapter	1
6V-2170	Tube Assembly	1
8S-2270	Fuel Collector	1
1U-8857	Extension	1
6V-6068	SAE J-967 Calibration Fluid	1

Perform the following procedures in order to determine if a fuel injection nozzle does not work correctly.

Bench test the fuel injection nozzles at a temperature of 18° to 20 °C (64° to 70 °F).

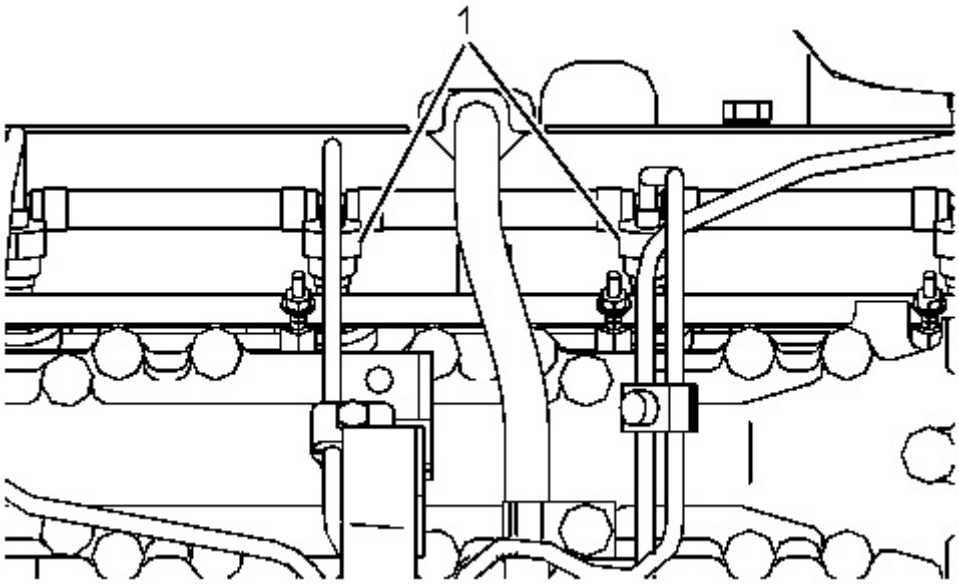


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

1. Run the engine at low idle.
2. Loosen the connection for the high pressure fuel line (1) at the fuel injection nozzle on No. 1 cylinder. Do not loosen the nut more than half of a turn. Listen for the low idle to decrease or become rough. Tighten the nut for the fuel supply line on No. 1 cylinder. Perform this test on each cylinder.
3. The fuel injection nozzle is faulty when the nut for the fuel supply line is loosened and the following events occur:
   - The engine rpm does not decrease.
   - The engine does not idle roughly.
4. Remove the fuel injection nozzle for additional testing.

   Note: If leakage occurs at the nut for the fuel supply line, make sure that fuel supply line and the nut are correctly aligned with the inlet connection of fuel injection nozzle. Do not tighten the nut for the fuel supply line on the high pressure fuel line more than the recommended torque. If the nut is tightened more, the fuel line may become restricted or the threads of the fuel injection nozzle and the nut may be damaged.

Cleaning of the Fuel Injection Nozzles

Before a fuel injection nozzle is tested, remove any loose carbon from the tip of the fuel injection nozzle. Do not use abrasive material or a wire brush in order to clean the nozzle.

The fuel injection nozzle is not a serviceable part. Disassembling or adjusting the nozzle will violate the standards for emissions.

Note: Extra care should be used in handling the fuel injection nozzle in order to prevent damage to the nozzle tip. A scratch or a burr could cause needle leakage or spray distortion. Dirt in the orifices of the nozzle tip can damage engine components. Dirt can also distort the spray pattern of the nozzle.

Pressure Test

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

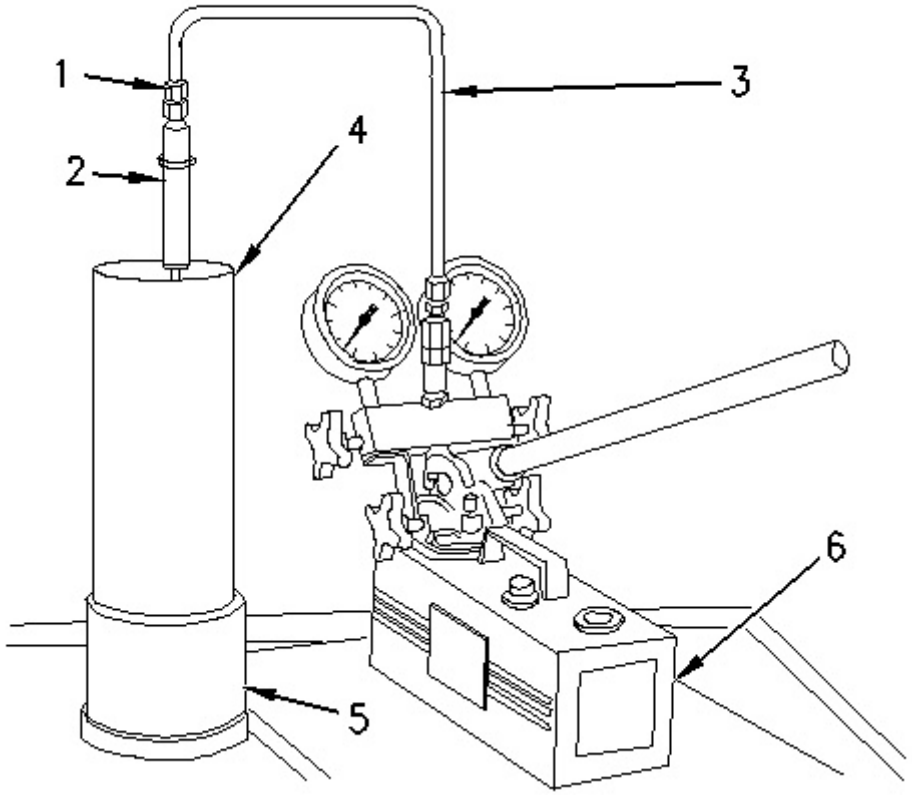


Illustration 2 g00804566

5P-4150 Nozzle Testing Group

(1) 5P-7448 Adapter

(2) Fuel injection nozzle

(3) 6V-2170 Tube assembly

(4) 1U-8857 Extension

(5) 8S-2270 Fuel collector

(6) 8T-5313 Filter

NOTICE

Do not use dirty test fluids when you test fuel injection nozzles. Also, do not test fuel injection nozzles unless you have the correct service tools.The use of dirty test fluids and the use of incorrect service tools will result in damage to fuel injection nozzles.

---

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

   Use clean **6V-6068** Calibration Fluid when the fuel injection nozzles are tested. The calibration fluid is equivalent to SAE J-967 (ISO 4113) oil.

2. Close the gauge protector valve. Close the shutoff valve. Open the pump isolator valve. In order to flush the fuel injection nozzle, operate the nozzle tester for 10 to 15 strokes at a rate of approximately 60 strokes per minute.

3. Open the gauge protector valve. Slowly increase the pressure until the valve in the fuel injection nozzle opens. Note the highest pressure indication on the dial indicator before the pointer moves to 0 kPa (0 psi). This highest pressure indication is the opening pressure of the fuel injection nozzle. The opening pressure is defined when the valve needle is lifted from the valve seat.

4. Refer to Specifications, "Fuel Injection Nozzles" for the correct pressure settings.

   If the opening pressure is not within the range of the setting that is given, the fuel injection nozzle must be replaced.

Back Leakage Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure to about 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

Release the handle. When the pressure begins to decrease, note the time that is required for the pressure to decrease to approximately 0 kPa (0 psi). If the fuel injection nozzle is not faulty, the time will not be less than 5 seconds or more than 45 seconds.

3. When the test in Step 2 is done, look for any leakage from the pressure faces of the holder and the retaining nut of the fuel injection nozzle. If leaks are visible, make sure that the components are tightened to the correct torque. Do not overtighten the components in order to stop the leakage. Instead, a pressure test on the fuel injection nozzle must be conducted. This test may force any foreign particles out of the nozzle. Replace the fuel injection nozzle if there is excessive fuel leakage.

4. If the pressure decreases to 0 kPa (0 psi) in less than 5 seconds, too much fuel is leaking around the valve needle. The valve needle or the fuel injection nozzle must be replaced in order to correct the problem.

Fuel Injection Nozzle and Seat Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure of the nozzle tester to approximately 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

   Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

   A drop of fuel should not form on the tip of the fuel injection nozzle for at least ten seconds. A light dampness is acceptable. If the results of the tests are not acceptable, clean the fuel injection nozzle. After you clean the fuel injection nozzle and the fuel leakage still occurs, the nozzle must be replaced.

Test the Spray Pattern

The pressure adjustment must be correct before the spray pattern is tested.

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

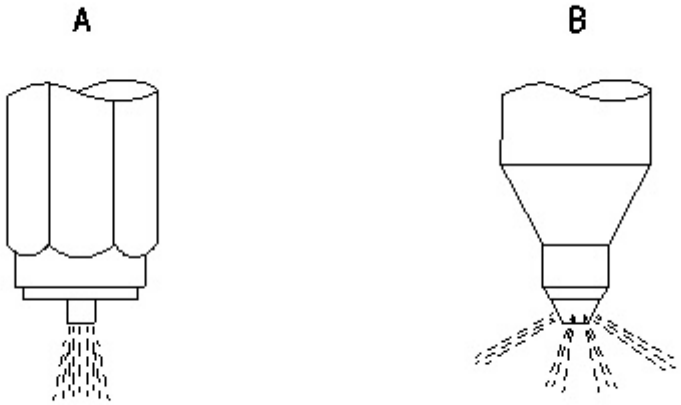


Illustration 3 g01007931

Spray patterns of the fuel injection nozzles

(A) Spray pattern for indirect injection

(B) Spray pattern for direct injection

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Close the gauge protector valve and the shutoff valve. Open the pump isolator valve.

3. Quickly pump the nozzle tester and look at the spray pattern when the fluid begins to flow through the orifices of the fuel injection nozzle.

   The spray, which flows from all of the orifices, must have the same pattern. The fuel injection nozzle is faulty if there is a difference in the vertical patterns or a difference in the horizontal patterns. Refer to the correct spray pattern in Illustration 3.

   Note: Be sure that the gauge protector valve is closed before the fuel injection nozzle is removed from the nozzle tester. Closing the valve will prevent damage to the pressure gauge.

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i04643912

Engine Crankcase Pressure (Blowby) - Test

SMCS - 1215; 1317

Table 1

Tools Needed		
Part Number	**Part Name**	**Quantity**
348-5430	Multi-Tool Gp	1
285-0900	Blowby Tool Group	1
NETG5049	Software License	1

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than a normal amount of blowby fumes rising from the crankcase breather. The breather can then become restricted in a short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.



Illustration 1 g02709261

348-5430 Multi-Tool Gp

The **348-5430** Multi-Tool Gp , or the **285-0900** Blowby Tool Group is used to check the amount of blowby. Refer to Tool Operating Manual, NEHS1087, " **348-5430** Multi-Tool Gp " for the test procedure for checking the blowby.

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Compression - Test

SMCS - 1215

Table 1

Tools Needed		
Part Number	Part Name	Qty
9U-6274	Compression Test Tool Gp	1

The following conditions can affect the results of the cylinder compression test:

- Battery
- Condition of the starter motor
- Ambient conditions
- Quality of the compression gauge

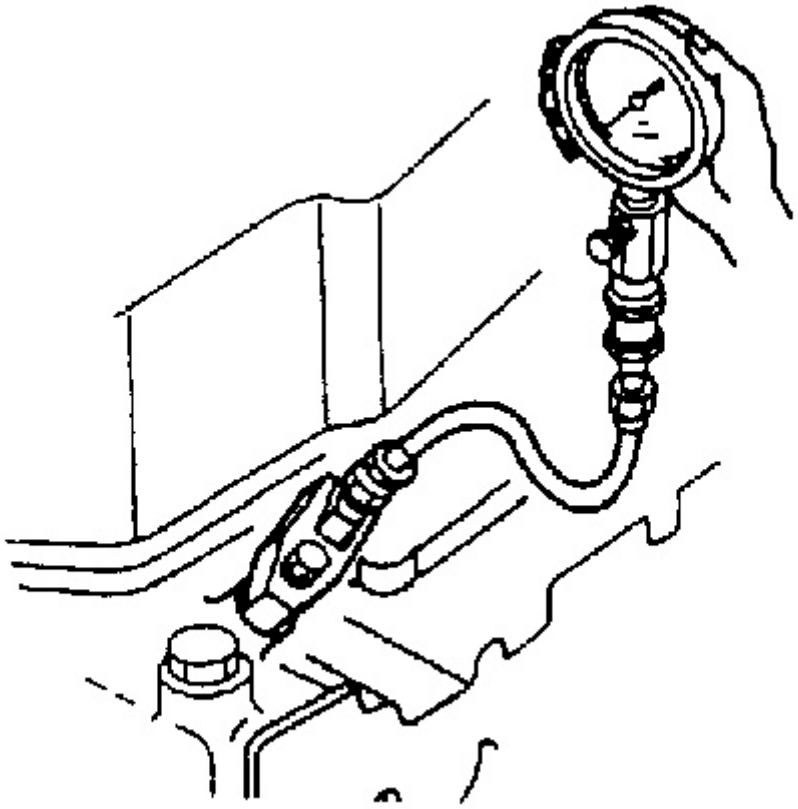


Illustration 1 g00564993

Checking compression of engine

1. Remove the fuel injection nozzle from the cylinder in order to measure the compression for that cylinder.
2. Connect a compression gauge to the cylinder.
3. Disconnect the fuel shutoff solenoid or hold the governor stop lever in the engine stop position.
4. Operate the starter motor and record the pressure on the compression gauge.
5. Repeat for each cylinder.

   Note: Compression tests should only be used to compare pressures between cylinders of an engine. If one or more cylinders vary more than 350 kPa (51 psi) then those cylinders may be damaged.

   Note: The cylinder compression test should not be the only test for determining the condition of an engine.

Table 2

	Standard at Assembly	**Repair Limit**
Compression Pressure [(1)]		

	2940 kPa (427 psi)	2650 kPa (384 psi)

(1) The compression pressure is taken at 300 rpm.

6. Repair procedures must be taken if the compression is lower than the repair limit.

NOTICE

Be sure to measure the compression on all of the cylinders. If all of the cylinders are not checked an improper diagnosis may result. The compression pressure will vary with the change in engine rpm. It is necessary to keep the engine rpm constant for all cylinders when you are taking a compression reading.

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Engine Valve Lash - Inspect/Adjust

SMCS - 1102-025

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8H-8581	Feeler Gauge	1

WARNING

To prevent possible injury, do not use the starter to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring valve clearance.

If the valve lash requires adjustment several times in a short period of time, excessive wear exists in a different part of the engine. Repair the problem in order to prevent more damage to the engine.

Not enough valve lash can be the cause of rapid wear of the camshaft and valve lifters. Not enough valve lash can indicate that the seats for the valves are damaged.

Valves become damaged due to the following causes:

- The fuel injection nozzles do not operate correctly.
- Excessive dirt and oil are present on the filters for the air inlet.
- Incorrect fuel settings on the fuel injection pump.
- The load capacity of the engine is frequently exceeded.

Too much valve lash can cause broken valve stems, springs, and spring retainers. Too much valve lash can be an indication of the following problems:

- Worn camshaft and valve lifters
- Worn rocker arms
- Bent pushrods
- Broken socket on the upper end of a pushrod
- Loose adjustment screw for the valve lash

If the camshaft and valve lifters show rapid wear, look for fuel in the lubrication oil or dirty lubrication oil as a possible cause.

Valve Lash Check

The valve lash is measured between the top of the valve stem and the rocker arm lever.

Valve Lash Setting (cold engine)

Inlet valve ... 0.25 mm (0.0098 inch)
Exhaust valve ... 0.25 mm (0.0098 inch)

If the measurement is not within the acceptable clearance, adjustment is necessary. Refer to "Valve Lash Adjustment".

Valve Lash Adjustment

Note: The No. 1 cylinder is at the front of the engine.

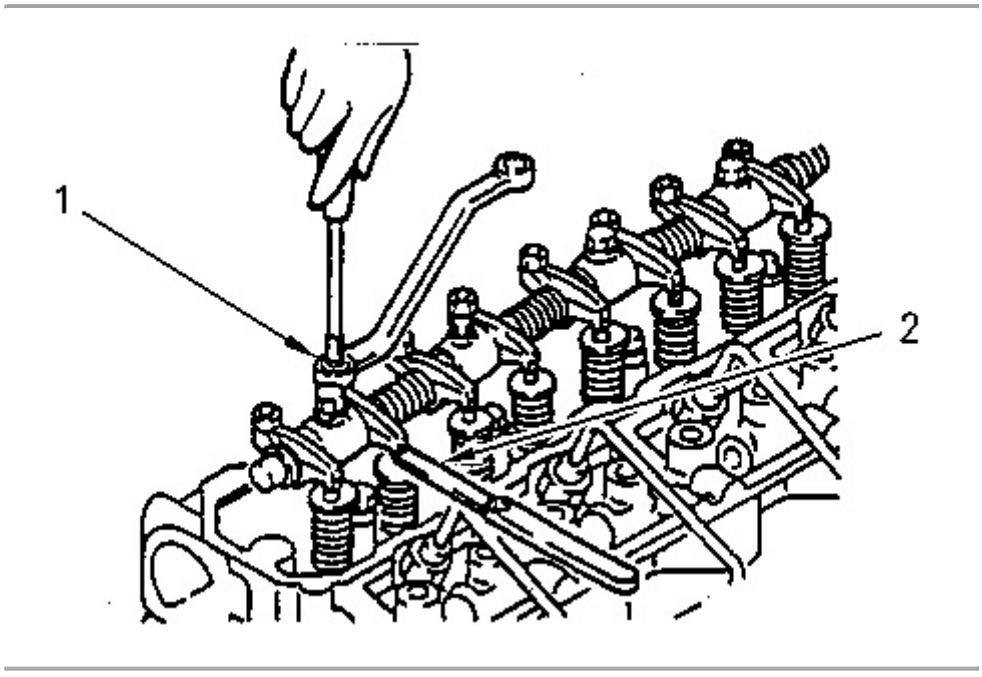


Illustration 1 g00987161

Setting the valve lash

(1) Adjustment screw

(2) Feeler gauge

WARNING

Accidental engine starting can cause injury or death to personnel.

To prevent accidental engine starting, turn the ignition switch to the OFF position and place a do not operate tag at the ignition switch location.

Remove the valve mechanism cover and perform the following procedure in order to adjust the valve lash:

1. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 4 cylinder has opened and the exhaust valve of the No. 4 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 1 cylinder. If necessary, make adjustment.

    a. Loosen the valve adjustment screw locknut that is on adjustment screw (1) .

    b. Place the appropriate feeler gauge (2) between the rocker arm and the valve stem. Turn adjustment screw (1) while the valve adjustment screw locknut is being held from turning. Adjust the valve lash until the correct specification is achieved.

    c. After each adjustment, tighten the valve adjustment screw locknut to the correct torque while adjustment screw (1) is being held from turning.

2. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 2 cylinder has opened and the exhaust valve of the No. 2 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 3 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

3. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 1 cylinder has opened and the exhaust valve of the No. 1 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 4 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

4. Rotate the crankshaft in the normal rotation of the engine. When the inlet valve of the No. 3 cylinder has opened and the exhaust valve of the No. 3 cylinder has not completely closed measure the valve lash of the inlet valve and the exhaust valve of No. 2 cylinder.

    If adjustment is necessary, refer to Steps 1.a, 1.b, and 1.c.

Note: Lubricate the rocker shaft assembly with clean engine oil after the valves have been adjusted. Lubricate the bearing surfaces on the rocker shaft, the tips of the valves, the pushrod sockets, and the pushrods so that the oil will drain in order to lubricate the lobes of the cam.

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Valve Depth - Inspect

SMCS - 1105-040

Introduction

This procedure is intended to give information on inspecting valve depth.

Required Tools

Table 1

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	8T-0455	Liner Projection Tool Group	1

Check Procedure

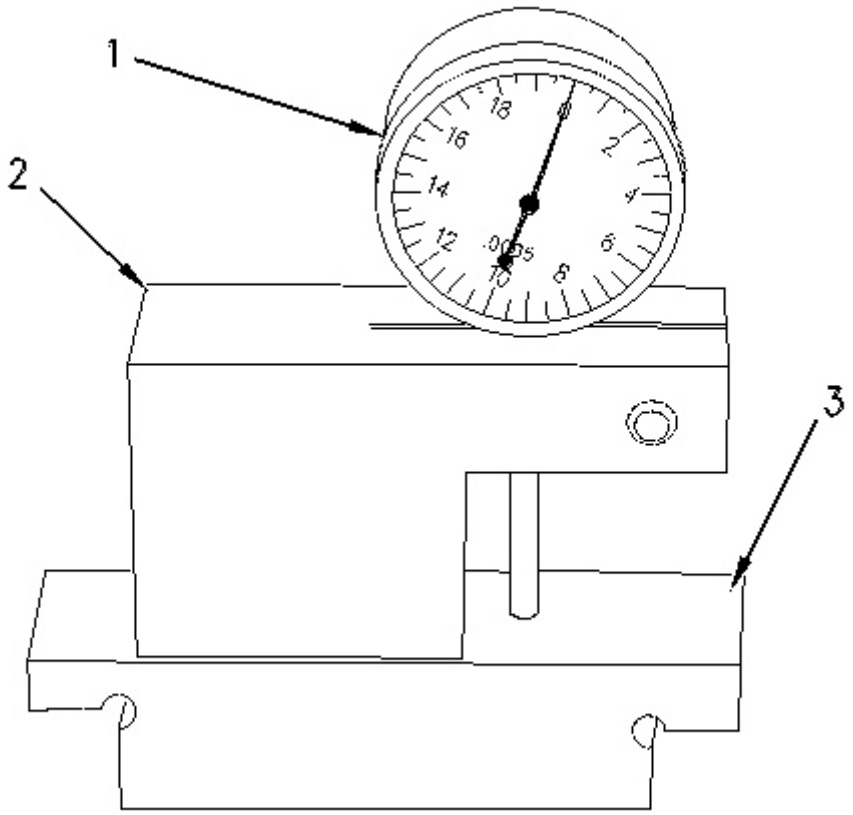


Illustration 1 g00323908

8T-0455 Liner Projection Tool Group

(1) Dial indicator

(2) Gauge body

(3) Gauge block

1. Use Tooling (A) in order to check the depths of the inlet valves and the exhaust valves below the face of the cylinder head. Use gauge block (3) to zero dial indicator (1) .

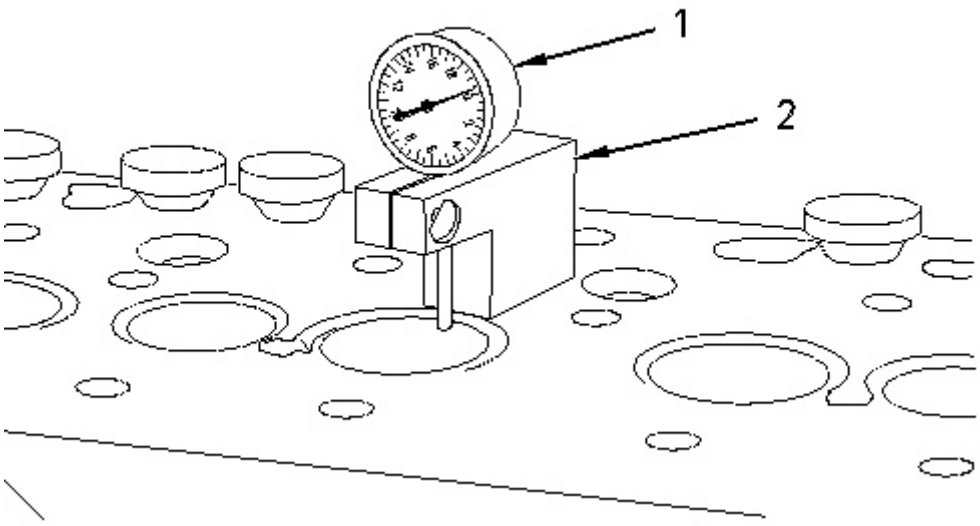


Illustration 2 g00323909

Measurement of the valve depth

(1) Dial indicator

(2) Gauge body

2. Position gauge body (2) and dial indicator (1) in order to measure the valve depth. Measure the depth of the inlet valve and the exhaust valve before the valve springs are removed.

   Refer to Specifications, "Cylinder Head Valves" for the minimum, the maximum, and the service wear limits for the valve depth below the cylinder head face.

   If the valve depth below the cylinder head face exceeds the service limit, use a new valve to check the valve depth. If the valve depth still exceeds the service limit, renew the cylinder head. If the valve depth is within the service limit, renew the valves.

3. Inspect the valves for cracks and other damage. Check that the valve stems for wear. Check that the valve springs are the correct length under the test force. Refer to Specifications, "Cylinder Head Valves" for the dimensions and tolerances of the valves and valve springs.

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Valve Guide - Inspect

SMCS - 1104-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Group	1

Perform this test in order to determine if a valve guide should be replaced.

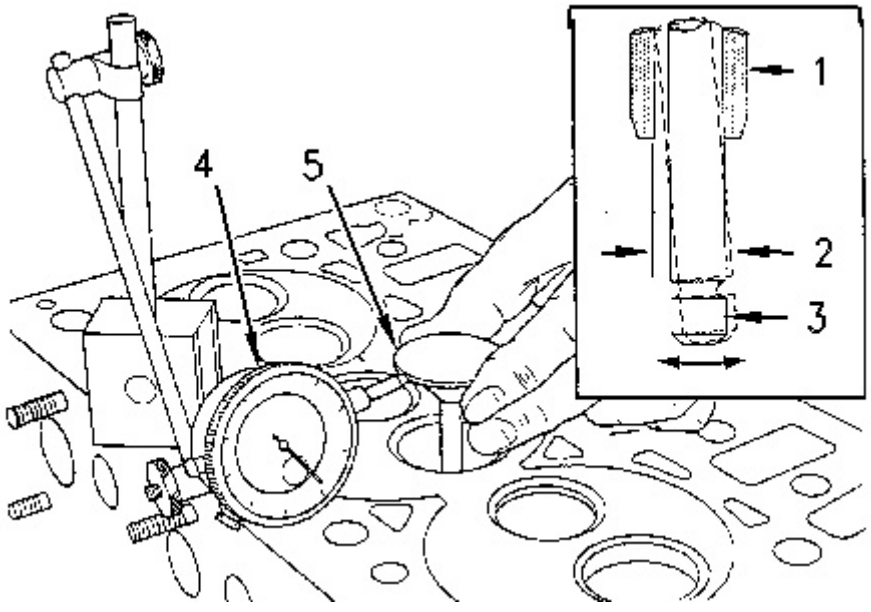


Illustration 1 g00314806

(1) Valve guide

(2) Radial movement of the valve in the valve guide

(3) Valve stem

(4) Dial indicator

(5) Valve head

1. Place a new valve in the valve guide.
2. Place the dial indicator with the magnetic base on the face of the cylinder head.
3. Lift the edge of the valve head to a distance of 15.0 mm (0.60 inch).
4. Move the valve in a radial direction away from the dial indicator. Make sure that the valve moves away from the dial indicator as far as possible. Position the contact point of the dial indicator on the edge of the valve head. Set the position of the needle of the dial indicator to zero.
5. Move the valve in a radial direction toward the dial indicator as far as possible. Note the distance of movement which is indicated on the dial indicator. If the distance is greater than the maximum clearance of the valve in the valve guide, replace the valve guide. Refer to Specifications, "Cylinder Head Valves" for the maximum clearance of the valve in the valve guide.

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Excessive Bearing Wear - Inspect

SMCS - 1203-040; 1211-040; 1219-040

When some components of the engine show bearing wear in a short time, the cause can be a restriction in an oil passage.

An engine oil pressure indicator may show that there is enough oil pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the oil supply to the component. A restriction in an oil supply passage will not allow enough lubrication to reach a component. This will result in early wear.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05183361

Piston Ring Groove - Inspect

SMCS - 1214-040

Introduction

This procedure is intended to give information on inspecting piston ring grove. Refer to the Specifications Manual for specifications for this procedure.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8H-8581	Feeler Gauge	1

Inspection Procedure

Inspect the Piston and the Piston Rings

1. Check the piston for wear and other damage.
2. Check that the piston rings are free to move in the grooves and that the rings are not broken.

Inspect the Clearance of the Piston Ring

1. Remove the piston rings and clean the grooves and the piston rings.

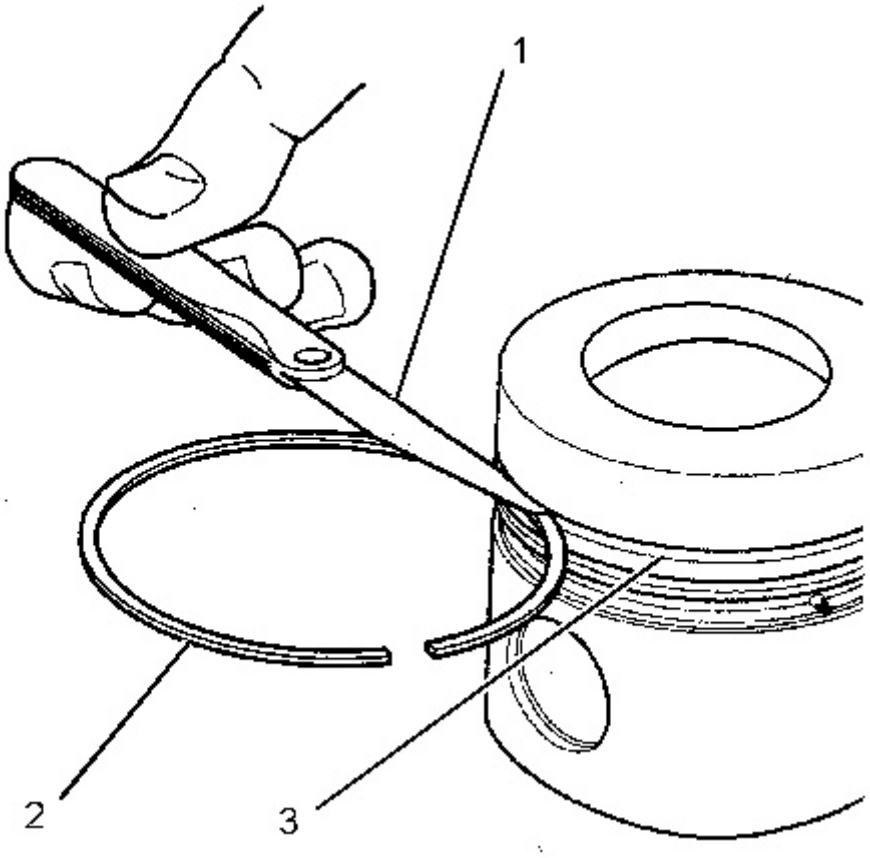


Illustration 1 g01284934

(1) Feeler gauge

(2) Piston ring

(3) Piston grooves

2. Fit new piston rings (2) in the piston grooves (3) .

3. Check the clearance for the piston ring by placing the **8H-8581** Feeler Gauge (1) between piston groove (3) and the top of piston ring (2) . Refer to Specifications, "Piston and Rings" for the dimensions.

   Note: Some pistons have a tapered top groove and the piston ring is wedged. The clearance for the top piston ring cannot be checked by the above method when this occurs.

Inspect the Piston Ring End Gap

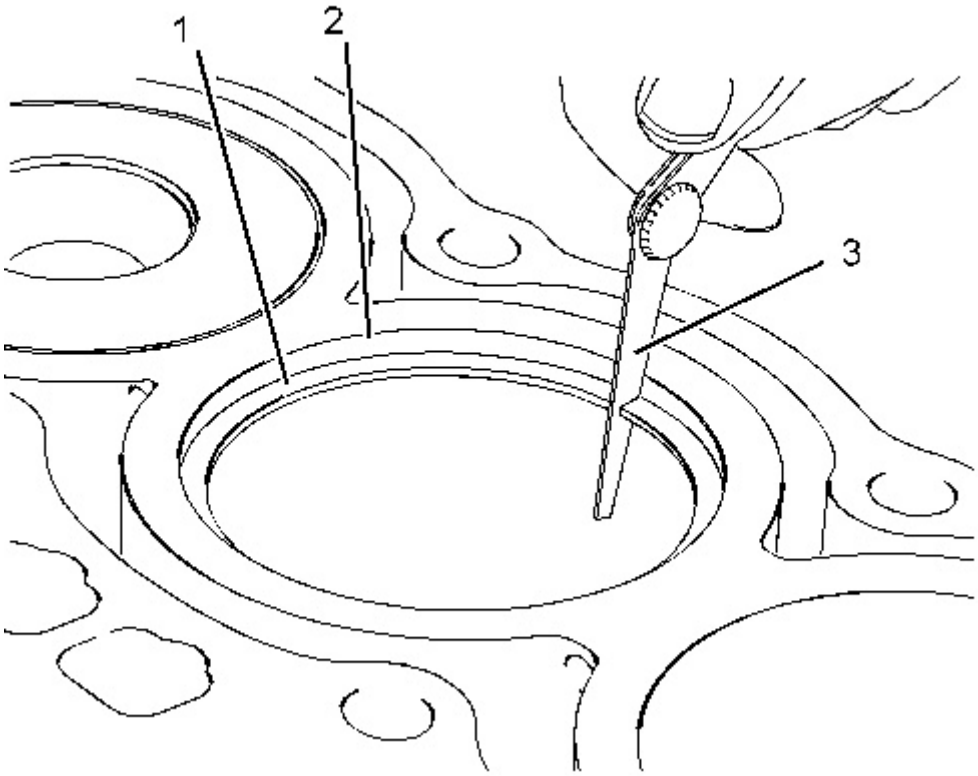


Illustration 2 g01358235

(1) Piston ring

(2) Cylinder ring ridge

(3) Feeler gauge

1. Clean all carbon from the top of the cylinder bores.
2. Place each piston ring (1) in the cylinder bore just below the cylinder ring ridge (2) .
3. Use the **8H-8581** Feeler Gauge (3) to measure piston ring end gap. Refer to Specifications, "Piston and Rings" for the dimensions.

   Note: The coil spring must be removed from the oil control ring before the gap of the oil control ring is measured.

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Connecting Rod - Inspect

SMCS - 1218-040

Inspect the Connecting Rod

1. Inspect the connecting rod for wear or cracking.
2. Inspect the piston pin bearing and the piston pin for wear and other damage. Check the piston pin bearing for a clogged oil hole.

   Note: Be sure that the oil holes of the piston pin bearing and the small end of the connecting rod are lined up.
3. Inspect the connecting rod bolts for stripped threads.

Measure Clearances and End Play

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
5P-2170	Dial Bore Gauge Group	1
8H-8581	Feeler Gauge	1

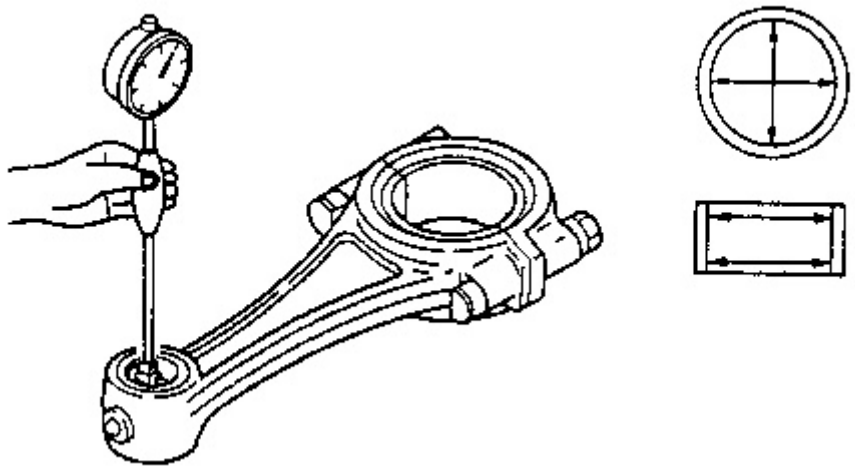


Illustration 1 g00994326

1. Measure the clearance of the piston pin in the piston pin bearing. Refer to Specifications, "Connecting Rod" for clearance dimensions.

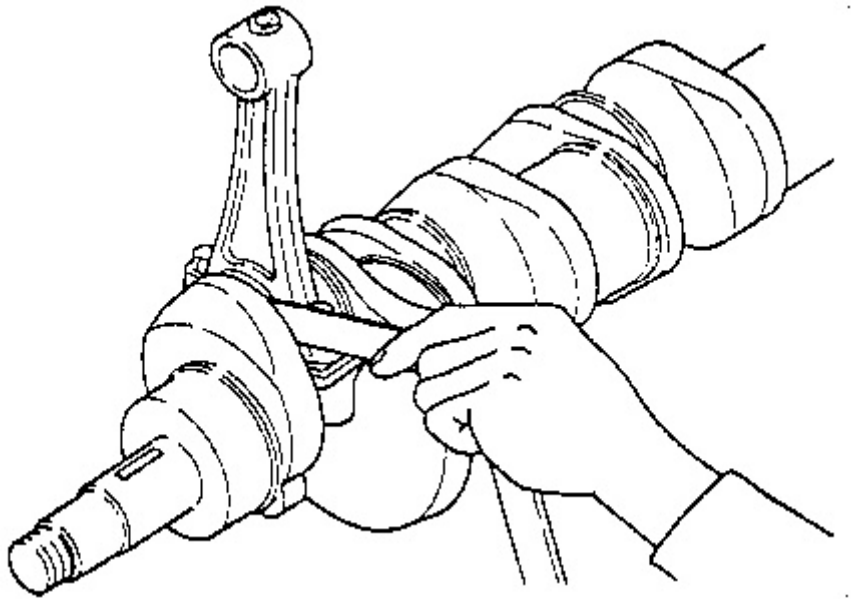


Illustration 2 g00994330

2. Install the connecting rod to the connecting rod journal. Tighten the bolts to the correct torque.
3. Measure the end play. Refer to Specifications, "Connecting Rod" for end play values.
4. If the end play exceeds the service limit, replace the connecting rod.

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i01748770

Connecting Rod Bearings - Inspect

SMCS - 1219-040

Check the connecting rod bearings and the connecting rod bearing journal for wear or other damage.

Connecting rod bearings are available with a smaller inside diameter than the original size bearings. These bearings are for crankshafts that have been ground.

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Main Bearings - Inspect

SMCS - 1203-040

Check the main bearings for wear or other damage. Replace both halves of the bearings and check the condition of the other bearings if a main bearing is worn or damaged.

Main bearings are available with a smaller inside diameter than the original size bearings. These bearings are for main bearing journals that have been ground.

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i01309662

Cylinder Block - Inspect

SMCS - 1201-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
1P-3537	Dial Bore Gauge Group	1

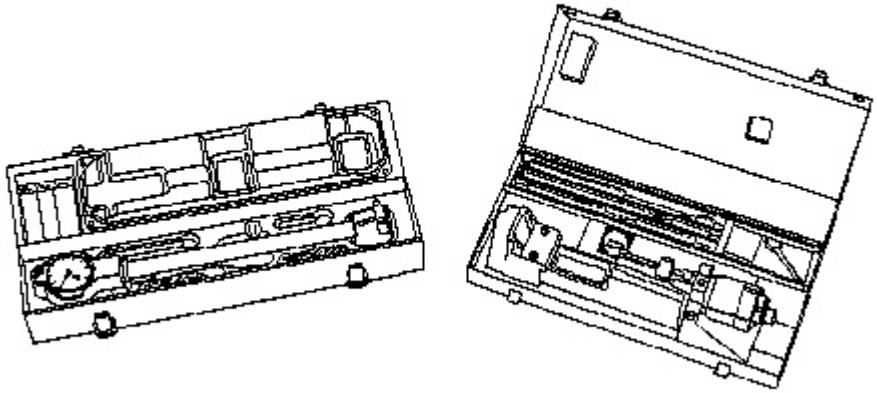


Illustration 1 g00285686

Inspect the top of the cylinder block for cracks and warpage. Refer to the Specifications Module, "Cylinder Block" topic for the tolerances.

Inspect each cylinder bore. There should be no scoring, rust or corrosion. Use a **1P-3537** Dial Bore Gauge Group in order to measure each cylinder bore. Each cylinder bore should be measured

at the top, middle and bottom. Refer to Special Instruction, GMG00981 for the instructions that are needed to use the dial bore gauge.

If the cylinder bores are out of the service limit, the cylinder block must be bored oversize. Refer to the Specifications Module, "Cylinder Block" topic for the tolerances.

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Cylinder Head - Inspect

SMCS - 1100-040

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8S-6691	Cylinder Head Repair Stand	1
8H-8581	Feeler Gauge	1

1. Remove the cylinder head from the engine.
2. Clean the cylinder head thoroughly. Make sure that the contact surfaces of the cylinder head and the cylinder block are clean, smooth and flat.
3. Inspect the bottom surface of the cylinder head for pitting, corrosion, and cracks. Inspect the area around the valve seat inserts and the holes for the fuel injection nozzles.

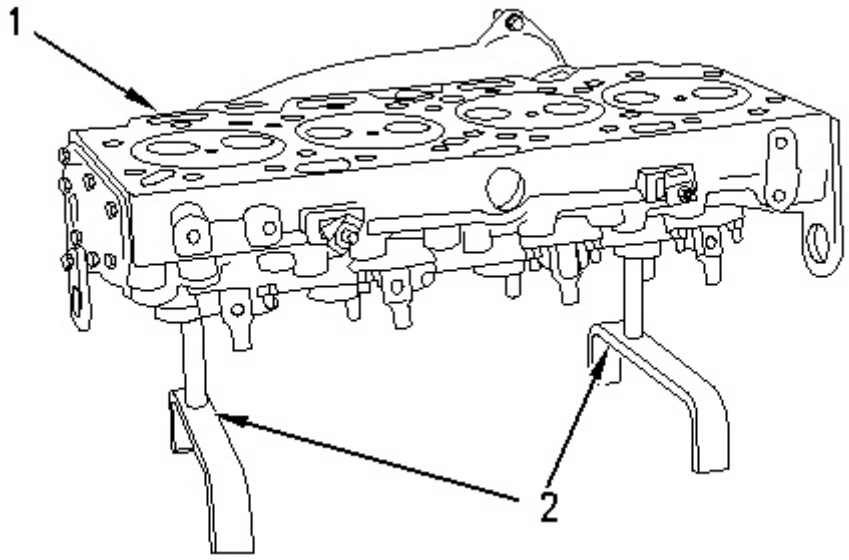


Illustration 1 g00876690

Typical example

(1) Cylinder head

(2) Cylinder head repair stand

4. Place cylinder head (1) on cylinder head repair stand (2) .

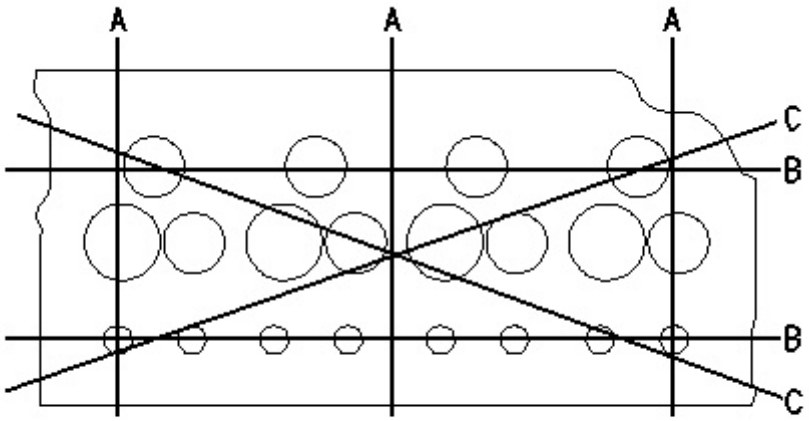


Illustration 2 g00987700

Measuring points on cylinder head

(A) Side to side

(B) End to end

(C) Corner to corner

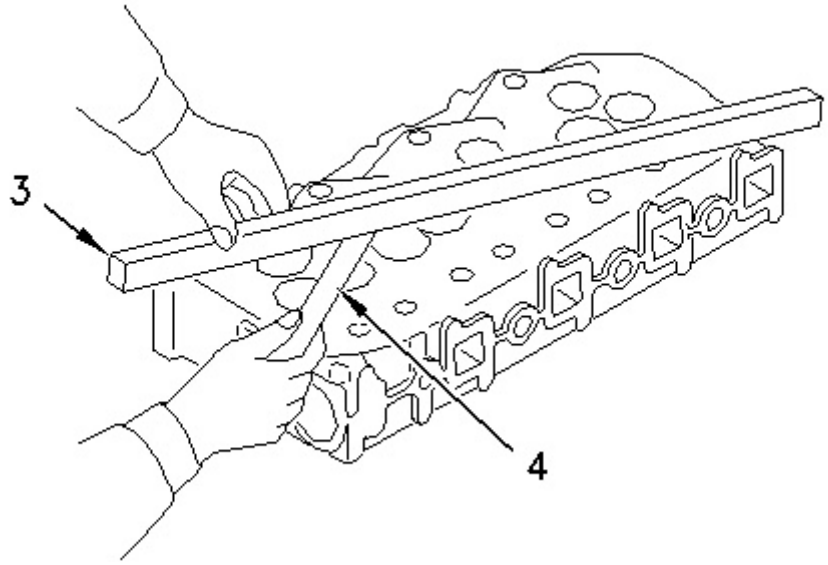


Illustration 3 g00987701

Measuring flatness

(3) Straight edge

(4) Feeler gauge

5. Measure the cylinder head for flatness. Measure the flatness with straight edge (3) and with feeler gauge (4) .
    - Measure the cylinder head from one side to the other side (A) .
    - Measure the cylinder head from one end to the other end (B) .
    - Measure the cylinder head from one corner to the other corner (C) .

    Refer to Specifications, "Cylinder Head" for the requirements of flatness.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05183429

Piston Height - Inspect

SMCS - 1214-040

Introduction

If the height of the piston above the top face of the cylinder block is not within the tolerance that is given in Specifications, "Piston and Rings", the piston and the piston pin bearing must be replaced. If any of the following components are replaced or remachined, the piston height above the top face of the cylinder block must be measured:

- Crankshaft
- Cylinder head
- Connecting rod
- Piston pin bearing
- Piston

The correct piston height must be maintained in order to ensure that the engine conforms to the standards for emissions.

Note: The top of the piston should not be machined. If the original piston is installed, be sure that the original piston is assembled to the correct connecting rod and installed in the original cylinder.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-0455	Liner Projection Tool Group	1

Inspection Procedure

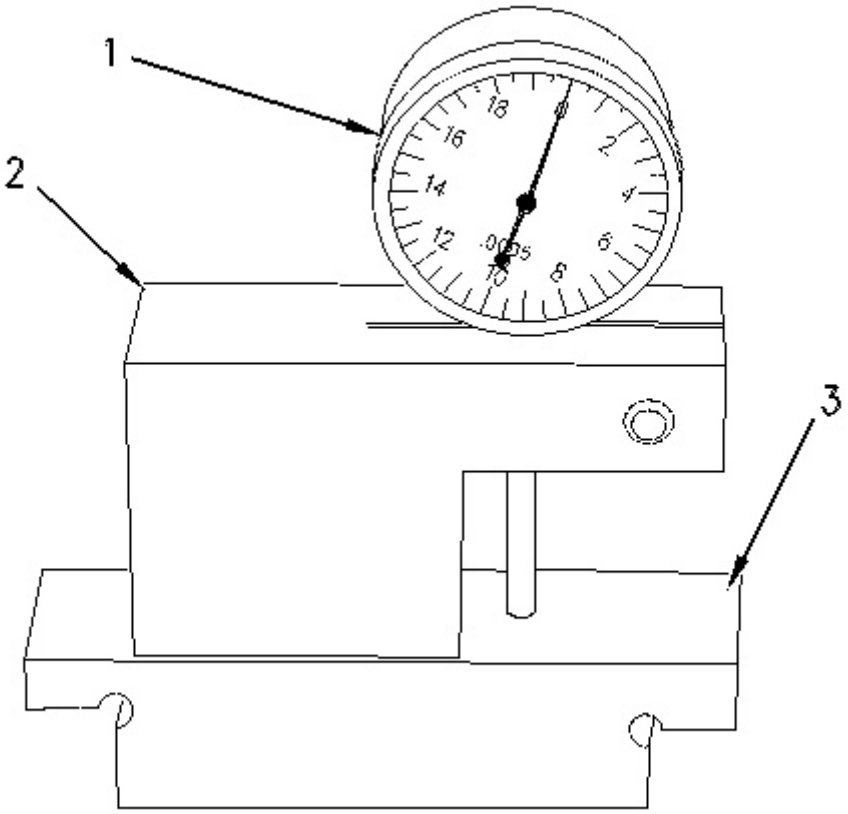


Illustration 1 g00323908

8T-0455 Liner Projection Tool Group

(1) 1P-2403 Dial Indicator

(2) 1P-2402 Gauge Body

(3) 1P-5507 Gauge Block

1. Use the **8T-0455** Liner Projection Tool Group in order to measure the piston height above the top face of the cylinder block. Use the gauge block (3) in order to zero the dial indicator (1) .

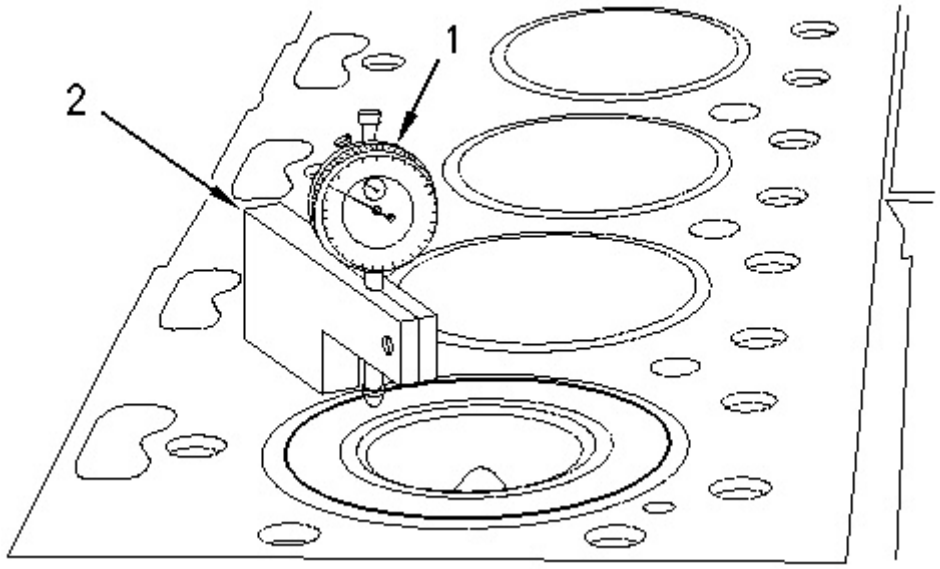


Illustration 2 g00326383

Measurement of the piston height

(1) 1P-2403 Dial Indicator

(2) 1P-2402 Gauge Body

2. Position gauge body (2) and dial indicator (1) in order to measure the piston height above the top face of the cylinder block. Slowly rotate the crankshaft in order to determine when the piston is at the highest position. Record this dimension. Compare this dimension with the dimensions that are given in Specifications, "Piston and Rings".

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Flywheel - Inspect

SMCS - 1156-040

Inspect the Flywheel

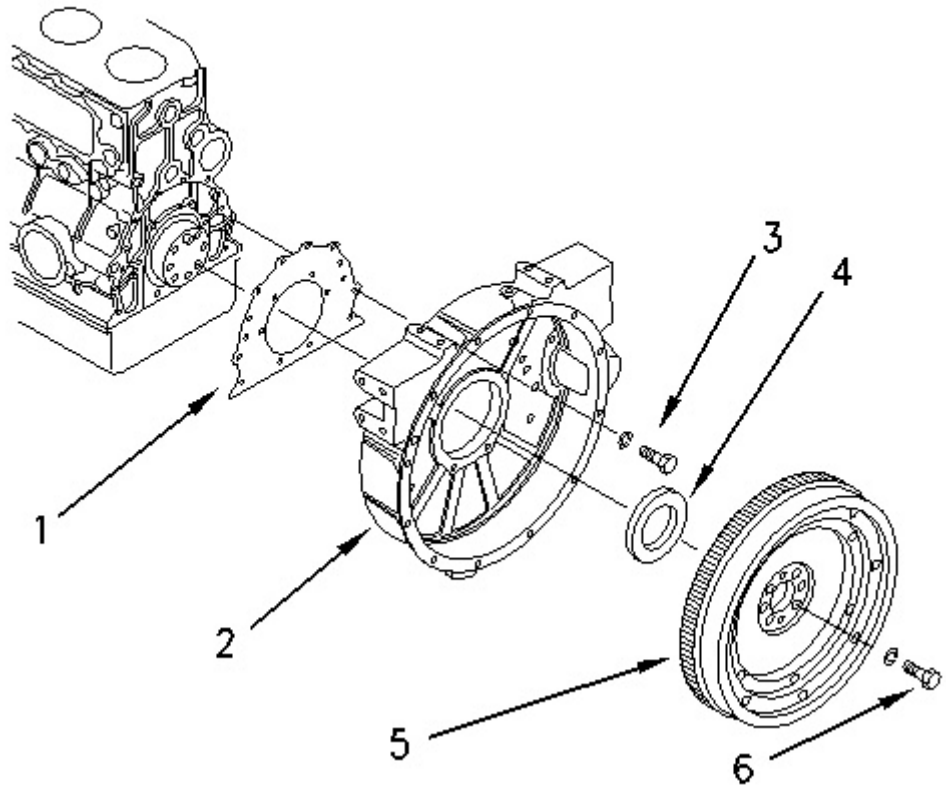


Illustration 1 g00987873

Exploded view of flywheel and flywheel housing

(1) Gasket

(2) Flywheel housing

(3) Bolt

(4) Rear oil seal

(5) Flywheel

(6) Bolt

1. Check for cracks or a damaged dowel hole.
2. Check the ring gear on flywheel (5) for teeth that are worn or damaged.
3. Inspect the flywheel bolts (6) for stripped threads.

Flatness of the Flywheel

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

Note: The flywheel must be removed from the engine in order to check the flatness.

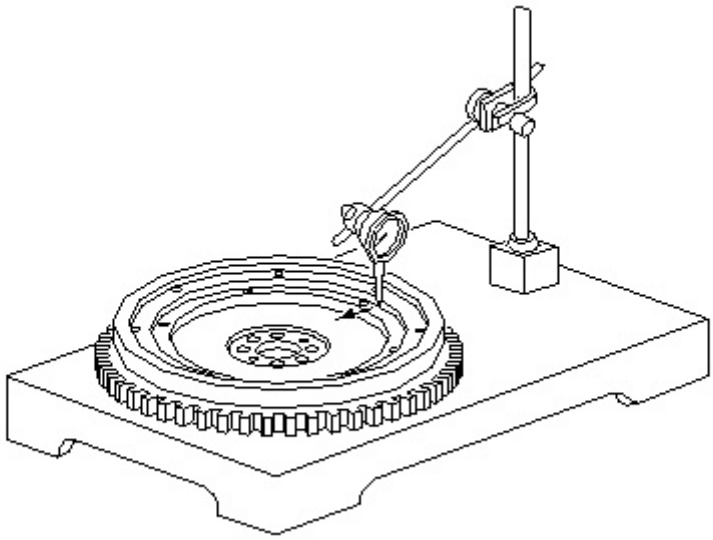


Illustration 2 g00987717

Flatness of flywheel

1. Place the flywheel on a surface plate.
2. Set a dial indicator at one side of the surface plate and move the dial indicator to the opposite side. Refer to Illustration 2.
3. Refer to Specifications, "Flywheel" for the correct values of the flatness.

Face Runout (Radial Eccentricity) of the Flywheel

Table 2

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

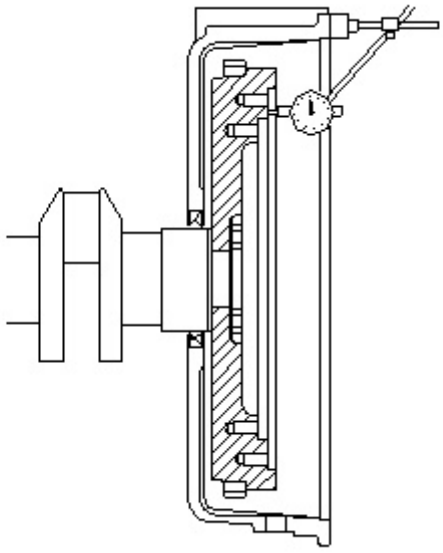


Illustration 3 g00987720

Runout of flywheel

1. Refer to Illustration 3 and install the dial indicator. Always put a force on the crankshaft in the same direction before the dial indicator is read. This will remove any crankshaft end clearance.
2. Set the dial indicator to read 0.0 mm (0.00 inch).
3. Turn the flywheel at intervals of 90 degrees and read the dial indicator.
4. Calculate the difference between the lower measurements and the higher measurements that are performed at all four points. Refer to Specifications, "Flywheel" for the correct values of the runout.

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Flywheel Housing - Inspect

SMCS - 1157-040

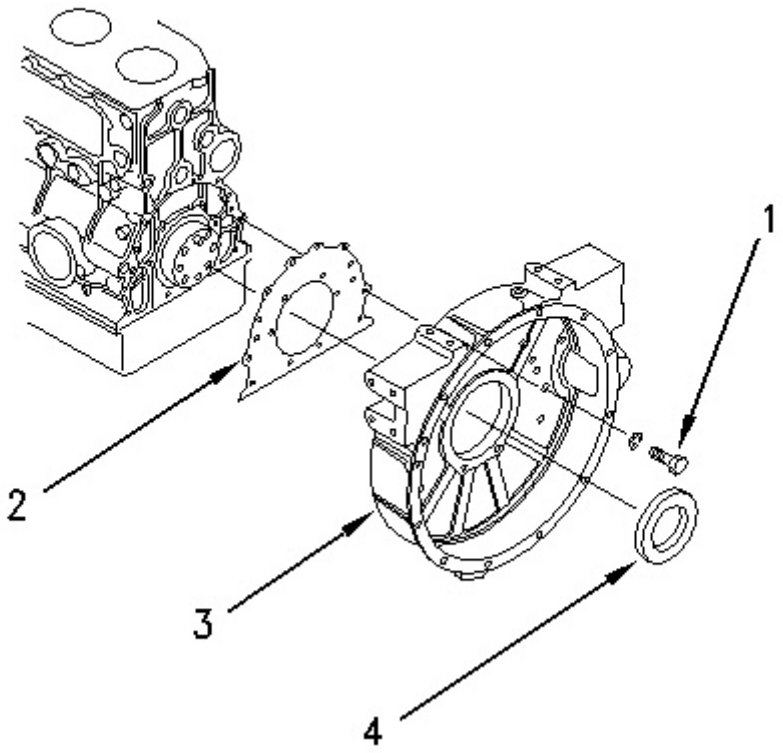


Illustration 1 g00987862

Exploded view of flywheel housing

(1) Bolt

(2) Gasket

(3) Flywheel housing

(4) Rear oil seal

1. Check for cracks or a damaged dowel hole.
2. Inspect bolts (1) that hold the flywheel housing in place for stripped threads.
3. Inspect rear oil seal (4) for leaks or damage.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01894383

Gear Group - Inspect

SMCS - 1206-040

Inspect the Gear Group

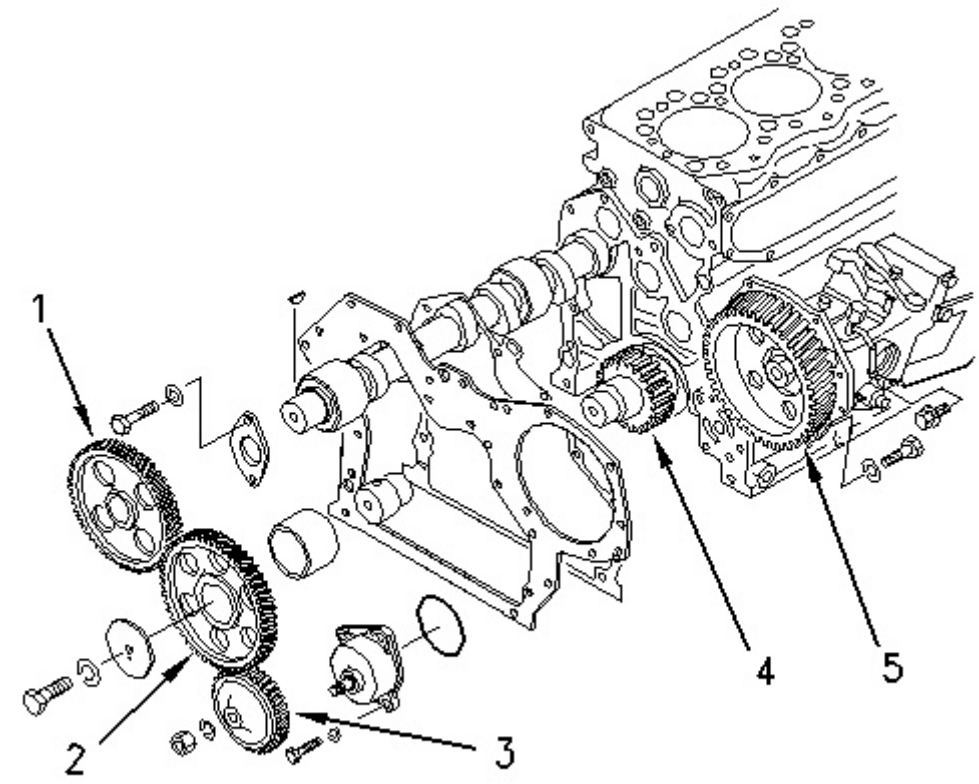


Illustration 1 g00987777

Exploded view of the front timing group

(1) Camshaft gear

(2) Upper idler gear

(3) Oil pump gear

(4) Crankshaft gear

(5) Fuel injection pump gear

Inspect the gears for wear or for damage. If the gears are worn or damaged, use new parts for replacement.

Note: If one or more of the gears need to be removed for repair, refer to Disassembly and Assembly in order to properly remove the gears.

Measure Backlash and End Play

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
8T-5096	Dial Indicator Gp	1

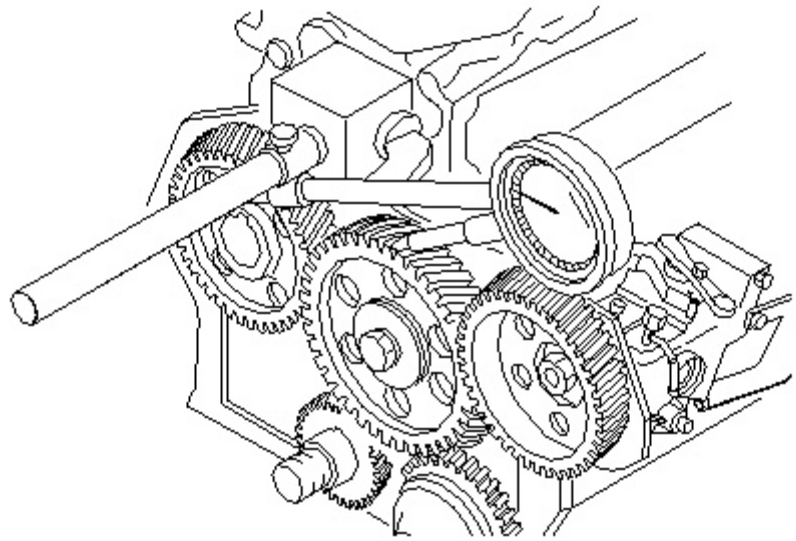


Illustration 2 g00987788

Measuring backlash

1. Install the dial indicator in Illustration 2, as shown.

2. Measure the backlash of the gears. Refer to Specifications, "Gear Group (Front)" for the values of the backlash.

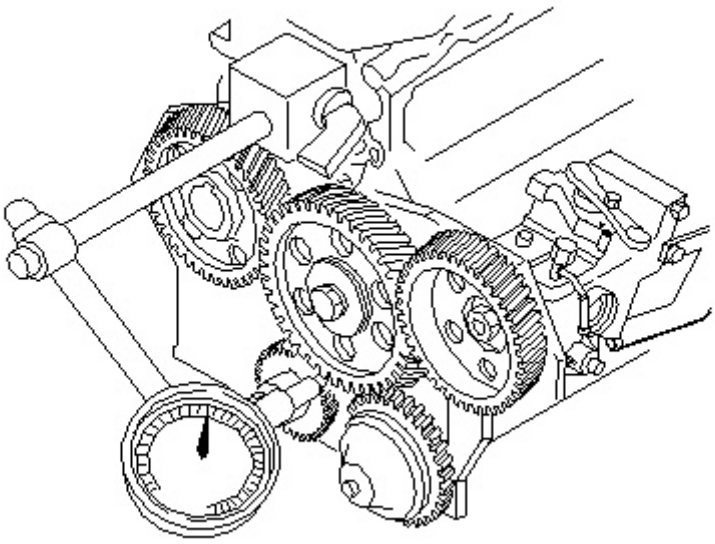


Illustration 3 g00987800

Measuring end play of the idler gear

1. Install the dial indicator in Illustration 3, as shown.
2. Measure the end play of the idler gear. Refer to Specifications, "Gear Group (Front)" for the values of the end play.

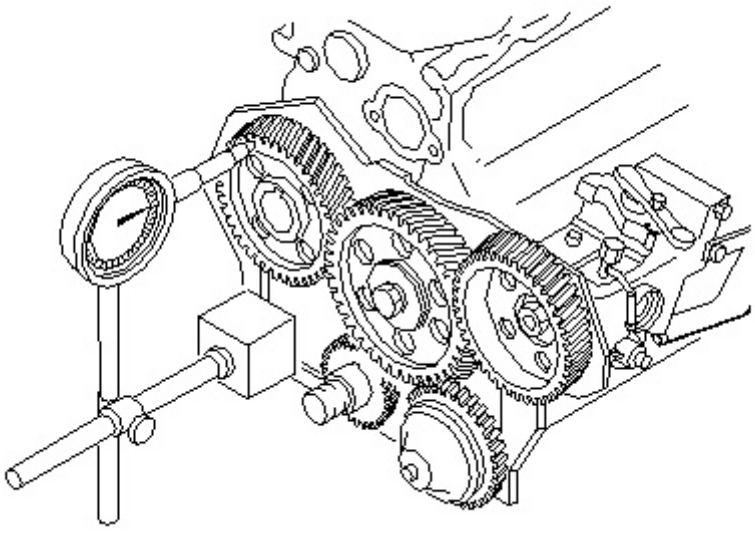


Illustration 4 g00996060

Measuring end play of the camshaft

1. Install the dial indicator in Illustration 4, as shown.
2. Measure the end play of the camshaft. Refer to Specifications, "Camshaft" for the values of the end play.

   Note: The end play is controlled by the camshaft thrust washer. If the end play is not within specifications, replace the thrust washer.

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Balancer - Remove

SMCS - 1220-011

Removal Procedure

Start By:

A. Remove the engine oil pan and remove the oil strainer. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

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1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

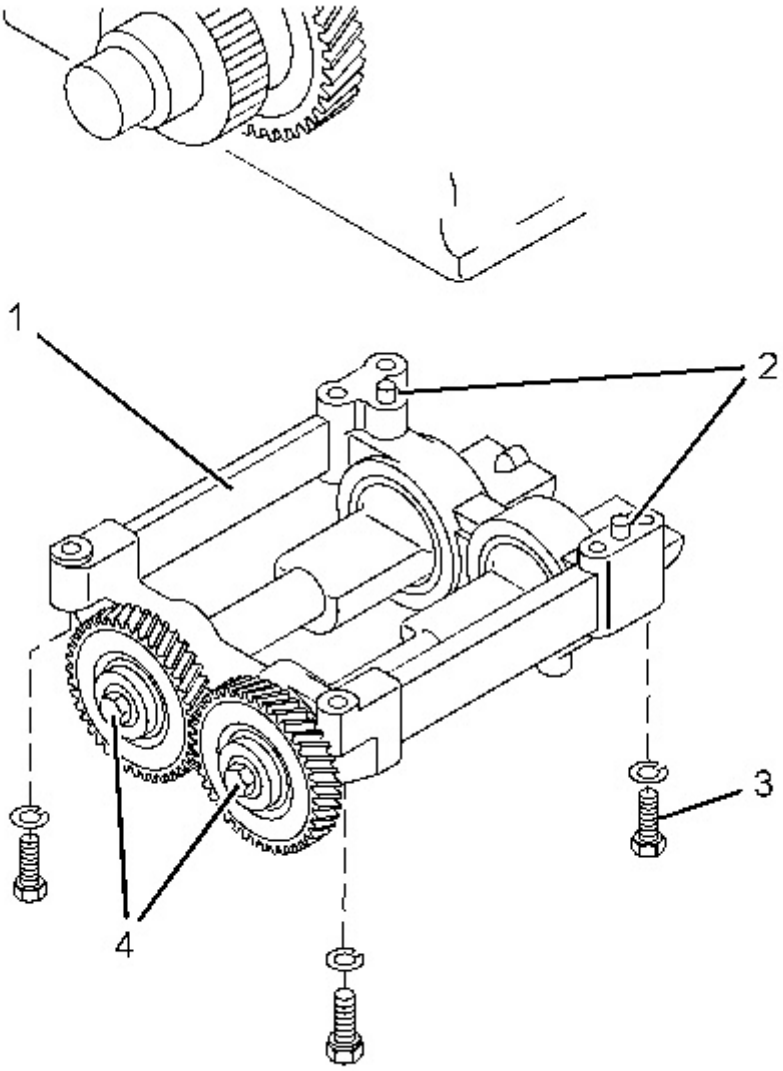


Illustration 1 g01344508

Note: If the balancer will be disassembled, loosen bolts (4) before the balancer is removed from the engine.

2. Support the weight of the balancer. The balancer weighs approximately 23 kg (51 lb). Remove bolts (3) and remove balancer (1) from the engine.

3. Do not remove dowels (2) unless the dowels are damaged.

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Balancer - Disassemble

SMCS - 1220-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

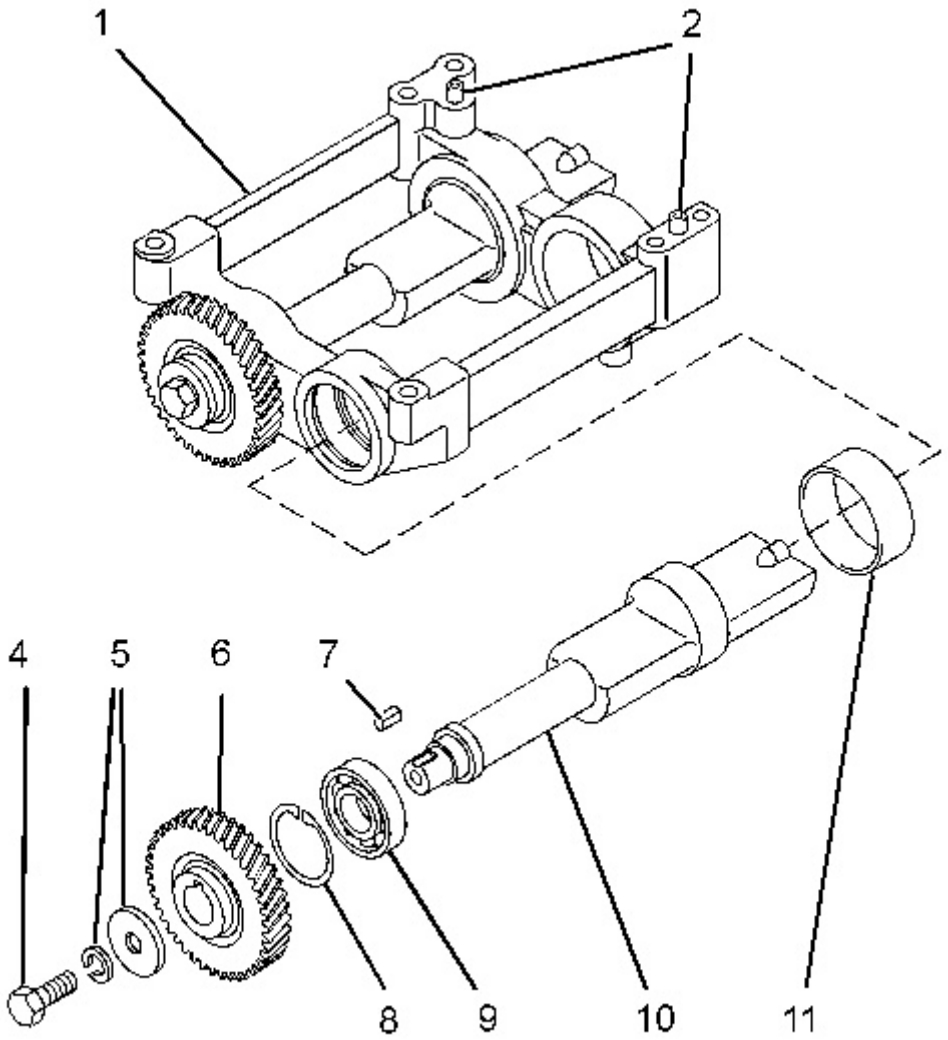


Illustration 1 g01344515

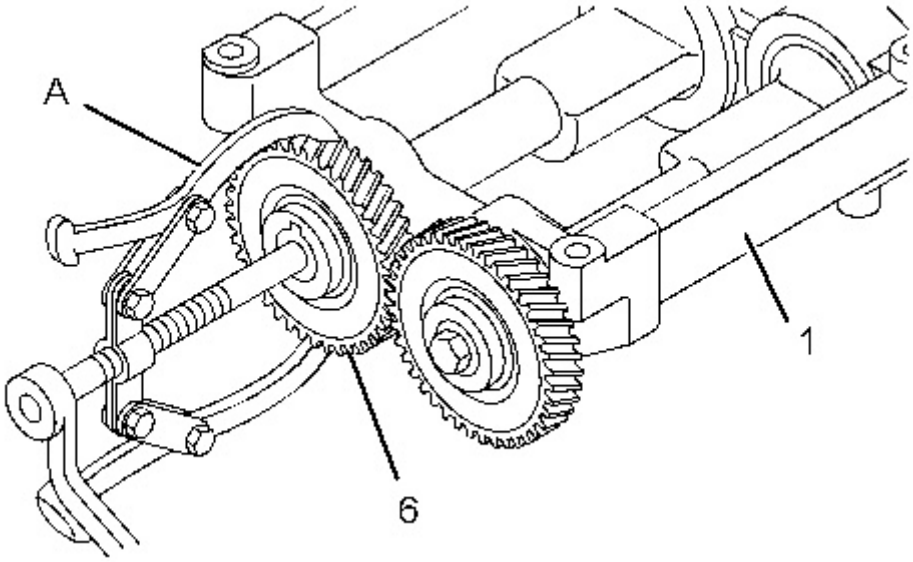


Illustration 2 g01344528

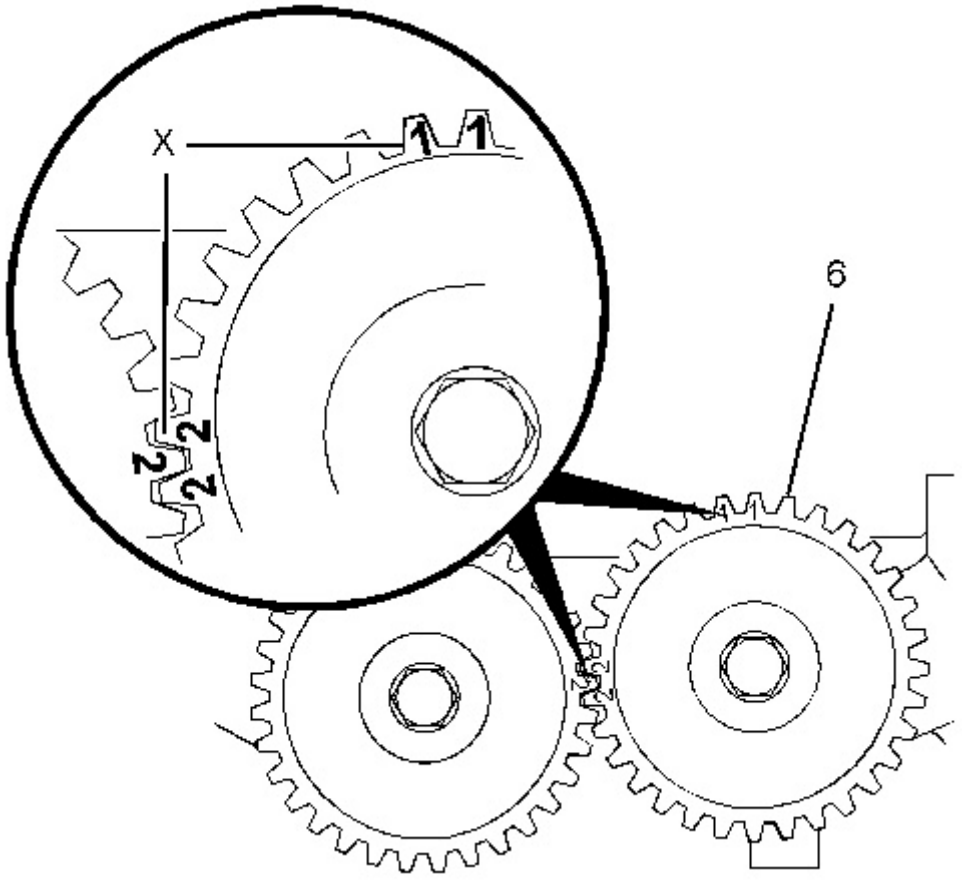


Illustration 3 g01344665

Timing marks

1. Remove bolts (4) and washers (5). Use Tooling (A) in order to remove gears (6). Ensure that balancer shaft (10) is protected from damage.

   Note: Gears (6) have different Markings (X). Refer to Illustration 3. Identify the position of the gears for installation.

2. Remove keys (7). Use Tooling (B) in order to remove retaining rings (8) .

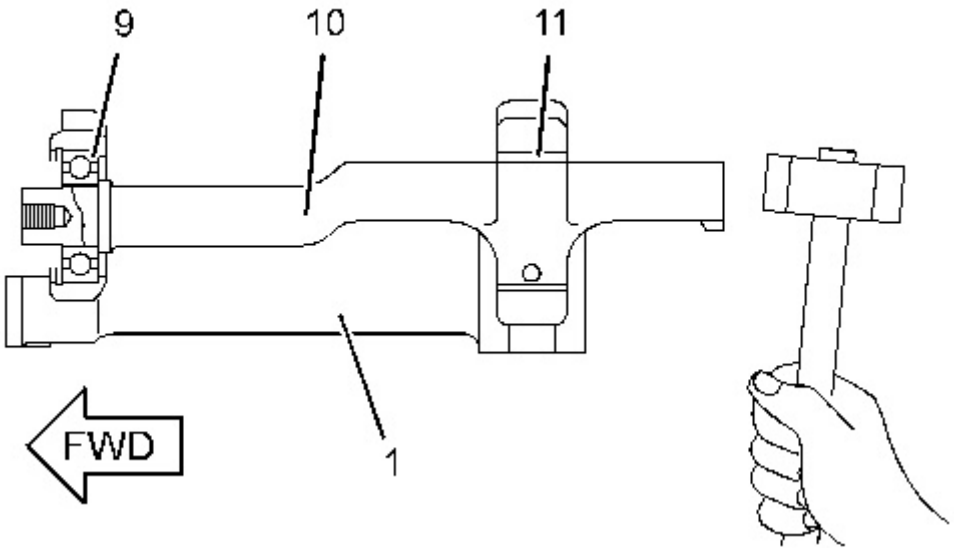


Illustration 4 g01344533

3. Carefully tap the assembly of bearing (9) and balancer shaft (10) forward until the shaft is clear of bushing (11). Refer to Illustration 4.

4. Use Tooling (A) in order to remove bearing (9) from balancer shaft (10) .

   Note: Ensure that the balancer shaft is protected from damage.

5. Slide balancer shaft (10) back through bushing (11) until the shaft is clear of the balancer.

6. If necessary, use Tooling (C) in order to remove bushing (11) from balancer (1) .

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i02744463

Balancer - Assemble

SMCS - 1220-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Gp	1
D	9S-3263	Thread Lock Compound	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components of the balancer are clean and free from damage.

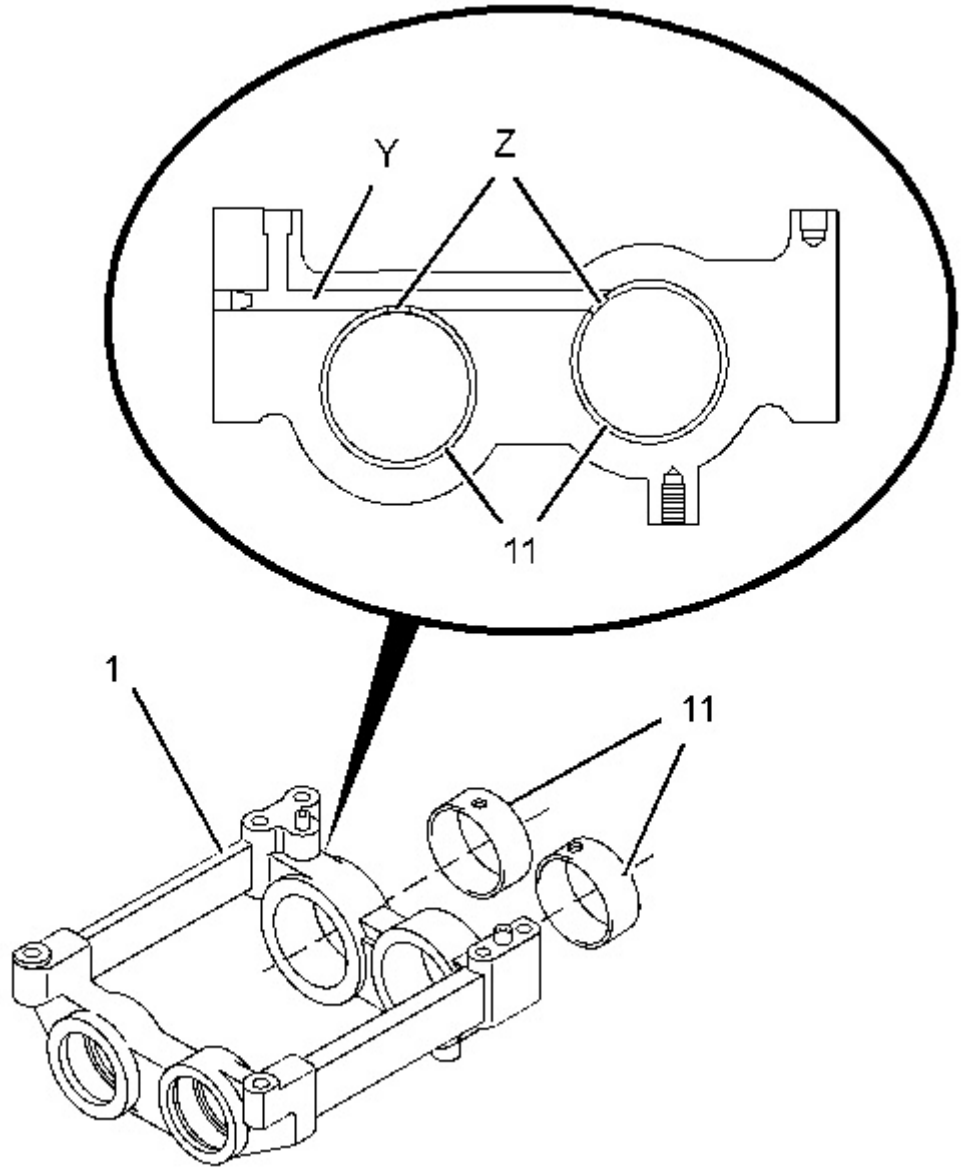


Illustration 1 g01344574

2. If new bushing (11) is installed to the balancer, follow Steps 2.a and 2.b.

   a. Align oil holes (Z) in bushing (11) to drilling (Y) in balancer (1) .

   b. Use Tooling (C) to install bushing (11) to balancer (1). Ensure that the oil holes (Z) are correctly aligned to drilling (Y) .

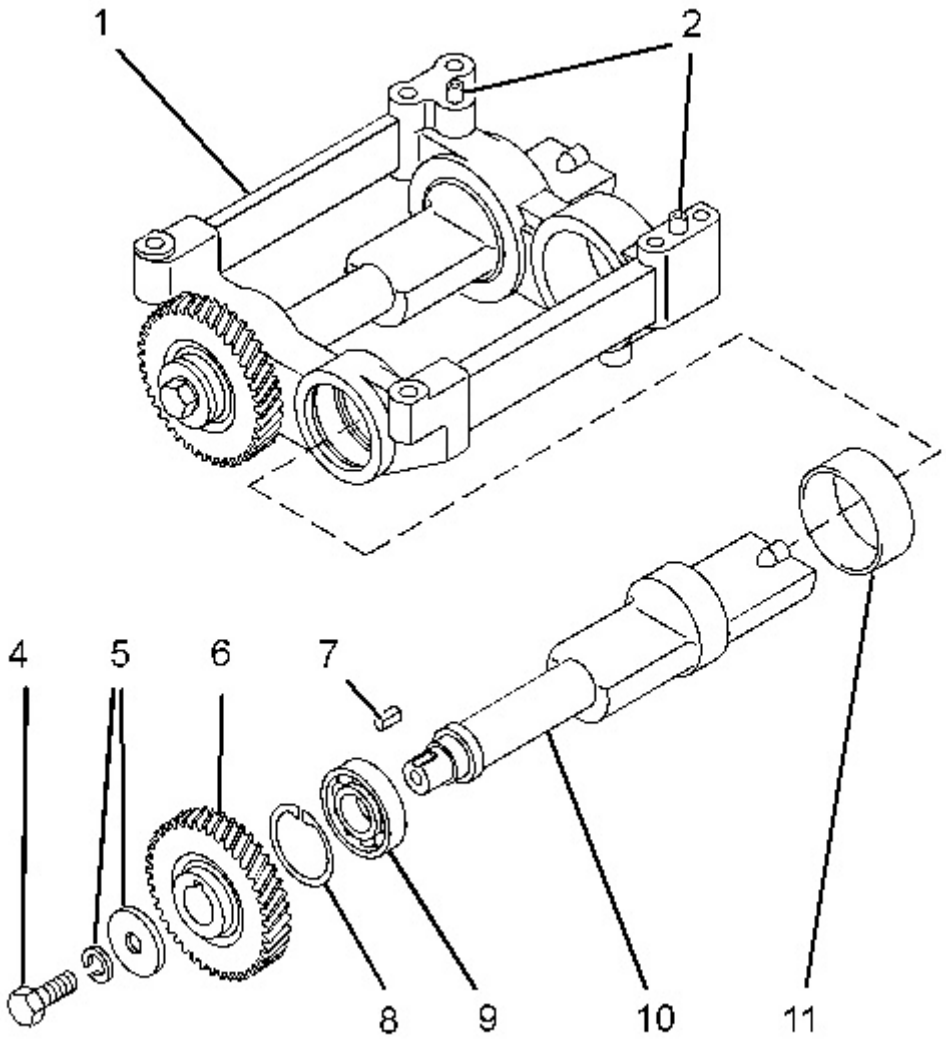


Illustration 2 g01344515

3. Use Tooling (C) in order to press bearings (9) into balancer (1) .

   Note: Do not press on the inner race of the bearing as this could result in damage to the bearing.

4. Use Tooling (B) to install retaining rings (8) .

   Note: Ensure that the retaining rings are fully located into the grooves in the balancer.

5. Lubricate balancer shafts (10) and bushing (11) with clean engine oil. Carefully install the balancer shafts to balancer (1) .

6. Install keys (7) .

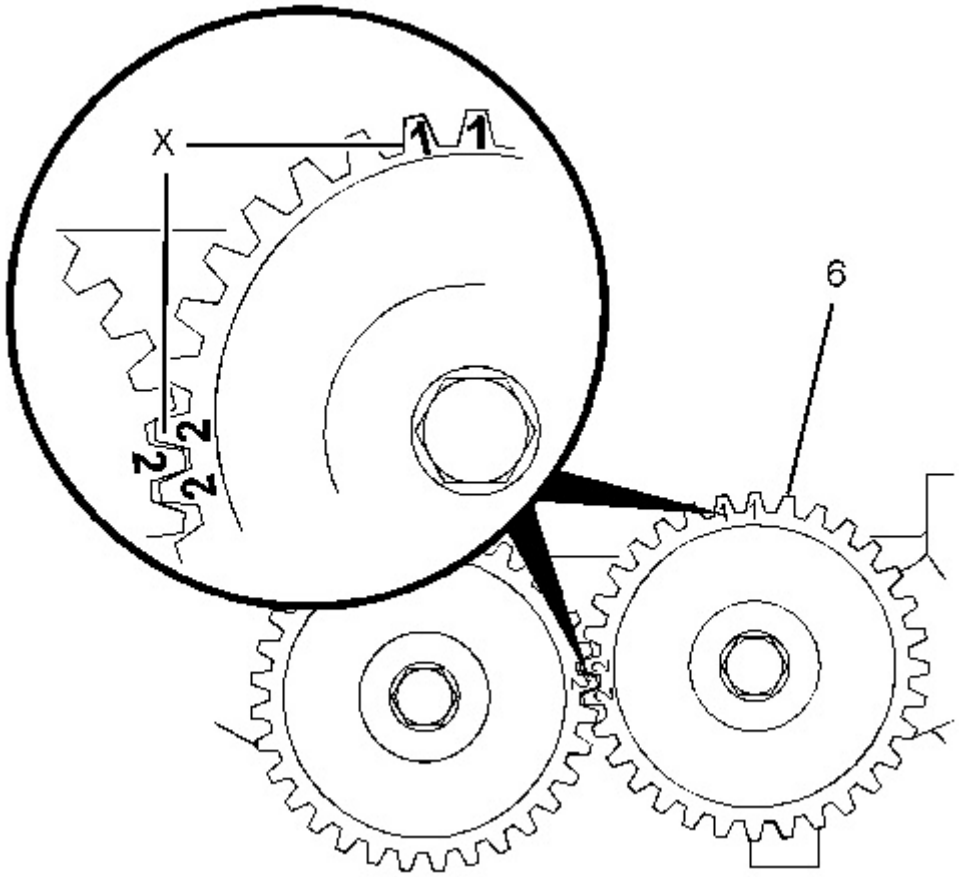


Illustration 3 g01344665

Timing marks

7. Align gears (6) with keys (7) and install the gears to balancer shafts (10). Ensure that the gears are installed in the correct position.

   Note: The gears have different Markings (X). The right hand gear is marked 1,1 and 2,2. The left hand gear is marked 2. Refer to Illustration 3.

8. Apply Tooling (D) to the threads of bolts (4). Install bolts (4) and washers (5). Tighten the bolts to a torque of 33 N·m (24 lb ft).

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i02639299

Balancer - Install

SMCS - 1220-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
F	9U-7324	Indicator Bracket	1
	7H-1942	Dial Indicator	1
	3S-3268	Indicator Contact Point	1
	7H-1940	Universal Attachment	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

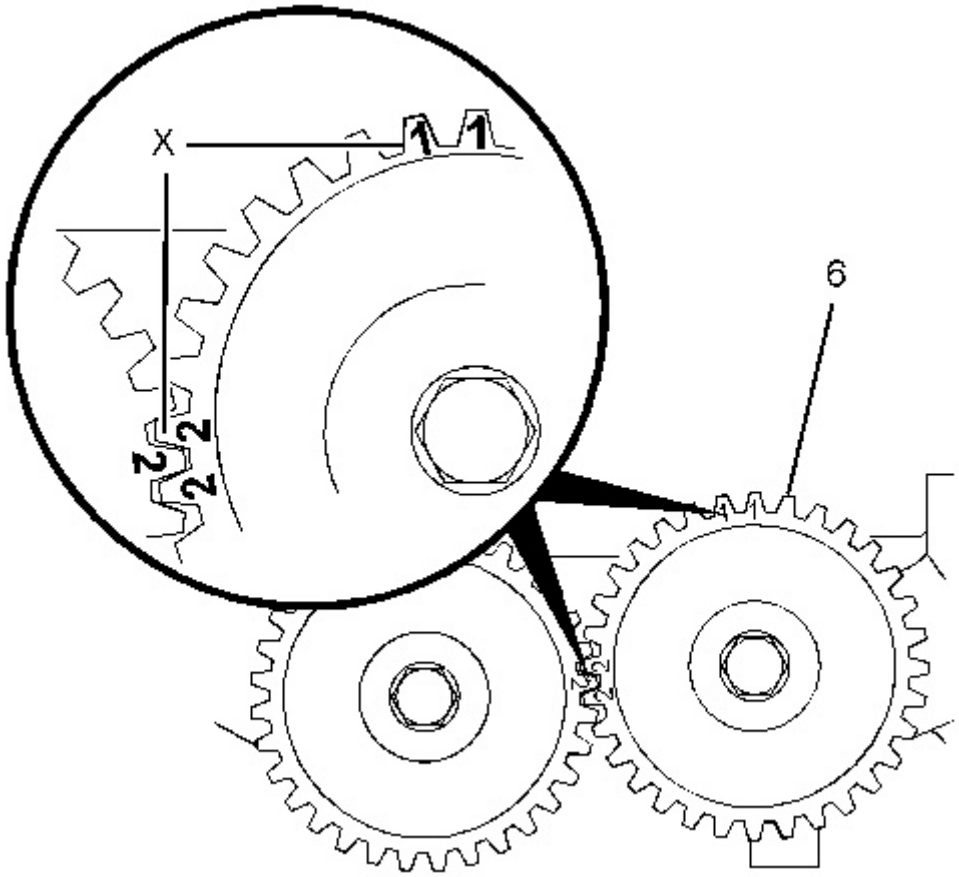


Illustration 1 g01344665

Timing marks

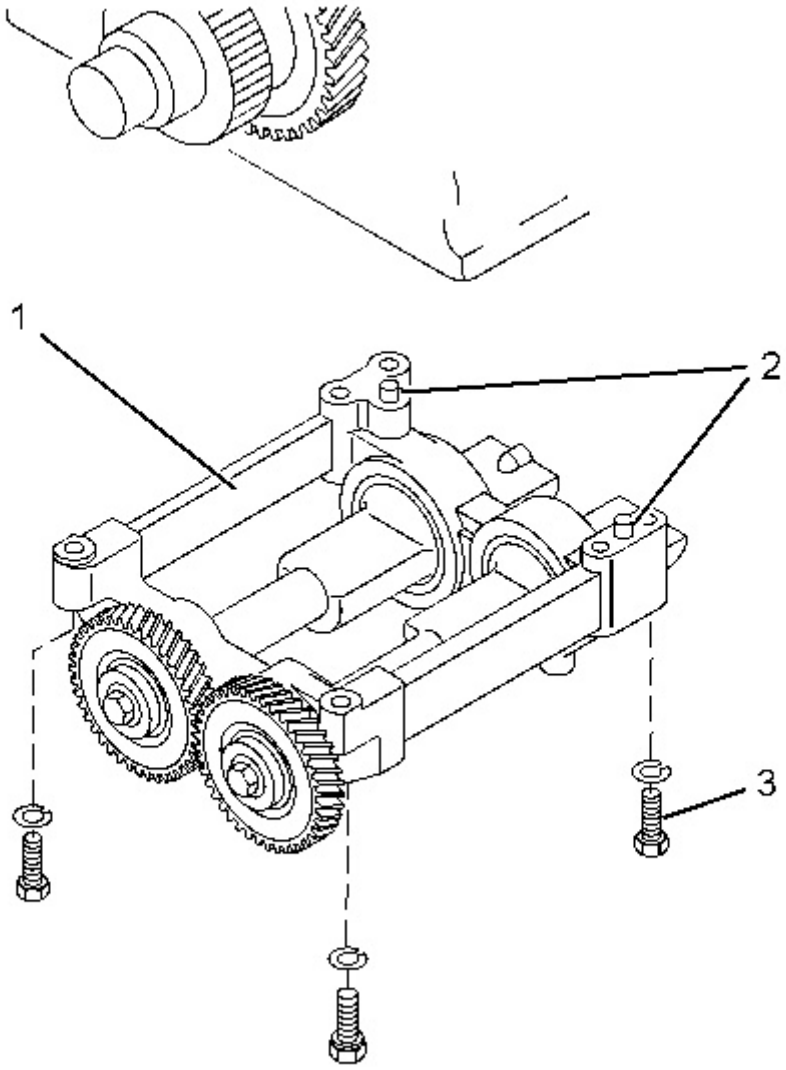


Illustration 2 g01344983

1. Ensure that dowels (2) are seated in balancer (1). Ensure that marks 2,2 and 2 on gears (6) are aligned. Refer to Illustration 1.

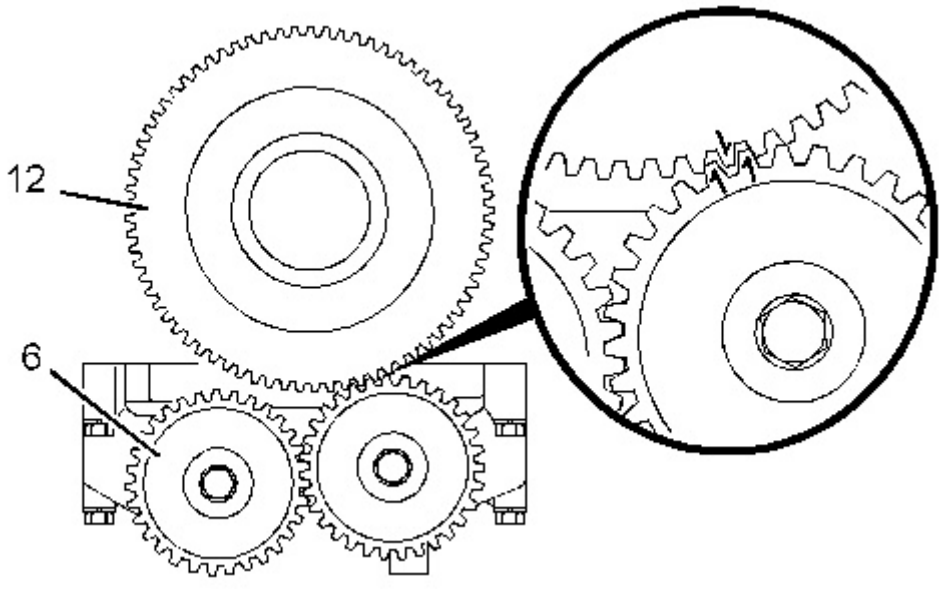


Illustration 3 g01344971

Alignment of the timing marks

2. Align dowels (2) with the holes in the cylinder block. Align mark 1,1 on gear (6) to mark 1 on crankshaft gear (12). Refer to Illustration 3. Position balancer (1) on the engine. The balancer weighs approximately 23 kg (51 lb).
3. Install bolts (3). Tighten the bolts to a torque of 30 N·m (22 lb ft).
4. Use Tooling (F) in order to check the backlash between gears (6). Refer to Specifications, "Gear Group (Front)".
5. Use Tooling (F) in order to check the backlash between gears (6) and (12). Refer to Specifications, "Gear Group - Front" for further information.

End By: Install the engine oil pan. Refer to Disassembly and Assembly, " Engine Oil Pan - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02506524

Belt Tension Chart

SMCS - 1357

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Note: Do not use the belt tension chart for belts with tensioners that are spring loaded.

Table 1

Belt Tension Chart		
Belt Type	**Deflection**	**Applied Force for Specified Deflection**
Type B	10 to 12 mm (0.4 to 0.6 inch)	98 N (22 lb)

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i02506524

Belt Tension Chart

SMCS - 1357

S/N - -

Note: Do not use the belt tension chart for belts with tensioners that are spring loaded.

Table 1

Belt Tension Chart		
Belt Type	**Deflection**	**Applied Force for Specified Deflection**
Type B	10 to 12 mm (0.4 to 0.6 inch)	98 N (22 lb)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02506460

Camshaft

SMCS - 1210

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

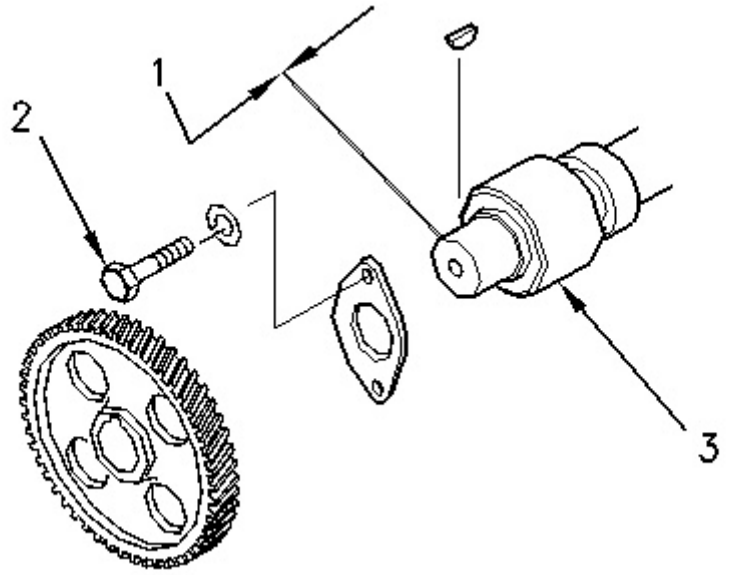


Illustration 1 g00988290

(1) End play of a new camshaft ... 0.10 ± 0.25 mm (0.0039 ± 0.0098 inch)

Maximum permissible end play of a worn camshaft ... 0.30 mm (0.0118 inch)

(2) Tighten the thrust plate bolts to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

(3) The diameters of the camshaft journals are given in the following table.

Table 1

Diameters of Camshaft Journals		
Camshaft Journals	Standard Diameter	Service Limit
No. 1,2	53.94 to 53.96 mm (2.123 to 2.124 inch)	53.90 mm (2.122 inch)
No. 3	52.94 to 52.96 mm (2.084 to 2.085 inch)	52.90 mm (2.083 inch)

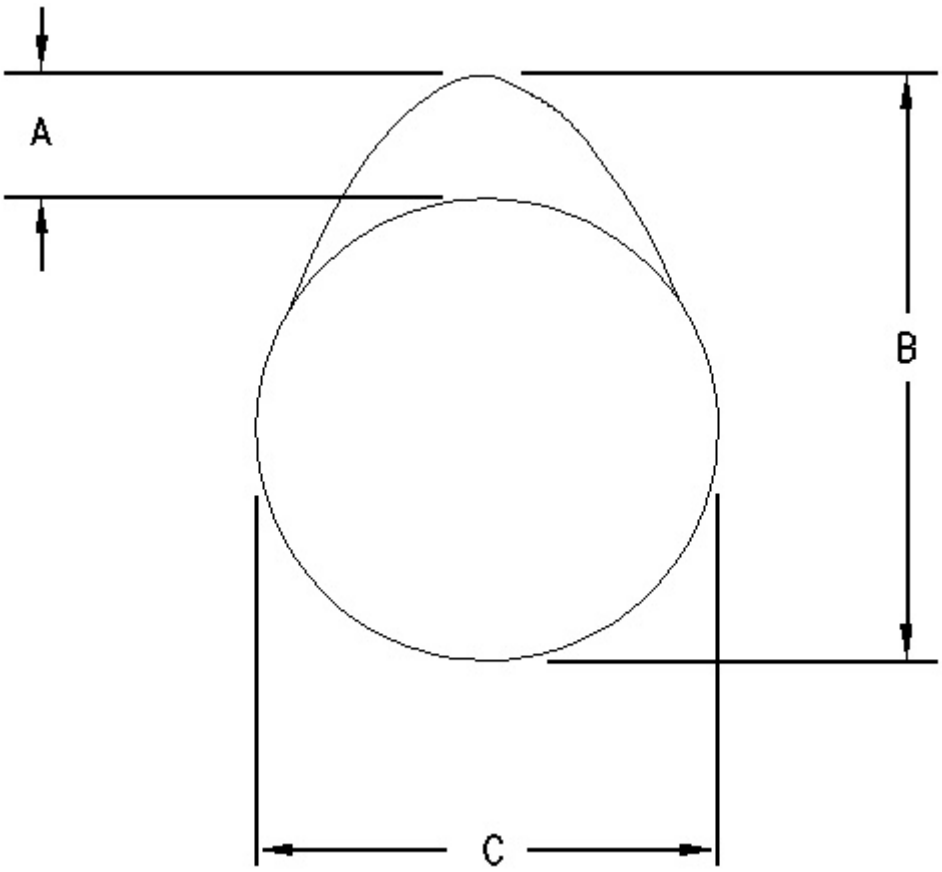


Illustration 2 g00987844

(A) Camshaft lobe lift

Naturally aspirated engines
Inlet lobe ... 6.722 mm (0.2646 inch)
Exhaust lobe ... 6.720 mm (0.2645 inch)

Turbocharged engines
Inlet lobe ... 6.682 mm (0.2631 inch)
Exhaust lobe ... 6.722 mm (0.2646 inch)

The service limit for camshaft lobe lift is given below:

Naturally aspirated engines
Inlet lobe ... 6.222 mm (0.2450 inch)
Exhaust lobe ... 6.220 mm (0.2449 inch)

Turbocharged engines
Inlet lobe ... 6.182 mm (0.2434 inch)
Exhaust lobe ... 6.222 mm (0.2450 inch)

(B) Camshaft lobe height

(C) Base circle

To determine the lobe lift, use the procedure that follows:

1. Measure the camshaft lobe height (B) .
2. Measure the base circle (C) .
3. Subtract the base circle that is found in Step 2 from the camshaft lobe height that is found in Step 1. The difference is the camshaft lobe lift.

If the camshaft lobe lift is less than the service limit, replace the camshaft.

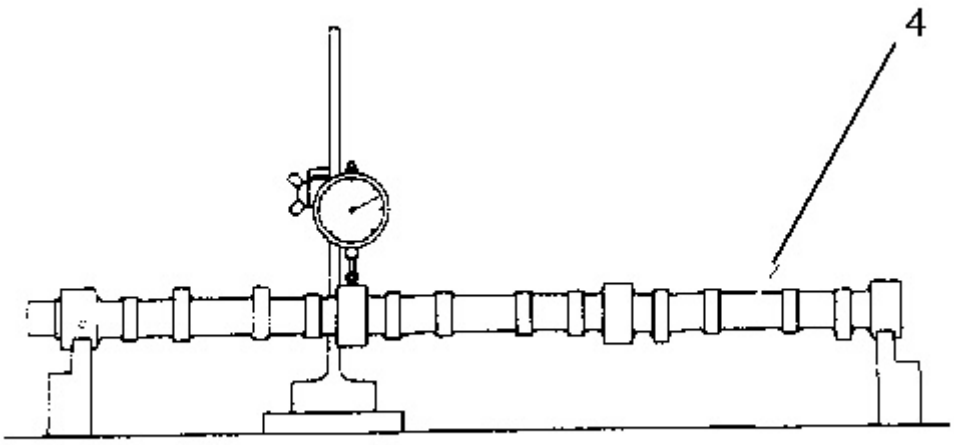


Illustration 3 g01014070

(4) Camshaft

Deflection over the full length of the camshaft

Maximum at assembly ... 0.02 mm (0.0008 inch)
Repair limit ... 0.05 mm (0.0020 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697692

Camshaft

SMCS - 1210

S/N - -

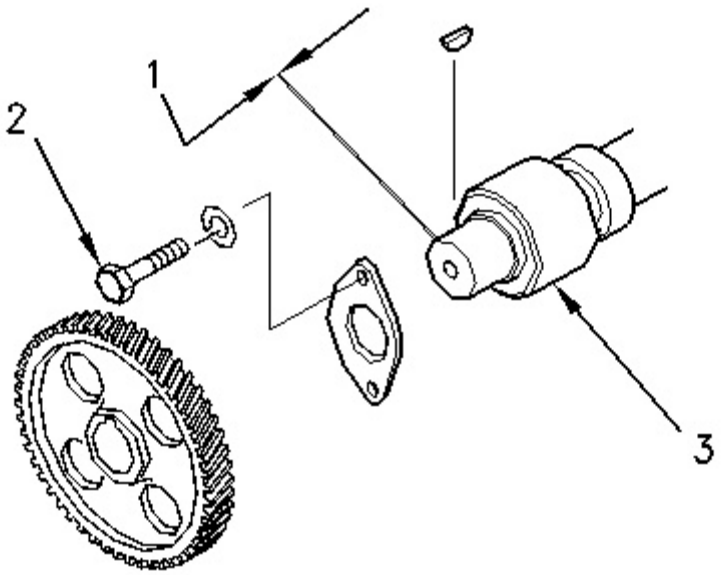


Illustration 1 g00988290

(1) End play of a new camshaft ... 0.10 ± 0.25 mm (0.0039 ± 0.0098 inch)

Maximum permissible end play of a worn camshaft ... 0.30 mm (0.0118 inch)

(2) Tighten the thrust plate bolts to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

(3) The diameters of the camshaft journals are given in the following table.

Table 1

Diameters of Camshaft Journals		
Camshaft Journals	Standard Diameter	Service Limit

No. 1,2	53.94 to 53.96 mm (2.123 to 2.124 inch)	53.90 mm (2.122 inch)
No. 3	52.94 to 52.96 mm (2.084 to 2.085 inch)	52.90 mm (2.083 inch)

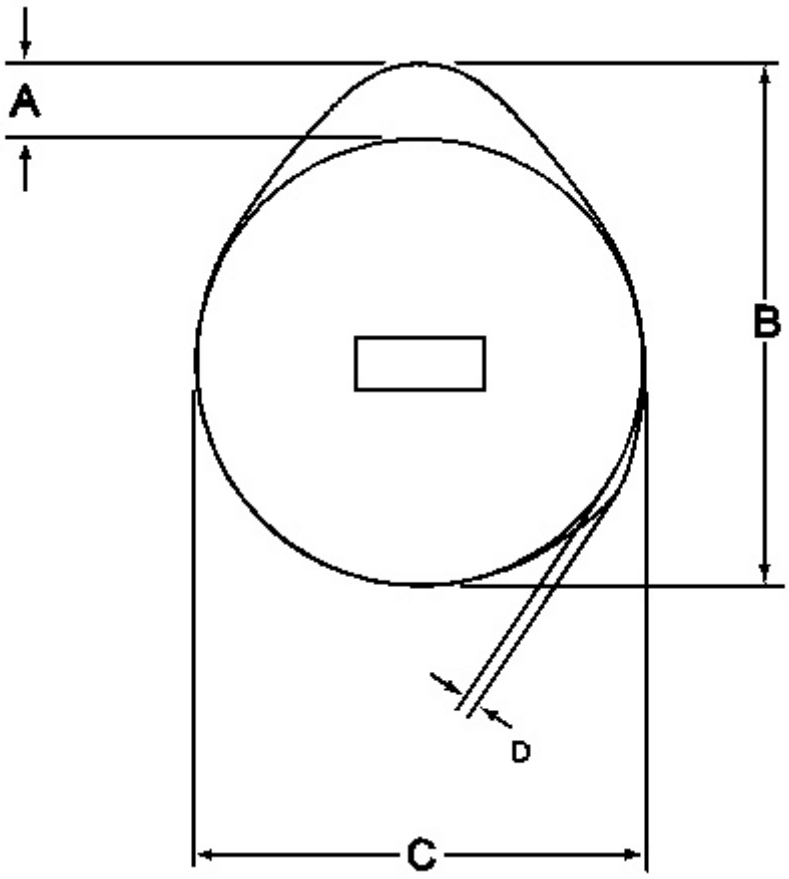


Illustration 2 g01353497

Typical example

(A) Camshaft lobe lift

Naturally aspirated engines
Inlet lobe ... 6.722 mm (0.2646 inch)
Exhaust lobe ... 6.720 mm (0.2645 inch)

Turbocharged engines
Inlet lobe ... 6.682 mm (0.2631 inch)
Exhaust lobe ... 6.722 mm (0.2646 inch)

The service limit for camshaft lobe lift is given below:

Naturally aspirated engines
Inlet lobe ... 6.222 mm (0.2450 inch)

Exhaust lobe ... 6.220 mm (0.2449 inch)

Turbocharged engines
Inlet lobe ... 6.182 mm (0.2434 inch)
Exhaust lobe ... 6.222 mm (0.2450 inch)

(B) Camshaft lobe height

(C) Base circle

(D) Lift for second camshaft lobe

Inlet valve for turbocharged engines
55 kW ... 0.923 mm (0.0363 inch)
62 kW ... 1.108 mm (0.0436 inch)

To determine the lobe lift, use the procedure that follows:

1. Measure the camshaft lobe height (B) .
2. Measure the base circle (C) .
3. Subtract the base circle that is found in Step 2 from the camshaft lobe height that is found in Step 1. The difference is the camshaft lobe lift.

If the camshaft lobe lift is less than the service limit, replace the camshaft.

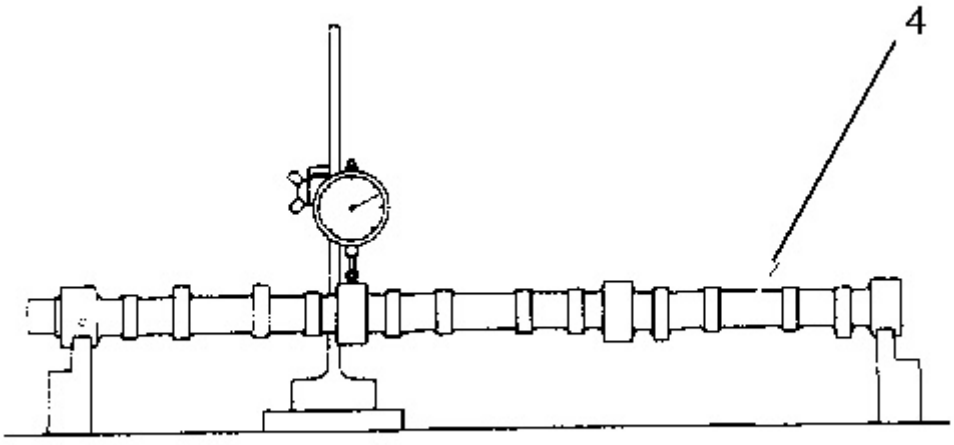


Illustration 3 g01014070

(4) Camshaft

Deflection over the full length of the camshaft

Maximum at assembly ... 0.02 mm (0.0008 inch)

Repair limit ... 0.05 mm (0.0020 inch)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01998748

Camshaft - Remove and Install

SMCS - 1210-010

Removal Procedure

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Turn the engine upside-down so the valve lifters are held in a position away from the camshaft.

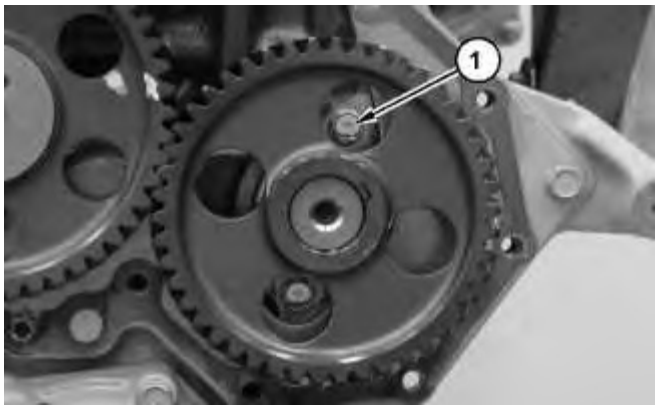


Illustration 1 g01034097

2. Remove bolts (1) .

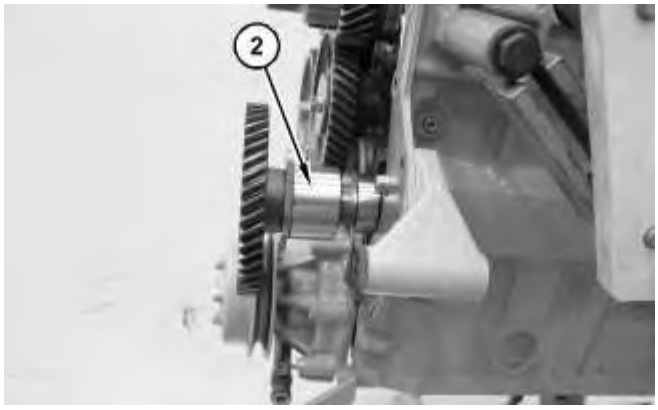


Illustration 2 g01034100

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

3. Carefully remove camshaft (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the camshaft is clean. Lubricate the camshaft with clean engine oil prior to installation.

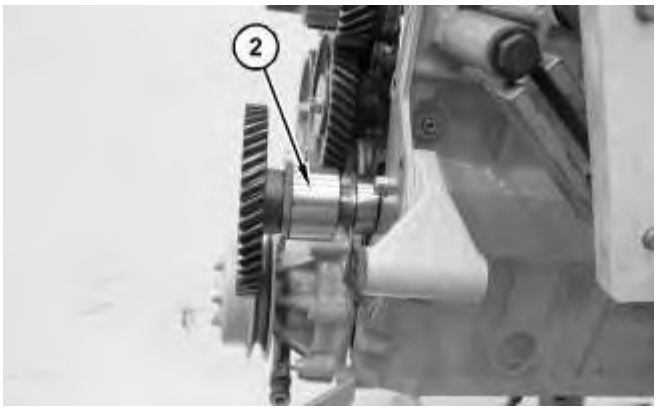


Illustration 3 g01034100

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

2. Carefully install camshaft (2) .

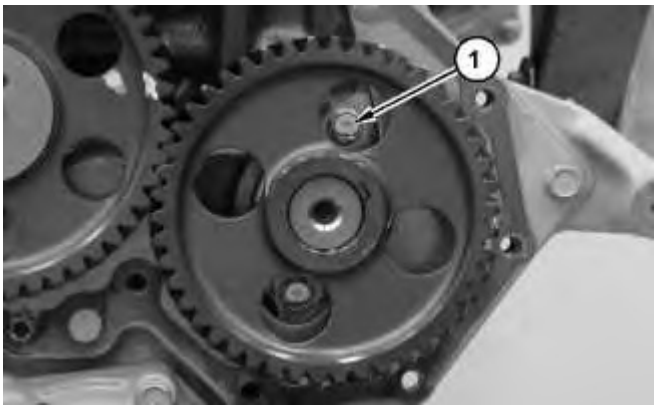


Illustration 4 g01034097

3. Install bolts (1). Tighten bolts (1) to a torque of 10 to 13 N·m (7 to 10 lb ft).

End By:

a. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".
b. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i03702890

Camshaft Gear - Remove and Install

SMCS - 1210-010-GE

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

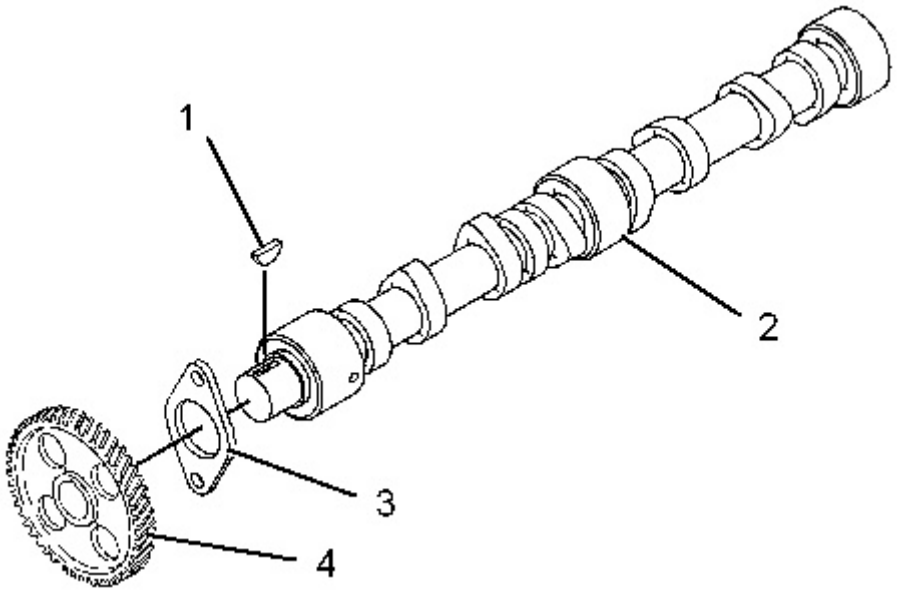


Illustration 1 g01993021

1. Use Tooling (A) to remove camshaft gear (4) from camshaft (2) . Remove key (1) and thrust plate (3) .

   Note: Do not lose the key from the camshaft gear.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the camshaft gear, the key, and the thrust plate for wear or damage.

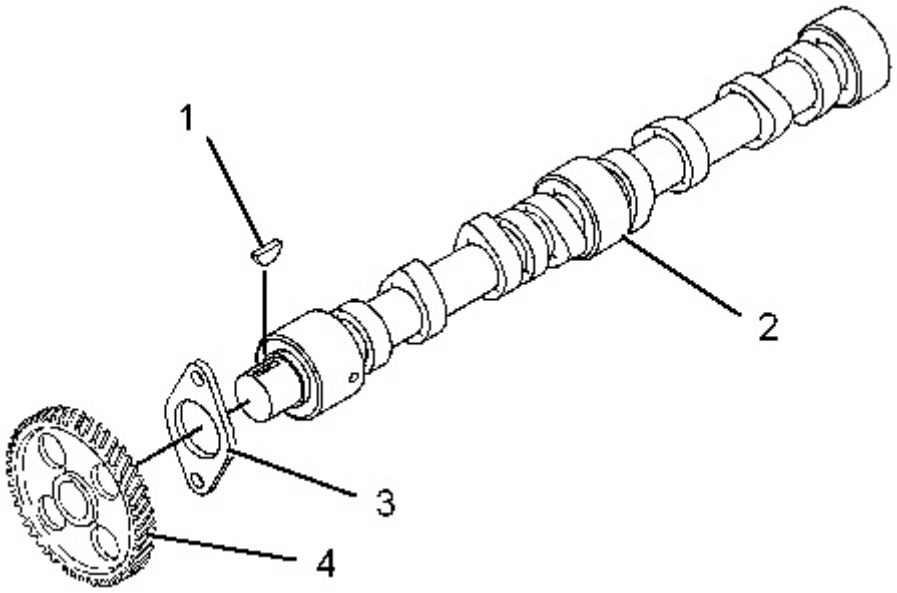


Illustration 2 g01993021

2. Install key (1) and thrust plate (3) . Raise the temperature of camshaft gear (4) and install camshaft gear (4) on camshaft (2) .

   Note: Ensure that the key is installed on the camshaft. When you install the camshaft gear, ensure that the marked teeth are facing toward the front. If necessary, tap the gear with a soft hammer in order to seat the key in the keyway.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02009092

Camshaft Bearings - Remove and Install

SMCS - 1211-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

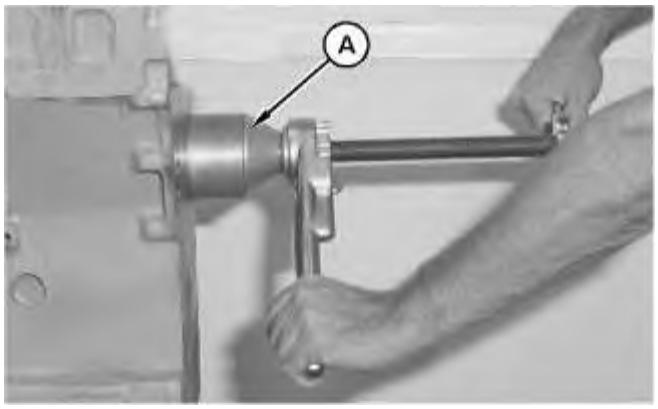


Illustration 1 g01038778

1. Use Tooling (A) to remove the camshaft bearing from the cylinder block.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the bore in the cylinder block for the camshaft bearing is clean and free of debris.

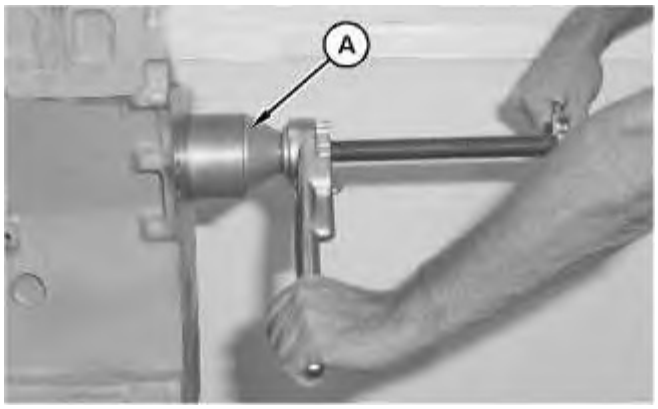


Illustration 2 g01038778

2. Use Tooling (A) to install the camshaft bearing in the cylinder block.

   Note: Align the oil holes in the camshaft bearing and the cylinder block. The camshaft bearing should be installed to a depth that is flush with the face of the recess in the cylinder block.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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i01998748

Camshaft - Remove and Install

SMCS - 1210-010

Removal Procedure

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Turn the engine upside-down so the valve lifters are held in a position away from the camshaft.

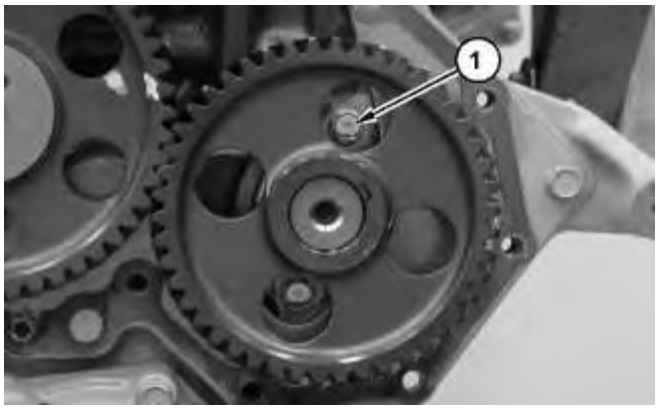


Illustration 1 g01034097

2. Remove bolts (1) .

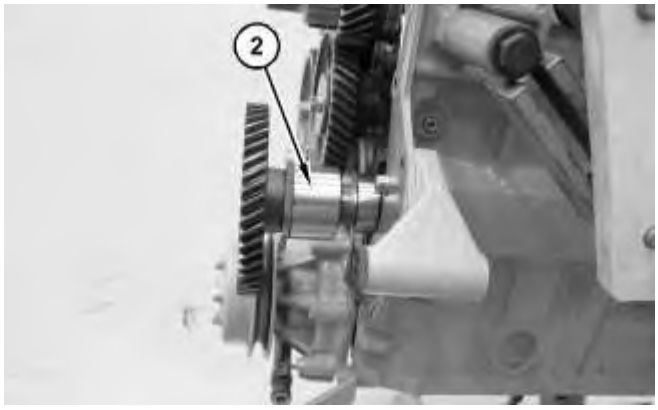


Illustration 2 g01034100

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

3. Carefully remove camshaft (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the camshaft is clean. Lubricate the camshaft with clean engine oil prior to installation.

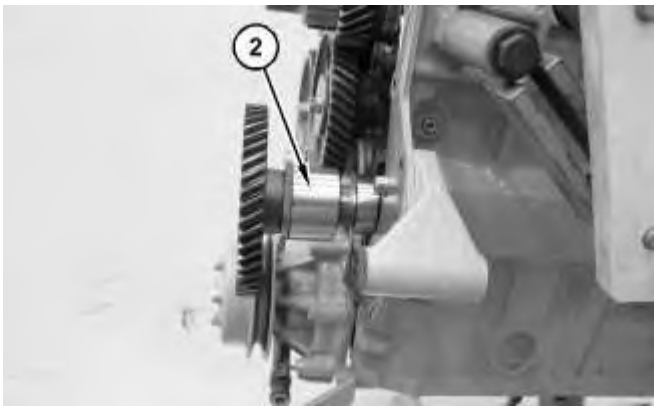


Illustration 3 g01034100

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

2. Carefully install camshaft (2) .

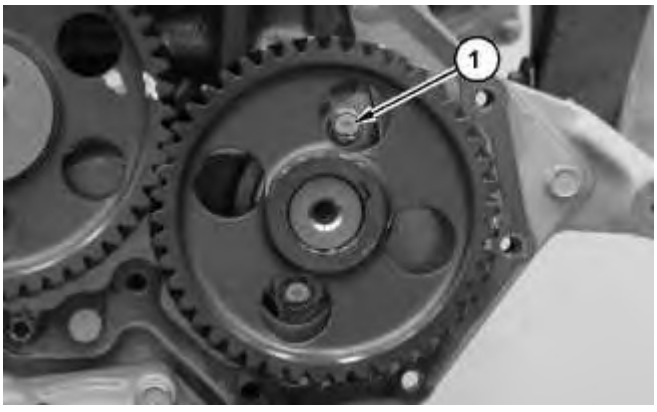


Illustration 4 g01034097

3. Install bolts (1). Tighten bolts (1) to a torque of 10 to 13 N·m (7 to 10 lb ft).

End By:

a. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".
b. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i03702890

Camshaft Gear - Remove and Install

SMCS - 1210-010-GE

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

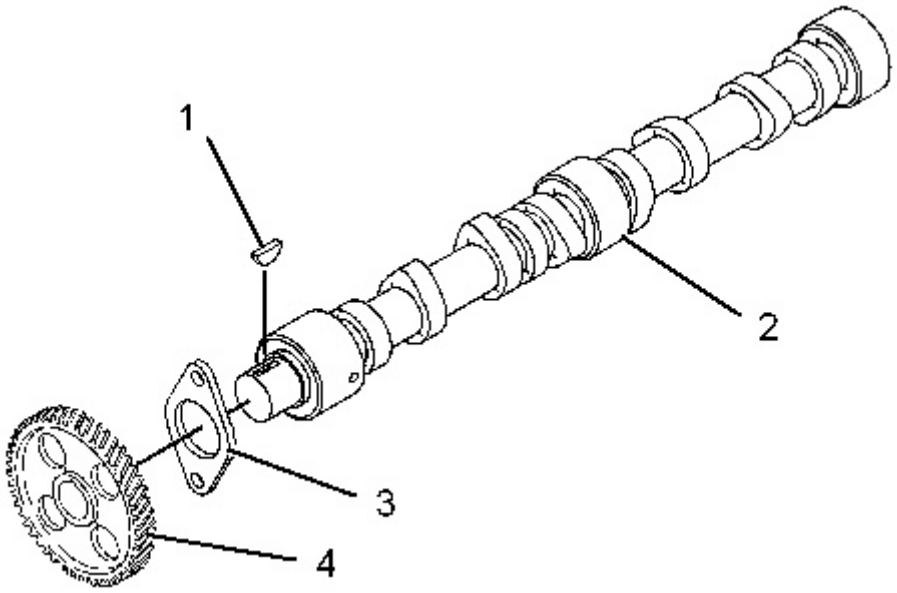


Illustration 1 g01993021

1. Use Tooling (A) to remove camshaft gear (4) from camshaft (2) . Remove key (1) and thrust plate (3) .

   Note: Do not lose the key from the camshaft gear.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the camshaft gear, the key, and the thrust plate for wear or damage.

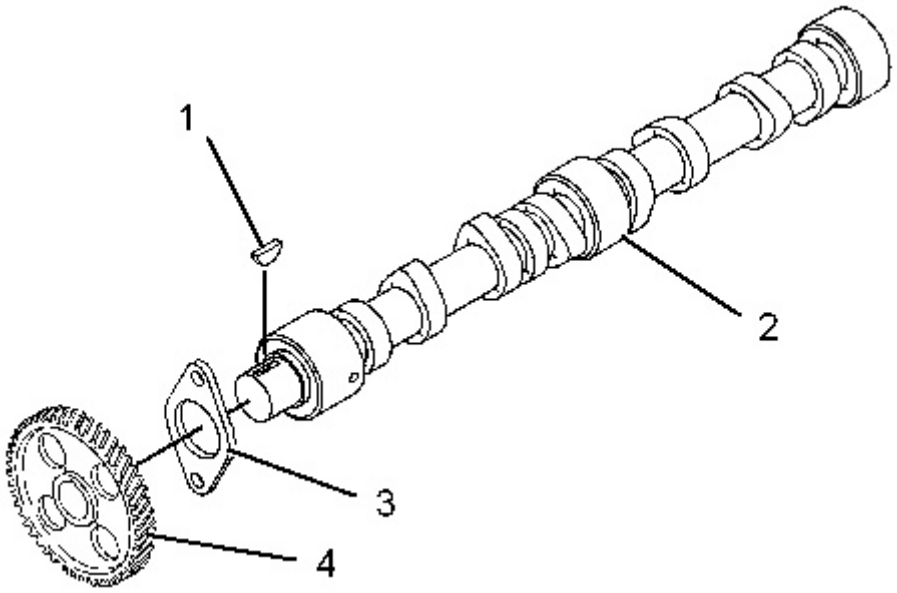


Illustration 2 g01993021

2. Install key (1) and thrust plate (3) . Raise the temperature of camshaft gear (4) and install camshaft gear (4) on camshaft (2) .

   Note: Ensure that the key is installed on the camshaft. When you install the camshaft gear, ensure that the marked teeth are facing toward the front. If necessary, tap the gear with a soft hammer in order to seat the key in the keyway.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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i02639294

Camshaft - Remove and Install

SMCS - 1210-010

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. The engine should be mounted on a suitable stand and placed in the inverted position.
2. Rotate the crankshaft so that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No.1 Piston".
3. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

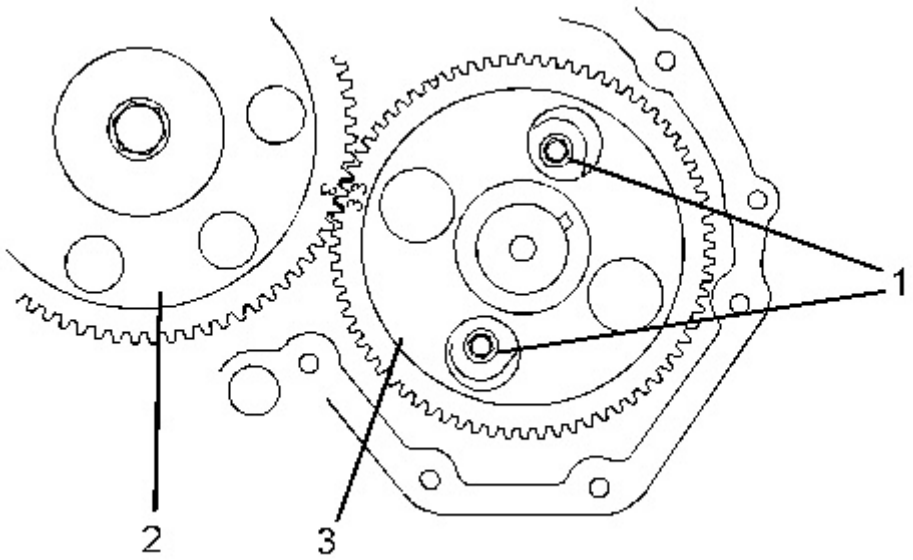


Illustration 1 g01349741

Typical example

4. Ensure that gears (2) and (3) are marked in order to show alignment. Refer to Illustration 1.

   Note: Identification will ensure that the camshaft can be installed in the original position.

5. Remove bolts (1) .

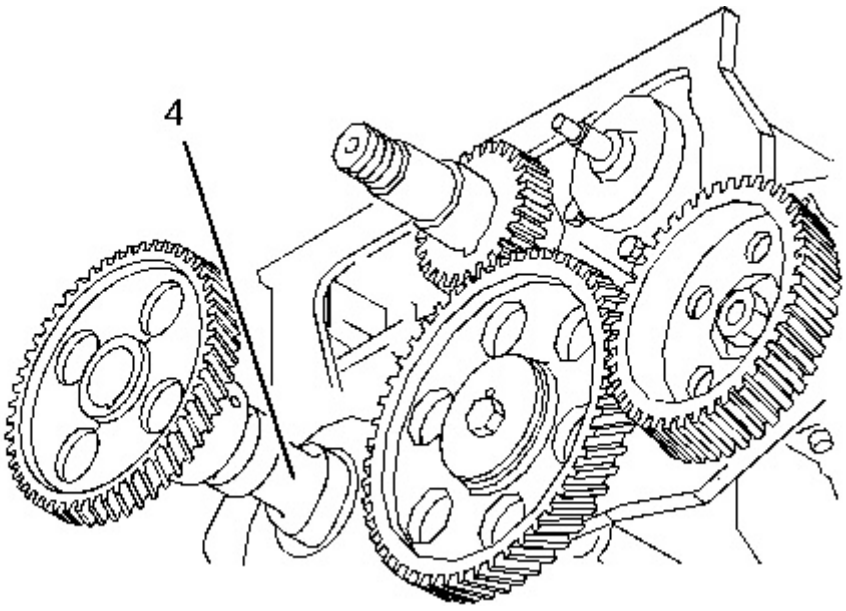


Illustration 2 g01350309

Typical example

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

6. Carefully remove camshaft assembly (4) from the cylinder block.
7. If necessary, remove the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear.- Remove and Install".

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7324	Indicator Bracket	1
	7H-1942	Dial Indicator	1
	3S-3268	Indicator Contact Point	1
	7H-1940	Universal Attachment	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the camshaft assembly is clean and free from wear or damage. If necessary, install the camshaft gear. Refer to Disassembly and Assembly, "Camshaft Gear.- Remove and Install".
2. Lubricate the camshaft assembly with clean engine oil prior to installation.

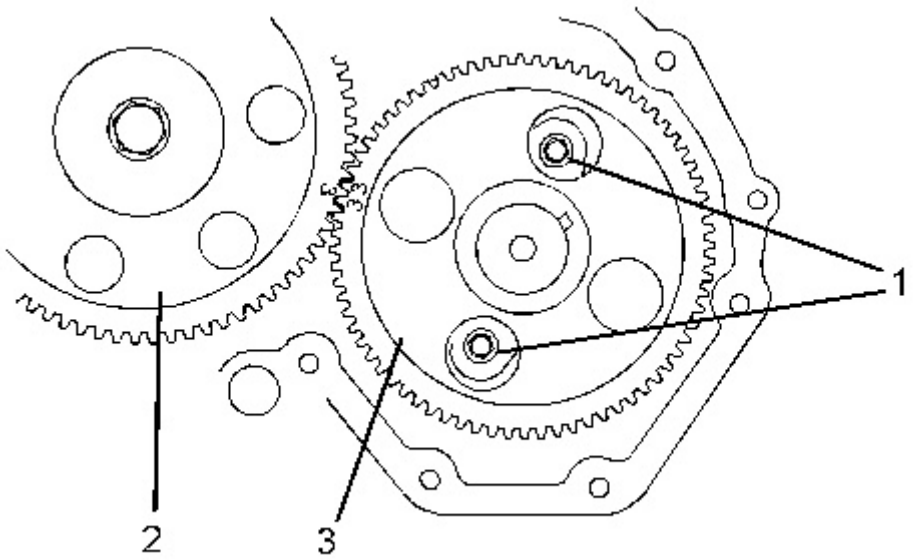


Illustration 3 g01349741

Typical example

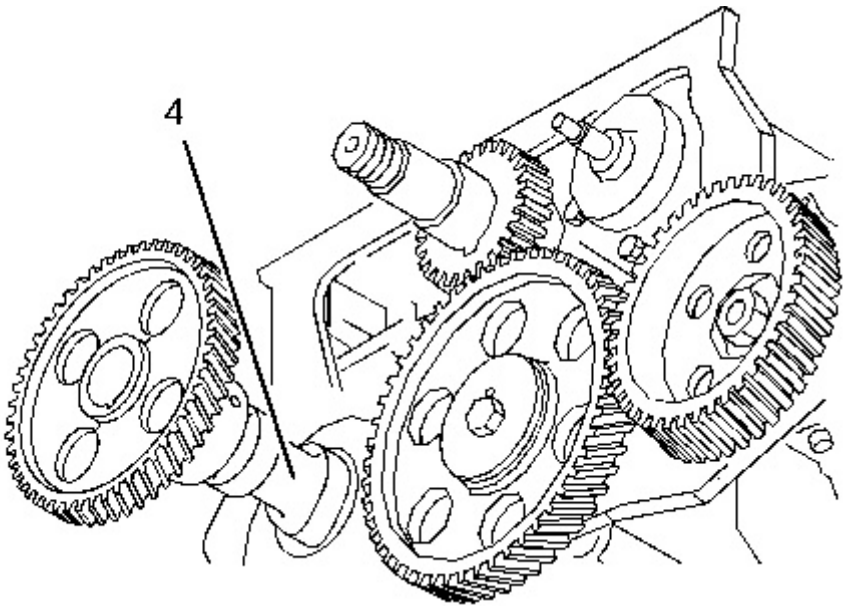


Illustration 4 g01350309

Typical example

NOTICE

Do not damage the lobes or the bearings when the camshaft is removed or installed.

3. Carefully install camshaft assembly (4) to the cylinder block. Ensure that the timing marks on gears (2) and (3) are in alignment and that the mesh of the gears is correct. Refer to Illustration 3.

4. Install bolts (1). Tighten the bolts to a torque of 12 N·m (106 lb in).

5. Use Tooling (A) to check the backlash between gears (2) and (3). Ensure that the backlash for the gears is within specified values. Refer to the Specifications, "Gear Group (Front)" for further information.

6. Use Tooling (A) to check the end play for camshaft gear (3). Ensure that the end play is within specified values. Refer to the Specifications, "Camshaft" for further information.

7. Lubricate the teeth of the gears with clean engine oil.

End By:

a. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".
b. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i02639295

Camshaft Gear - Remove and Install

SMCS - 1210-010-GE

Removal Procedure

Start By:

A. Remove the camshaft assembly from the engine. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

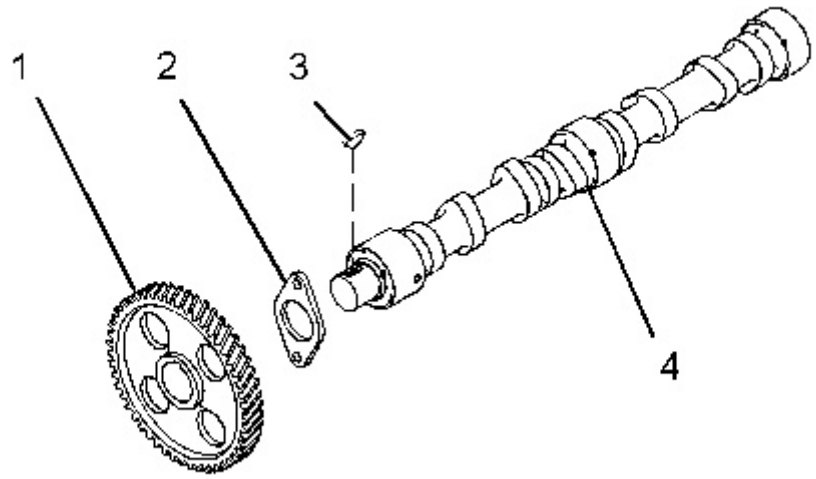


Illustration 1 g01350917

1. Place the camshaft assembly on a suitable support. Use a press to remove camshaft gear (1) from camshaft (4) .
2. Remove thrust plate (2) and woodruff key (3) from camshaft (4). Note the orientation of the thrust plate for installation.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components of the camshaft assembly are clean and free from damage.

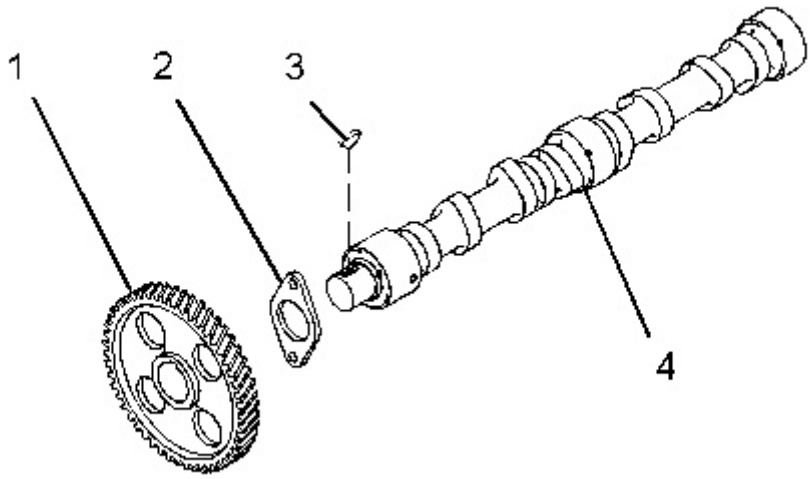


Illustration 2 g01350917

2. Install woodruff key (3) and thrust plate (2) to camshaft (4) .

   Note: Ensure that the machined face of the thrust plate is toward the camshaft.

WARNING

Always wear protective gloves when handling parts that have been heated.

3. Raise the temperature of camshaft gear (1). Align the camshaft gear with woodruff key (3) and install the camshaft gear to camshaft (4) .

End By: Install the camshaft assembly to the engine. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01894898

Crankshaft

SMCS - 1202

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

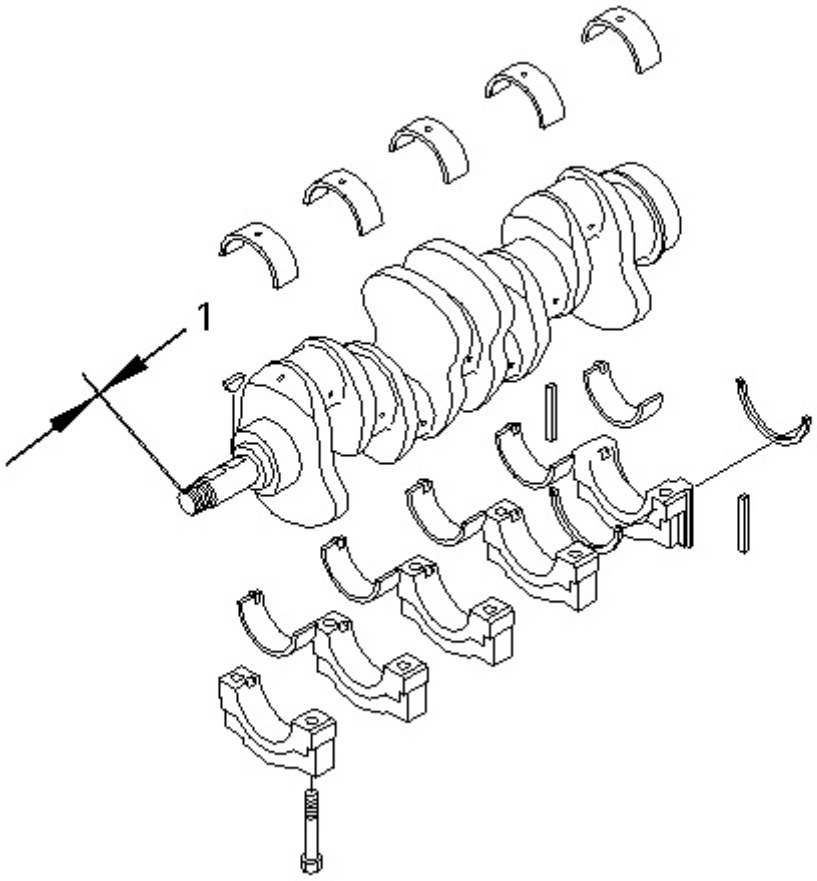


Illustration 1 g00987940

(1) Crankshaft end play

Standard at assembly ... 0.100 to 0.264 mm (0.0039 to 0.0104 inch)
Repair limit ... 0.300 mm (0.0118 inch)

Crankshaft deflection

Maximum at assembly ... 0.02 mm (0.0008 inch)
Repair limit ... 0.05 mm (0.0020 inch)

Clearance between crankshaft bearing and crankshaft journal

Standard at assembly ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)
Repair limit ... 0.200 mm (0.0079 inch)

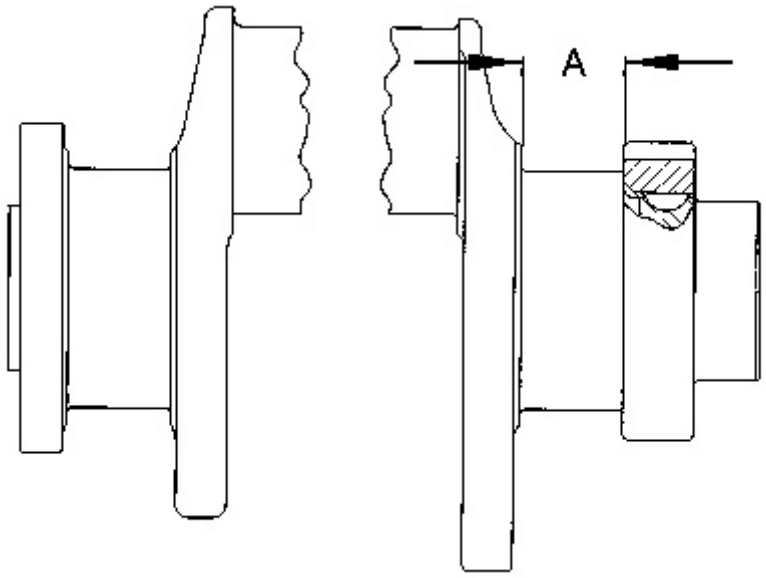


Illustration 2 g00994009

(A) Original width of the rear crankshaft journal ... 31.000 to 31.039 mm (1.2205 to 1.2220 inch)

Table 1

Width of Crankshaft Journal for Oversize Thrust Washers		
Oversize Thrust Washer	**Oversize Width for Front OR Rear**	**Oversize Width for Front AND Rear**
0.15 mm (0.006 inch)	31.150 to 31.189 mm (1.2264 to 1.2279 inch)	31.300 to 31.339 mm (1.2323 to 1.2338 inch)
0.30 mm (0.012 inch)	31.300 to 31.339 mm (1.2323 to 1.2338 inch)	31.450 to 31.489 mm (1.2382 to 1.2397 inch)
0.45 mm (0.018 inch)	31.450 to 31.489 mm (1.2382 to 1.2397 inch)	31.600 to 31.639 mm (1.2441 to 1.2456 inch)

Refer to Specifications, "Connecting Rod Bearing Journal" for information on the connecting rod bearing journals.

Refer to Specifications, "Main Bearing Journal" for information on the main bearing journals and the main bearings.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01059939

Crankshaft Seals

SMCS - 1160; 1161

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

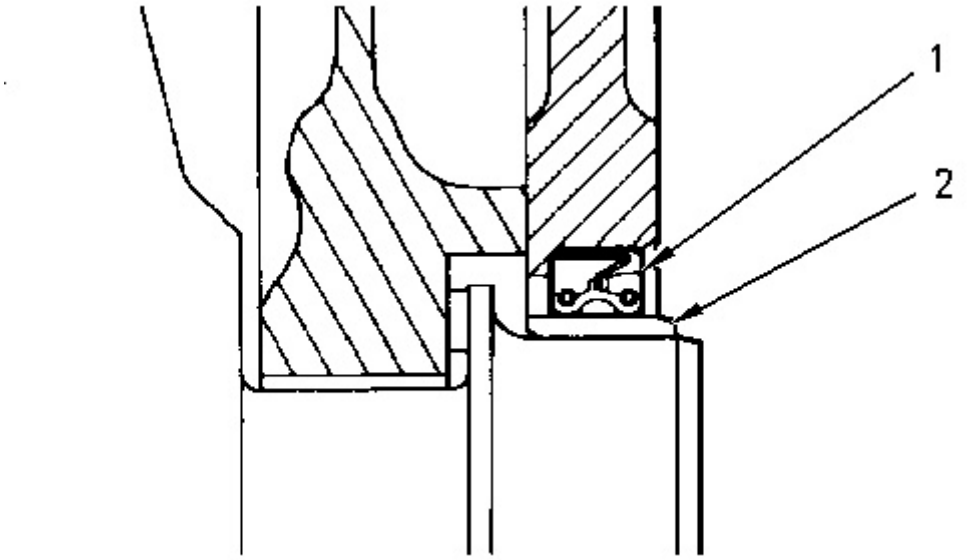


Illustration 1 g00554030

(1) Oil seal

(2) Oil seal sleeve

Inspect the contact surface between the oil seal and the crankshaft for wear. If the crankshaft is worn, replace the oil seal with an oil seal and a sleeve assembly.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01907581

Connecting Rod Bearing Journal

SMCS - 1202; 1219; 1225

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod Bearings	
Original Size Journal (1)	57.955 to 57.970 mm (2.2817 to 2.2823 inch)
Undersize Journal 0.25 mm (0.010 inch)	57.705 to 57.720 mm (2.2718 to 2.2724 inch)
Undersize Journal 0.50 mm (0.020 inch)	57.455 to 57.470 mm (2.2620 to 2.2626 inch)
Undersize Journal 0.75 mm (0.030 inch)	57.205 to 57.220 mm (2.2522 to 2.2528 inch)

(1) Regrind the connecting rod bearing journals to the next undersize dimension if the repair limit of 57.800 mm (2.2756 inch) is exceeded.

The clearance between a new connecting rod bearing and a new connecting rod bearing journal is the following value. ... 0.030 to 0.090 mm (0.0012 to 0.0035 inch)

Service limit for clearance between a connecting rod bearing and a connecting rod bearing journal ... 0.200 mm (0.0079 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01907583

Main Bearing Journal

SMCS - 1202; 1203

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Main Bearings	
Original Size Journal (1)	77.955 to 77.970 mm (3.0691 to 3.0697 inch)
Undersize Journal 0.25 mm (0.010 inch)	77.705 to 77.720 mm (3.0592 to 3.0598 inch)
Undersize Journal 0.50 mm (0.020 inch)	77.455 to 77.470 mm (3.0494 to 3.0500 inch)
Undersize Journal 0.75 mm (0.030 inch) (2)	77.205 to 77.220 mm (3.0396 to 3.0402 inch)

(1) Regrind the main bearing journals to the next undersize dimension if the repair limit of 77.850 mm (3.0650 inch) is exceeded.

(2) Service limit 77.100 mm (3.0354 inch)

The clearance between a new main bearing and a new main bearing journal is the following value. ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)

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Specifications

C3.4 Engines for Caterpillar Built Machines

Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01894898

Crankshaft

SMCS - 1202

S/N - -

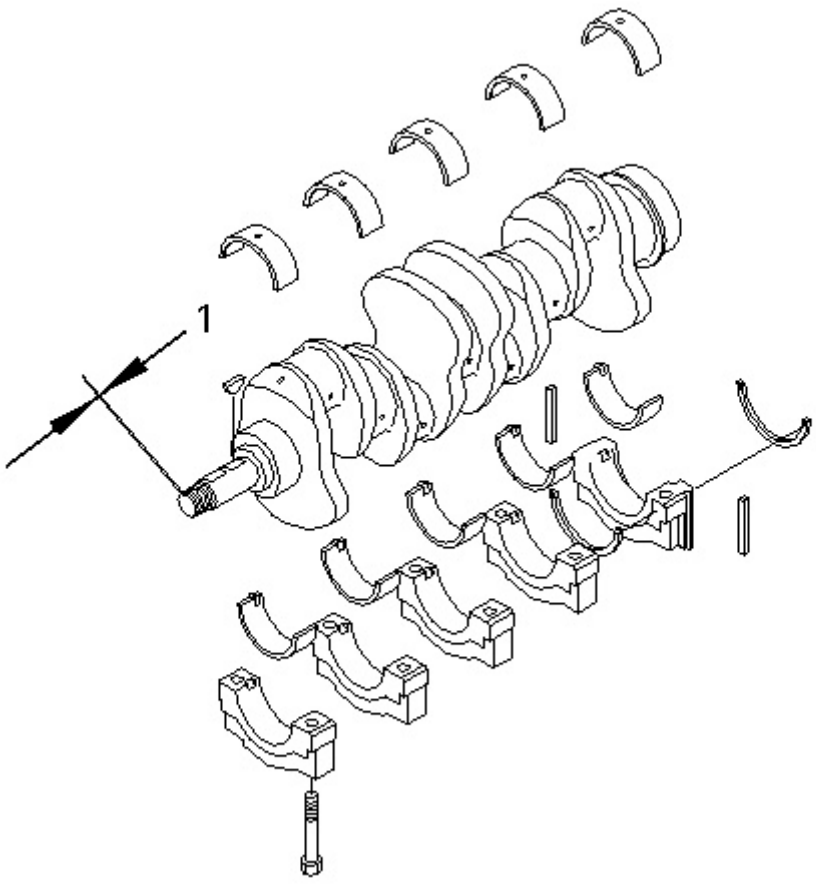


Illustration 1 g00987940

(1) Crankshaft end play

Standard at assembly ... 0.100 to 0.264 mm (0.0039 to 0.0104 inch)

Repair limit ... 0.300 mm (0.0118 inch)

Crankshaft deflection

Maximum at assembly ... 0.02 mm (0.0008 inch)
Repair limit ... 0.05 mm (0.0020 inch)

Clearance between crankshaft bearing and crankshaft journal

Standard at assembly ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)
Repair limit ... 0.200 mm (0.0079 inch)

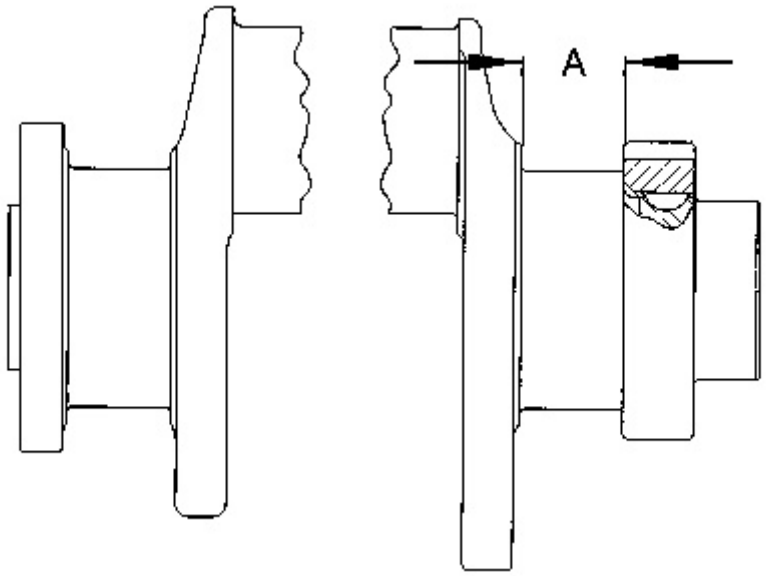


Illustration 2 g00994009

(A) Original width of the rear crankshaft journal ... 31.000 to 31.039 mm (1.2205 to 1.2220 inch)

Table 1

Width of Crankshaft Journal for Oversize Thrust Washers		
Oversize Thrust Washer	**Oversize Width for Front OR Rear**	**Oversize Width for Front AND Rear**
0.15 mm (0.006 inch)	31.150 to 31.189 mm (1.2264 to 1.2279 inch)	31.300 to 31.339 mm (1.2323 to 1.2338 inch)
0.30 mm (0.012 inch)	31.300 to 31.339 mm (1.2323 to 1.2338 inch)	31.450 to 31.489 mm (1.2382 to 1.2397 inch)
0.45 mm (0.018 inch)	31.450 to 31.489 mm (1.2382 to 1.2397 inch)	31.600 to 31.639 mm (1.2441 to 1.2456 inch)

Refer to Specifications, "Connecting Rod Bearing Journal" for information on the connecting rod bearing journals.

Refer to Specifications, "Main Bearing Journal" for information on the main bearing journals and the main bearings.

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697791

Crankshaft Seals

SMCS - 1160; 1161

S/N - -

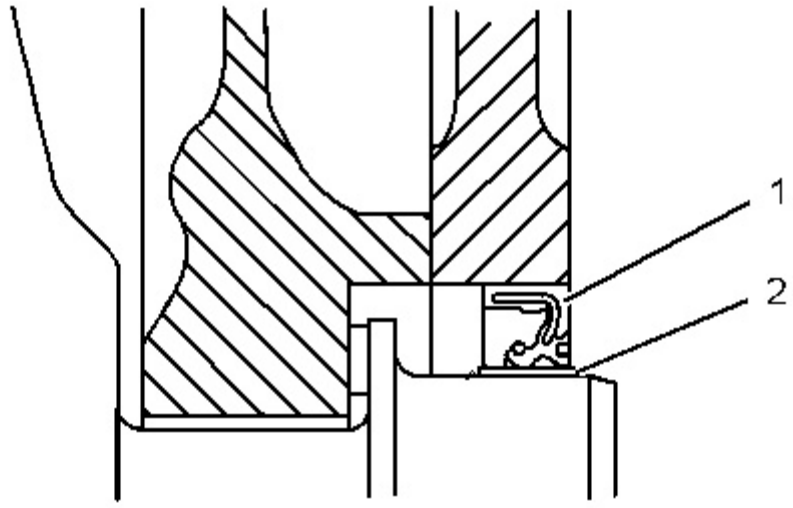


Illustration 1 g01353567

Typical example

(1) Oil seal

(2) Oil seal sleeve

Inspect the contact surface between the oil seal and the crankshaft for wear. If the crankshaft is worn, replace the oil seal with an oil seal and a sleeve assembly.

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i01907581

Connecting Rod Bearing Journal

SMCS - 1202; 1219; 1225

S/N - -

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod Bearings	
Original Size Journal (1)	57.955 to 57.970 mm (2.2817 to 2.2823 inch)
Undersize Journal 0.25 mm (0.010 inch)	57.705 to 57.720 mm (2.2718 to 2.2724 inch)
Undersize Journal 0.50 mm (0.020 inch)	57.455 to 57.470 mm (2.2620 to 2.2626 inch)
Undersize Journal 0.75 mm (0.030 inch)	57.205 to 57.220 mm (2.2522 to 2.2528 inch)

(1) Regrind the connecting rod bearing journals to the next undersize dimension if the repair limit of 57.800 mm (2.2756 inch) is exceeded.

The clearance between a new connecting rod bearing and a new connecting rod bearing journal is the following value. ... 0.030 to 0.090 mm (0.0012 to 0.0035 inch)

Service limit for clearance between a connecting rod bearing and a connecting rod bearing journal ... 0.200 mm (0.0079 inch)

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i01907583

Main Bearing Journal

SMCS - 1202; 1203

S/N - -

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Main Bearings	
Original Size Journal (1)	77.955 to 77.970 mm (3.0691 to 3.0697 inch)
Undersize Journal 0.25 mm (0.010 inch)	77.705 to 77.720 mm (3.0592 to 3.0598 inch)
Undersize Journal 0.50 mm (0.020 inch)	77.455 to 77.470 mm (3.0494 to 3.0500 inch)
Undersize Journal 0.75 mm (0.030 inch) (2)	77.205 to 77.220 mm (3.0396 to 3.0402 inch)

(1) Regrind the main bearing journals to the next undersize dimension if the repair limit of 77.850 mm (3.0650 inch) is exceeded.

(2) Service limit 77.100 mm (3.0354 inch)

The clearance between a new main bearing and a new main bearing journal is the following value. ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01999095

Crankshaft Rear Seal - Remove

SMCS - 1161-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

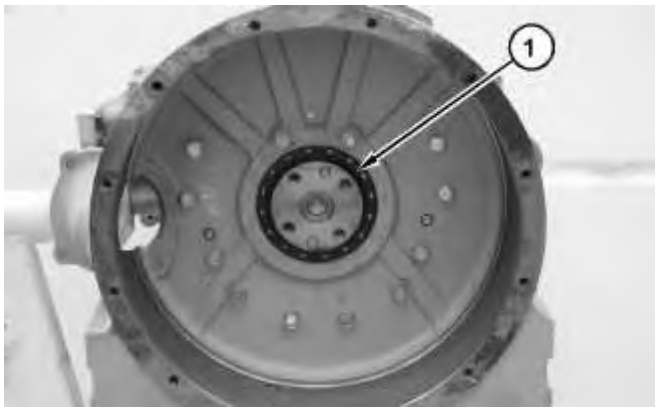


Illustration 1 g01034321

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft rear seal (1) .
2. Use Tooling (B) in each of the three holes to evenly remove crankshaft rear seal (1) .

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i05485179

Crankshaft Rear Seal - Install

SMCS - 1161-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	438-3244	Oil Seal Installer	1
	438-3245	Seal Adapter	1
	8T-0375	Bolt	1
	5P-8247	Hard Washer	1
	9U-6172	Bolt	2
B	5P-0944	Dowel Puller Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the crankshaft flange and the inside of the flywheel housing are clean and free of debris.

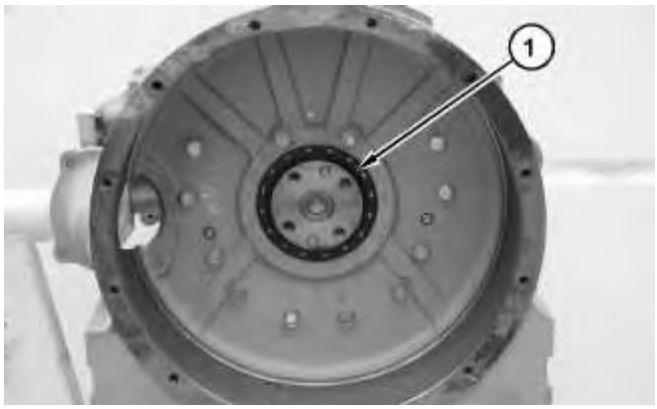


Illustration 1 g01034321

2. Apply a thin coat of clean engine oil to the lip of crankshaft rear seal (1) .
3. Use Tooling (B) in order to remove the dowel pins from the crankshaft.
4. Use Tooling (A) in order to install crankshaft rear seal (1) , as follows:
    a. Install the locator onto the crankshaft.
    b. Position crankshaft rear seal (1) in the installer.
    c. Put the bolt and the washer through the installer and thread into the locator.
    d. Push crankshaft rear seal (1) onto the crankshaft until the installer bottoms out.
    e. Remove Tooling (A) and check crankshaft rear seal (1) for correct installation.
5. Install the dowel pins in the crankshaft.

End By: Install the flywheel.

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i01999219

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

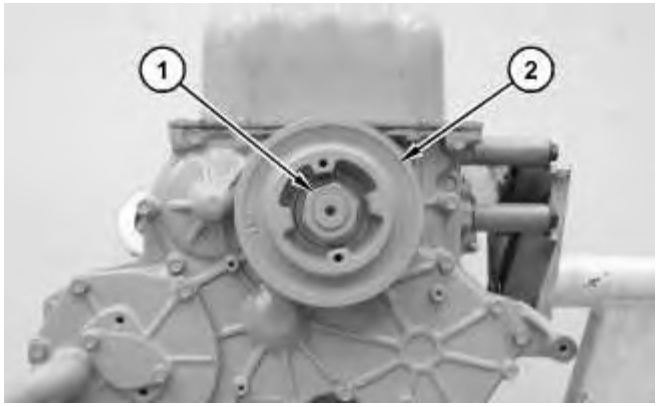


Illustration 1 g01034425

1. Loosen nut (1) .

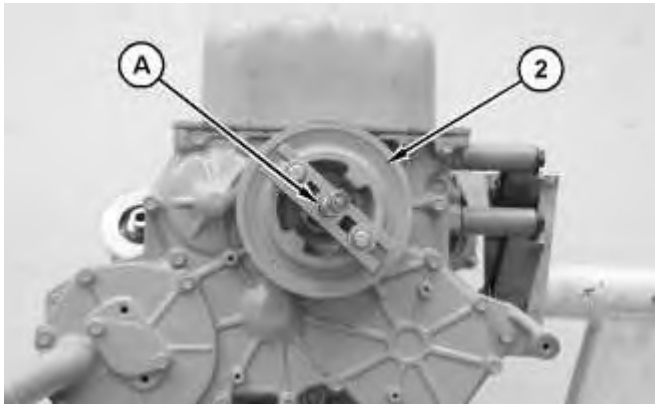


Illustration 2 g01034426

2. Use Tooling (A) to loosen crankshaft pulley (2). Remove Tooling (A). Remove nut (1) and remove pulley (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

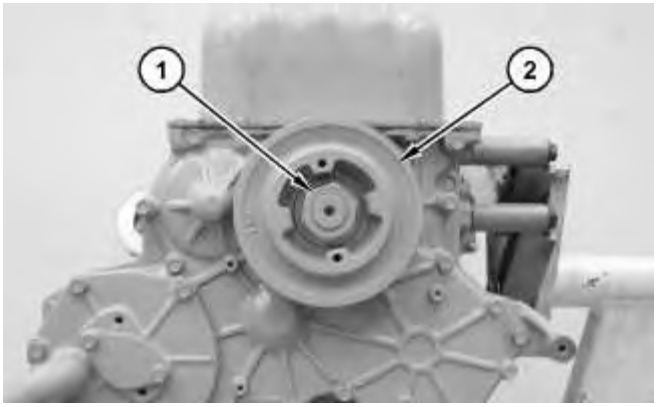


Illustration 3 g01034425

1. Position pulley (2) and install nut (1) .
2. Tighten nut (1) to a torque of 480 to 500 N·m (354 to 369 lb ft).

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
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i01998722

Crankshaft Front Seal - Remove

SMCS - 1160-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

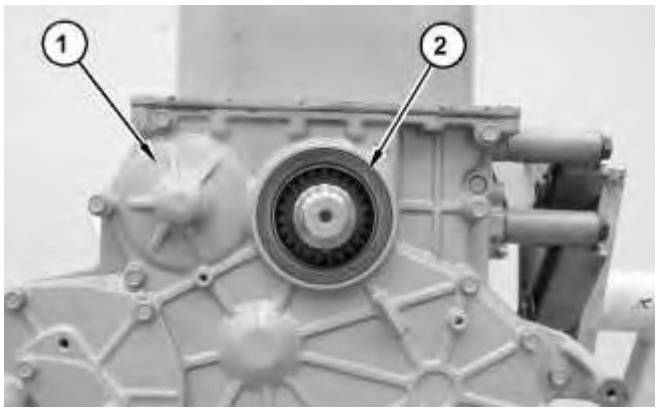


Illustration 1 g01034060

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft front seal (2) .
2. Use Tooling (B) in each of the three holes to evenly remove crankshaft front seal (2) from front housing (1) .

NOTICE

Ensure that the main lip is used in order to remove the crankshaft front seal. Do not damage the edge of the housing for the crankshaft front seal.

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i01998728

Crankshaft Front Seal - Install

SMCS - 1160-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	4C-6376	Seal Installer Stud	1
	4C-6377	Washer	1
	4C-6378	Seal Installer Sleeve	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the housing for the crankshaft front seal and inspect the housing for damage.

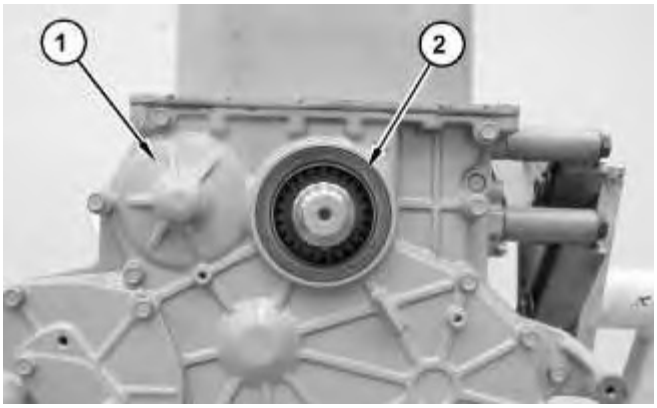


Illustration 1 g01034060

2. Apply a thin coat of clean engine oil to the lip of a new crankshaft front seal (2) .
3. Use Tooling (C) to install crankshaft front seal (2) into front housing (1) .

NOTICE

Ensure that the lip of the crankshaft front seal that is spring loaded is facing toward the inside of the front housing and that it is square with the bore of the housing for the crankshaft front seal.

4. Remove Tooling (C) and check for correct installation. The front seal must contact the bottom face of front housing (1) .
5. Apply clean engine oil on the area of the crankshaft pulley that will be in contact with crankshaft front seal (2) .

End By: Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

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i02707279

Crankshaft Main Bearings - Remove

SMCS - 1203-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the flywheel housing in order to remove the rear main bearing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Make sure that the main bearing caps are marked for the location and direction for installation. The main bearings and the main bearing caps must be installed in the same location.

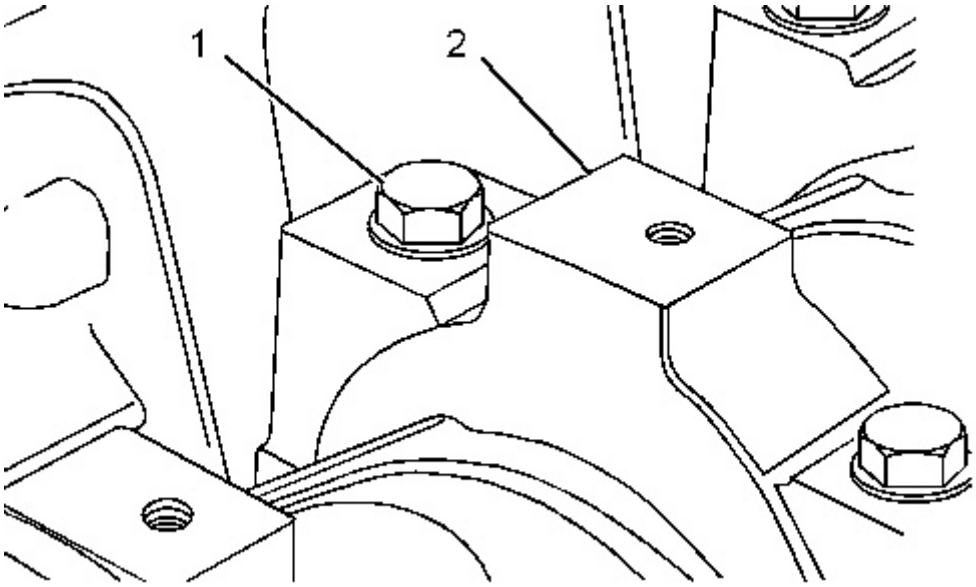


Illustration 1 g01358190

2. Remove bolts (1) and main bearing cap (2) .

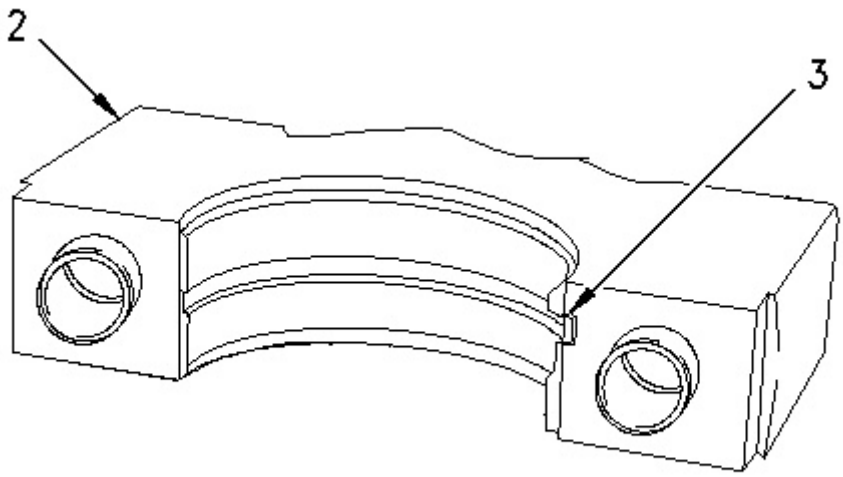


Illustration 2 g00934803

3. Remove lower main bearing (3) from main bearing cap (2). Keep the respective main bearing and the main bearing cap together for proper installation.

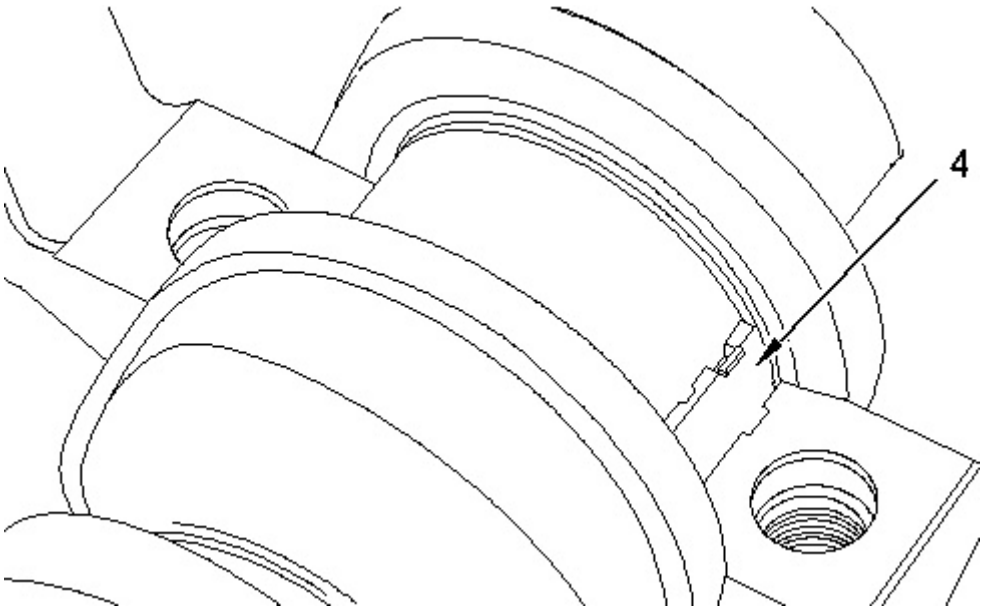


Illustration 3 g00934767

4. Push upper main bearing (4) from the opposite side of the bearing tab with a suitable tool. Carefully rotate the crankshaft while you push on the bearing. Remove upper main bearing (4) from the cylinder block. Keep the upper bearing halves together in order to ensure proper installation.

5. Repeat Step 2 through Step 4 for the remaining main bearings.

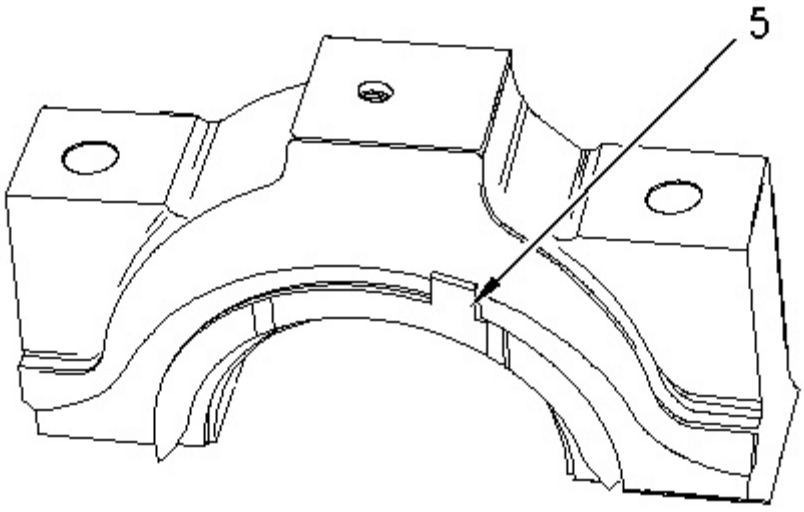


Illustration 4 g00934744

6. Remove the lower half of thrust washers (5) from both sides of the rear main bearing cap. Remove the seals from the rear main bearing cap.

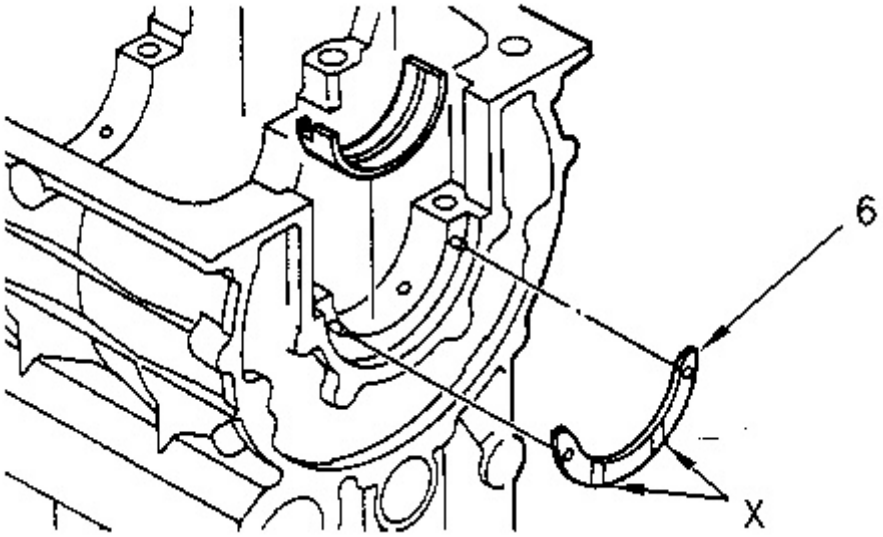


Illustration 5 g01001838

7. Remove the upper half of thrust washer (6) from the rear of the cylinder block. Carefully rotate the crankshaft while you push on thrust washer (6). If necessary, move the crankshaft to the front or to the rear in order to loosen a tight thrust washer.

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i02707287

Crankshaft Main Bearings - Install

SMCS - 1203-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

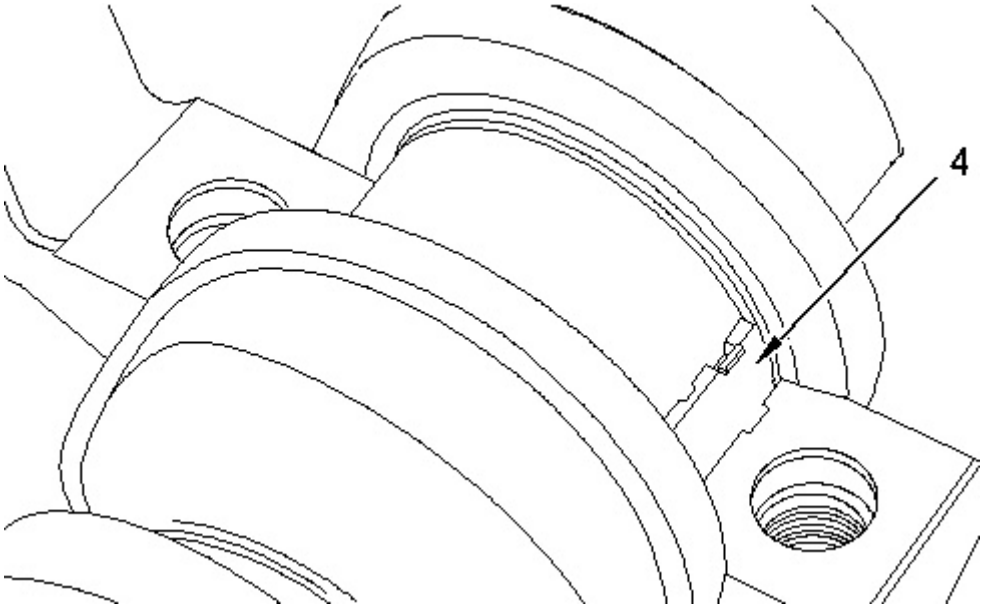


Illustration 1 g00934767

1. Clean upper main bearing (4) and lubricate the bearing surface with clean engine oil.

   Note: Do not put oil on the back sides of the crankshaft main bearings.

   Note: Ensure that the upper halves of the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block.

NOTICE

Only the upper half of the main bearing has lubrication holes. Make sure the upper half of the main bearing is installed correctly in the cylinder block to ensure proper lubrication.

2. Slide upper main bearing (4) into position between the crankshaft journal and the cylinder block.

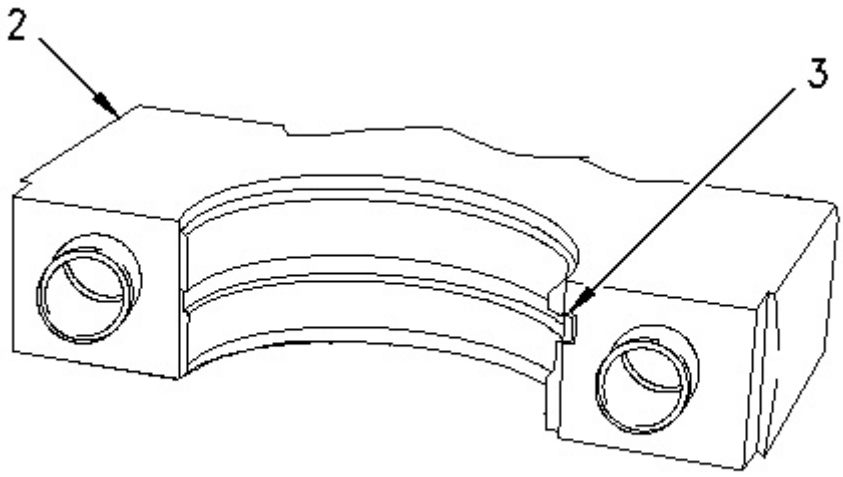


Illustration 2 g00934803

3. Clean main bearing cap (2) and lower main bearing (3). Lubricate the bearing surface of lower main bearing (3) with clean engine oil.

   Note: Ensure that the lower halves of the main bearings are installed so that the bearing tabs fit into the notch in the main bearing caps.

4. Install lower main bearing (3) in main bearing cap (2) .

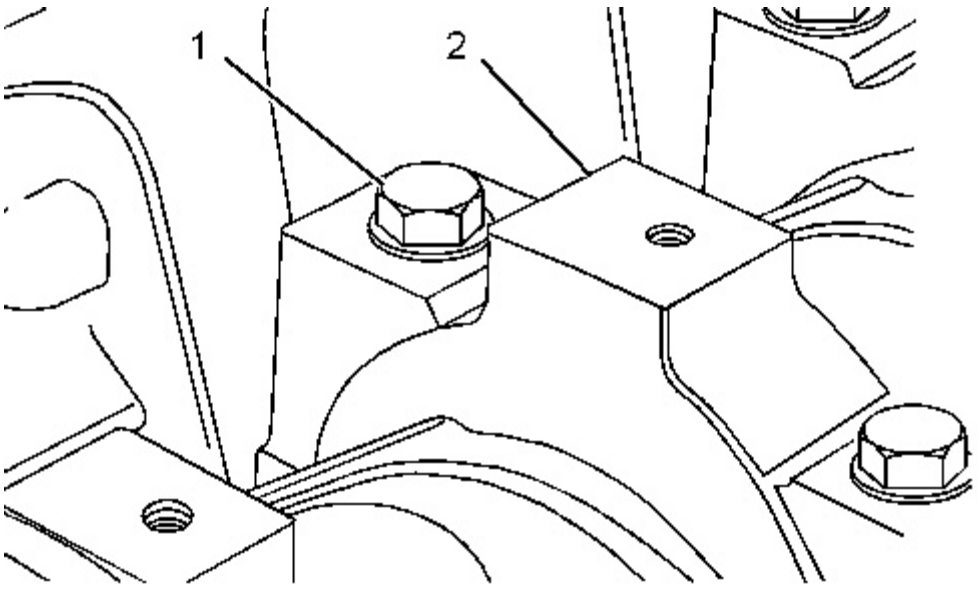


Illustration 3 g01358190

5. Install main bearing cap (2). Lubricate the threads of bolts (1) with clean engine oil. Install bolts (1) and tighten finger tight.

6. Repeat Steps 1 through 5 for the remaining main bearings.

   Note: Do not install the rear main bearing cap yet.

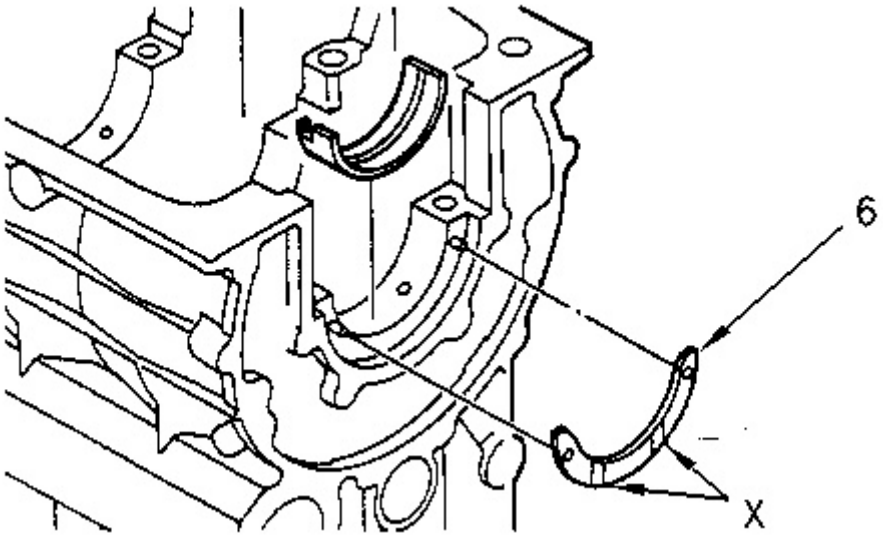


Illustration 4 g01001838

7. Install the upper half of thrust washer (6) on the rear of the cylinder block with the Oil Grooves (X) toward the outside. If necessary, move the crankshaft to the front or to the rear in order to install the thrust washer.

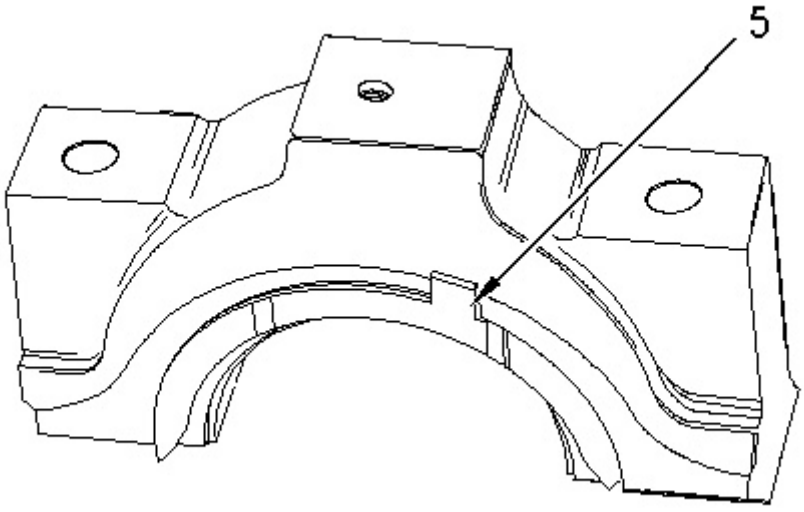


Illustration 5 g00934744

8. Install the lower half of thrust washer (5) on each side of the rear main bearing cap. The grooves on the thrust washer must be located against the crankshaft.

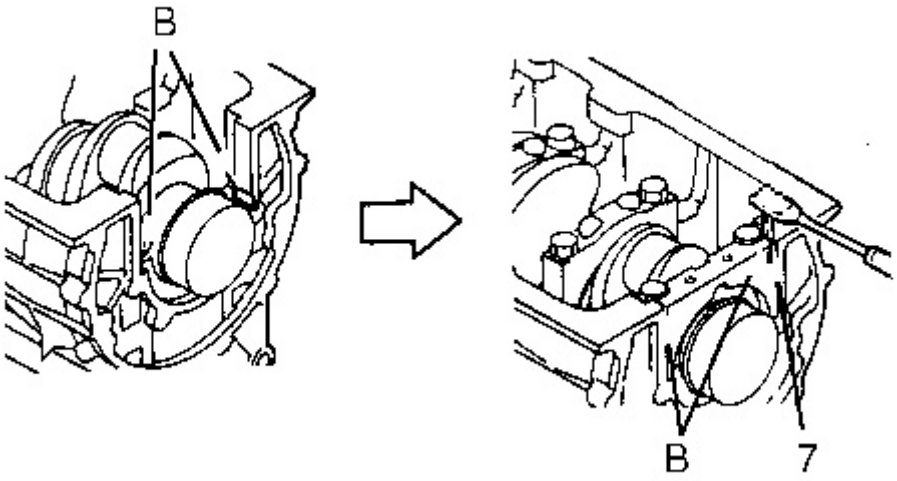


Illustration 6 g01041142

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

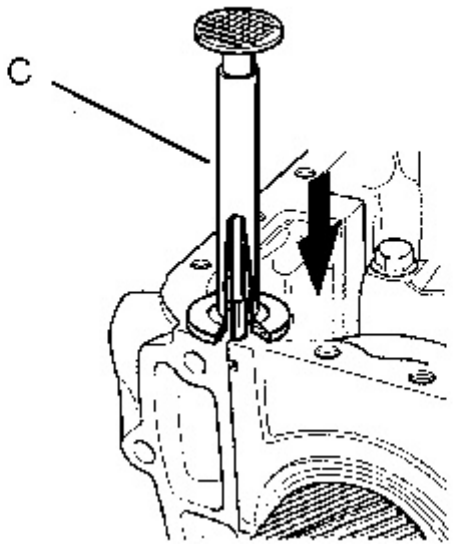


Illustration 7 g01033394

10. Apply soapy water to side seals (7). Position side seals (7) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push

the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (7) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

13. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
b. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
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i02707297

Crankshaft - Remove

SMCS - 1202-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".
C. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Rotate the crankshaft.

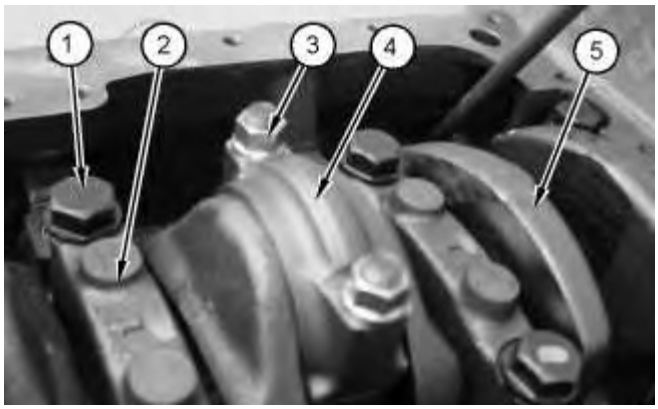


Illustration 1 g01033376

Note: Make sure that the main bearing caps and the connecting rod caps are marked for the location and direction for installation.

2. Remove main bearing cap bolts (1) .
3. Remove main bearing caps (2) from the cylinder block. Remove the bearings from the main bearing caps. Remove the lower thrust washers from the rear main bearing cap. Keep the main bearings with the respective main bearing cap.
4. Remove nuts (3) from the connecting rod bolts.
5. Remove connecting rod caps (4) from the connecting rods. Remove the bearings from the connecting rod caps. Keep the connecting rod bearings with the respective connecting rod cap.

NOTICE

Do not allow the connecting rods to strike the piston cooling jets. Damage or misalignment may occur.

Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the piston assemblies into the cylinder bores.
7. Attach a suitable lifting device to the crankshaft. Lift the crankshaft out of the cylinder block. The weight of crankshaft (5) is approximately 32 kg (70 lb).

Note: Be careful not to damage the finished surfaces on the crankshaft.

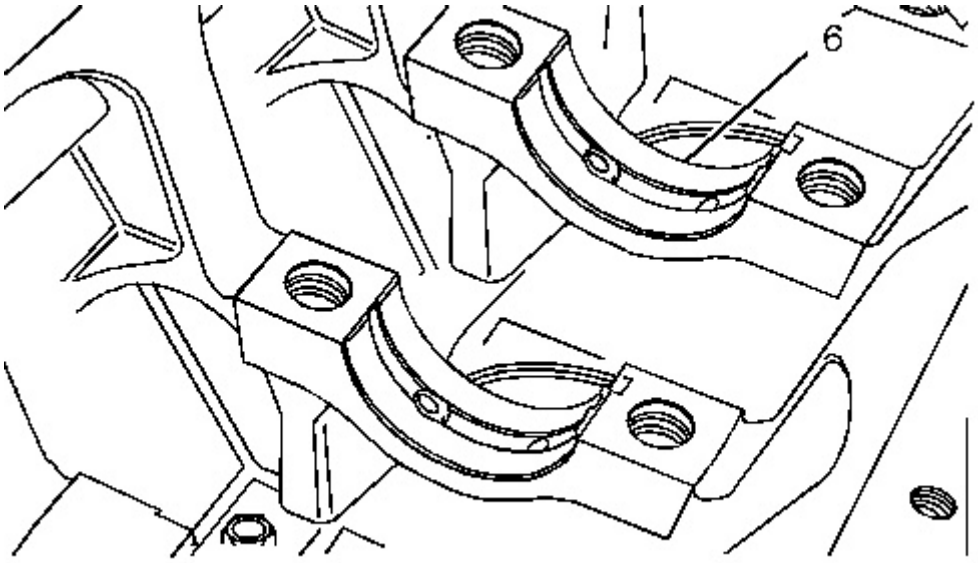


Illustration 2 g01358194

8. Remove upper main bearings (6). If necessary, remove the upper thrust washer from the rear of the cylinder block. Keep the upper main bearings with the respective main bearing caps.

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Disassembly and Assembly
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i02707299

Crankshaft - Install

SMCS - 1202-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all of the lubrication passages are clean and free of debris.

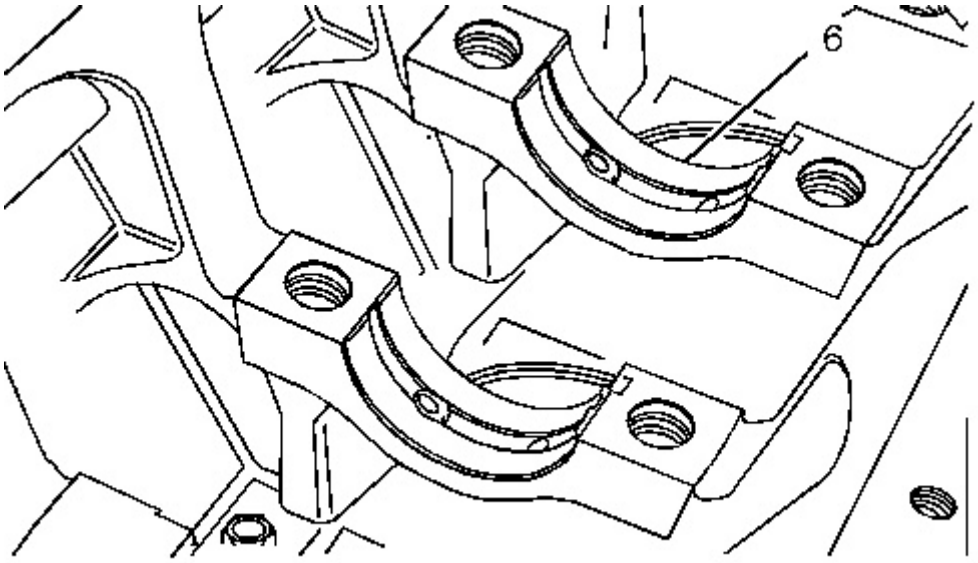


Illustration 1 g01358194

2. Install upper main bearings (6). The bearing tabs for the upper main bearings must be located in the correct position in the cylinder block. Lubricate upper main bearings (6) with clean engine oil.

3. Lubricate the upper half of the thrust washer. Place the upper half of the thrust washer on the rear of the cylinder block with the oil grooves toward the outside.

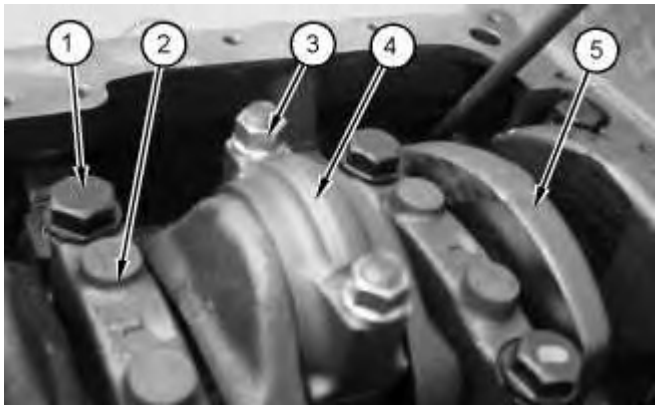


Illustration 2 g01033376

4. Ensure that the main bearing journals and the connecting rod bearing journals of the crankshaft are clean. Attach a suitable lifting device in order to position crankshaft (5) in the cylinder block. The weight of the crankshaft is approximately 32 kg (70 lb).

   Note: Be careful not to damage the finished surfaces on the crankshaft.

5. Lubricate the lower half of the thrust washers. Place the lower half of the thrust washers on both sides of the rear main bearing cap. The grooves on the thrust washers must be positioned toward the crankshaft.

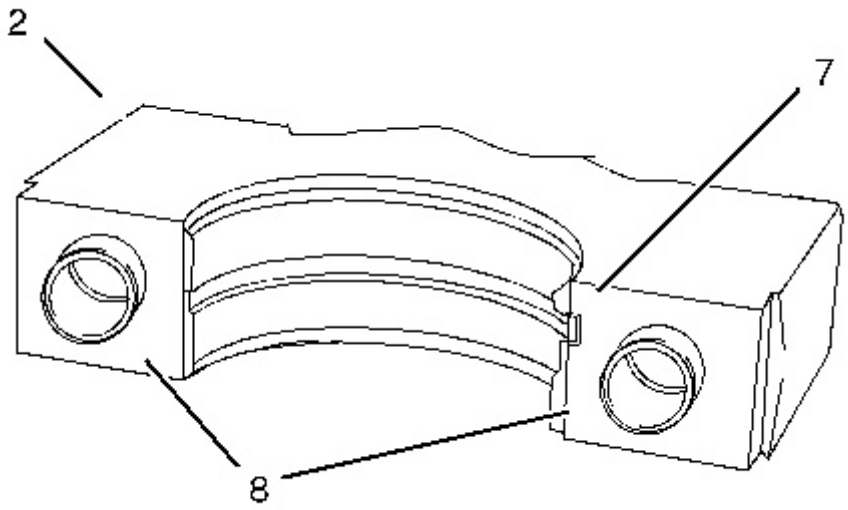


Illustration 3 g01041202

6. Clean the lower main bearings. Install lower main bearings (7) in main bearing caps (2) with the bearing tabs in the correct position. Lubricate the lower main bearing caps with clean engine oil.

7. Ensure that locating dowels (8) for main bearing caps (2) are in the correct position in the main bearing caps or in the cylinder block.

8. Install main bearing caps (2) in the position that was marked during the removal process. All of the bearing tabs for the main bearings should be on the same side. Install main bearing cap bolts (1) and tighten finger tight.

   Note: Do not install the rear main bearing cap yet.

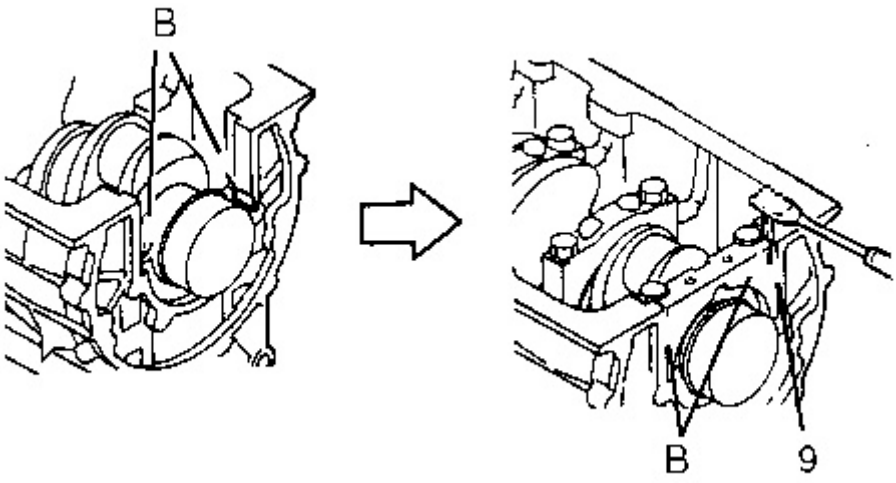


Illustration 4 g01033393

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

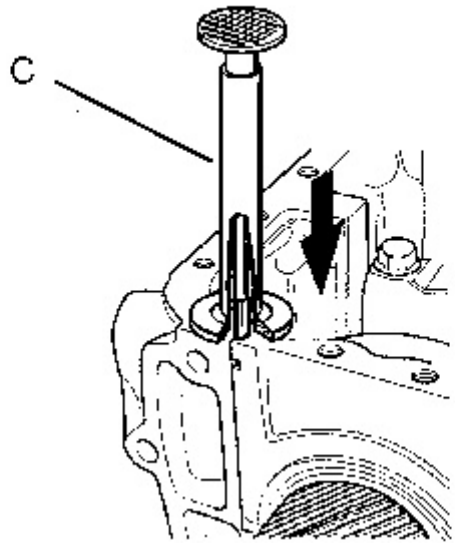


Illustration 5 g01033394

10. Apply soapy water to side seals (9). Position side seals (9) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (9) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Ensure that the upper connecting rod bearings are centered in the connecting rod. Ensure that the lower connecting rod bearings are centered in the connecting rod cap. Lubricate the bearing faces with clean engine oil.

    Note: Remove the tape or rubber tubing on the connecting rod bolts.

    Note: Ensure that the mark on the connecting rod cap matches the mark on the connecting rod. Ensure that the marks are on the same side.

13. Install connecting rod caps (4). Install nuts (3) and tighten to a torque of 49 to 59 N·m (36 to 44 lb ft).

14. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

15. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housng - Remove and Install".
b. Install the front housing. Refer to Disassembly and Assembly, "Housng (Front) - Install".
c. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i01996316

Crankshaft Gear - Remove and Install

SMCS - 1204-010-GE

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

Note: In this removal procedure, the crankshaft gear is removed with the crankshaft in the engine.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

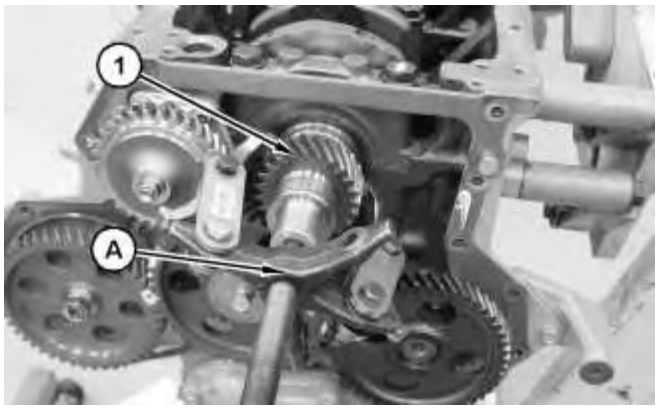


Illustration 1 g01033299

2. Use Tooling (A) to remove crankshaft gear (1). Remove the key from the crankshaft.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

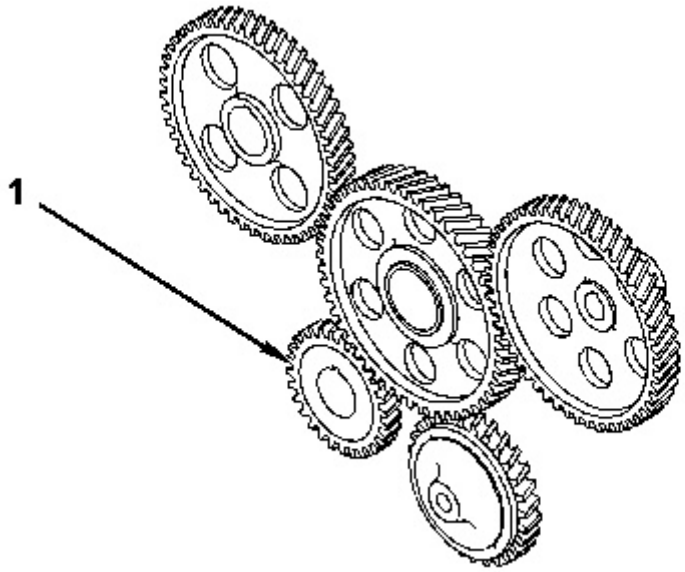


Illustration 2 g01033302

WARNING

Always wear protective gloves when handling parts that have been heated.

1. Raise the temperature of the crankshaft gear in an oven to 100 °C (212 °F).

   Note: Ensure that the timing marks on the timing gears are in alignment.

2. Align the keyway in the gear with the key in the crankshaft. Install crankshaft gear (1). Tap the end of the gear with a rubber mallet or a brass hammer. Ensure that the crankshaft gear is seated against the shoulder on the crankshaft.

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

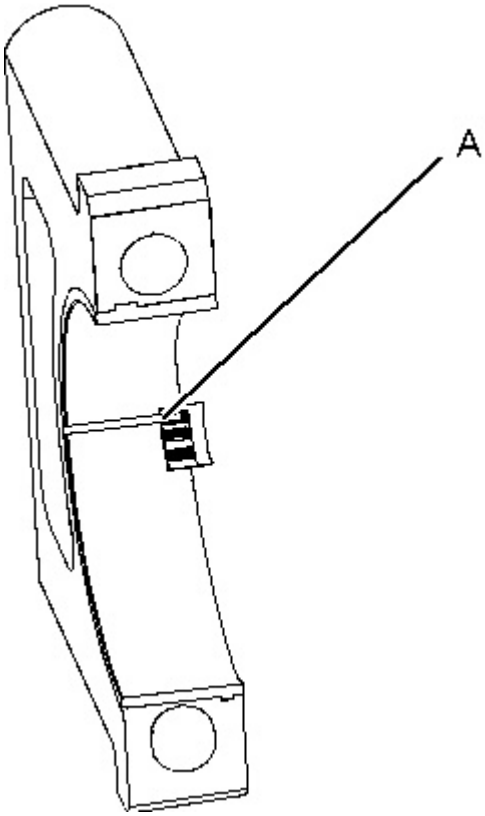


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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i01999095

Crankshaft Rear Seal - Remove

SMCS - 1161-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

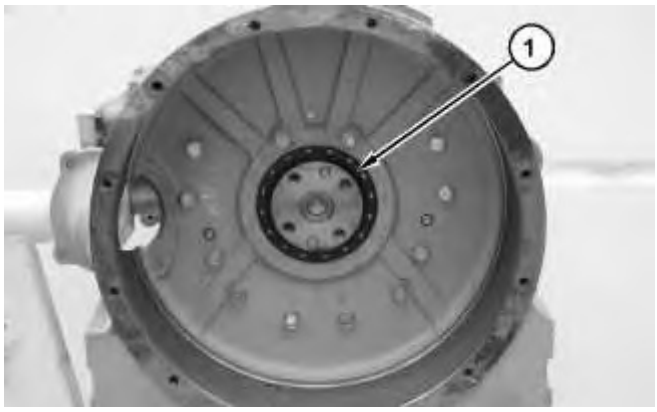


Illustration 1 g01034321

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft rear seal (1) .
2. Use Tooling (B) in each of the three holes to evenly remove crankshaft rear seal (1) .

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i05485179

Crankshaft Rear Seal - Install

SMCS - 1161-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	438-3244	Oil Seal Installer	1
	438-3245	Seal Adapter	1
	8T-0375	Bolt	1
	5P-8247	Hard Washer	1
	9U-6172	Bolt	2
B	5P-0944	Dowel Puller Gp	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the crankshaft flange and the inside of the flywheel housing are clean and free of debris.

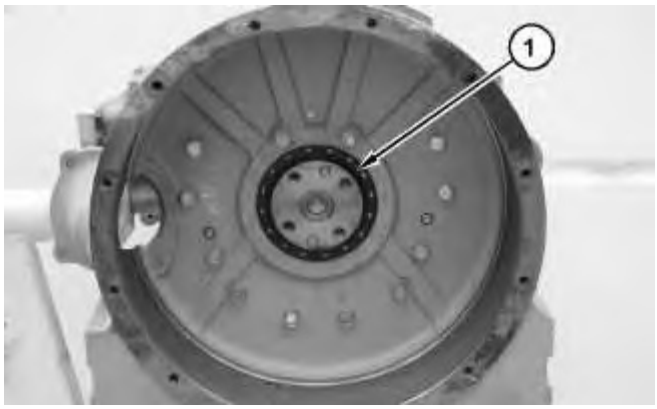


Illustration 1 g01034321

2. Apply a thin coat of clean engine oil to the lip of crankshaft rear seal (1) .
3. Use Tooling (B) in order to remove the dowel pins from the crankshaft.
4. Use Tooling (A) in order to install crankshaft rear seal (1) , as follows:
    a. Install the locator onto the crankshaft.
    b. Position crankshaft rear seal (1) in the installer.
    c. Put the bolt and the washer through the installer and thread into the locator.
    d. Push crankshaft rear seal (1) onto the crankshaft until the installer bottoms out.
    e. Remove Tooling (A) and check crankshaft rear seal (1) for correct installation.
5. Install the dowel pins in the crankshaft.

End By: Install the flywheel.

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i05322247

Crankshaft Wear Sleeve (Rear) - Remove

SMCS - 1161-011-ZV

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	242-9955	Puller	1
	-	Spacer	1

Start By:

A. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove and Install" for the correct procedure.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Wear sleeves are used to reclaim worn seal surfaces or damaged seal surfaces. Wear sleeves are not original equipment. The wear sleeve is supplied with a crankshaft rear seal that has a larger internal diameter than a standard crankshaft rear seal. A standard crankshaft rear seal cannot be used if a wear sleeve is installed.

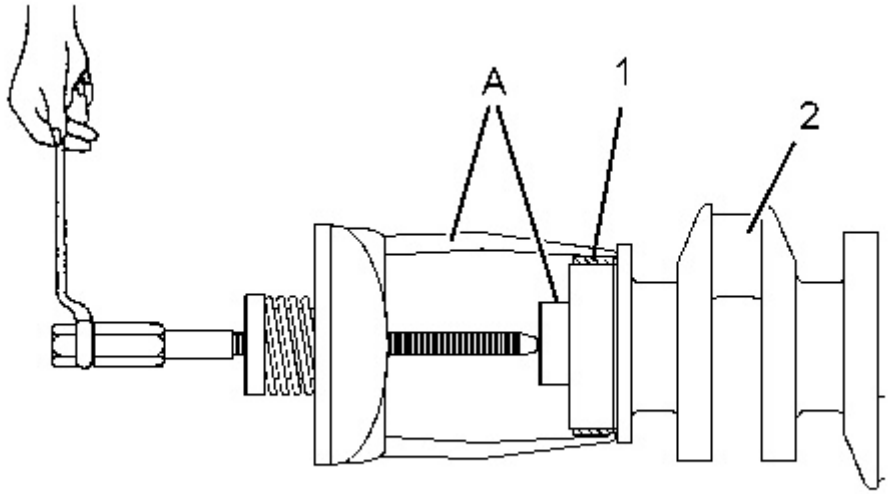


Illustration 1 g02815577

Typical example

1. Use Tooling (A) in order to remove crankshaft wear sleeve (1) from crankshaft (2) .

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i05482490

Crankshaft Wear Sleeve (Rear) - Install

SMCS - 1161-012-ZV

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	438-3244	Oil Seal Installer	1
	438-3245	Oil Seal Locator	1
	8T-0375	Bolt	1
	5P-8247	Hard Washer	1
	9U-6172	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Wear sleeves are used to reclaim worn seal surfaces or damaged seal surfaces. Wear sleeves are not original equipment. The wear sleeve is supplied with a crankshaft rear seal that has a larger internal diameter than a standard crankshaft rear seal. A standard crankshaft rear seal cannot be used if a wear sleeve is installed.

1. Ensure that the crankshaft is thoroughly clean and dry. Remove any areas of raised damage.
2. Lubricate the inner surface of the crankshaft wear sleeve with clean engine oil.

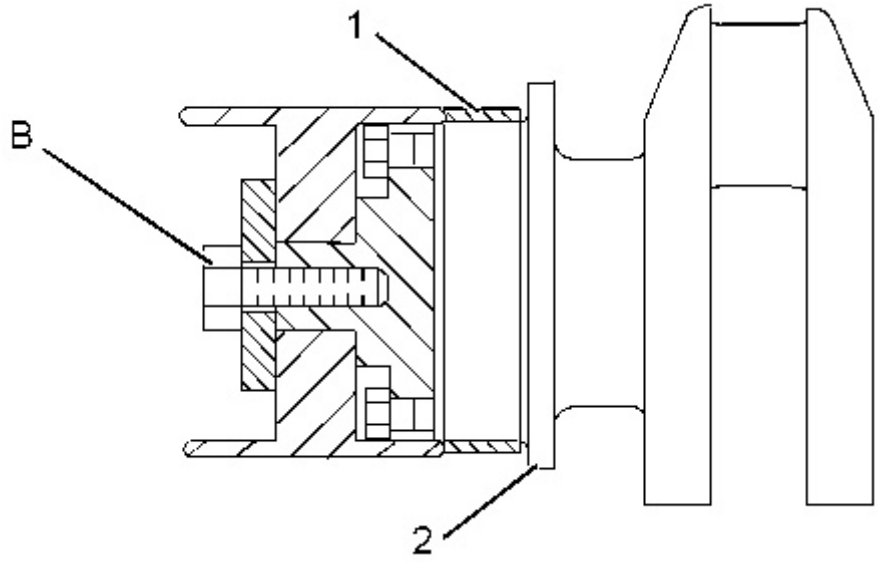


Illustration 1 g01377790

Sectional view of the crankshaft, the wear sleeve, and the installation tool

3. Use Tooling (A) in order to install the crankshaft wear sleeve, as follows:

   a. Align the locator with the dowels in crankshaft (2) . Install the locator to the crankshaft. Ensure the correct orientation of the locator.

      Note: Check that the installer will slide freely over the locator.

   b. Carefully slide crankshaft wear sleeve (3) over the locator until the crankshaft wear sleeve contacts the rear of crankshaft (2) .

   c. Assemble the installer to the locator and install the bolt and the washer. Ensure that the face of the installer with the deep counterbore is toward crankshaft wear sleeve (3) .

   d. Tighten the bolt until the installer bottoms out on the locator in order to pull crankshaft wear sleeve (3) onto crankshaft (2) .

   e. Remove Tooling (A) .

End By: Install the new crankshaft rear seal that was supplied with the crankshaft wear sleeve.

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i01999219

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

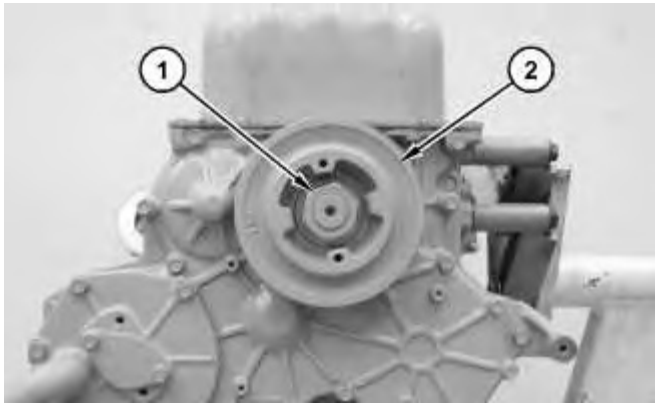


Illustration 1 g01034425

1. Loosen nut (1) .

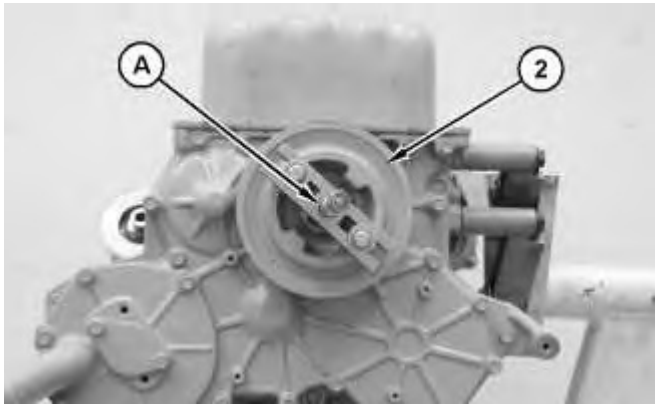


Illustration 2 g01034426

2. Use Tooling (A) to loosen crankshaft pulley (2). Remove Tooling (A). Remove nut (1) and remove pulley (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

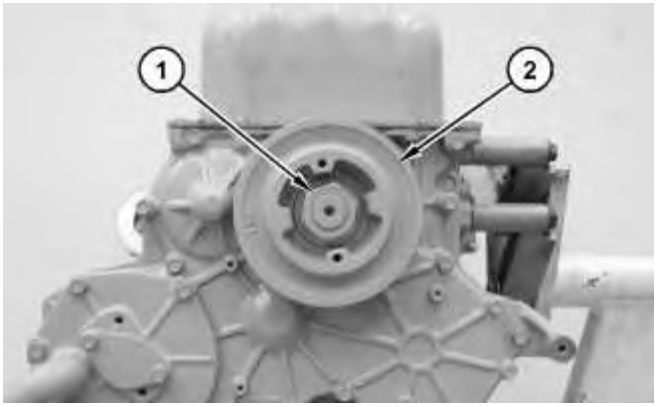


Illustration 3 g01034425

1. Position pulley (2) and install nut (1) .
2. Tighten nut (1) to a torque of 480 to 500 N·m (354 to 369 lb ft).

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i01998722

Crankshaft Front Seal - Remove

SMCS - 1160-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

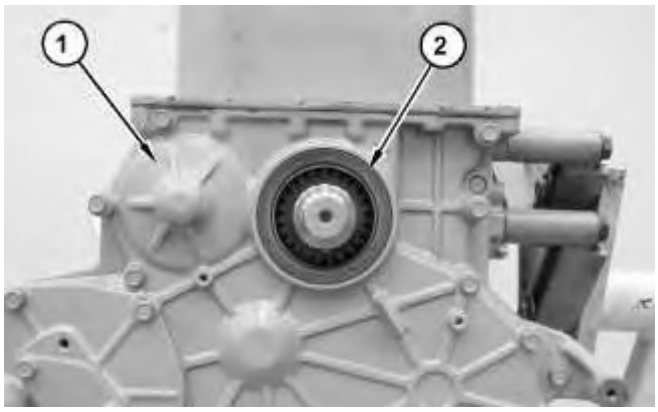


Illustration 1 g01034060

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft front seal (2) .
2. Use Tooling (B) in each of the three holes to evenly remove crankshaft front seal (2) from front housing (1) .

NOTICE

Ensure that the main lip is used in order to remove the crankshaft front seal. Do not damage the edge of the housing for the crankshaft front seal.

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i01998728

Crankshaft Front Seal - Install

SMCS - 1160-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	4C-6376	Seal Installer Stud	1
	4C-6377	Washer	1
	4C-6378	Seal Installer Sleeve	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the housing for the crankshaft front seal and inspect the housing for damage.

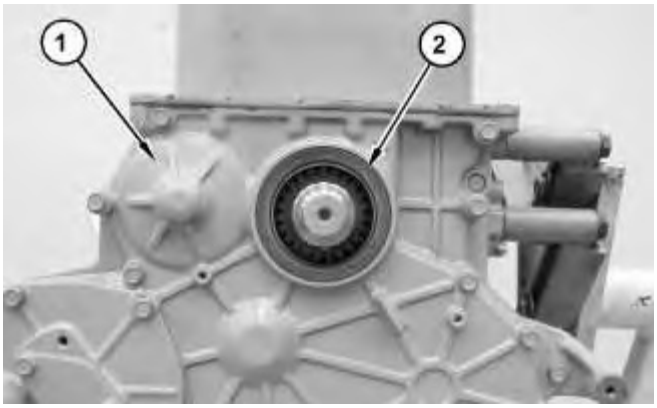


Illustration 1 g01034060

2. Apply a thin coat of clean engine oil to the lip of a new crankshaft front seal (2) .
3. Use Tooling (C) to install crankshaft front seal (2) into front housing (1) .

NOTICE

Ensure that the lip of the crankshaft front seal that is spring loaded is facing toward the inside of the front housing and that it is square with the bore of the housing for the crankshaft front seal.

4. Remove Tooling (C) and check for correct installation. The front seal must contact the bottom face of front housing (1) .
5. Apply clean engine oil on the area of the crankshaft pulley that will be in contact with crankshaft front seal (2) .

End By: Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

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i02707279

Crankshaft Main Bearings - Remove

SMCS - 1203-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the flywheel housing in order to remove the rear main bearing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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1. Make sure that the main bearing caps are marked for the location and direction for installation. The main bearings and the main bearing caps must be installed in the same location.

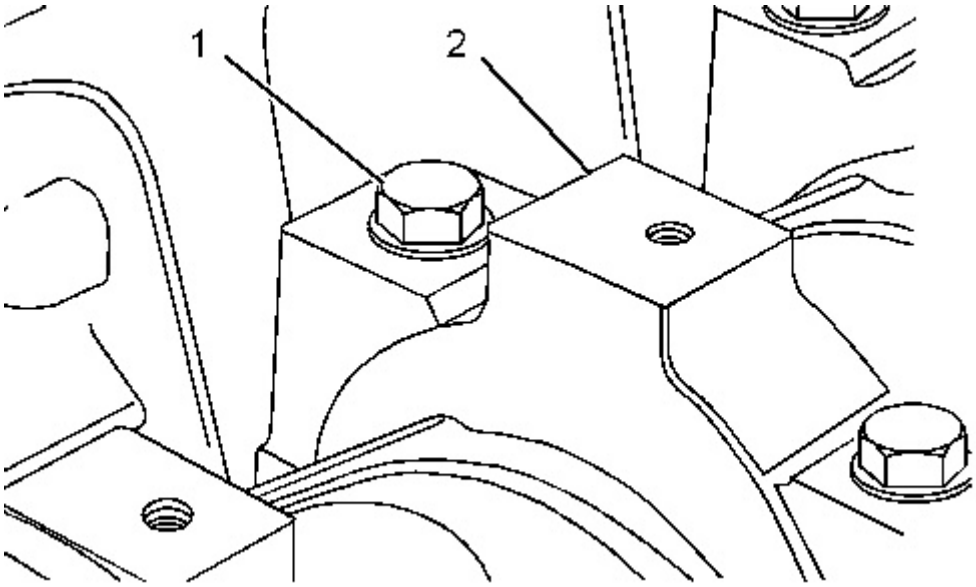


Illustration 1 g01358190

2. Remove bolts (1) and main bearing cap (2) .

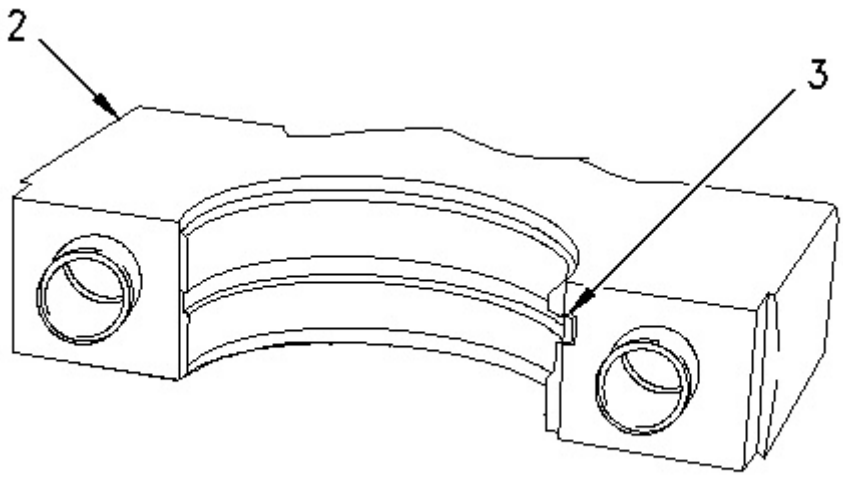


Illustration 2 g00934803

3. Remove lower main bearing (3) from main bearing cap (2). Keep the respective main bearing and the main bearing cap together for proper installation.

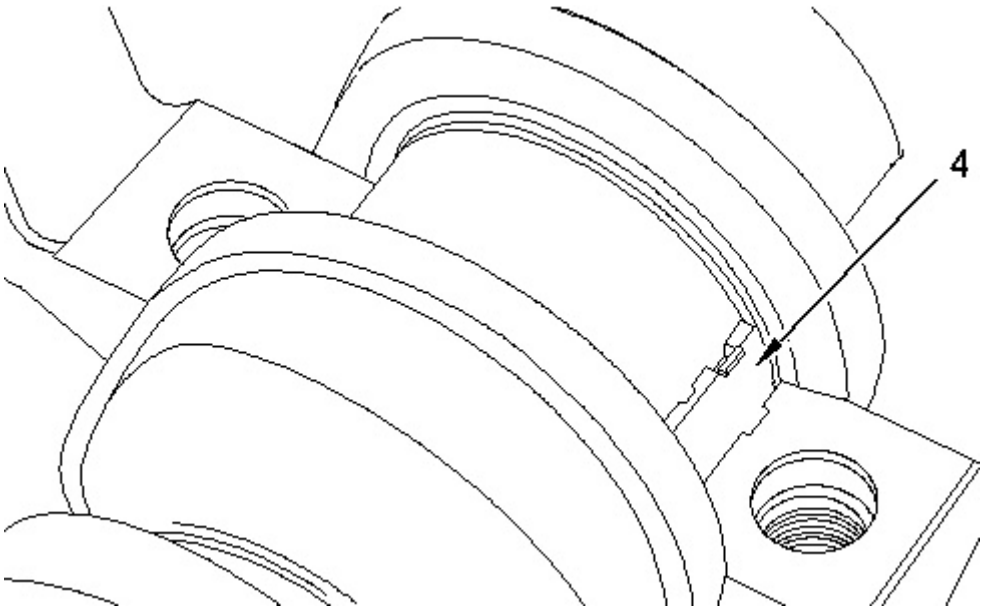


Illustration 3 g00934767

4. Push upper main bearing (4) from the opposite side of the bearing tab with a suitable tool. Carefully rotate the crankshaft while you push on the bearing. Remove upper main bearing (4) from the cylinder block. Keep the upper bearing halves together in order to ensure proper installation.

5. Repeat Step 2 through Step 4 for the remaining main bearings.

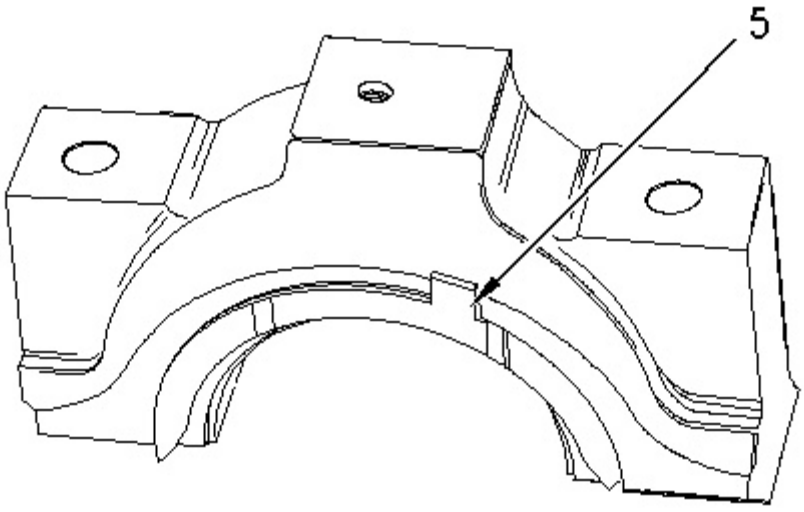


Illustration 4 g00934744

6. Remove the lower half of thrust washers (5) from both sides of the rear main bearing cap. Remove the seals from the rear main bearing cap.

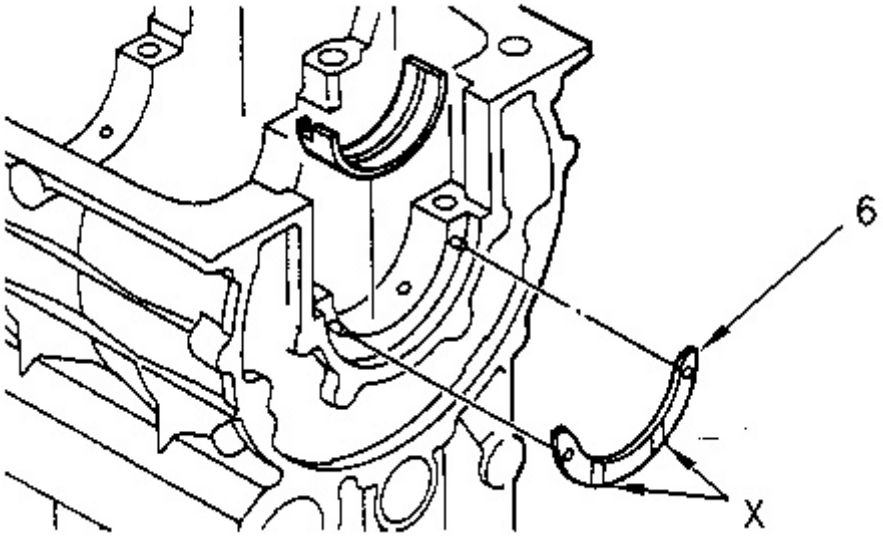


Illustration 5 g01001838

7. Remove the upper half of thrust washer (6) from the rear of the cylinder block. Carefully rotate the crankshaft while you push on thrust washer (6). If necessary, move the crankshaft to the front or to the rear in order to loosen a tight thrust washer.

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i02707287

Crankshaft Main Bearings - Install

SMCS - 1203-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

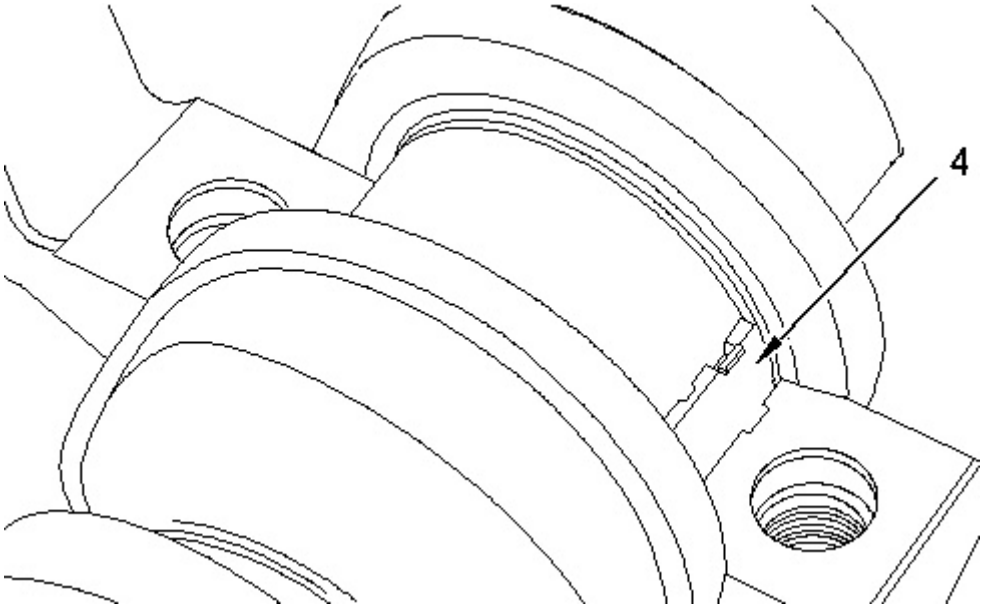


Illustration 1 g00934767

1. Clean upper main bearing (4) and lubricate the bearing surface with clean engine oil.

   Note: Do not put oil on the back sides of the crankshaft main bearings.

   Note: Ensure that the upper halves of the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block.

NOTICE

Only the upper half of the main bearing has lubrication holes. Make sure the upper half of the main bearing is installed correctly in the cylinder block to ensure proper lubrication.

2. Slide upper main bearing (4) into position between the crankshaft journal and the cylinder block.

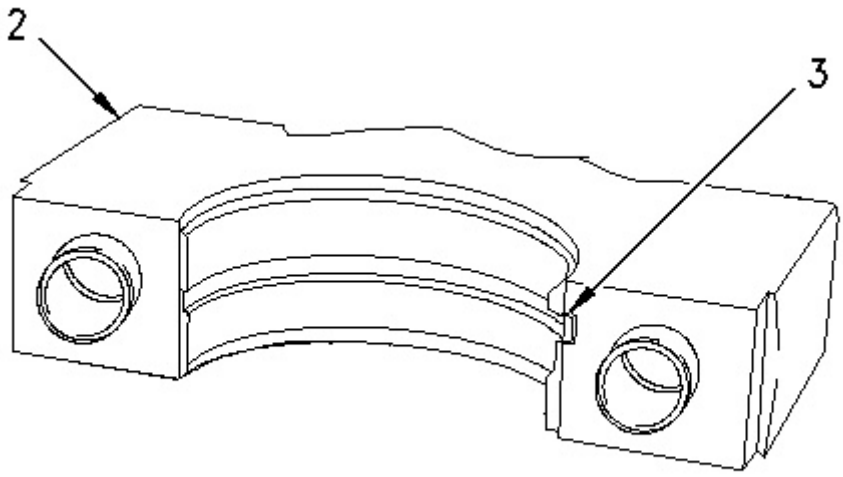


Illustration 2 g00934803

3. Clean main bearing cap (2) and lower main bearing (3). Lubricate the bearing surface of lower main bearing (3) with clean engine oil.

   Note: Ensure that the lower halves of the main bearings are installed so that the bearing tabs fit into the notch in the main bearing caps.

4. Install lower main bearing (3) in main bearing cap (2) .

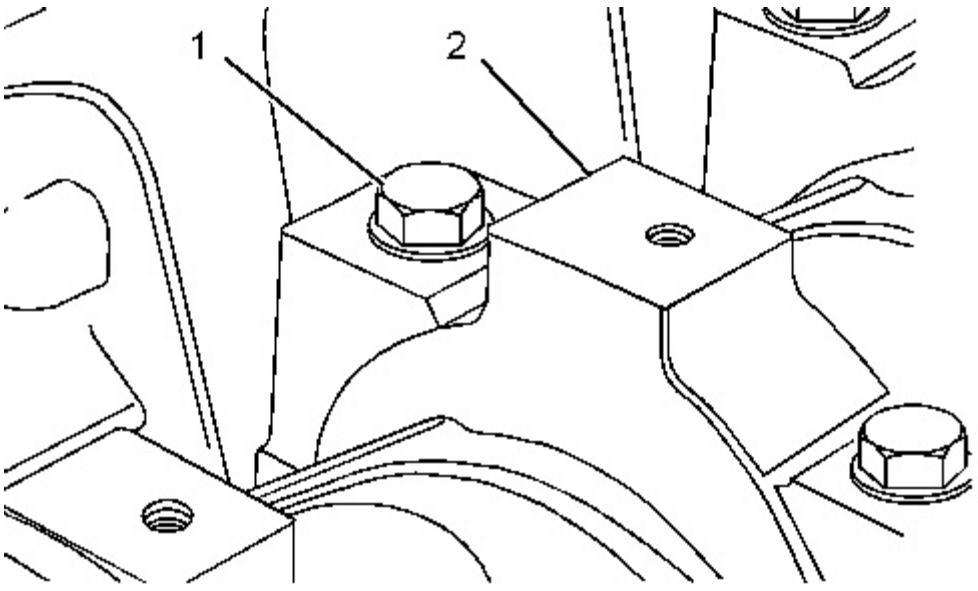


Illustration 3 g01358190

5. Install main bearing cap (2). Lubricate the threads of bolts (1) with clean engine oil. Install bolts (1) and tighten finger tight.

6. Repeat Steps 1 through 5 for the remaining main bearings.

   Note: Do not install the rear main bearing cap yet.

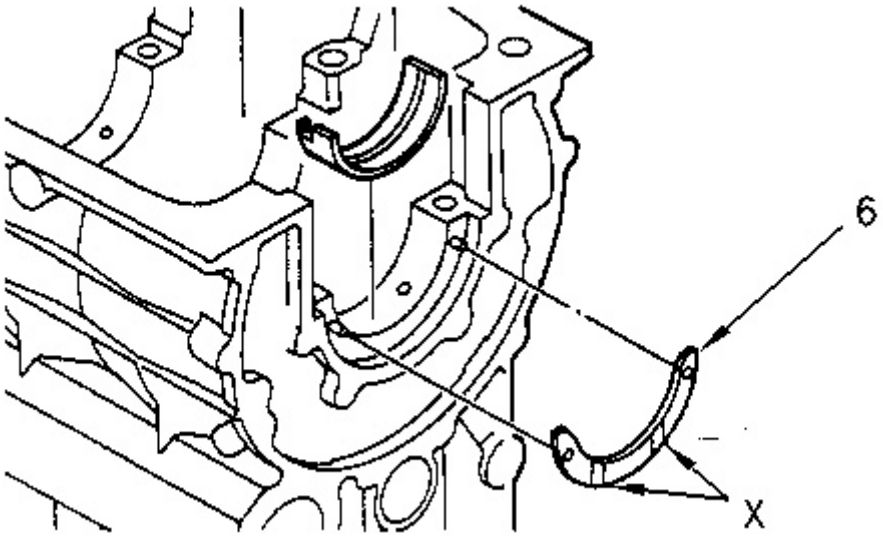


Illustration 4 g01001838

7. Install the upper half of thrust washer (6) on the rear of the cylinder block with the Oil Grooves (X) toward the outside. If necessary, move the crankshaft to the front or to the rear in order to install the thrust washer.

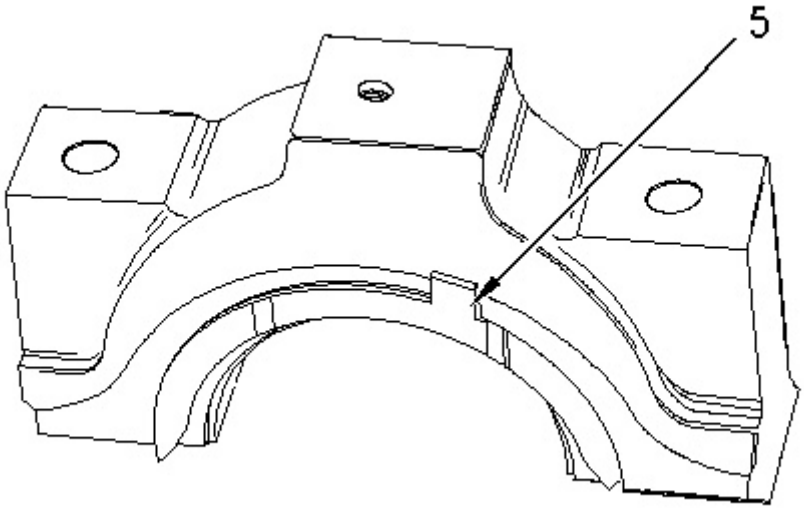


Illustration 5 g00934744

8. Install the lower half of thrust washer (5) on each side of the rear main bearing cap. The grooves on the thrust washer must be located against the crankshaft.

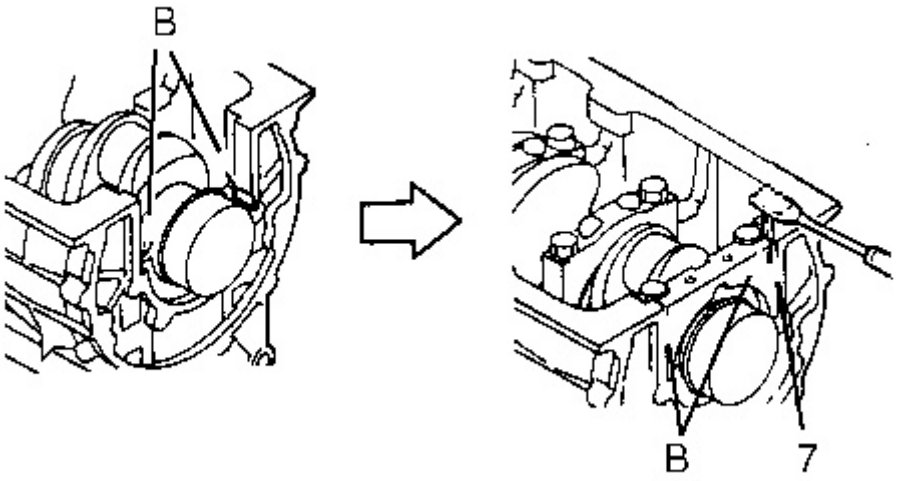


Illustration 6 g01041142

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

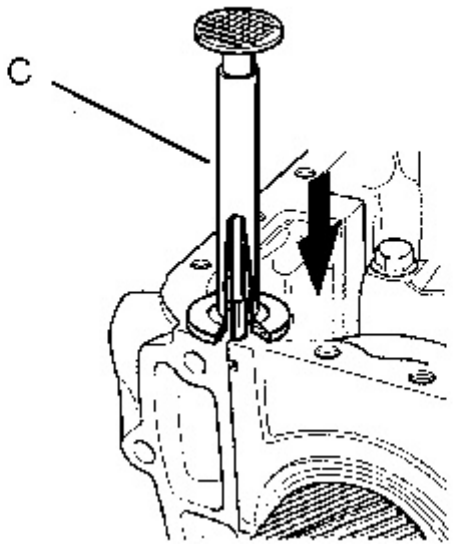


Illustration 7 g01033394

10. Apply soapy water to side seals (7). Position side seals (7) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push

the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (7) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

13. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
b. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02707297

Crankshaft - Remove

SMCS - 1202-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".
C. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Rotate the crankshaft.

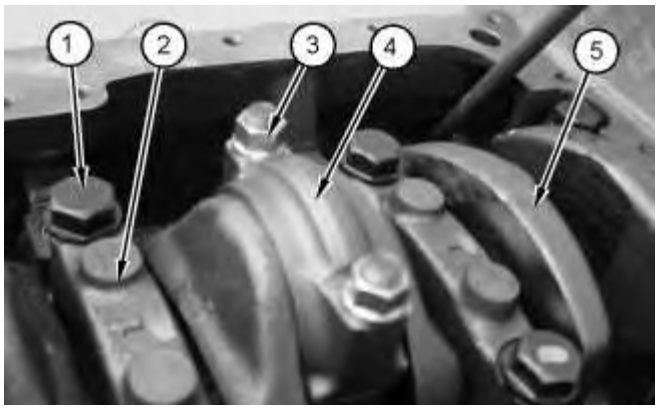


Illustration 1 g01033376

Note: Make sure that the main bearing caps and the connecting rod caps are marked for the location and direction for installation.

2. Remove main bearing cap bolts (1) .
3. Remove main bearing caps (2) from the cylinder block. Remove the bearings from the main bearing caps. Remove the lower thrust washers from the rear main bearing cap. Keep the main bearings with the respective main bearing cap.
4. Remove nuts (3) from the connecting rod bolts.
5. Remove connecting rod caps (4) from the connecting rods. Remove the bearings from the connecting rod caps. Keep the connecting rod bearings with the respective connecting rod cap.

NOTICE

Do not allow the connecting rods to strike the piston cooling jets. Damage or misalignment may occur.

Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the piston assemblies into the cylinder bores.
7. Attach a suitable lifting device to the crankshaft. Lift the crankshaft out of the cylinder block. The weight of crankshaft (5) is approximately 32 kg (70 lb).

Note: Be careful not to damage the finished surfaces on the crankshaft.

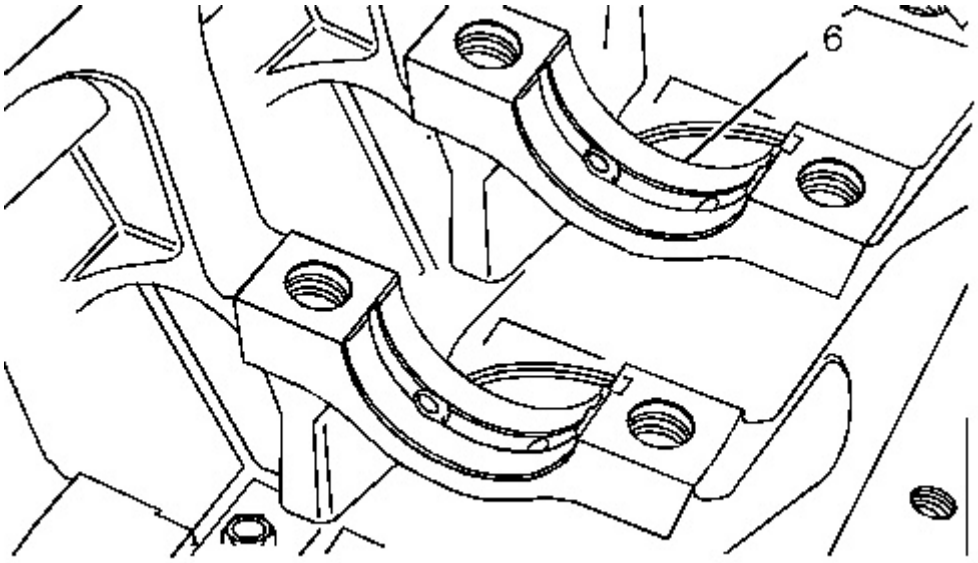


Illustration 2 g01358194

8. Remove upper main bearings (6). If necessary, remove the upper thrust washer from the rear of the cylinder block. Keep the upper main bearings with the respective main bearing caps.

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i02707299

Crankshaft - Install

SMCS - 1202-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all of the lubrication passages are clean and free of debris.

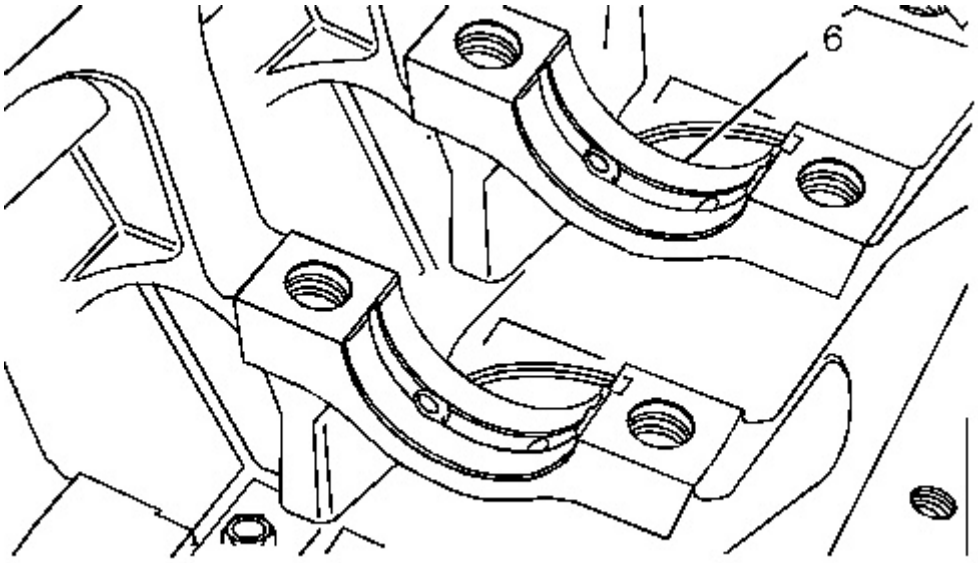


Illustration 1 g01358194

2. Install upper main bearings (6). The bearing tabs for the upper main bearings must be located in the correct position in the cylinder block. Lubricate upper main bearings (6) with clean engine oil.

3. Lubricate the upper half of the thrust washer. Place the upper half of the thrust washer on the rear of the cylinder block with the oil grooves toward the outside.

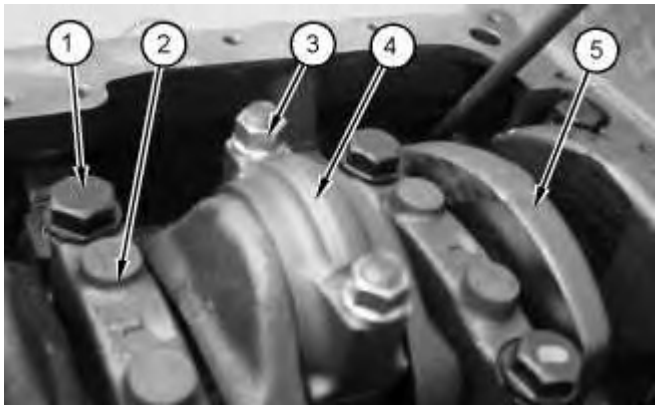


Illustration 2 g01033376

4. Ensure that the main bearing journals and the connecting rod bearing journals of the crankshaft are clean. Attach a suitable lifting device in order to position crankshaft (5) in the cylinder block. The weight of the crankshaft is approximately 32 kg (70 lb).

   Note: Be careful not to damage the finished surfaces on the crankshaft.

5. Lubricate the lower half of the thrust washers. Place the lower half of the thrust washers on both sides of the rear main bearing cap. The grooves on the thrust washers must be positioned toward the crankshaft.

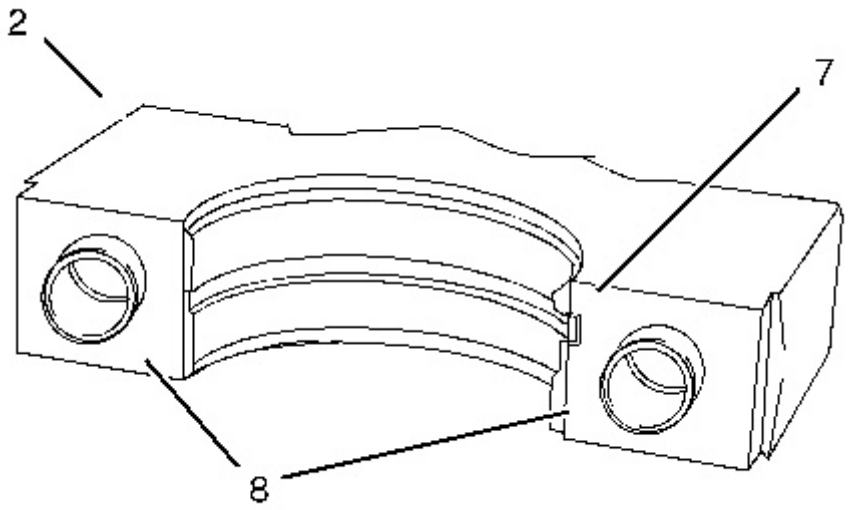


Illustration 3 g01041202

6. Clean the lower main bearings. Install lower main bearings (7) in main bearing caps (2) with the bearing tabs in the correct position. Lubricate the lower main bearing caps with clean engine oil.

7. Ensure that locating dowels (8) for main bearing caps (2) are in the correct position in the main bearing caps or in the cylinder block.

8. Install main bearing caps (2) in the position that was marked during the removal process. All of the bearing tabs for the main bearings should be on the same side. Install main bearing cap bolts (1) and tighten finger tight.

   Note: Do not install the rear main bearing cap yet.

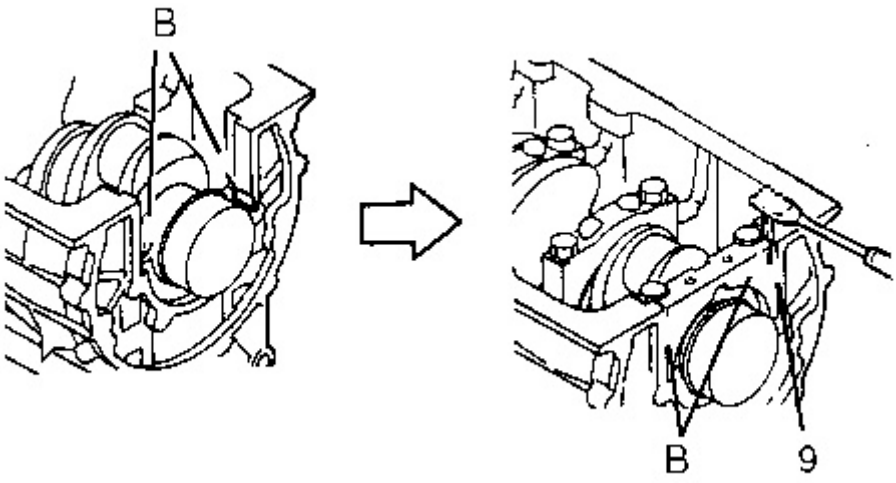


Illustration 4 g01033393

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

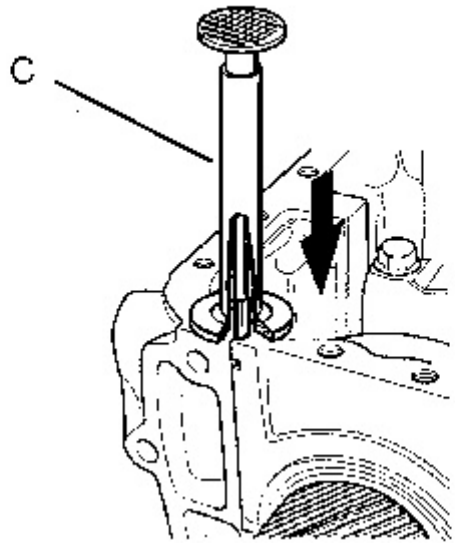


Illustration 5 g01033394

10. Apply soapy water to side seals (9). Position side seals (9) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (9) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Ensure that the upper connecting rod bearings are centered in the connecting rod. Ensure that the lower connecting rod bearings are centered in the connecting rod cap. Lubricate the bearing faces with clean engine oil.

    Note: Remove the tape or rubber tubing on the connecting rod bolts.

    Note: Ensure that the mark on the connecting rod cap matches the mark on the connecting rod. Ensure that the marks are on the same side.

13. Install connecting rod caps (4). Install nuts (3) and tighten to a torque of 49 to 59 N·m (36 to 44 lb ft).

14. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

15. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housng - Remove and Install".
b. Install the front housing. Refer to Disassembly and Assembly, "Housng (Front) - Install".
c. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i01996316

Crankshaft Gear - Remove and Install

SMCS - 1204-010-GE

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

Note: In this removal procedure, the crankshaft gear is removed with the crankshaft in the engine.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

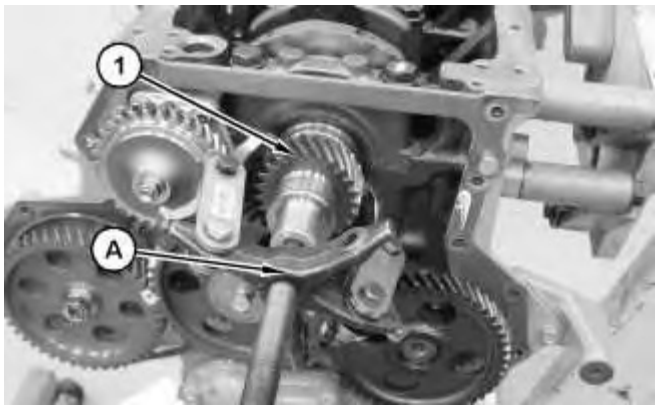


Illustration 1 g01033299

2. Use Tooling (A) to remove crankshaft gear (1). Remove the key from the crankshaft.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

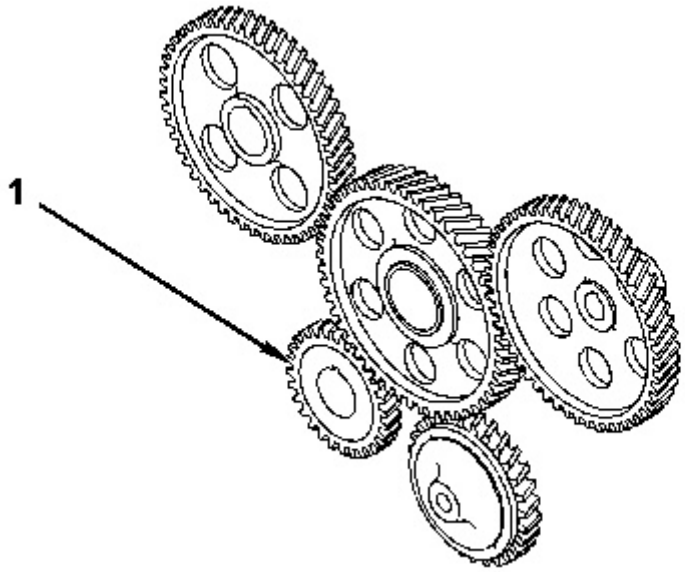


Illustration 2 g01033302

WARNING

Always wear protective gloves when handling parts that have been heated.

1. Raise the temperature of the crankshaft gear in an oven to 100 °C (212 °F).

   Note: Ensure that the timing marks on the timing gears are in alignment.

2. Align the keyway in the gear with the key in the crankshaft. Install crankshaft gear (1). Tap the end of the gear with a rubber mallet or a brass hammer. Ensure that the crankshaft gear is seated against the shoulder on the crankshaft.

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

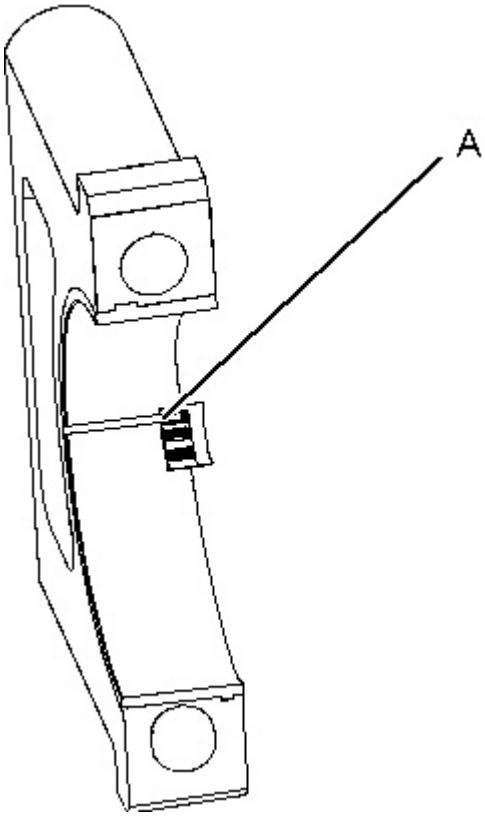


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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i05485089

Crankshaft Rear Seal - Remove and Install

SMCS - 1161-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the flywheel.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

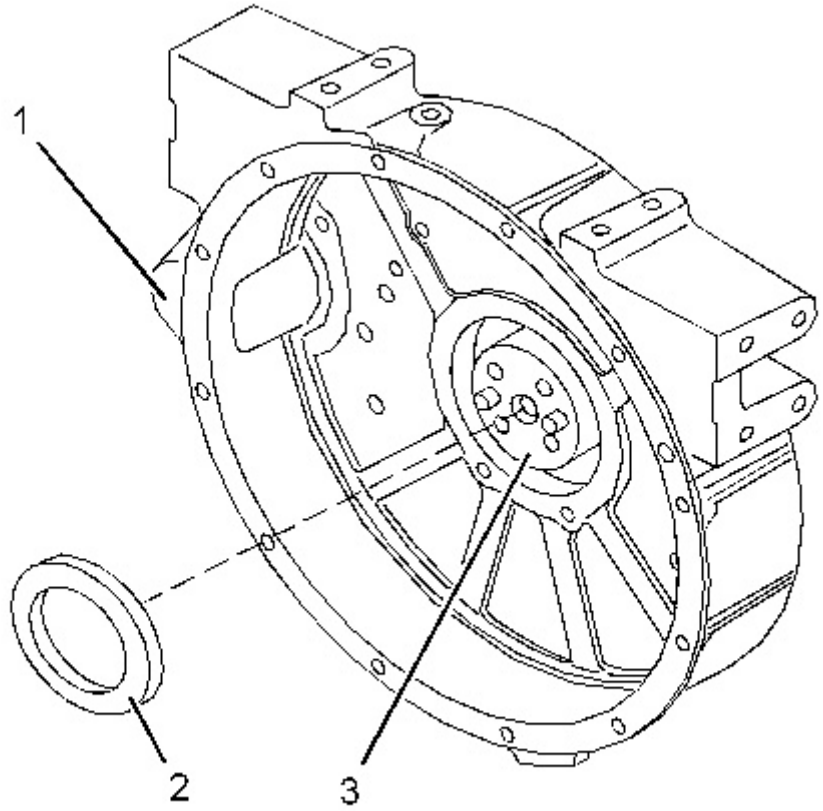


Illustration 1 g01335312

Typical example

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft rear seal (2) .
2. Use Tooling (B) to remove crankshaft rear seal (2) from flywheel housing (1) . Alternate the position of Tooling (B) from one hole to another hole. This will allow you to remove the crankshaft rear seal from the flywheel housing.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	438-3244	Oil Seal Installer	1

	438-3245	Seal Adapter	1
	8T-0375	Bolt	1
	5P-8247	Hard Washer	1
	9U-6172	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the flange of the crankshaft and the inside of the flywheel housing are clean and free of damage. It is possible to reclaim a crankshaft flange that has a worn seal surface, or a damaged seal surface by installing a wear sleeve. Refer to Disassembly and Assembly, "Crankshaft Wear Sleeve (Rear) - Remove and Install" for more information.

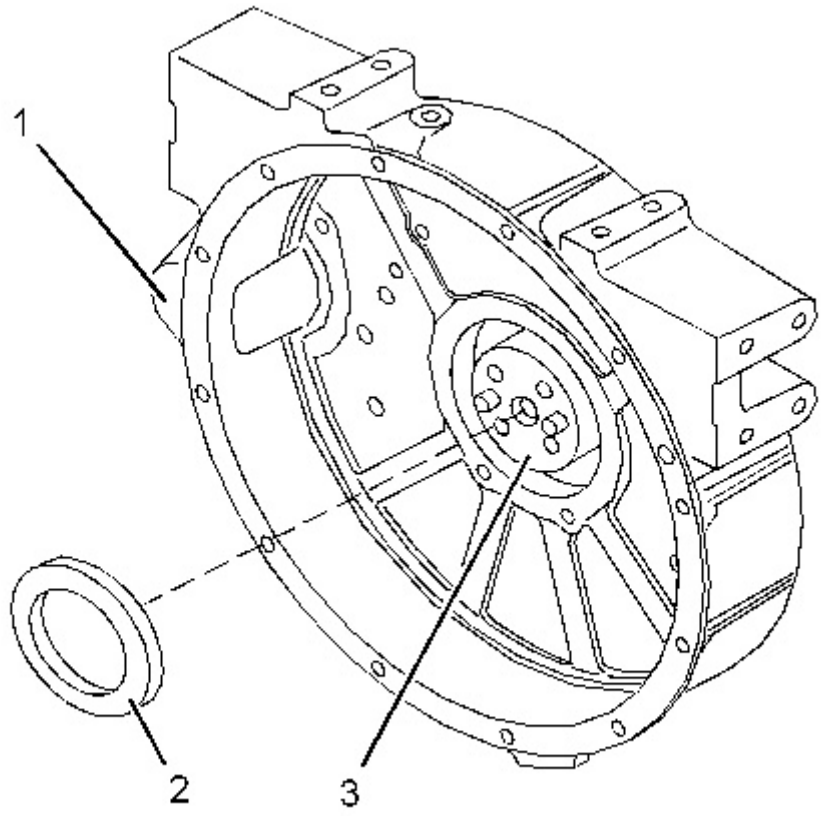


Illustration 2 g01335312

Typical example

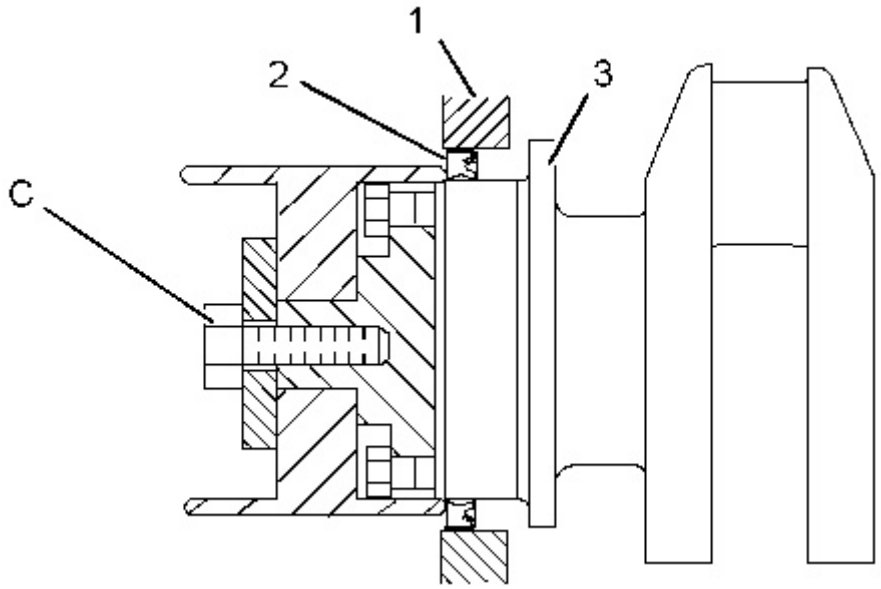


Illustration 3 g01368204

Sectional view of the crankshaft rear seal, the crankshaft, and the installation tool

2. Apply a thin coat of clean engine oil to the lip of crankshaft rear seal (2) .
3. Use Tooling (C) in order to install crankshaft rear seal (2) , as follows:
    a. Align the locator with the dowels in crankshaft (3) . Install the locator to the crankshaft. Ensure the correct orientation of the locator.

       Note: Check that the installer will slide freely over the locator.

    b. Carefully slide crankshaft rear seal (2) over the locator until the crankshaft rear seal contacts the rear of crankshaft (3) .

       Note: Ensure that the lip of the crankshaft rear seal that is spring loaded is facing toward the flywheel housing.

    c. Assemble the installer to the locator and install the bolt and the washer. Ensure that the face of the installer with the deep counterbore is toward crankshaft rear seal (2) .

    d. Tighten the bolt until the installer bottoms out on the locator in order to pull crankshaft rear seal (2) into flywheel housing (1) .

    e. Remove Tooling (C) .

End By: Install the flywheel.

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i05482669

Crankshaft Wear Sleeve (Rear) - Remove and Install

SMCS - 1161-010-ZV

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	242-9955	Puller	1
	-	Spacer	1

Start By:

A. Remove the crankshaft rear seal.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Wear sleeves are used to reclaim worn seal surfaces or damaged seal surfaces. Wear sleeves are not original equipment. The wear sleeve is supplied with a crankshaft rear seal that has a larger internal diameter than a standard crankshaft rear seal. A standard crankshaft rear seal cannot be used if a wear sleeve is installed.

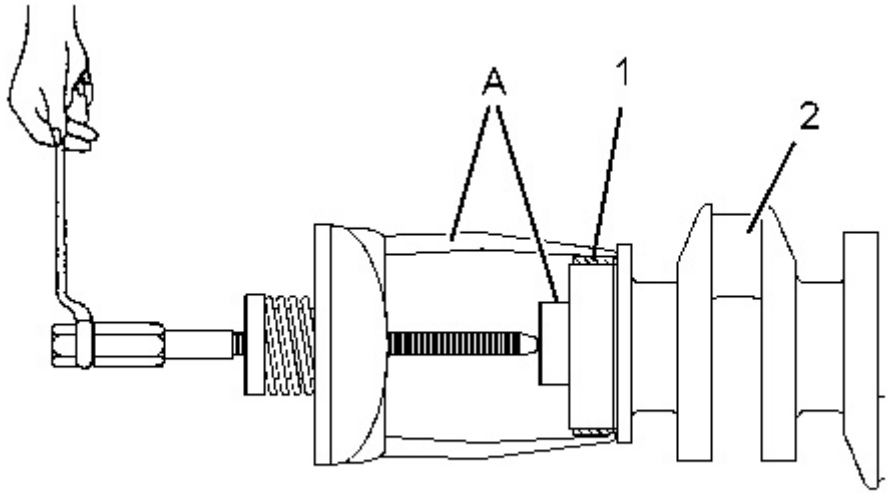


Illustration 1 g02815577

Typical example

1. Use Tooling (A) in order to remove crankshaft wear sleeve (1) from crankshaft (2) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	438-3245	Oil Seal Installer	1
	438-3245	Seal Adapter	1
	8T-0375	Bolt	1
	5P-8247	Hard Washer	1
	9U-6172	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Wear sleeves are used to reclaim worn seal surfaces or damaged seal surfaces. Wear sleeves are not original equipment. The wear sleeve is supplied with a crankshaft rear seal that has a larger

internal diameter than a standard crankshaft rear seal. A standard crankshaft rear seal cannot be used if a wear sleeve is installed.

1. Ensure that the crankshaft is thoroughly clean and dry. Remove any areas of raised damage.
2. Lubricate the inner surface of the crankshaft wear sleeve with clean engine oil.

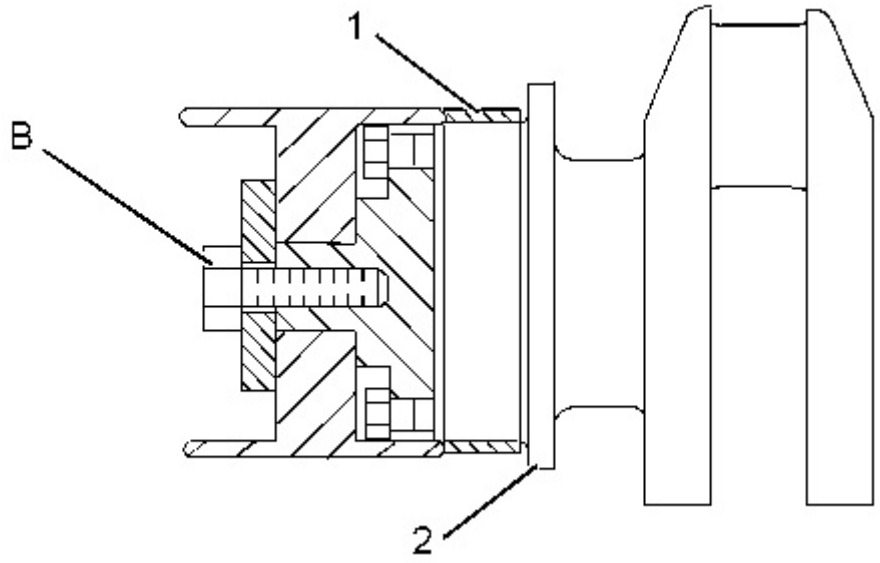


Illustration 2 g01377790

Sectional view of the crankshaft, the wear sleeve, and the installation tool

3. Use Tooling (A) in order to install the crankshaft wear sleeve, as follows:
   a. Align the locator with the dowels in crankshaft (2) . Install the locator to the crankshaft. Ensure the correct orientation of the locator.

      Note: Check that the installer will slide freely over the locator.

   b. Carefully slide crankshaft wear sleeve (3) over the locator until the crankshaft wear sleeve contacts the rear of crankshaft (2) .
   c. Assemble the installer to the locator and install the bolt and the washer. Ensure that the face of the installer with the shallow counterbore is toward crankshaft wear sleeve (3) .
   d. Tighten the bolt until the installer bottoms out on the locator in order to pull crankshaft wear sleeve (3) onto crankshaft (2) .
   e. Remove Tooling (A) .

End By: Install the new crankshaft rear seal.

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05016832

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-9120	Socket	1
B	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

Start By:

A. Remove the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Use a suitable method to prevent the crankshaft from rotating.

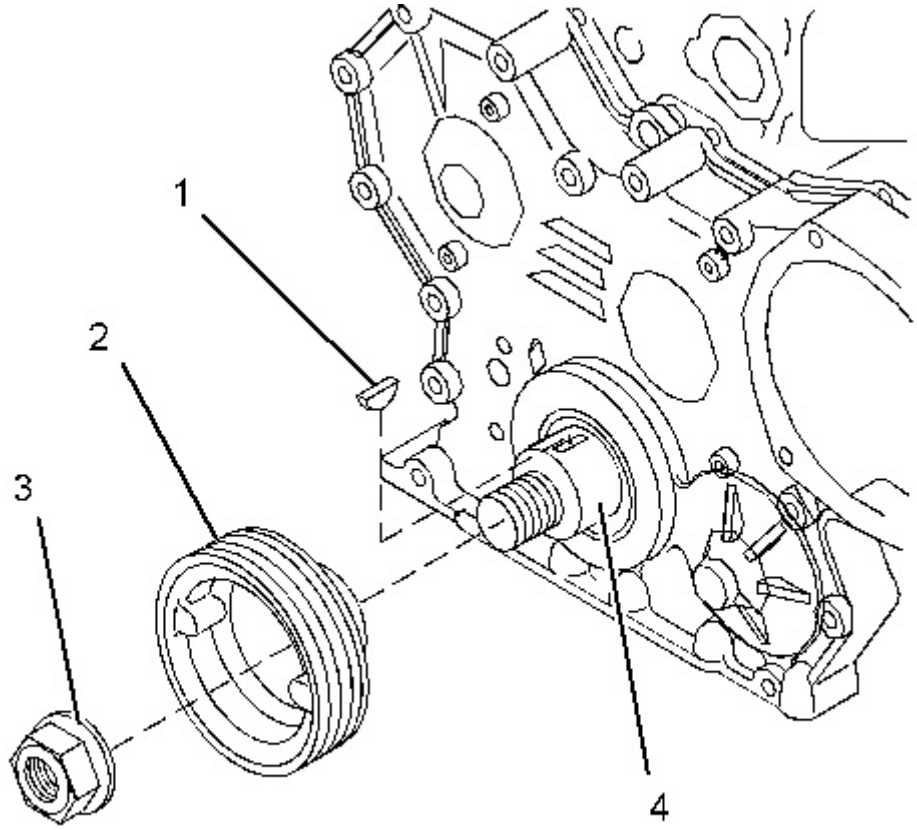


Illustration 1 g01335388

Typical example

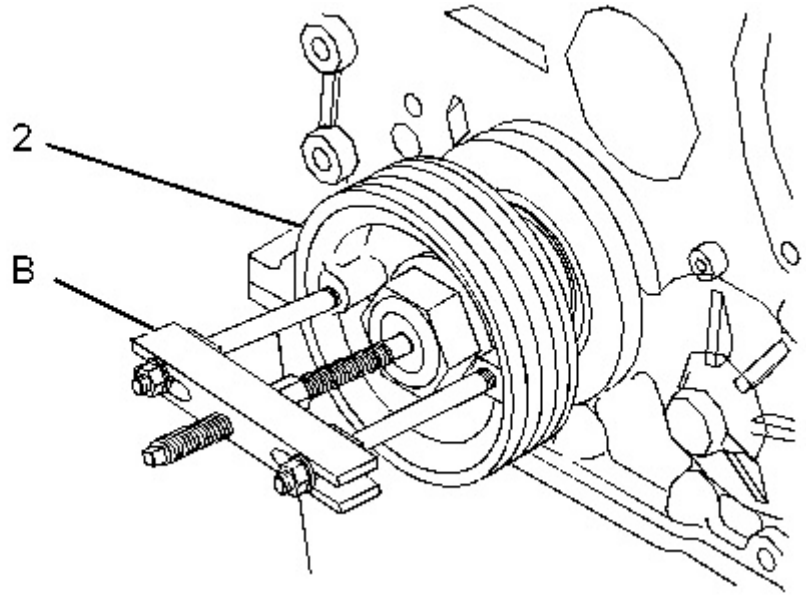


Illustration 2 g01335508

Typical example

2. Use Tooling (A) in order to loosen nut (3) .

   Note: Do not remove the nut at this time.

3. Install Tooling (B) to crankshaft pulley (2) . Use Tooling (B) to loosen the crankshaft pulley. Remove Tooling (B) .

4. Remove nut (3) and remove crankshaft pulley (2) .

5. If necessary, remove woodruff key (1) from crankshaft (4) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	-	Loctite 5900	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

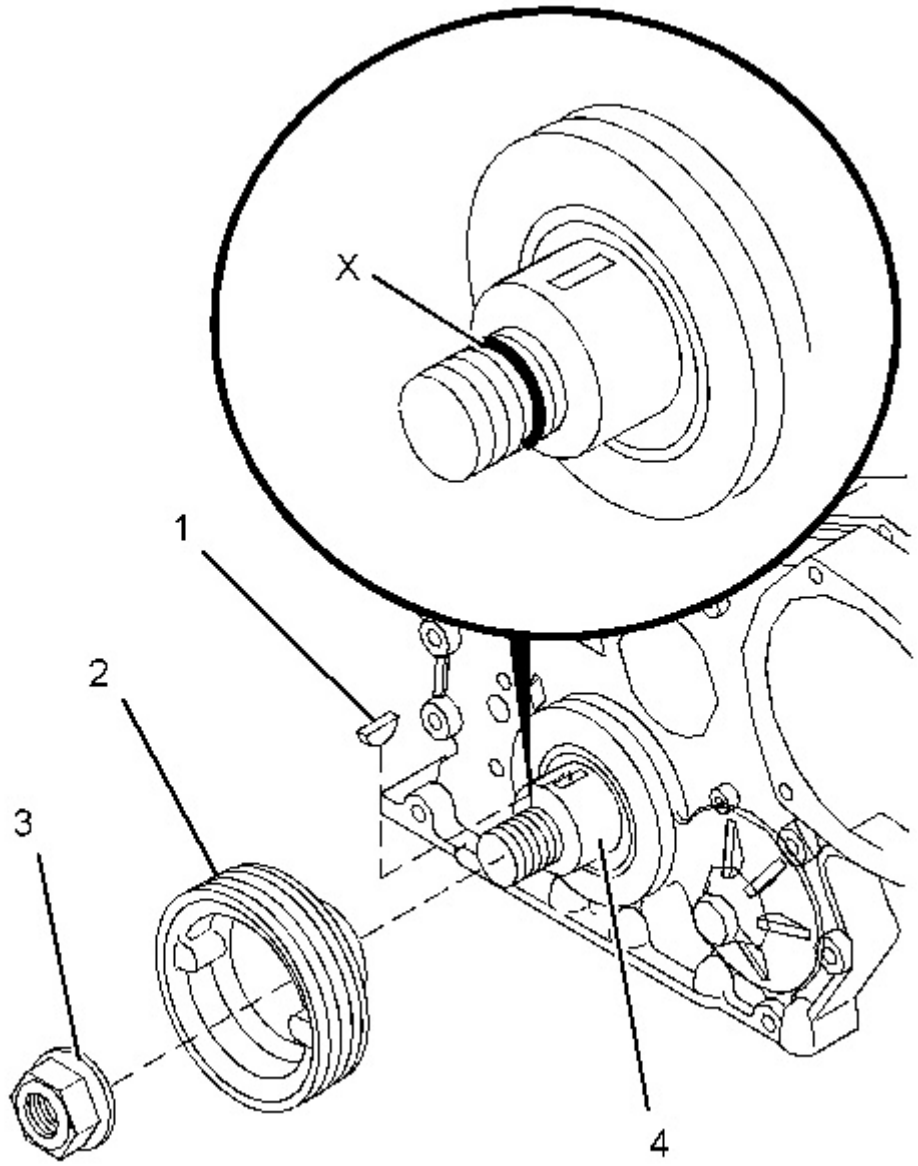


Illustration 3 g01368691

Typical example

1. Ensure that the threads of crankshaft (4) and nut (3) are clean and free from damage. If necessary, install woodruff key (1) to the crankshaft.
2. Apply a continuous bead of Tooling (C) around the threads of crankshaft (4) at position (X) approximately 10 mm (0.4 inch) from the shoulder of the crankshaft.
3. Install pulley (2) to crankshaft (4) .
4. Use a suitable method to prevent the crankshaft from rotating.
5. Install nut (3) . Tighten the nut to a torque of 490 N·m (361 lb ft).

End By: Install the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

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i02639320

Crankshaft Front Seal - Remove and Install

SMCS - 1160-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8145	Drill Bit (4.10 mm)	1
B	1U-7600	Slide Hammer Puller	1

Start By:

A. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Ensure that the main lip is used in order to remove the crankshaft front seal. Do not damage the edge of the housing for the crankshaft front seal.

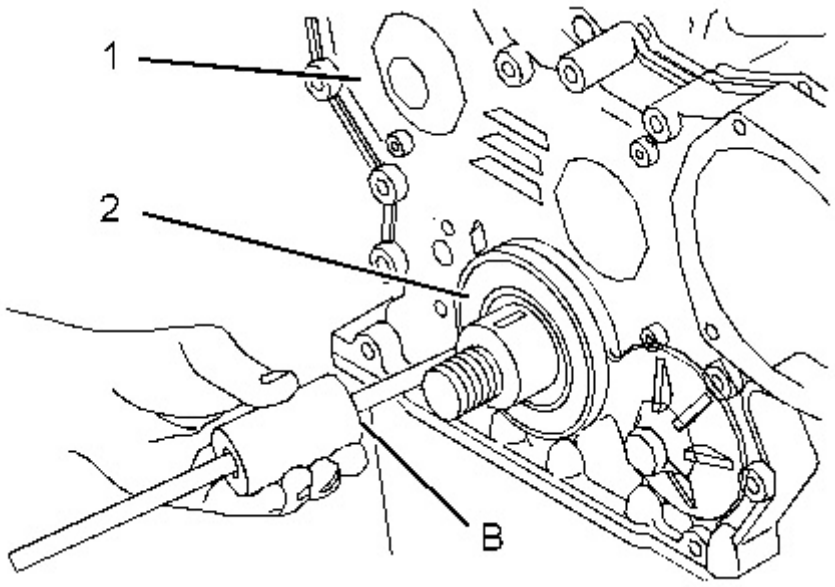


Illustration 1 g01335759

Typical example

1. Use Tooling (A) to drill three evenly spaced holes in crankshaft front seal (2) .
2. Use Tooling (B) to carefully remove crankshaft front seal (2). Alternate the position of Tooling (B) from one hole to another hole. This will allow you to evenly remove the crankshaft front seal from front housing (1) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	4C-6376	Seal Installer Stud	1
	4C-6377	Washer	1
	4C-6378	Seal Installer Sleeve	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

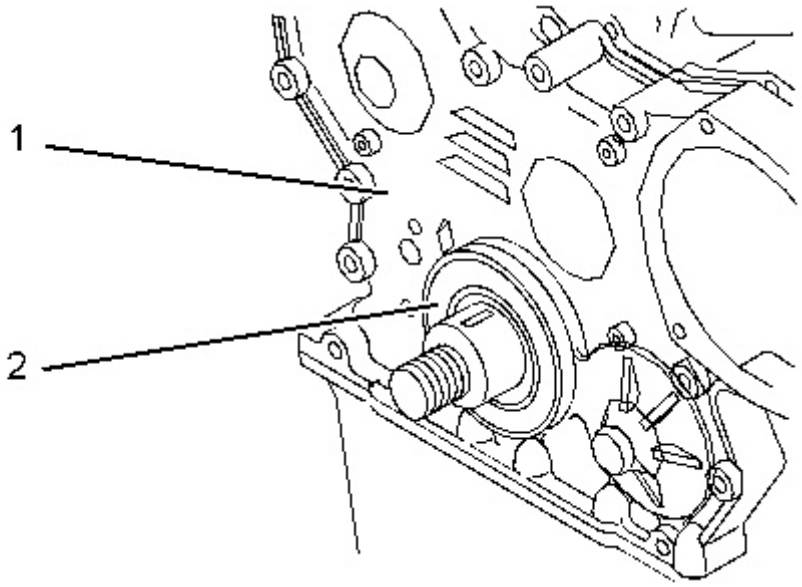


Illustration 2 g01335757

Typical example

1. Ensure that the bore in front housing (1) and the nose of the crankshaft are clean and free from damage.
2. Lubricate the outside diameter of a new crankshaft front seal (2) with clean engine oil.
3. Position crankshaft front seal (2) in the bore of front housing (1) .

NOTICE

Ensure that the lip of the crankshaft front seal that is spring loaded is facing toward the inside of the front housing and that it is square with the bore of the housing for the crankshaft front seal.

4. Use Tooling (C) to install crankshaft front seal (2) into front housing (1) .
5. Remove Tooling (C) and check for correct installation of crankshaft front seal (2) .
6. Apply clean engine oil to the lip of crankshaft front seal (2) .

End By: Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".

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i05016837

Crankshaft Main Bearings - Remove and Install - Crankshaft in position

SMCS - 1203-010

Removal Procedure

Start By:

A. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove". If the engine is not equipped with a balancer, remove the oil strainer. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

This procedure must only be used to remove and install the main bearing shells with the crankshaft in position.

The removal procedure and the installation procedure must be completed for each pair of main bearing shells before the next pair of main bearing shells are removed.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that the main bearing caps are marked for the correct location and orientation.

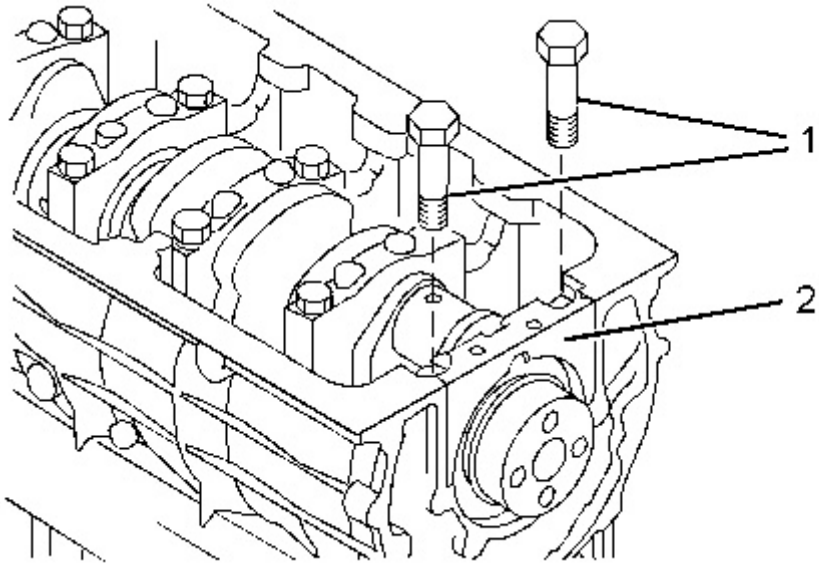


Illustration 1 g01353474

Typical example

2. Remove bolts (1) . Remove main bearing cap (2) from the cylinder block.

   Note: Number 5 main bearing cap must be removed squarely from the cylinder block. Do not twist the main bearing cap during removal as damage may result.

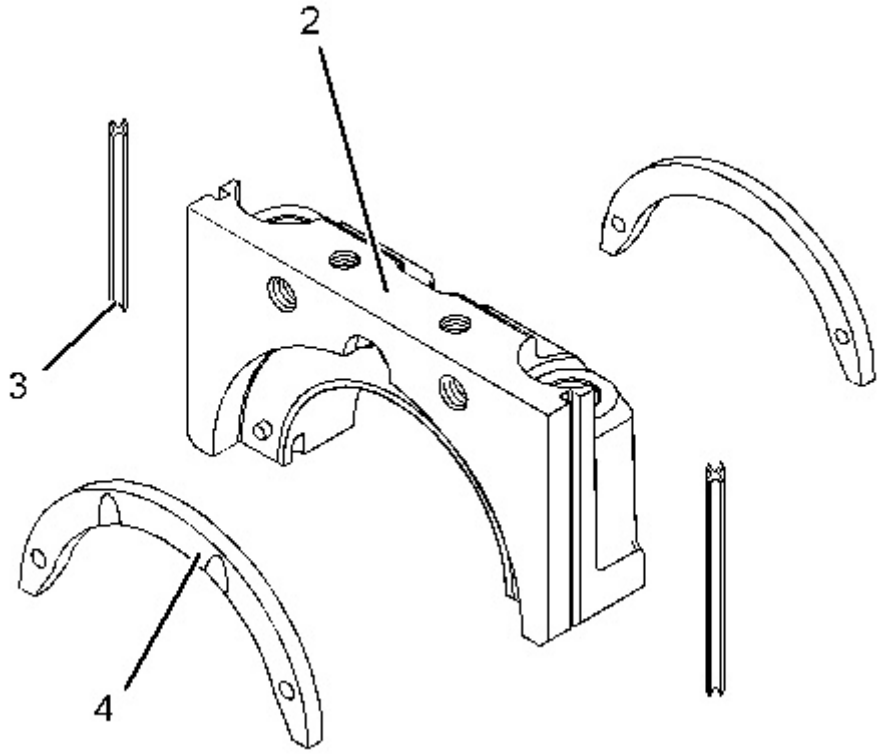


Illustration 2 g01353478

Number 5 main bearing cap

3. For number 5 main bearing cap, remove lower thrust washers (4) and remove seals (3) .

   Note: It is not possible to remove the upper thrust washer from the cylinder block with the crankshaft in position. If the upper thrust washer requires removal, the crankshaft must be removed. Refer to Disassembly and Assembly, "Crankshaft - Remove".

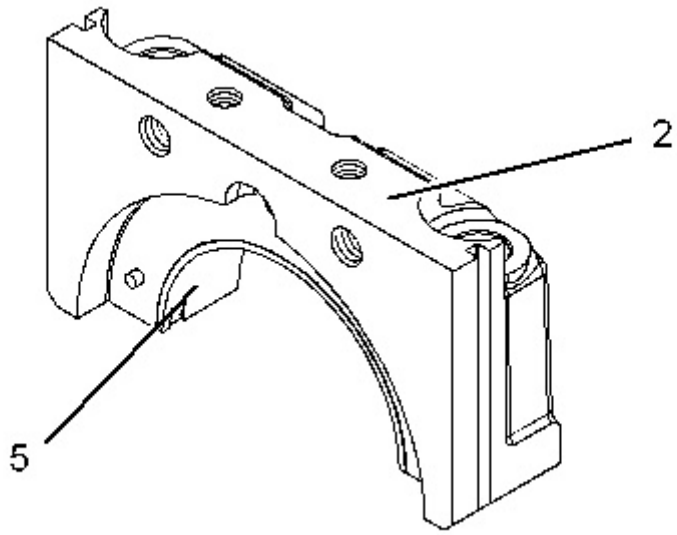


Illustration 3 g01353475

Number 5 main bearing cap

4. Remove lower main bearing (5) from main bearing cap (2) . Keep the main bearing and the main bearing cap together.

   Note: The lower main bearing is a plain bearing that has no oil holes.

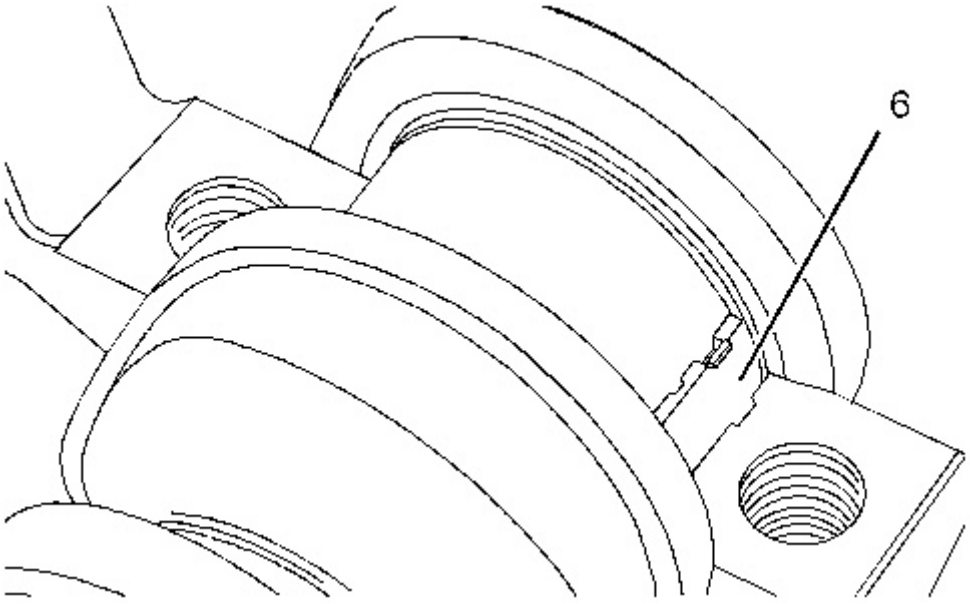


Illustration 4 g01353517

Typical example

5. Push out upper main bearing (6) with a suitable tool from the side opposite the locating tab. Carefully rotate the crankshaft while you push on the bearing. Remove upper main bearing (6) from the cylinder block. Keep the bearings together.

   Note: Do not damage the machined surfaces of the crankshaft during removal of the upper main bearing. The upper main bearing has a groove and two oil holes.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-
B	198-9113	Seal Installer	1
C	8T-5096	Dial Indicator Group	1

NOTICE

This procedure must only be used to remove and install the main bearing shells with the crankshaft in position.

The removal procedure and the installation procedure must be completed for each pair of main bearing shells before the next pair of main bearing shells are removed.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that the main bearings are clean and free from wear or damage. If necessary, replace the main bearings.

2. Clean the journal of the crankshaft. Inspect the journal of the crankshaft for damage. If necessary, replace the crankshaft or recondition the crankshaft. Refer to Disassembly and Assembly, "Crankshaft - Remove" for more information.

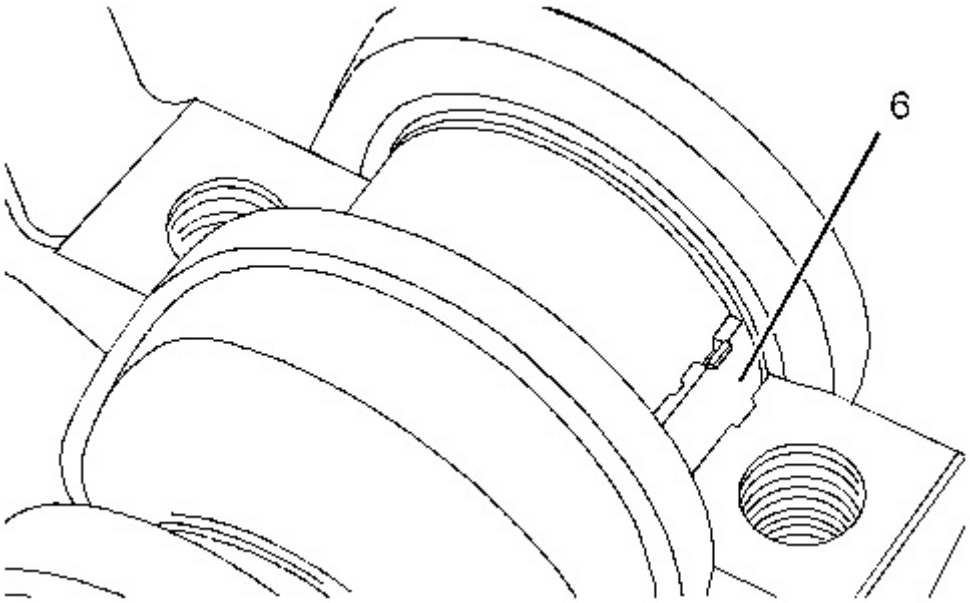


Illustration 5 g01353517

Typical example

3. Lubricate the crankshaft journal and the upper main bearing (6) with clean engine oil. Slide the upper main bearing into position between the crankshaft journal and the cylinder block. Ensure that the locating tab for the upper main bearing is correctly seated in the slot in the cylinder block.

   Note: The upper main bearing has a groove and two oil holes.

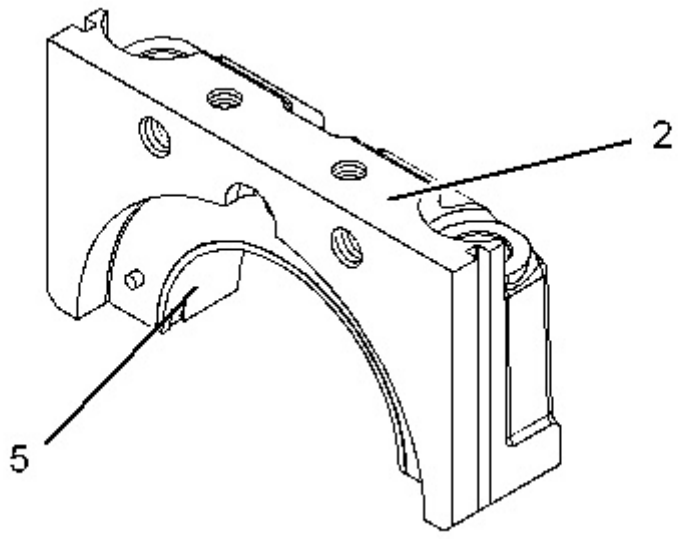


Illustration 6 g01353475

Number 5 main bearing cap

4. Install lower main bearing (5) into main bearing cap (2) . Ensure that the locating tab for the lower main bearing is correctly seated into the slot in the bearing cap.

   Note: The lower main bearing is a plain bearing that has no oil holes.

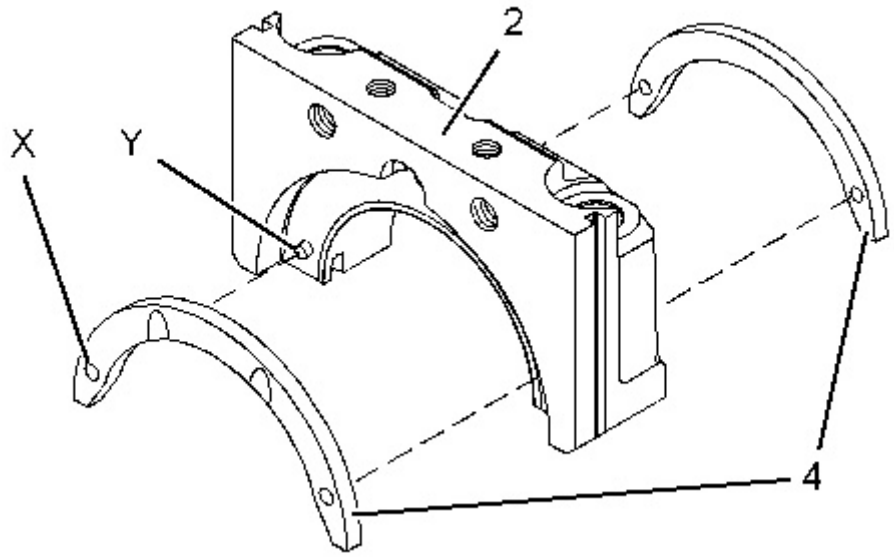


Illustration 7 g01353916

Number 5 main bearing cap

5. For number 5 main bearing cap, follow Steps 5.a through 5.c in order to install the lower thrust washers (4) to the main bearing cap.

   Note: It is not possible to install the upper thrust washer to the cylinder block with the crankshaft in position. If the upper thrust washer requires removal and installation, the crankshaft must be removed. Refer to Disassembly and Assembly, "Crankshaft - Remove".

   a. Ensure that lower thrust washers (4) are clean and free from wear or damage. If necessary, replace the thrust washers. Lubricate the thrust washers with clean engine oil.

   b. Install lower thrust washers (4) to main bearing cap (2) . Ensure that holes (X) in the thrust washers are aligned with dowels (Y) in the main bearing cap. Ensure that the grooves in the thrust washers face toward the crankshaft.

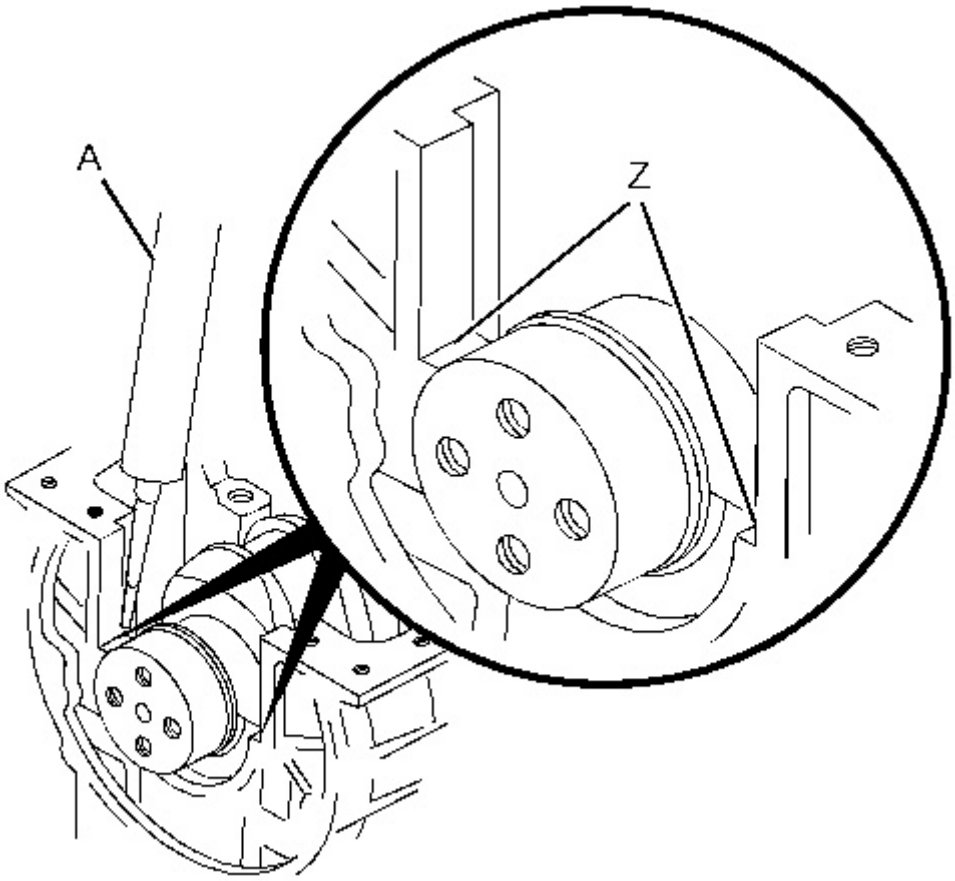


Illustration 8 g01354237

c. Ensure that the recess in the cylinder block for number 5 main bearing cap is clean and dry. Apply a bead of Tooling (A) to the corners of the recess at positions (Z) .

6. Lubricate the crankshaft journal and the lower main bearing with clean engine oil. Install main bearing cap (2) to the cylinder block. Ensure the correct orientation of the main bearing cap. The locating tab for the upper and the lower bearing should be on the same side of the engine.

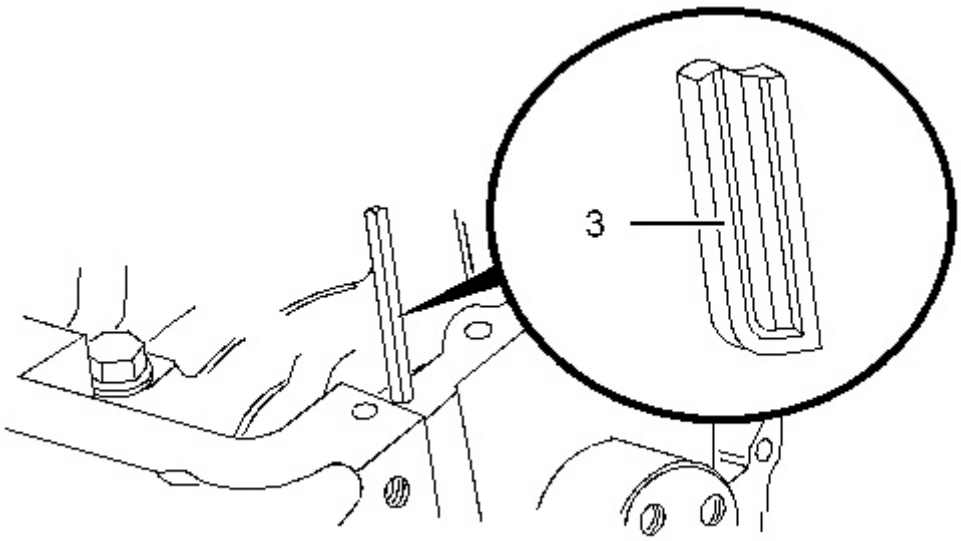


Illustration 9 g01359531

Typical example

7. Inject a small quantity of Tooling (A) into the two grooves in number 5 main bearing cap. Position new seals (3) in the grooves. Ensure that rounded edges of the seals are outward. Push the first 25 mm (1 inch) of the seal into the grooves by hand.

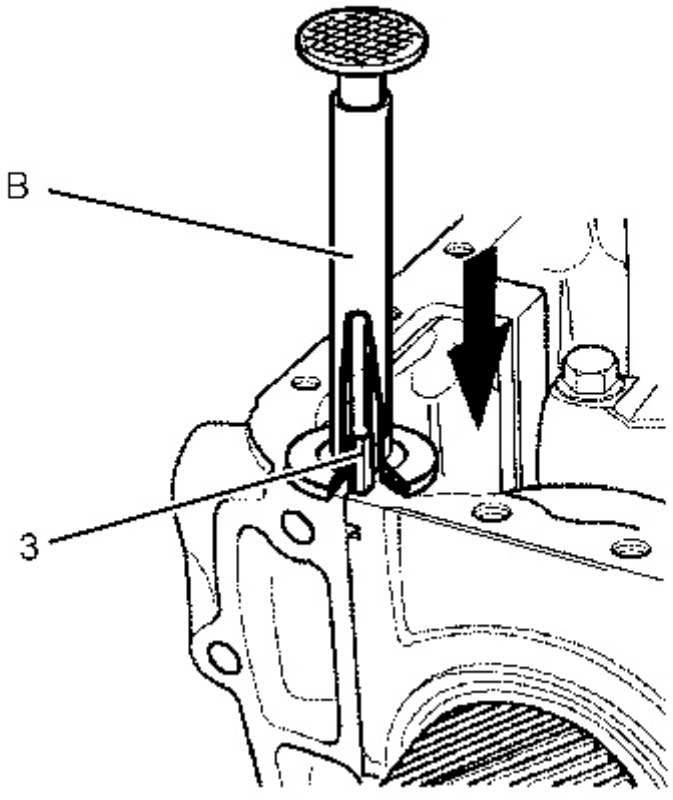


Illustration 10 g01354238

Typical example

8. Use Tooling (B) in order to push seals (3) fully into the grooves.

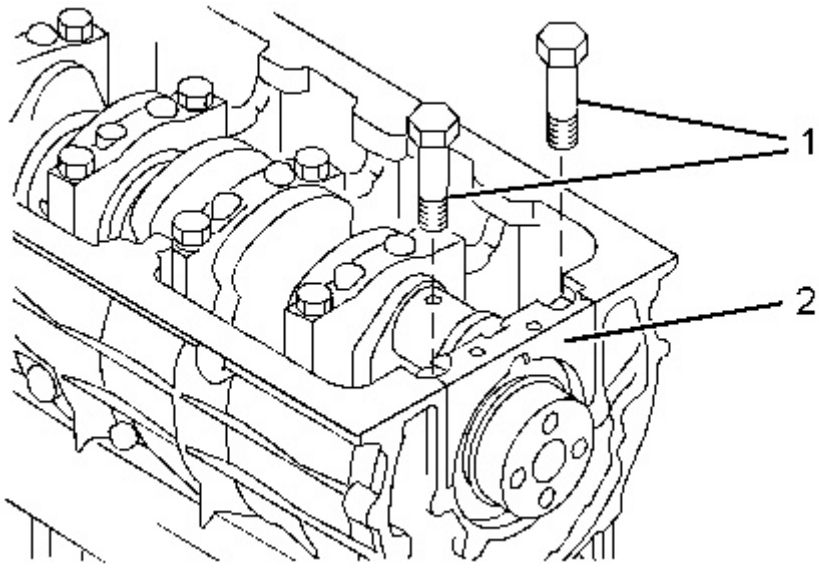


Illustration 11 g01353474

Typical example

9. Lubricate the threads of bolts (1) with clean engine oil. Lubricate the underside of the heads of the bolts with clean engine oil.
10. Install bolts (1) to main bearing cap (2) . Evenly tighten the bolts in order to pull the main bearing cap into position. Ensure that the main bearing cap is correctly seated.

    For number 5 main bearing cap, Ensure that the rear face of the main bearing cap is flush with the rear face of the cylinder block.

    Note: Do not tap the main bearing cap into position as the bearing may be dislodged.
11. Tighten bolts (1) to a torque of 103 N·m (76 lb ft).
12. Rotate the crankshaft in order to ensure that there is no binding.

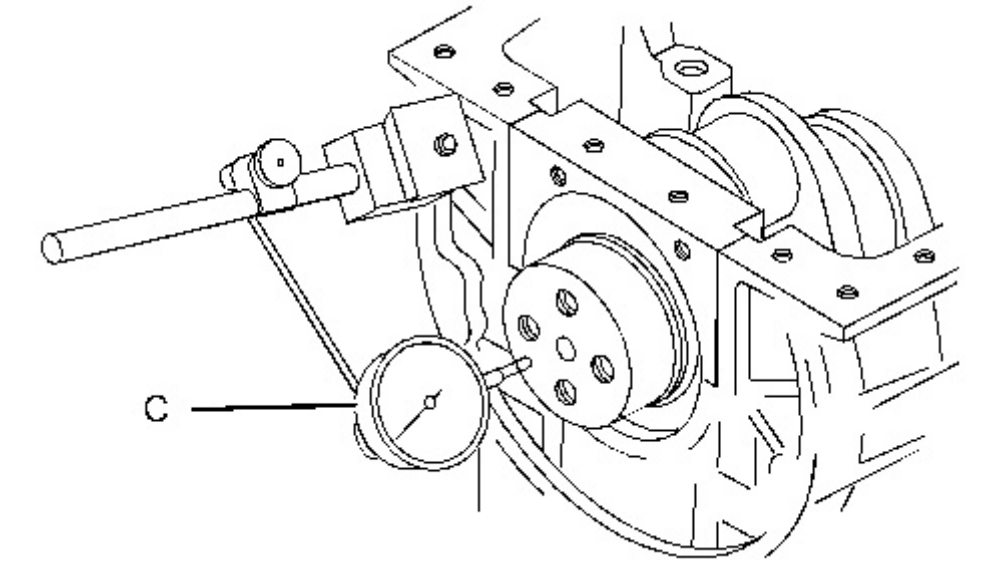


Illustration 12 g01359530

Typical example

13. Check the crankshaft end play. Refer to Specifications, "Crankshaft" for more information. Push the crankshaft toward the front of the engine. Install Tooling (C) . Push the crankshaft toward the rear of the engine in order to measure the end play.

End By:

a. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install". If the engine is not equipped with a balancer, install the oil

strainer and install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

b. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

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i02639308

Crankshaft - Remove

SMCS - 1202-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-8221	Lifting Sling	1

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove". If the engine is not equipped with a balancer, remove the oil strainer. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
C. Remove the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
D. Remove the front plate. Refer to Disassembly and Assembly, "Front Plate - Remove".

NOTICE

If the crankshaft has been reground or if the crankshaft has been replaced, the height of the piston above the cylinder block must be inspected. It is necessary to remove the cylinder head in order to inspect the height of the piston above the cylinder block.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. The engine should be mounted on a suitable stand and placed in the inverted position.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

2. If necessary, remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove". Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Remove".

   If the cylinder head, the pistons and the connecting rods have not been removed, remove the connecting rod caps. Refer to Disassembly and Assembly, "Connecting Rod Bearings - Remove". Carefully push the piston and connecting rod assemblies into the cylinder bores.

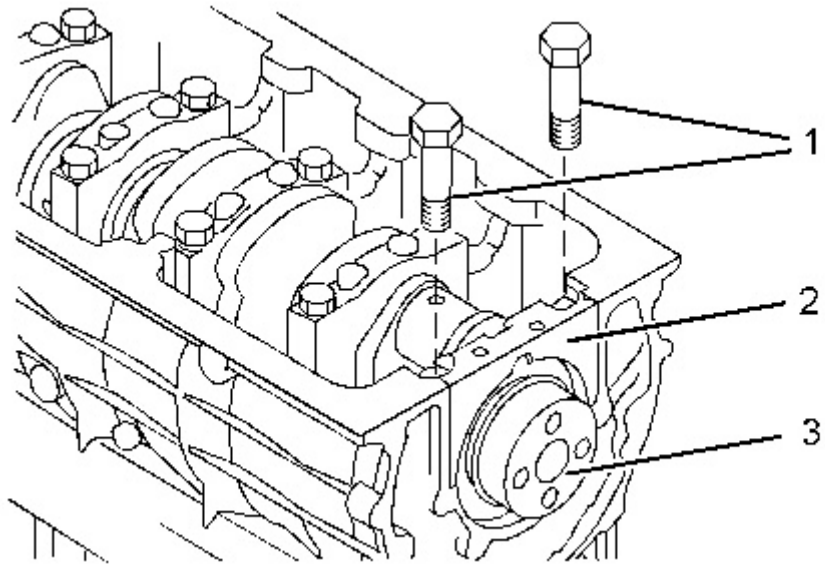


Illustration 1 g01359995

3. Ensure that bearing caps (2) are marked for the location and orientation.
4. Remove bolts (1) from bearing caps (2) .
5. Remove bearing caps (2) from the cylinder block.

   Note: Number five main bearing cap must be removed squarely from the cylinder block. Do not twist the main bearing cap during removal as damage may result.

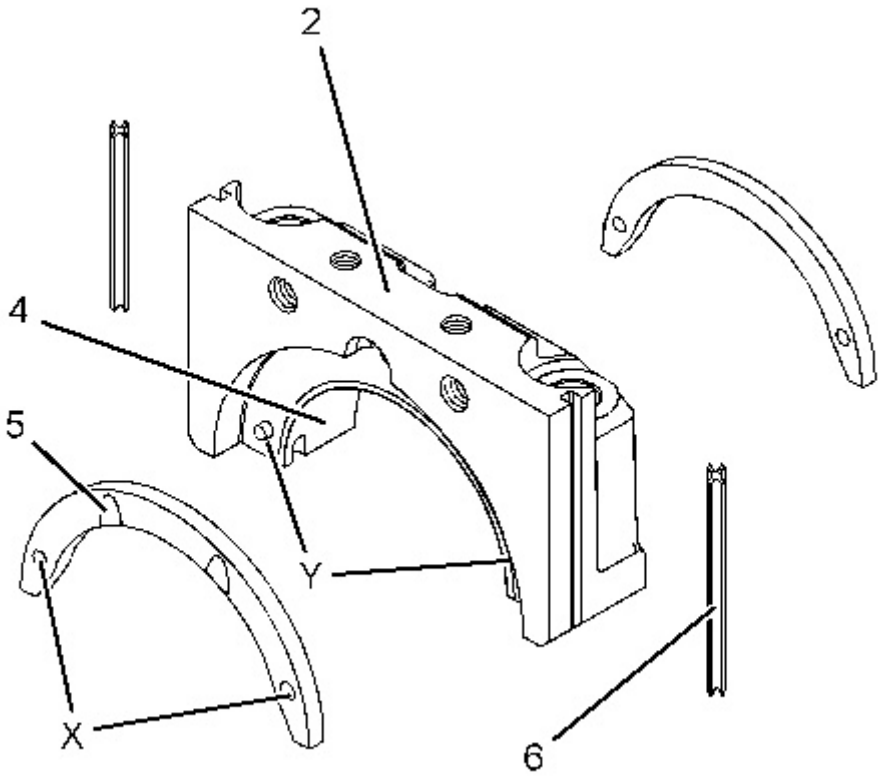


Illustration 2 g01359992

Number five main bearing cap

6. Remove lower main bearings (4) from main bearing caps (2). Keep the main bearings and the main bearing caps together.

   For number five main bearing cap, remove lower thrust washers (5) and remove seals (6) .

   Note: The lower main bearings are plain bearings with no oil holes.

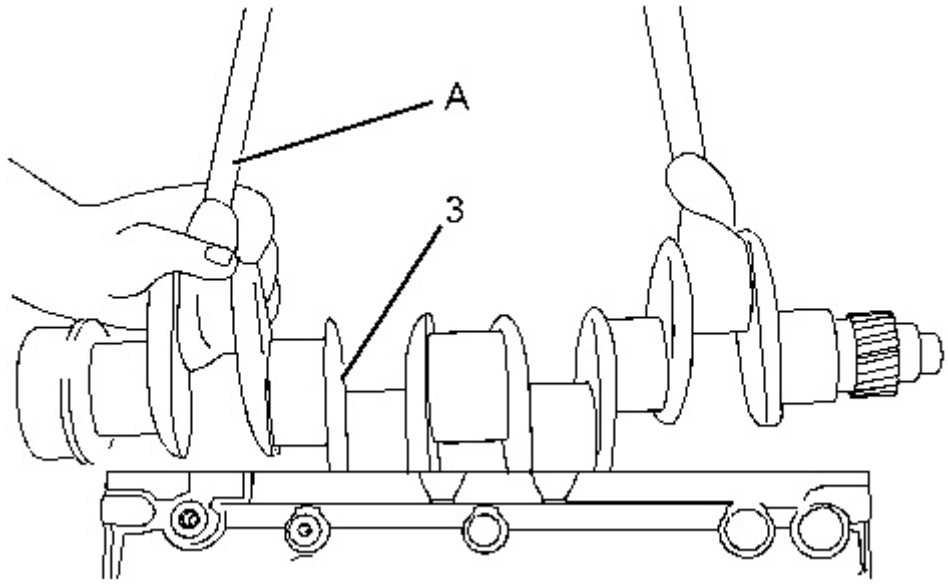


Illustration 3 g01359996

7. Attach a Tooling (A) and a suitable lifting device to crankshaft (3). Carefully lift the crankshaft out of the cylinder block. The weight of the crankshaft is approximately 32 kg (70 lb).

   Note: Do not damage the finished surfaces on the crankshaft.

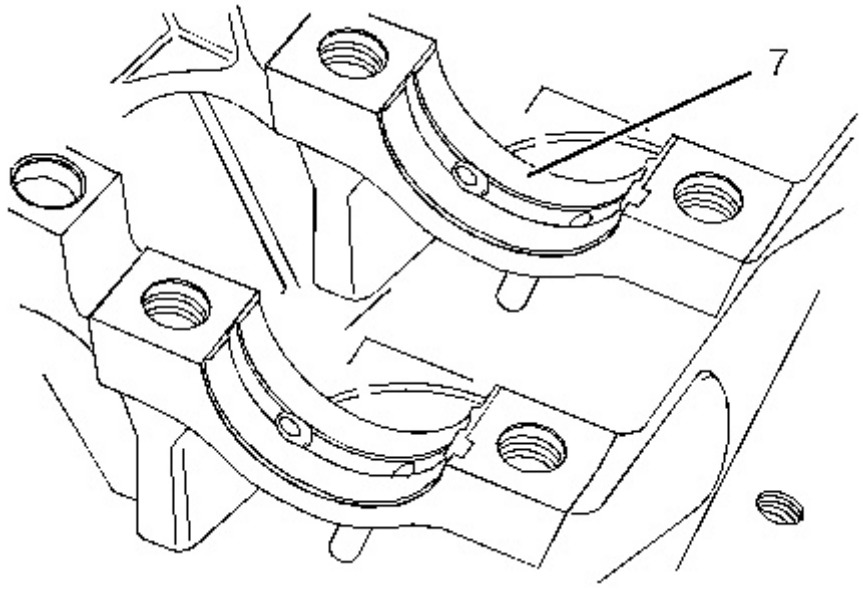


Illustration 4 g01359993

Typical example

8. Remove upper main bearings (7). Keep the upper main bearings and the upper thrust washer with the respective main bearing caps.

For number five main bearing, remove the upper thrust washer from the rear of the cylinder block.

Note: The upper main bearings have a groove and two oil holes.

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i05016871

Crankshaft - Install

SMCS - 1202-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-
B	198-9113	Seal Installer	1
C	8T-5096	Dial Indicator Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The engine should be mounted on a suitable stand and placed in the inverted position.

1. Clean the crankshaft and inspect the crankshaft for wear or damage. Refer to Specifications, "Crankshaft" for more information. If necessary, replace the crankshaft or recondition the crankshaft.

2. Ensure that the parent bores for the crankshaft bearings in the cylinder block are clean. Ensure that the threads for the bearing bolts in the cylinder block are clean and free from damage.

3. Clean the crankshaft bearings and the thrust washers. Inspect the bearings and the thrust washers for wear or damage. If necessary, replace the bearings and the thrust washers.

Note: If the crankshaft bearings are replaced, check whether oversize bearings were previously installed. If the thrust washers are replaced, check whether oversize thrust washers were previously installed.

4. Ensure that all of the lubrication passages are clean and free of debris.

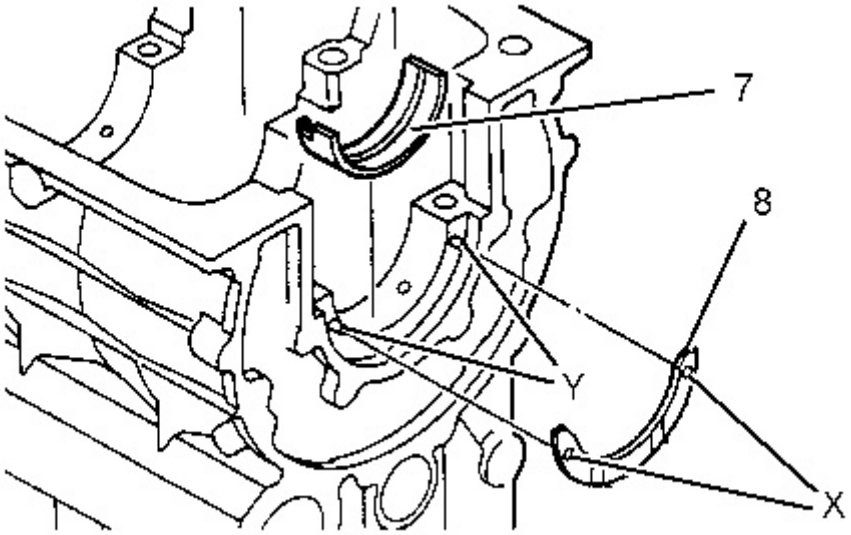


Illustration 1 g01360029

Typical example

5. Install upper bearings (7) to the cylinder block. Ensure that the locating tabs for the upper bearings are seated in the slots in the cylinder block.

   Note: The upper bearings have a groove and two oil holes.

6. Lubricate upper thrust washer (8) . Install the upper thrust washer to the rear of the cylinder block with the oil grooves toward the outside. Ensure that holes (X) in the thrust washer are aligned with dowels (Y) in the cylinder block.

7. Lubricate upper bearings (7) with clean engine oil.

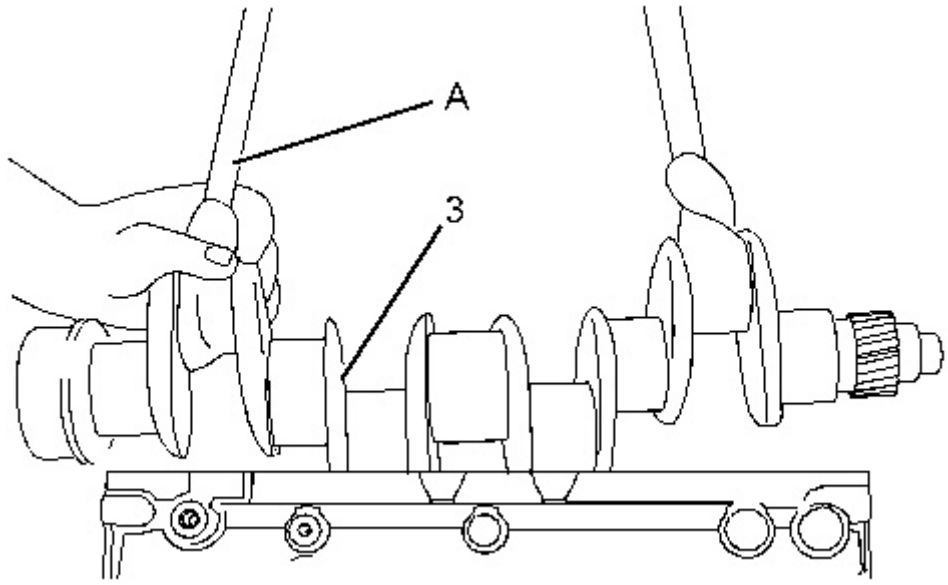


Illustration 2 g01359996

Typical example

8. Attach Tooling (A) and a suitable lifting device to crankshaft (3) . Carefully lift the crankshaft into the cylinder block. The weight of the crankshaft is approximately 32 kg (70 lb). Remove Tooling (A) .

   Note: Do not damage any of the finished surfaces on the crankshaft. Do not damage the bearings.

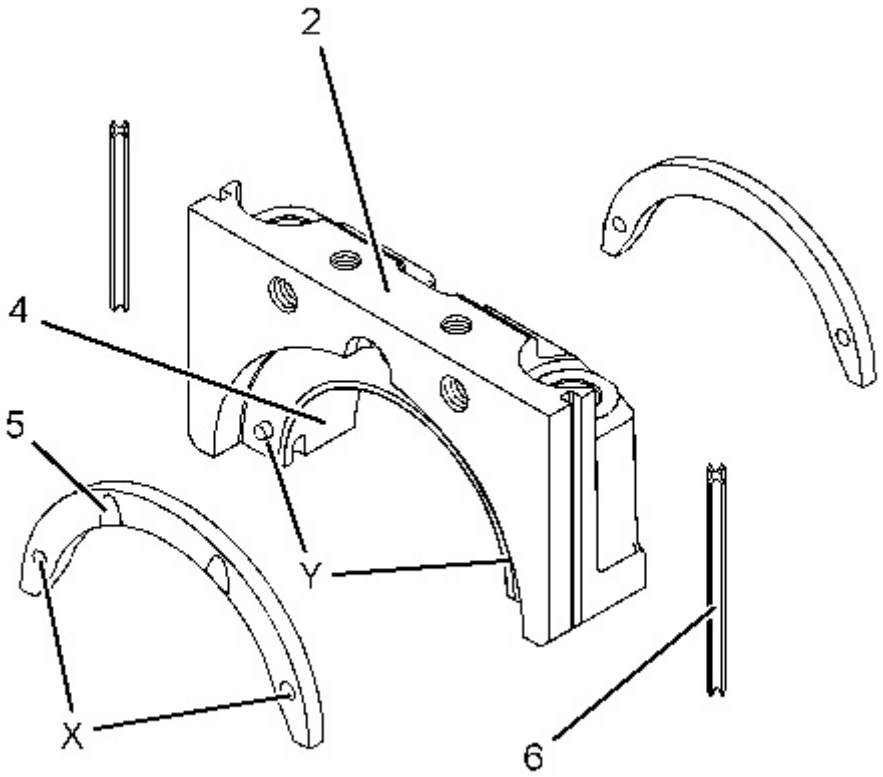


Illustration 3 g01359992

Number 5 main bearing cap

9. Install lower bearings (4) to main bearing caps (2) . Ensure that the locating tabs for the lower bearings are seated in the slots in the bearing caps.

   Note: The lower bearings are plain bearing with no oil holes.

10. For number 5 main bearing cap, follow Steps 10.a through 10.c in order to install the lower thrust washers (5) to the main bearing cap.

    a. Ensure that lower thrust washers (5) are clean and free from wear or damage. If necessary, replace the thrust washers. Lubricate the thrust washers with clean engine oil.

    b. Install lower thrust washers (5) to main bearing cap (2) . Ensure that holes (X) in the thrust washers are aligned with dowels (Y) in the main bearing cap.

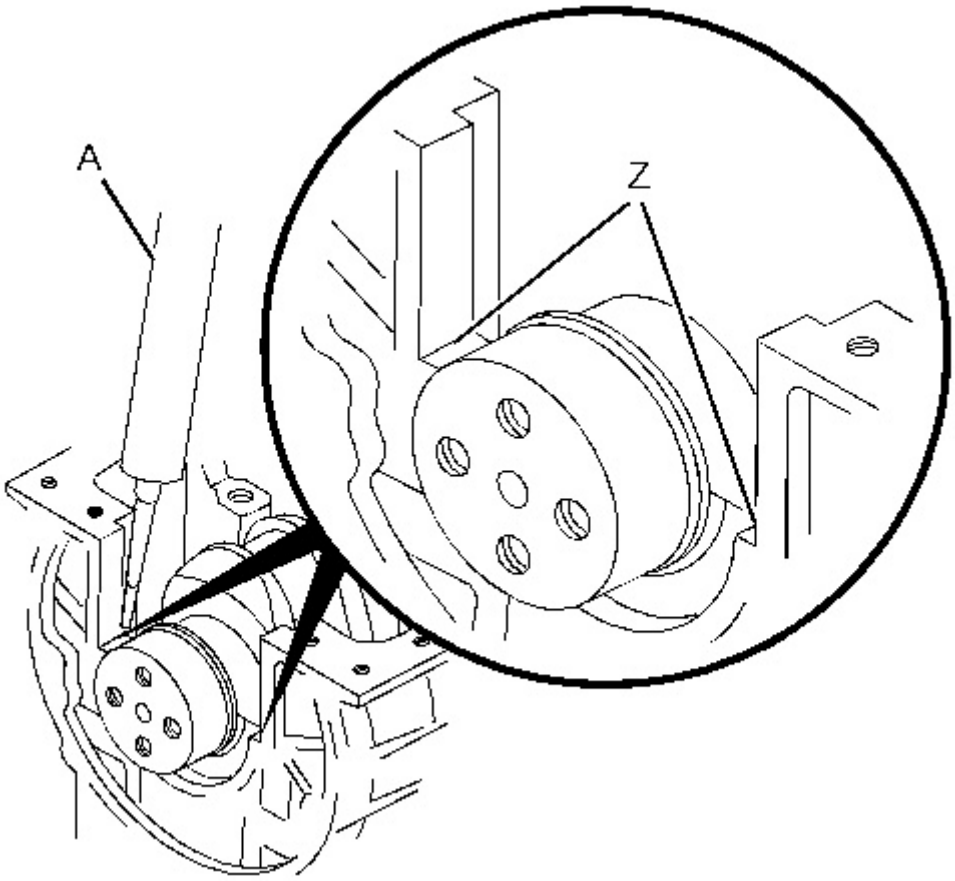


Illustration 4 g01354237

c. Apply a bead of Tooling (A) to the corners of the recess in the cylinder block at positions (Z) .

11. Lubricate the crankshaft journals and the lower main bearings with clean engine oil. Install main bearing caps (2) to the cylinder block. Ensure the correct orientation of the main bearing caps. The locating tab for the upper and the lower bearing should be on the same side of the engine.

    Note: For number 5 main bearing cap, ensure that the rear face of the main bearing cap is flush with the rear face of the cylinder block.

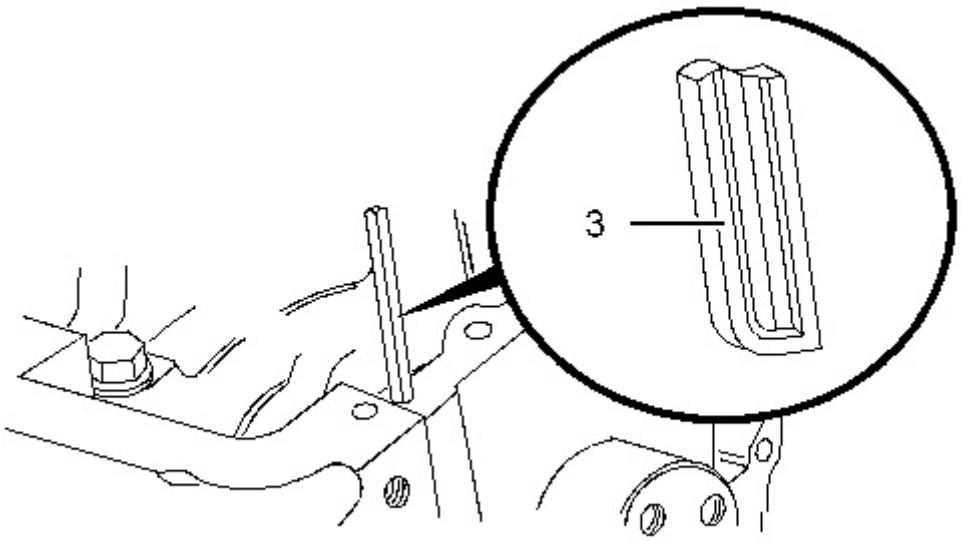


Illustration 5 g01359531

Typical example

12. Inject a small quantity of Tooling (A) into the two grooves in number 5 main bearing cap. Position new seals (3) in the grooves. Ensure that rounded edges of the seals are outward. Push the first 25 mm (1 inch) of the seal into the grooves by hand.

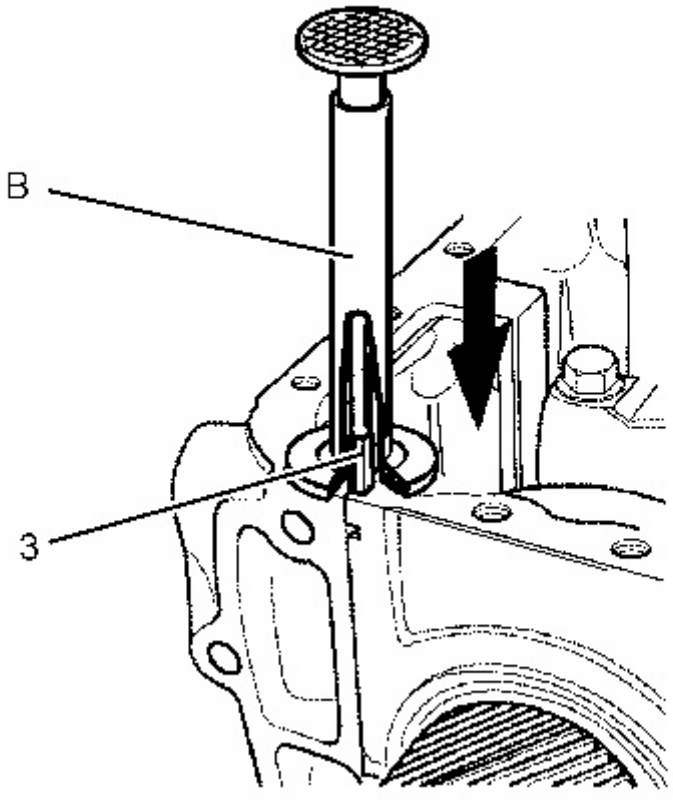


Illustration 6 g01354238

Typical example

13. Use Tooling (B) in order to push seals (3) fully into the grooves.

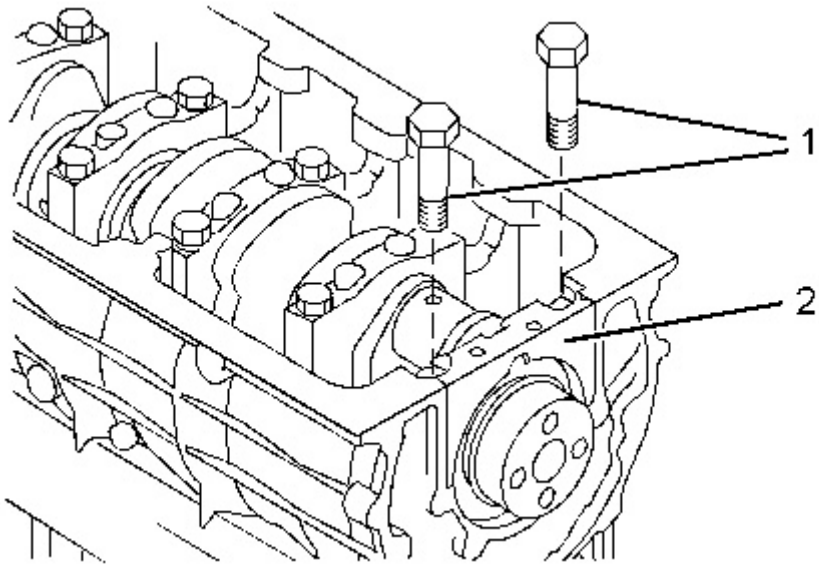


Illustration 7 g01353474

Typical example

14. Lubricate the threads of bolts (1) with clean engine oil. Lubricate the underside of the heads of the bolts with clean engine oil.

15. Install bolts (1) to main bearing caps (2) . Evenly tighten the bolts in order to pull the main bearing caps into position. Ensure that the caps are correctly seated.

    Note: Do not tap the main bearing caps into position as the bearing may be dislodged.

16. Tighten bolts (1) to a torque of 103 N·m (76 lb ft).

17. Rotate the crankshaft in order to ensure that there is no binding.

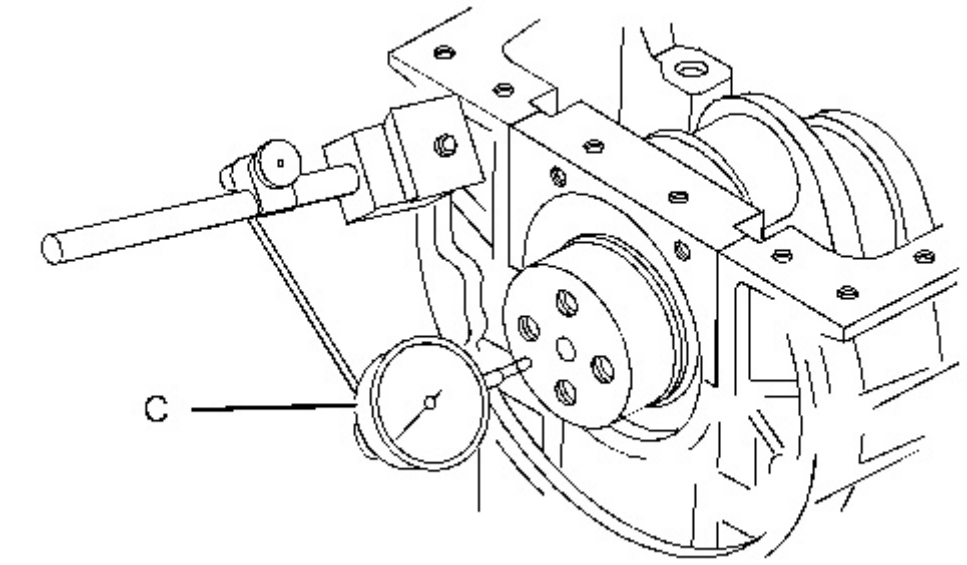


Illustration 8 g01359530

Typical example

18. Check the crankshaft end play. Refer to Specifications, "Crankshaft" for more information. Push the crankshaft toward the front of the engine. Install Tooling (A) . Push the crankshaft toward the rear of the engine in order to measure the end play.

19. If the crankshaft has been replaced or the crankshaft has been reconditioned, inspect the height of the pistons above the cylinder block. Refer to Systems Operation, Testing and Adjusting, "Piston Height - Inspect" for more information. First install the pistons and connecting rods. Refer to Disassembly and Assembly, "Pistons and Connecting Rods - Install". Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

If the crankshaft has not been replaced or the crankshaft has not been reconditioned, install the connecting rod caps. Refer to Disassembly and Assembly, "Connecting Rod Bearings - Install".

End By:

a. Install the front plate. Refer to Disassembly and Assembly, "Front Plate - Install".
b. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
c. If the engine has a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install". If the engine does not have a balancer, install the oil strainer and install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Install".
d. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Push Rod - Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639310

Crankshaft Gear - Remove and Install

SMCS - 1204-010-GE

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".

Note: In this procedure, the crankshaft gear is removed with the crankshaft in the engine.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

2. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove".

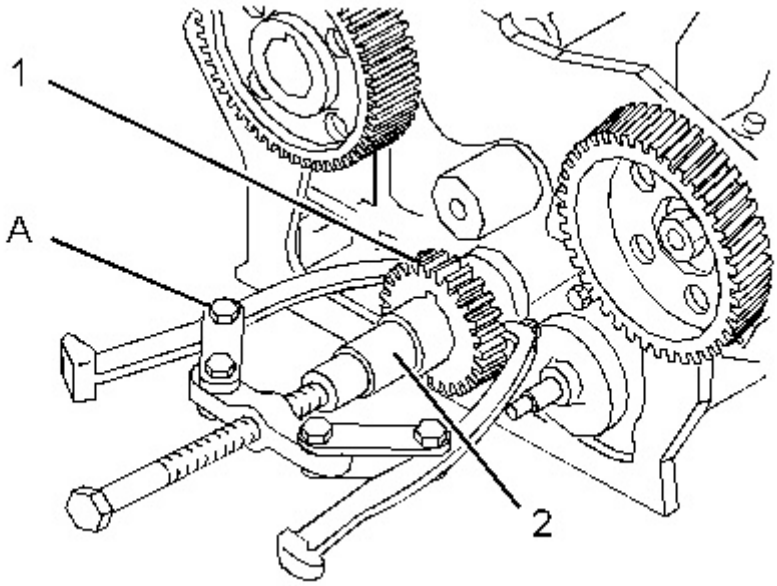


Illustration 1 g01343991

Typical example

3. Use Tooling (A) to remove crankshaft gear (1) from crankshaft (2) .
4. If necessary, remove the keys (not shown) from crankshaft (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

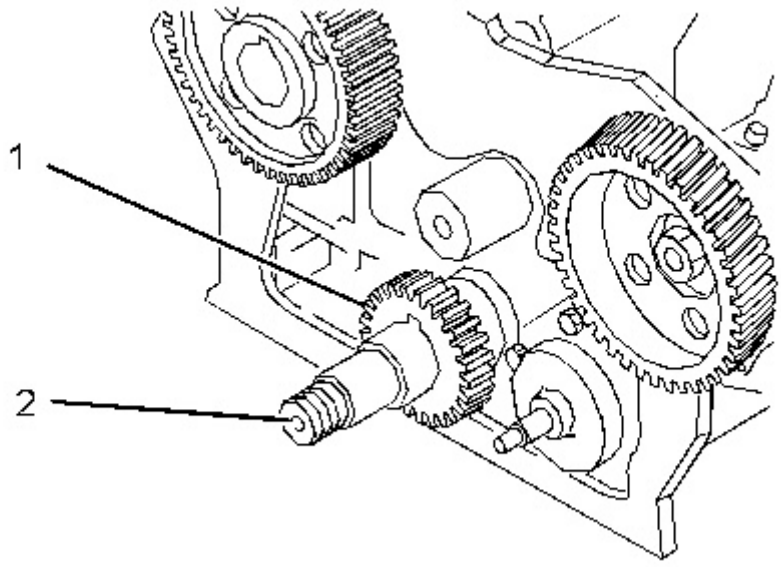


Illustration 2 g01344011

Typical example

1. If necessary, install the keys (not shown) to crankshaft (2) .

WARNING

Always wear protective gloves when handling parts that have been heated.

2. Raise the temperature of crankshaft gear (1) in an oven to 100 °C (212 °F).
3. Align the keyway in crankshaft gear (1) with the keys in crankshaft (2). Install crankshaft gear (1). Ensure that the crankshaft gear is seated squarely against the crankshaft.
4. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".
5. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install".

End By: Install the idler gear. Refer to Disassembly and Assembly, "Idler Gear- Remove and Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

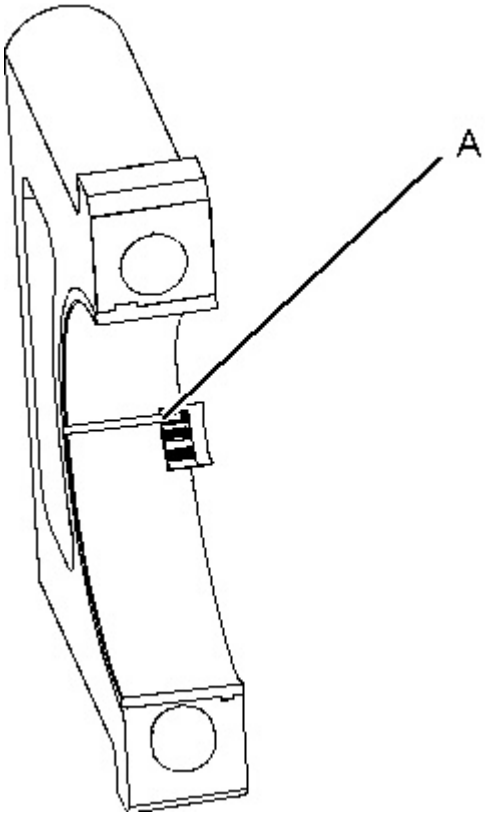


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02510693

Cylinder Block

SMCS - 1201

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-9022	Silicone Gasket	1
B	198-9113	Seal Installer	1

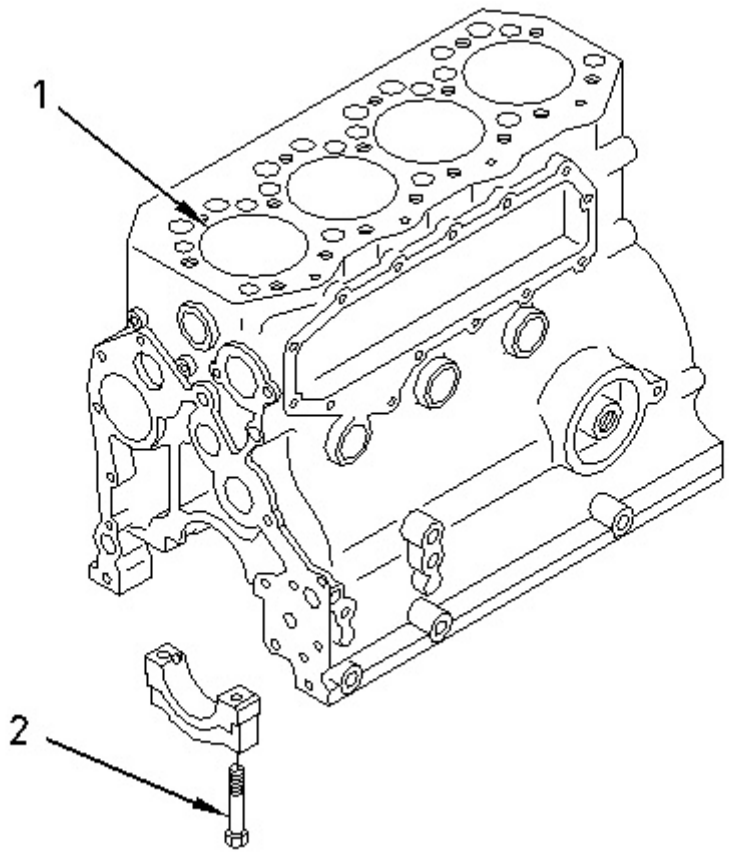


Illustration 1 g00987933

(1) Cylinder bore

Table 2

Tolerances of Cylinder Bores			

	Standard at Assembly	Repair Limit (1)	Service Limit (2)
Inside Diameter	94.000 to 94.035 mm (3.7008 to 3.7022 inch)	94.200 mm (3.7087 inch)	94.700 mm (3.7283 inch)
Out of Round	0.010 mm (0.0004 inch)	N/A	N/A
Taper	0.015 mm (0.0006 inch)	N/A	N/A

(1) Bore the cylinder to the specified oversize dimension if the repair limit has been reached.

(2) Install a cylinder liner or replace the cylinder block if the service limit has been reached.

Bore the cylinder to the oversize dimension if the cylinder has uneven wear. Refer to Table 3.

Table 3

Oversize Bore	Cylinder Bore Size
0.250 mm (0.0100 inch)	94.250 to 94.285 mm (3.7106 to 3.7120 inch)
0.500 mm (0.0197 inch)	94.500 to 94.535 mm (3.7205 to 3.7218 inch)

The permissible distortion of the contact surface of the gasket is given below.

Maximum at assembly ... 0.05 mm (0.0020 inch)
Repair limit ... 0.20 mm (0.0079 inch)

(2) Main bearing cap bolts

Use the following procedure in order to install the main bearing cap bolts:

1. Apply clean engine oil to the bearings and install the bearings to the caps.

   Note: Apply Tooling (A) to the corners of the cylinder block for the rear main bearing cap. After the rear main bearing cap is installed, remove any excess sealant from the inside of the recess for the rear oil seal. Excess sealant prevents the correct seating of the rear oil seal.

2. Install the cap to the crankcase so that the rear face of the cap is even with the rear face of the crankcase.

3. Apply clean engine oil to the threads of the main bearing cap bolts.

   Tighten the main bearing cap bolts to the following torque. ... 98 to 108 N·m (72 to 80 lb ft)

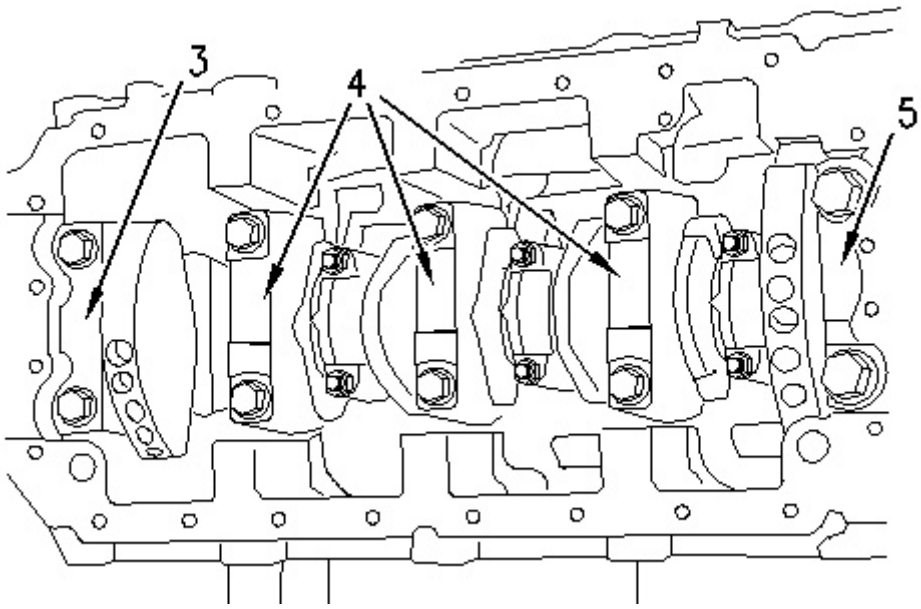


Illustration 2 g01007113

(3) Rear main bearing cap

(4) Main bearing caps should have a marking that indicates placement and orientation.

(5) Front main bearing cap

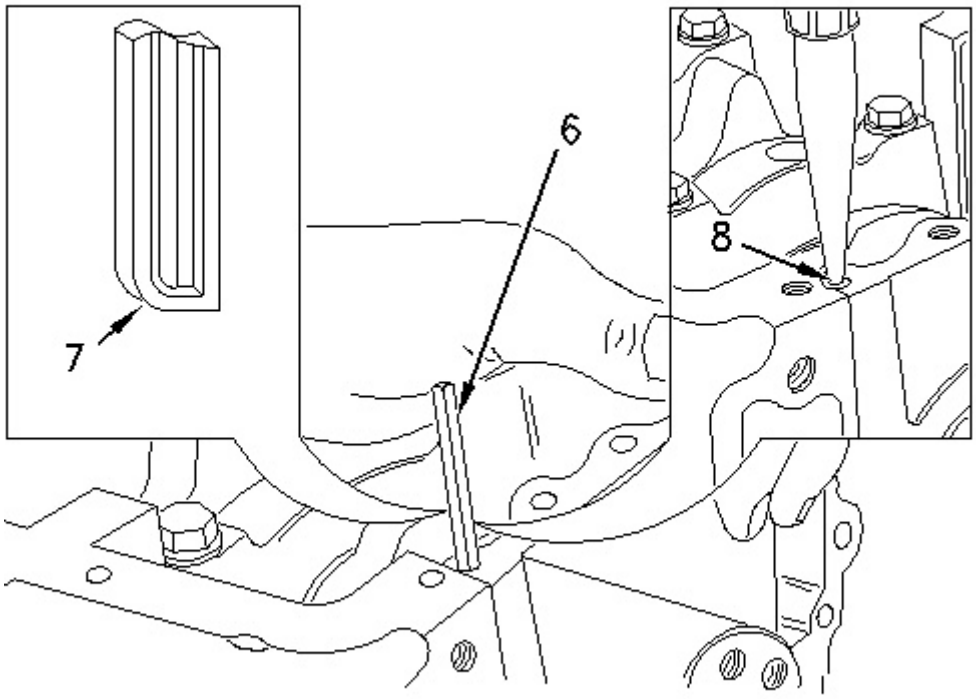


Illustration 3 g01007117

(6) Seal for the front and rear main bearing caps.

(7) The seals for the front and the rear main bearing caps have a curve at one end. The curved side must be installed toward the side of the engine. The curved end is inserted first into the hole. Use Tooling (B) to correctly install the seals.

(8) Before installing the seals, inject a small quantity of Tooling (A) in the holes for the seals.

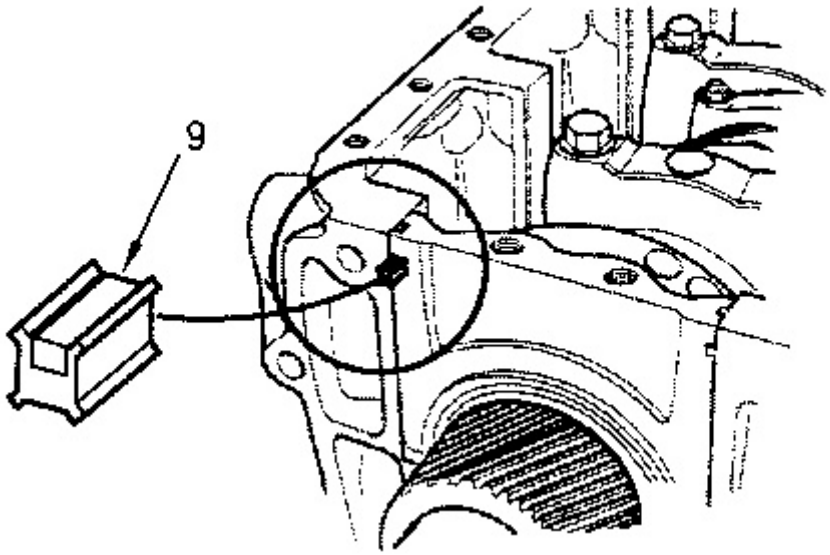


Illustration 4 g01007175

(9) Seal for the front main bearing cap.

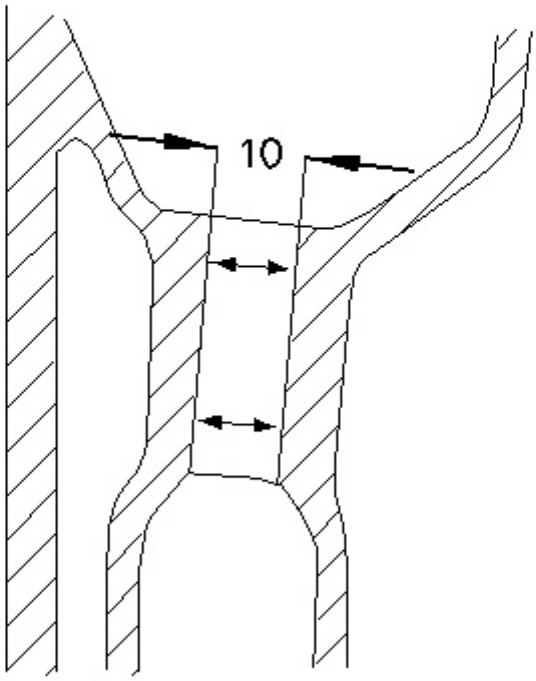


Illustration 5 g00988954

(10) Inside diameter of the lifter bore

Standard at assembly ... 14.000 to 14.018 mm (0.5512 to 0.5519 inch)
Service limit ... 14.100 mm (0.5551 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01907583

Main Bearing Journal

SMCS - 1202; 1203

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Main Bearings	
Original Size Journal (1)	77.955 to 77.970 mm (3.0691 to 3.0697 inch)
Undersize Journal 0.25 mm (0.010 inch)	77.705 to 77.720 mm (3.0592 to 3.0598 inch)
Undersize Journal 0.50 mm (0.020 inch)	77.455 to 77.470 mm (3.0494 to 3.0500 inch)
Undersize Journal 0.75 mm (0.030 inch) (2)	77.205 to 77.220 mm (3.0396 to 3.0402 inch)

(1) Regrind the main bearing journals to the next undersize dimension if the repair limit of 77.850 mm (3.0650 inch) is exceeded.

(2) Service limit 77.100 mm (3.0354 inch)

The clearance between a new main bearing and a new main bearing journal is the following value. ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)

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i02697761

Cylinder Block

SMCS - 1201

S/N - -

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-9022	Silicone Gasket	1
B	198-9113	Seal Installer	1

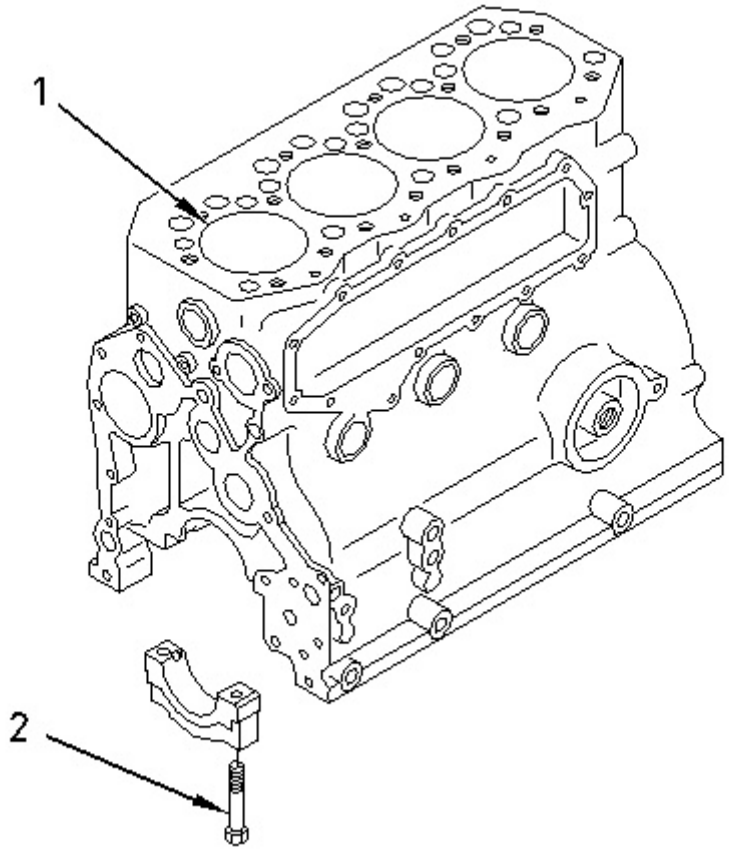


Illustration 1 g00987933

(1) Cylinder bore

Table 2

Tolerances of Cylinder Bores			
	Internal Diameter	**Out of Round**	**Taper**
Standard at Assembly	94.000 to 94.035 mm (3.7008 to 3.7022 inch)	0.010 mm (0.0004 inch)	0.015 mm (0.0006 inch)
Repair Limit	94.200 mm (3.7087 inch)	N/A	N/A
1st Standard Oversize +0.25 mm (0.001 inch)	94.250 to 94.285 mm (3.7106 to 3.7120 inch)	0.010 mm (0.0004 inch)	0.015 mm (0.0006 inch)
Repair Limit	94.450 mm (3.7185 inch)	N/A	N/A
2nd Standard Oversize +0.50 mm (0.02 inch)	94.500 to 94.535 mm (3.7205 to 3.7218 inch)	0.010 mm (0.0004 inch)	0.015 mm (0.0006 inch)

Service Limit	94.700 mm (3.7283 inch)	N/A	N/A

Bore the cylinder to the oversize dimension if the cylinder has uneven wear. Refer to Table 2.

The permissible distortion of the contact surface of the gasket is given below.

Maximum at assembly ... 0.05 mm (0.0020 inch)
Repair limit ... 0.20 mm (0.0079 inch)

(2) Main bearing cap bolts

Use the following procedure in order to install the main bearing cap bolts:

1. Apply clean engine oil to the bearings and install the bearings to the caps.

   Note: Apply Tooling (A) to the corners of the cylinder block for the rear main bearing cap. After the rear main bearing cap is installed, remove any excess sealant from the inside of the recess for the rear oil seal. Excess sealant prevents the correct seating of the rear oil seal.

2. Install the cap to the crankcase so that the rear face of the cap is even with the rear face of the crankcase.

3. Apply clean engine oil to the threads of the main bearing cap bolts.

   Tighten the main bearing cap bolts to the following torque. ... 98 to 108 N·m (72 to 80 lb ft)

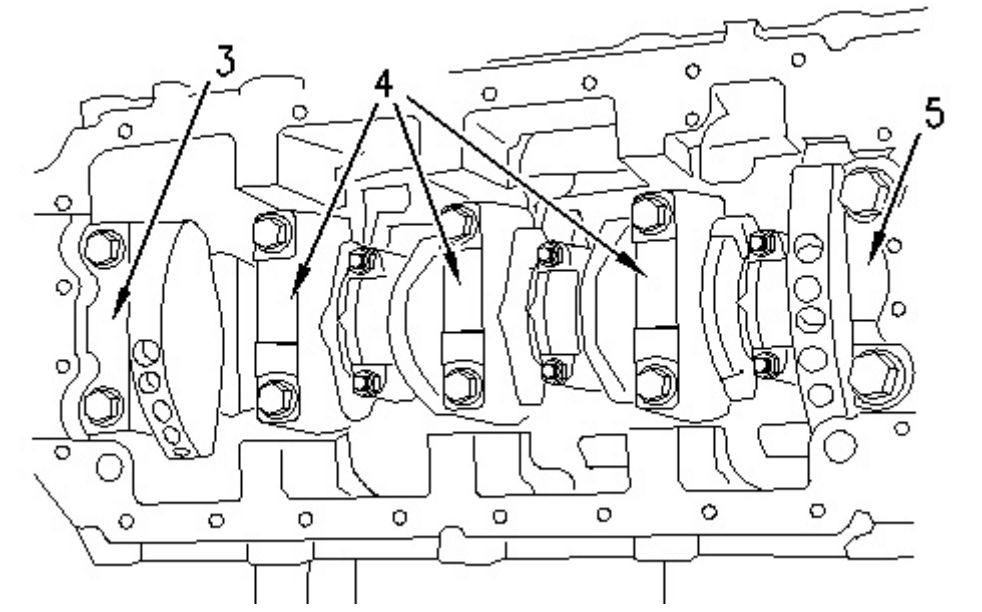


Illustration 2 g01007113

(3) Rear main bearing cap

(4) Main bearing caps should have a marking that indicates placement and orientation.

(5) Front main bearing cap

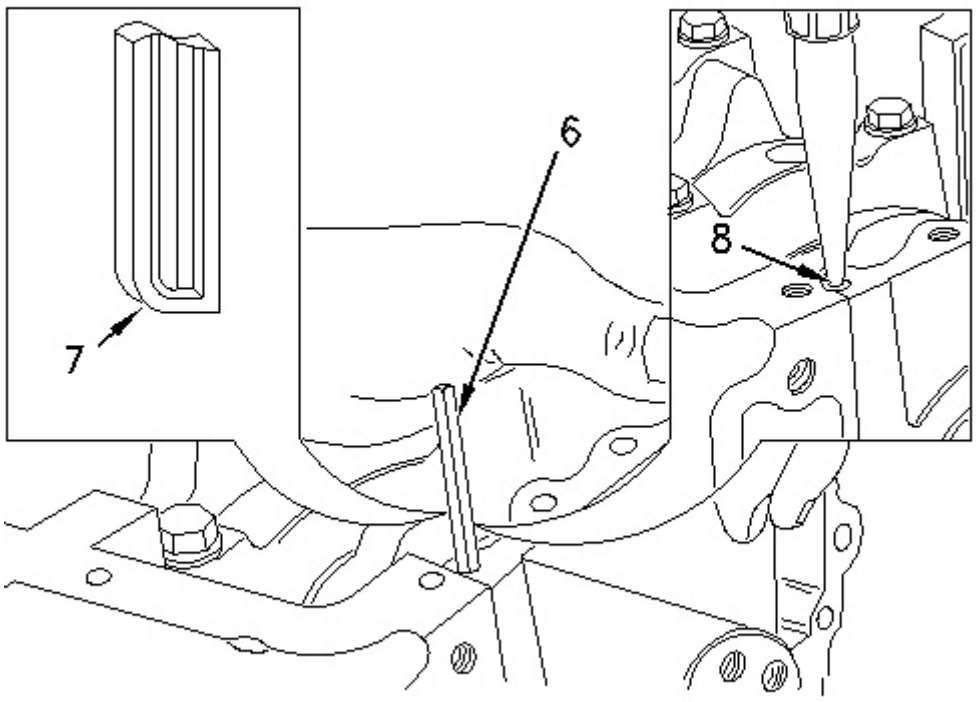


Illustration 3 g01007117

(6) Seal for the front and rear main bearing caps.

(7) The seals for the front and the rear main bearing caps have a curve at one end. The curved side must be installed toward the side of the engine. The curved end is inserted first into the hole. Use Tooling (B) to correctly install the seals.

(8) Before installing the seals, inject a small quantity of Tooling (A) in the holes for the seals.

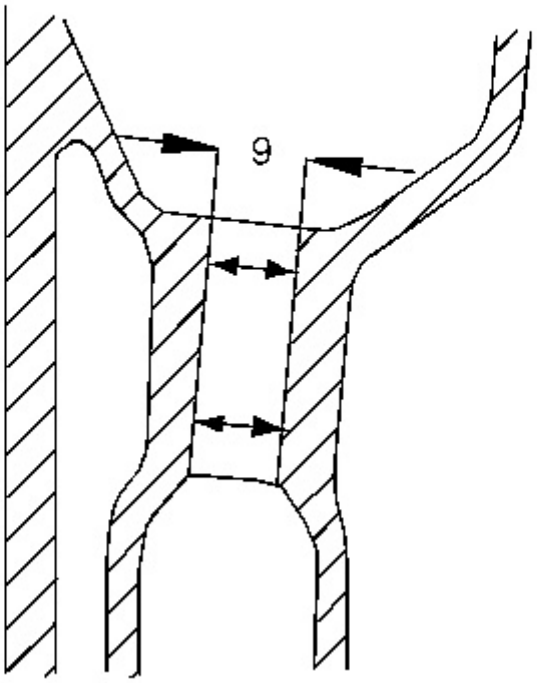


Illustration 4 g01353554

(9) Inside diameter of the lifter bore

Standard at assembly ... 14.000 to 14.018 mm (0.5512 to 0.5519 inch)
Service limit ... 14.100 mm (0.5551 inch)

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i01907583

Main Bearing Journal

SMCS - 1202; 1203

S/N - -

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Main Bearings	
Original Size Journal (1)	77.955 to 77.970 mm (3.0691 to 3.0697 inch)
Undersize Journal 0.25 mm (0.010 inch)	77.705 to 77.720 mm (3.0592 to 3.0598 inch)
Undersize Journal 0.50 mm (0.020 inch)	77.455 to 77.470 mm (3.0494 to 3.0500 inch)
Undersize Journal 0.75 mm (0.030 inch) (2)	77.205 to 77.220 mm (3.0396 to 3.0402 inch)

(1) Regrind the main bearing journals to the next undersize dimension if the repair limit of 77.850 mm (3.0650 inch) is exceeded.

(2) Service limit 77.100 mm (3.0354 inch)

The clearance between a new main bearing and a new main bearing journal is the following value. ... 0.050 to 0.110 mm (0.0020 to 0.0043 inch)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02009092

Camshaft Bearings - Remove and Install

SMCS - 1211-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

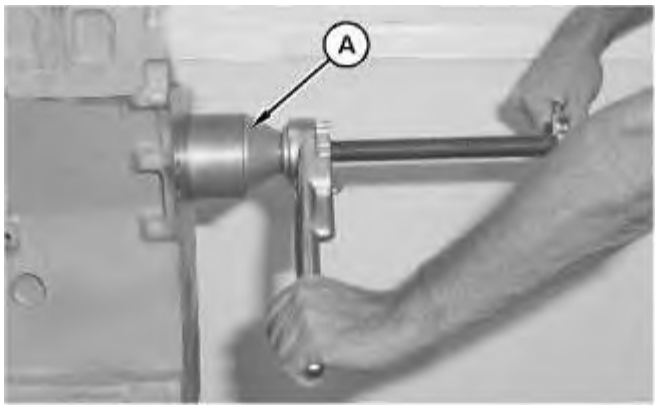


Illustration 1 g01038778

1. Use Tooling (A) to remove the camshaft bearing from the cylinder block.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the bore in the cylinder block for the camshaft bearing is clean and free of debris.

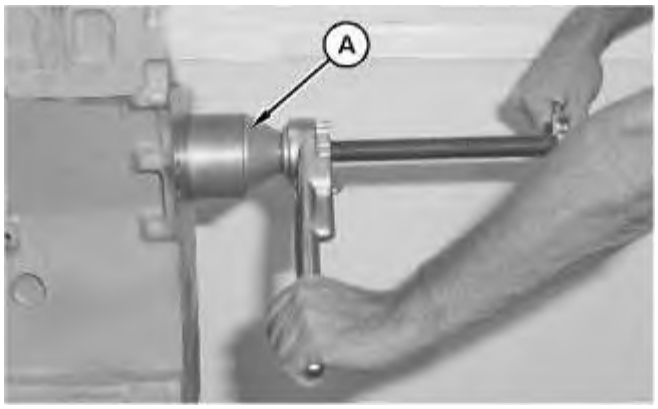


Illustration 2 g01038778

2. Use Tooling (A) to install the camshaft bearing in the cylinder block.

   Note: Align the oil holes in the camshaft bearing and the cylinder block. The camshaft bearing should be installed to a depth that is flush with the face of the recess in the cylinder block.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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i02707279

Crankshaft Main Bearings - Remove

SMCS - 1203-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the flywheel housing in order to remove the rear main bearing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Make sure that the main bearing caps are marked for the location and direction for installation. The main bearings and the main bearing caps must be installed in the same location.

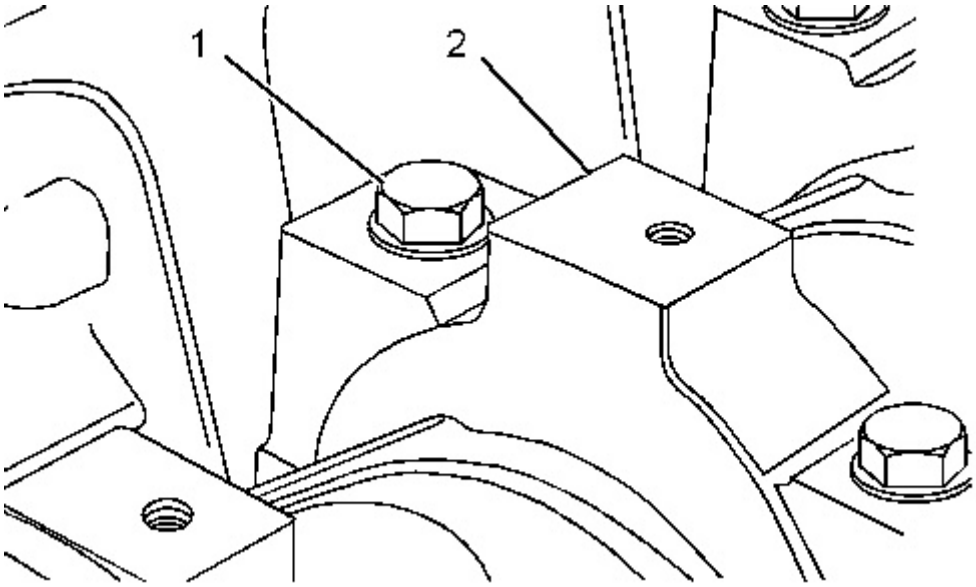


Illustration 1 g01358190

2. Remove bolts (1) and main bearing cap (2) .

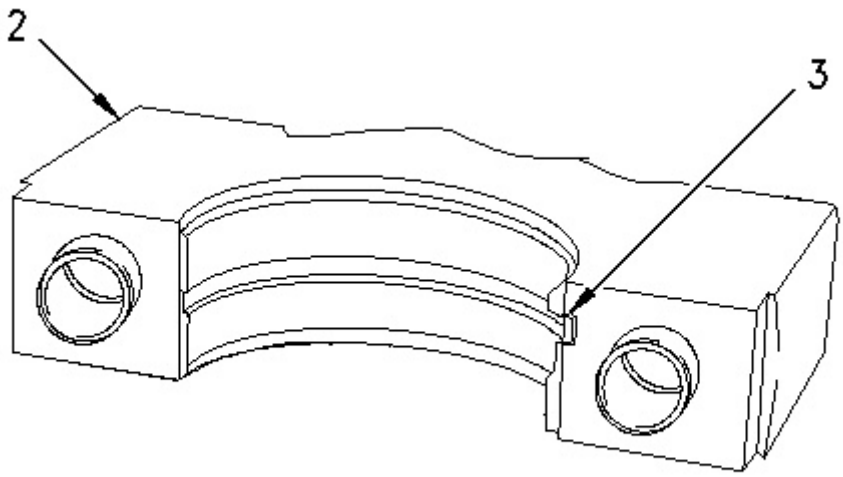


Illustration 2 g00934803

3. Remove lower main bearing (3) from main bearing cap (2). Keep the respective main bearing and the main bearing cap together for proper installation.

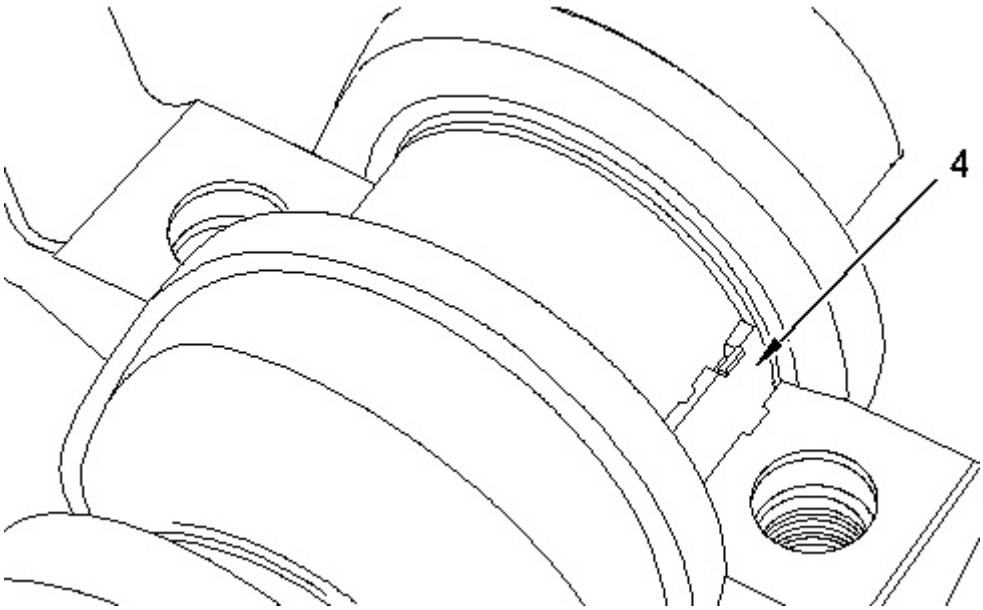


Illustration 3 g00934767

4. Push upper main bearing (4) from the opposite side of the bearing tab with a suitable tool. Carefully rotate the crankshaft while you push on the bearing. Remove upper main bearing (4) from the cylinder block. Keep the upper bearing halves together in order to ensure proper installation.

5. Repeat Step 2 through Step 4 for the remaining main bearings.

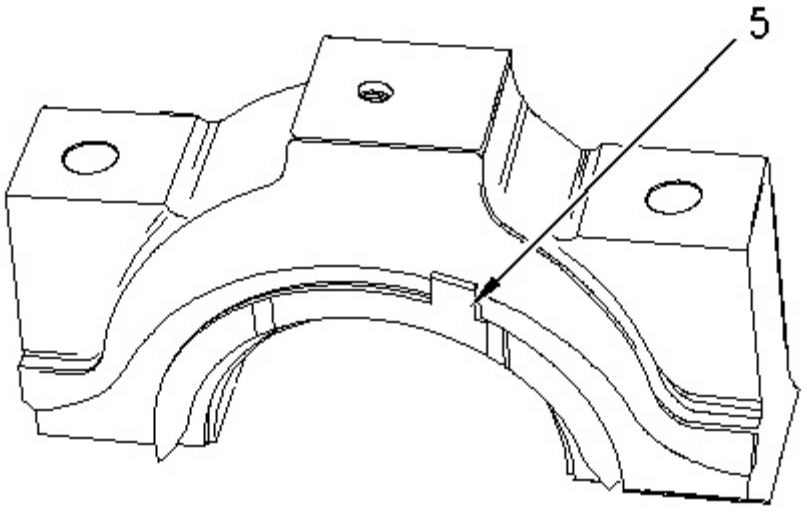


Illustration 4 g00934744

6. Remove the lower half of thrust washers (5) from both sides of the rear main bearing cap. Remove the seals from the rear main bearing cap.

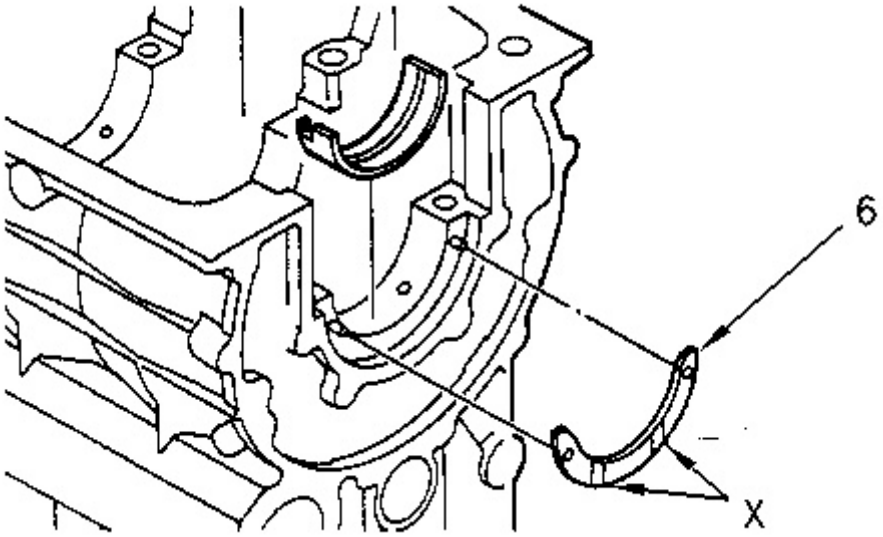


Illustration 5 g01001838

7. Remove the upper half of thrust washer (6) from the rear of the cylinder block. Carefully rotate the crankshaft while you push on thrust washer (6). If necessary, move the crankshaft to the front or to the rear in order to loosen a tight thrust washer.

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i02707287

Crankshaft Main Bearings - Install

SMCS - 1203-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

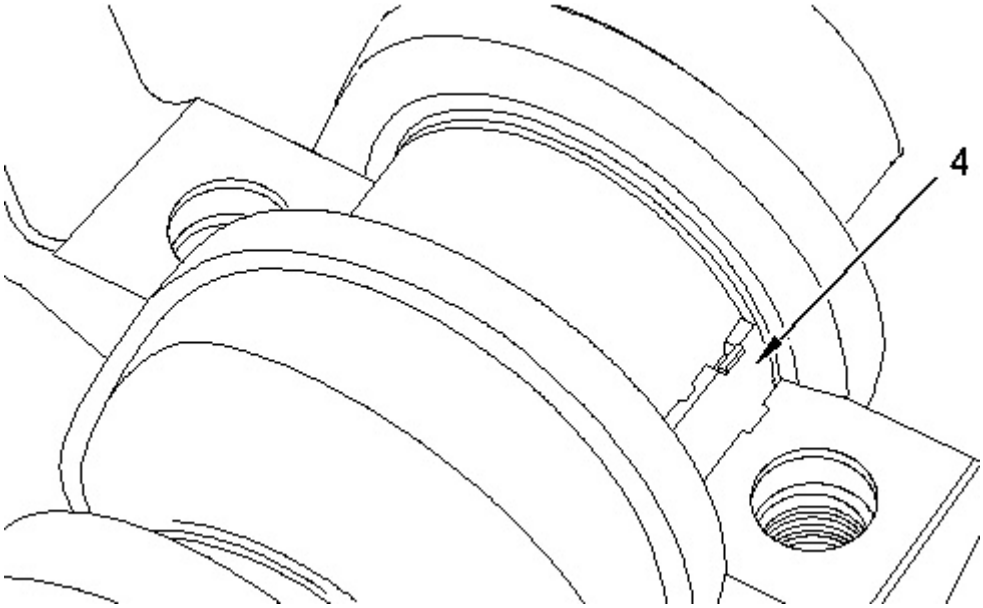


Illustration 1 g00934767

1. Clean upper main bearing (4) and lubricate the bearing surface with clean engine oil.

   Note: Do not put oil on the back sides of the crankshaft main bearings.

   Note: Ensure that the upper halves of the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block.

NOTICE

Only the upper half of the main bearing has lubrication holes. Make sure the upper half of the main bearing is installed correctly in the cylinder block to ensure proper lubrication.

2. Slide upper main bearing (4) into position between the crankshaft journal and the cylinder block.

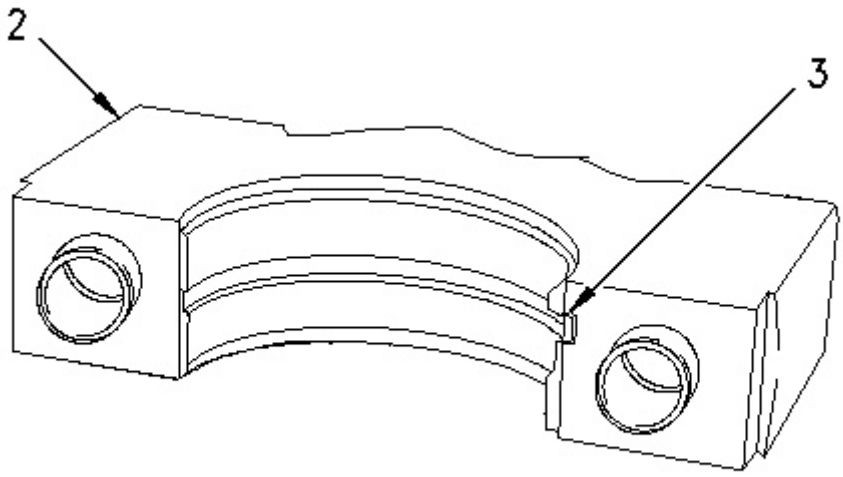


Illustration 2 g00934803

3. Clean main bearing cap (2) and lower main bearing (3). Lubricate the bearing surface of lower main bearing (3) with clean engine oil.

   Note: Ensure that the lower halves of the main bearings are installed so that the bearing tabs fit into the notch in the main bearing caps.

4. Install lower main bearing (3) in main bearing cap (2) .

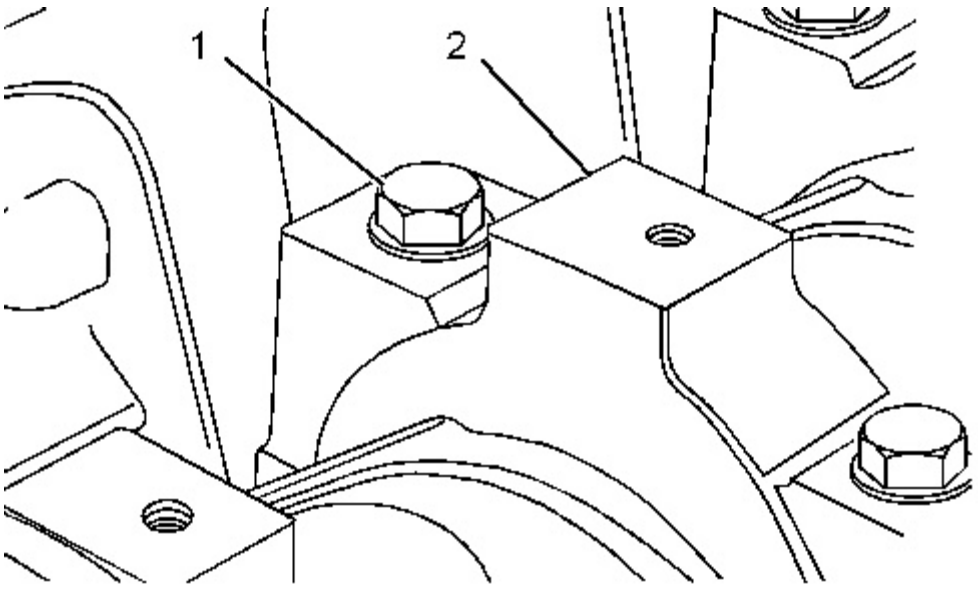


Illustration 3 g01358190

5. Install main bearing cap (2). Lubricate the threads of bolts (1) with clean engine oil. Install bolts (1) and tighten finger tight.

6. Repeat Steps 1 through 5 for the remaining main bearings.

   Note: Do not install the rear main bearing cap yet.

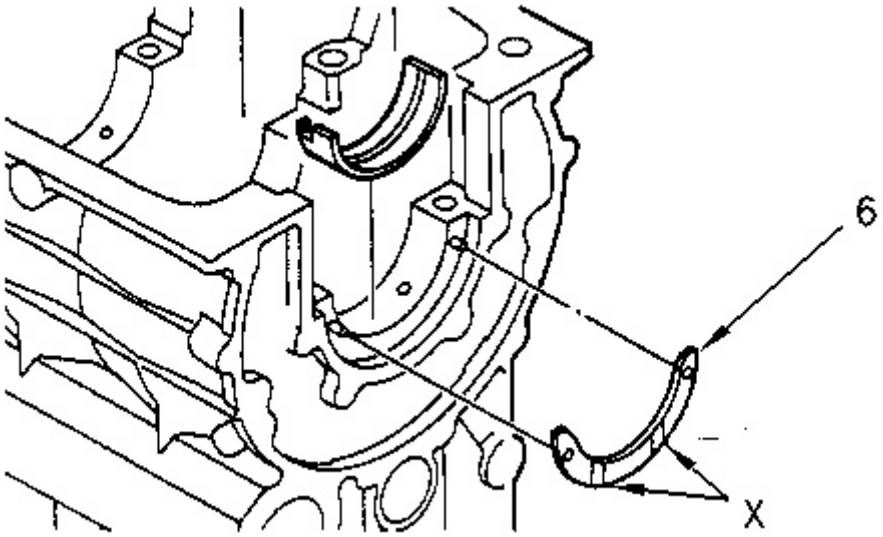


Illustration 4 g01001838

7. Install the upper half of thrust washer (6) on the rear of the cylinder block with the Oil Grooves (X) toward the outside. If necessary, move the crankshaft to the front or to the rear in order to install the thrust washer.

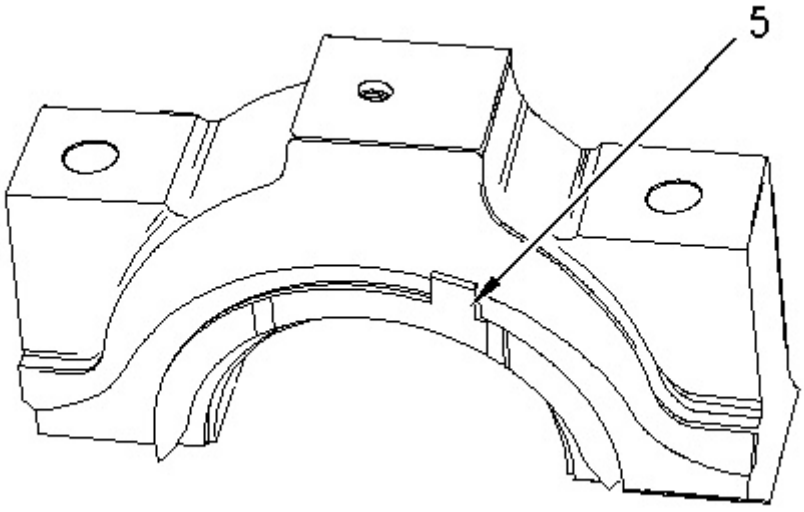


Illustration 5 g00934744

8. Install the lower half of thrust washer (5) on each side of the rear main bearing cap. The grooves on the thrust washer must be located against the crankshaft.

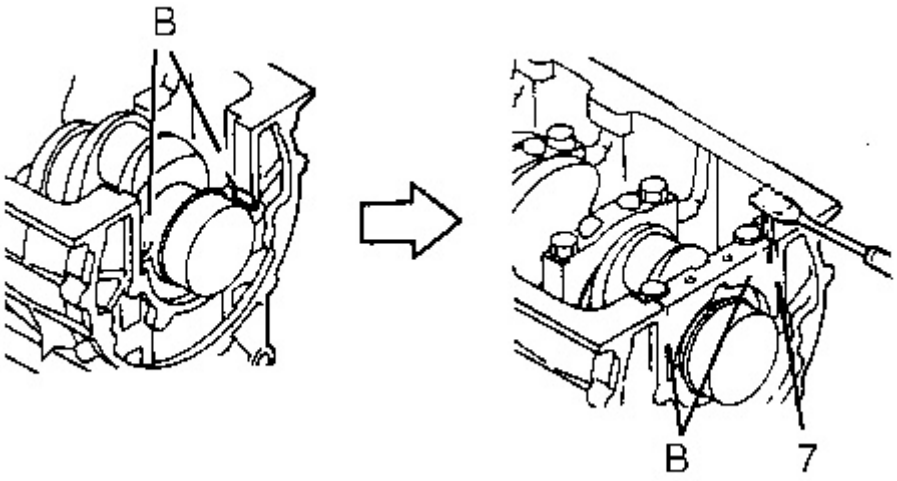


Illustration 6 g01041142

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

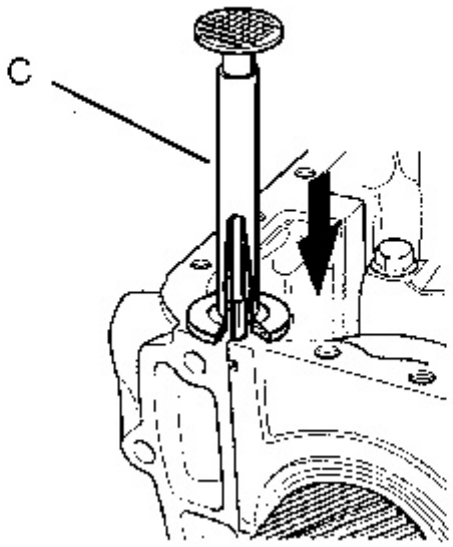


Illustration 7 g01033394

10. Apply soapy water to side seals (7). Position side seals (7) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push

the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (7) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

13. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
b. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

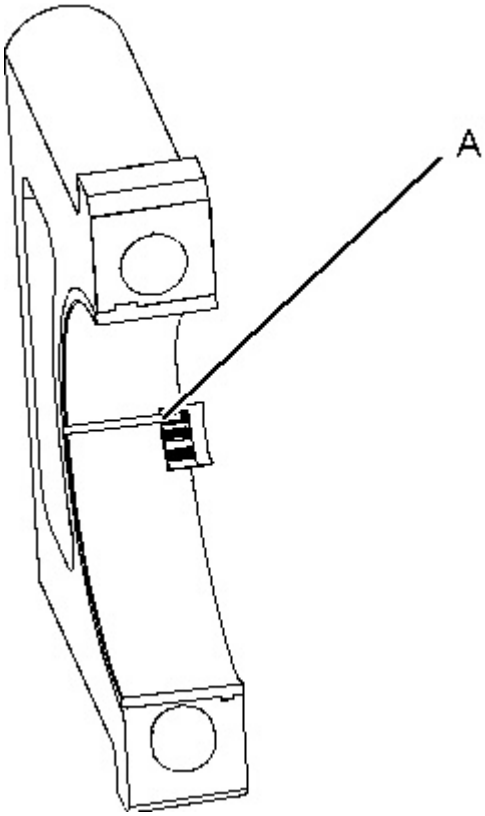


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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i02707279

Crankshaft Main Bearings - Remove

SMCS - 1203-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the flywheel housing in order to remove the rear main bearing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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1. Make sure that the main bearing caps are marked for the location and direction for installation. The main bearings and the main bearing caps must be installed in the same location.

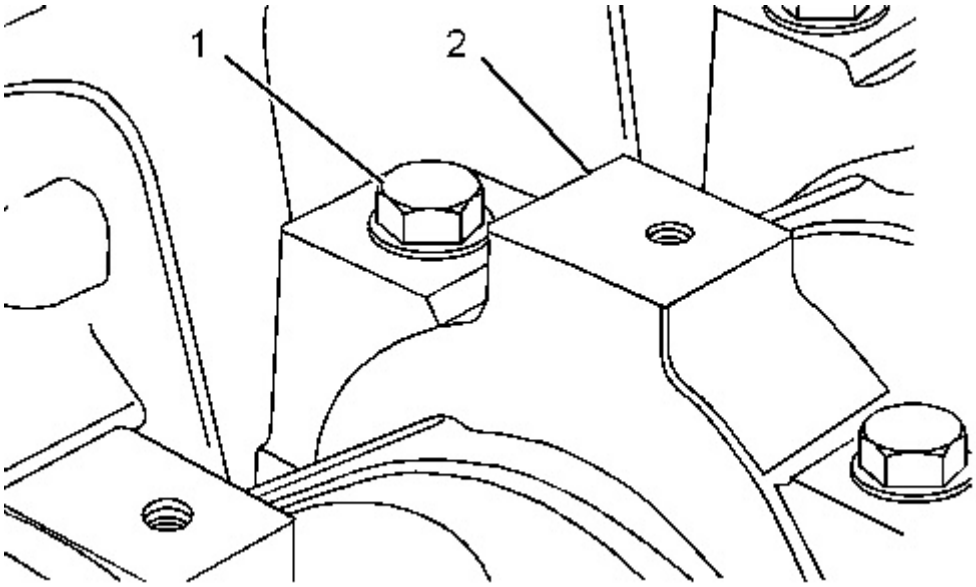


Illustration 1 g01358190

2. Remove bolts (1) and main bearing cap (2) .

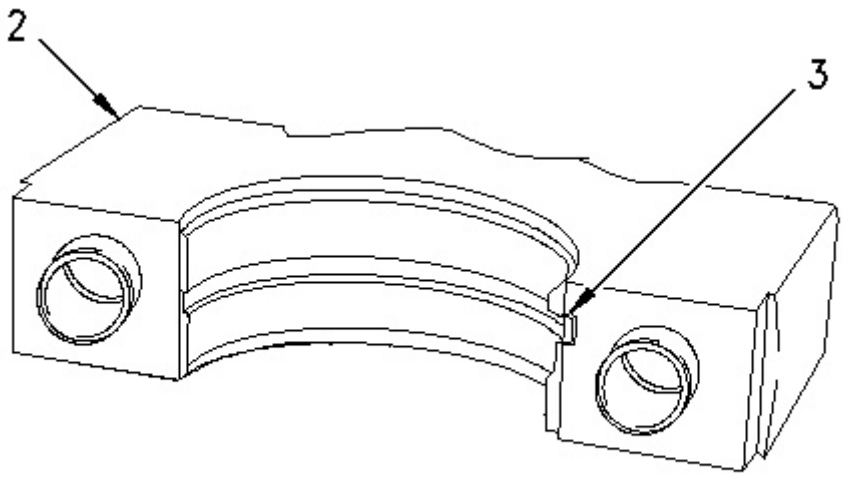


Illustration 2 g00934803

3. Remove lower main bearing (3) from main bearing cap (2). Keep the respective main bearing and the main bearing cap together for proper installation.

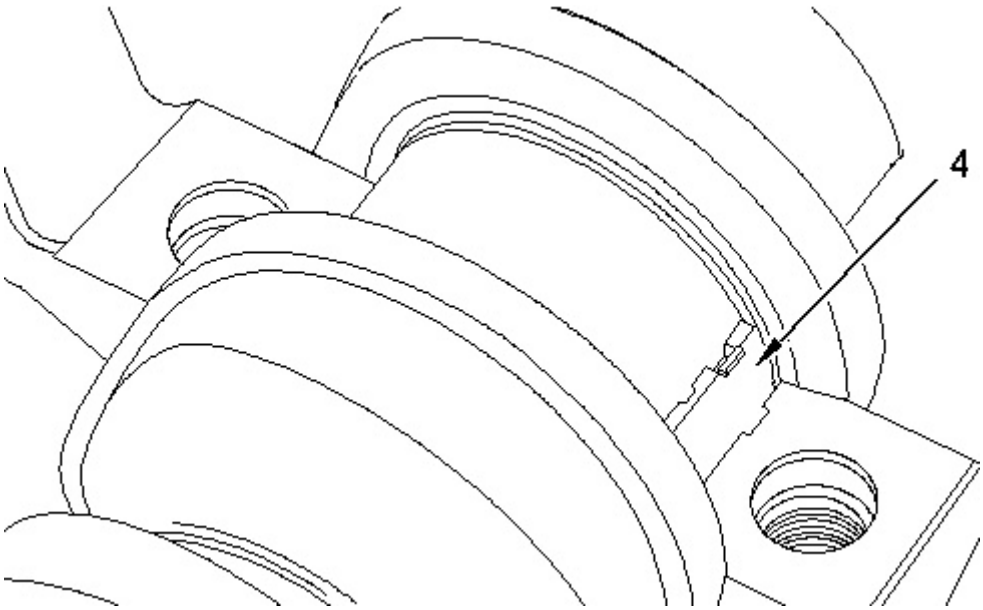


Illustration 3 g00934767

4. Push upper main bearing (4) from the opposite side of the bearing tab with a suitable tool. Carefully rotate the crankshaft while you push on the bearing. Remove upper main bearing (4) from the cylinder block. Keep the upper bearing halves together in order to ensure proper installation.

5. Repeat Step 2 through Step 4 for the remaining main bearings.

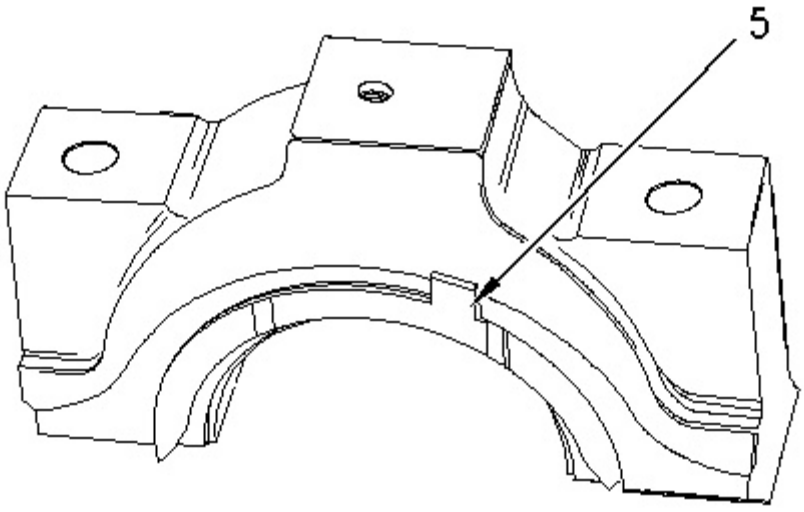


Illustration 4 g00934744

6. Remove the lower half of thrust washers (5) from both sides of the rear main bearing cap. Remove the seals from the rear main bearing cap.

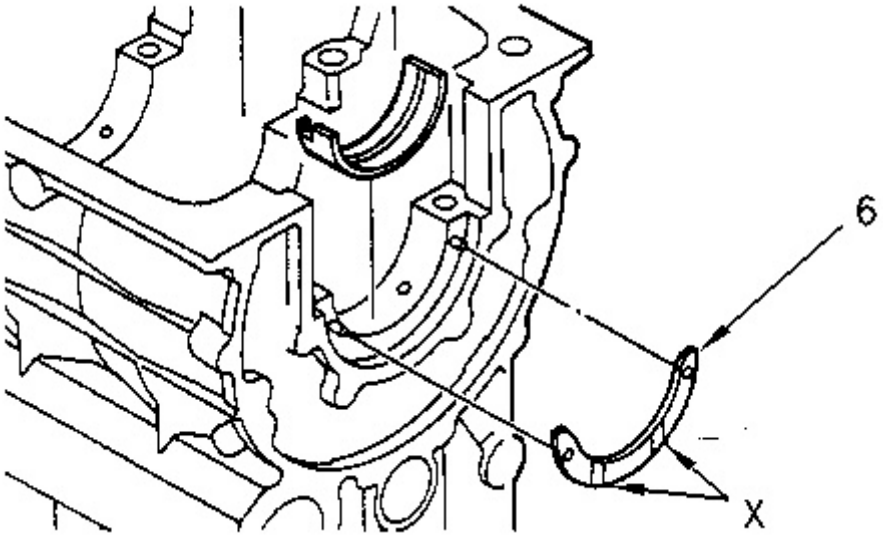


Illustration 5 g01001838

7. Remove the upper half of thrust washer (6) from the rear of the cylinder block. Carefully rotate the crankshaft while you push on thrust washer (6). If necessary, move the crankshaft to the front or to the rear in order to loosen a tight thrust washer.

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i02707287

Crankshaft Main Bearings - Install

SMCS - 1203-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Gp	1
B	8T-9022	Silicone Gasket	-
C	198-9113	Seal Installer	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

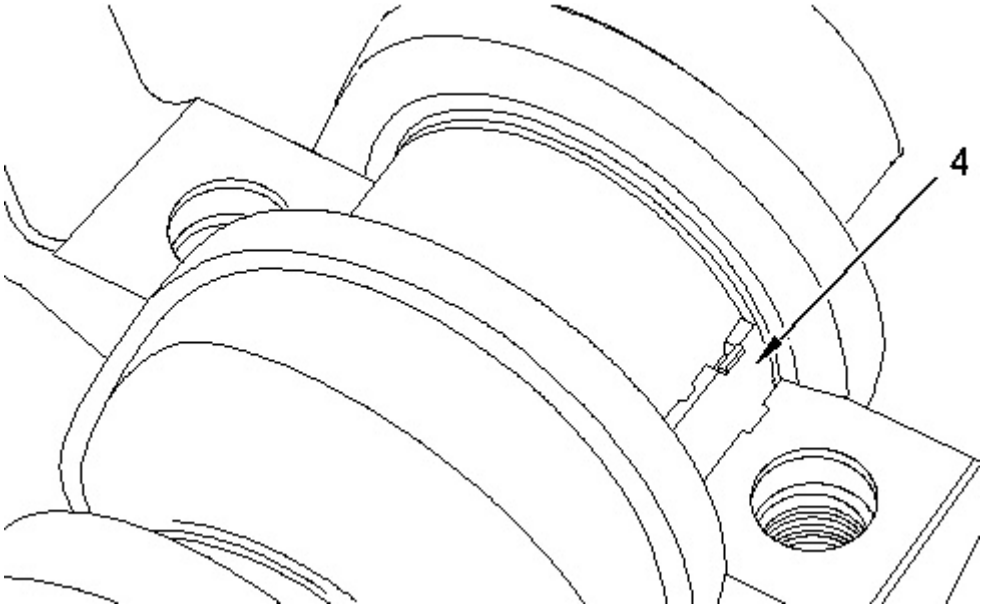


Illustration 1 g00934767

1. Clean upper main bearing (4) and lubricate the bearing surface with clean engine oil.

   Note: Do not put oil on the back sides of the crankshaft main bearings.

   Note: Ensure that the upper halves of the main bearings are installed so that the bearing tabs fit into the notch in the cylinder block.

NOTICE

Only the upper half of the main bearing has lubrication holes. Make sure the upper half of the main bearing is installed correctly in the cylinder block to ensure proper lubrication.

2. Slide upper main bearing (4) into position between the crankshaft journal and the cylinder block.

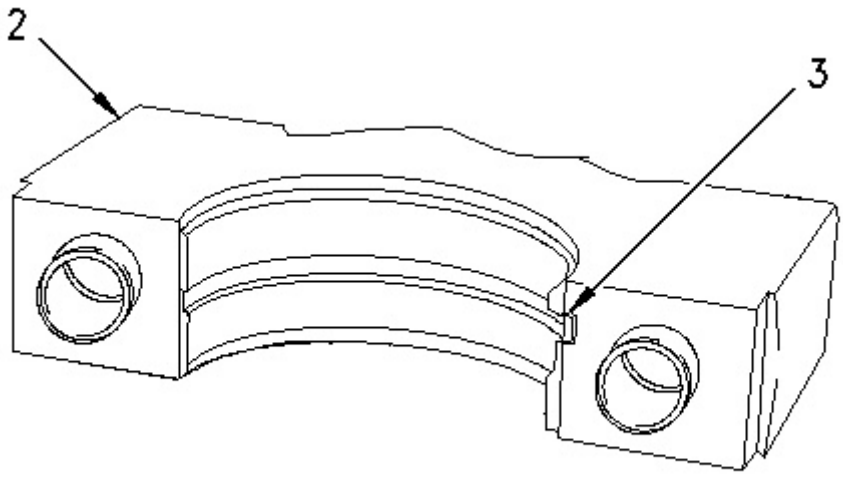


Illustration 2 g00934803

3. Clean main bearing cap (2) and lower main bearing (3). Lubricate the bearing surface of lower main bearing (3) with clean engine oil.

   Note: Ensure that the lower halves of the main bearings are installed so that the bearing tabs fit into the notch in the main bearing caps.

4. Install lower main bearing (3) in main bearing cap (2) .

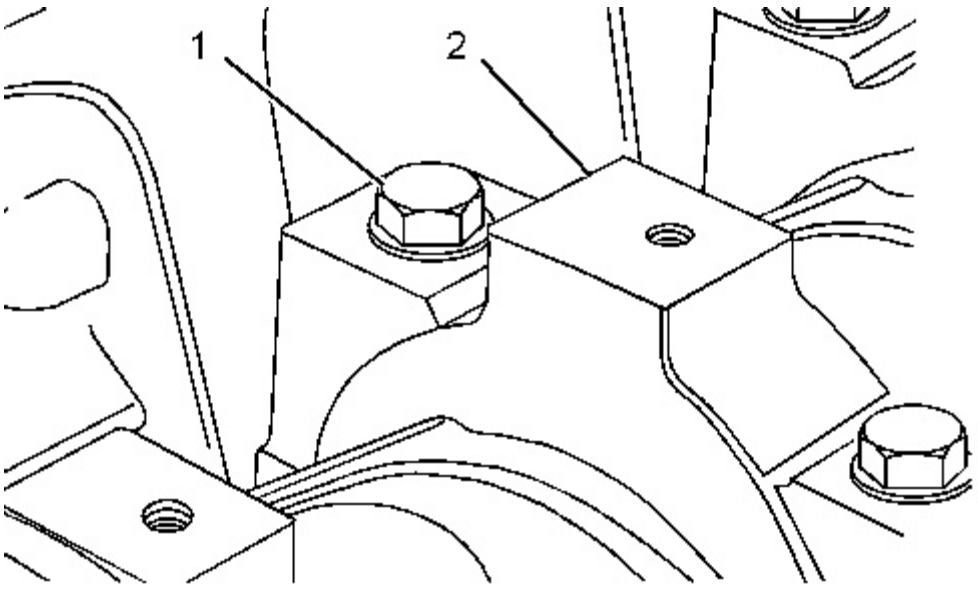


Illustration 3 g01358190

5. Install main bearing cap (2). Lubricate the threads of bolts (1) with clean engine oil. Install bolts (1) and tighten finger tight.

6. Repeat Steps 1 through 5 for the remaining main bearings.

   Note: Do not install the rear main bearing cap yet.

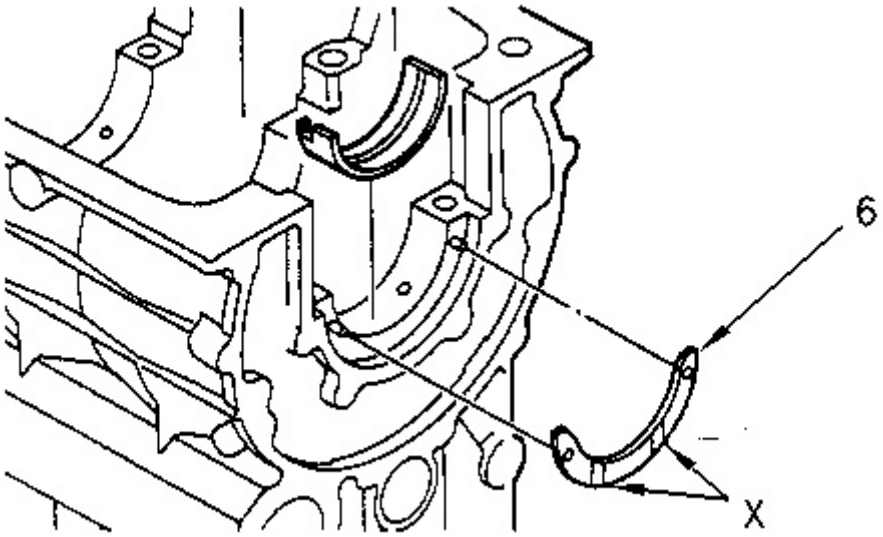


Illustration 4 g01001838

7. Install the upper half of thrust washer (6) on the rear of the cylinder block with the Oil Grooves (X) toward the outside. If necessary, move the crankshaft to the front or to the rear in order to install the thrust washer.

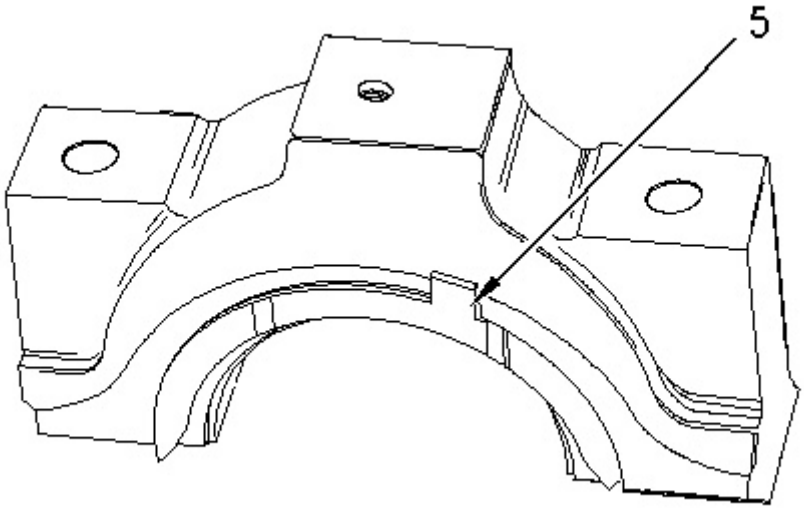


Illustration 5 g00934744

8. Install the lower half of thrust washer (5) on each side of the rear main bearing cap. The grooves on the thrust washer must be located against the crankshaft.

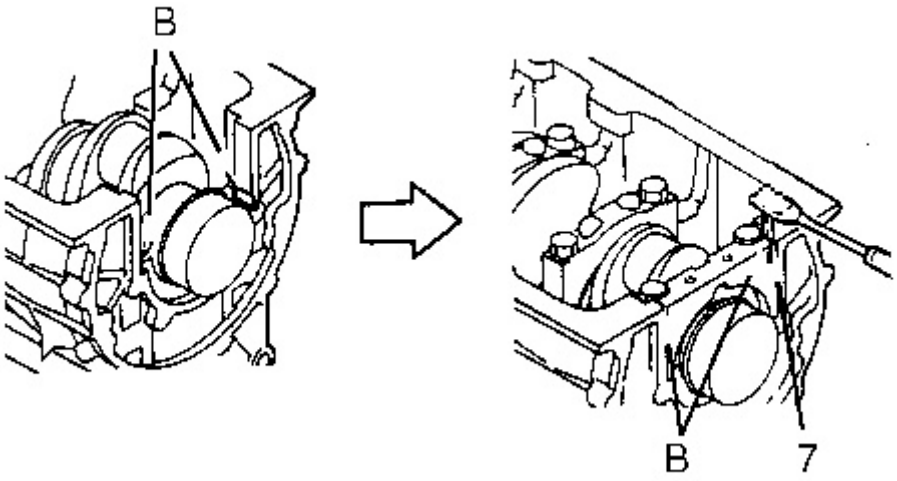


Illustration 6 g01041142

9. Apply Tooling (B) to the corners of the rear main bearing cap. Install the rear main bearing cap to the cylinder block so that the rear face is even with the rear face of the cylinder block.

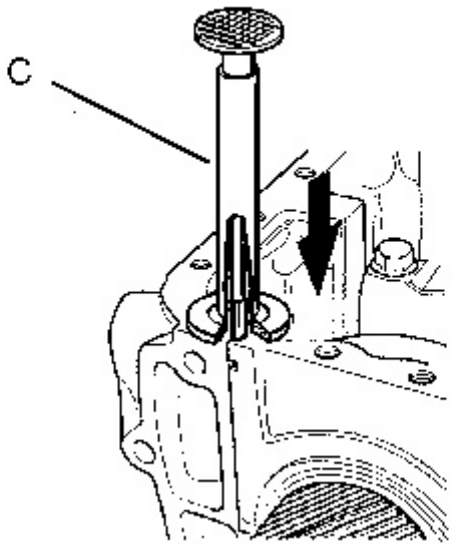


Illustration 7 g01033394

10. Apply soapy water to side seals (7). Position side seals (7) in the grooves on the rear main bearing cap with the rounded edges of the seals toward the outside. Use Tooling (C) to push

the seal into position in order to reduce the risk of damaging the seal's metal core. Apply Tooling (B) around side seals (7) .

11. Install the bolts for the rear main bearing cap. Tighten all of the bolts for the main bearing caps to a torque of 98 to 108 N·m (72 to 80 lb ft).

12. Rotate the crankshaft in order to ensure that the crankshaft turns freely.

13. Check the crankshaft end play. Use a prybar to move the crankshaft toward the front of the engine. Use Tooling (A) to measure the end play. The maximum permissible crankshaft end play is 0.300 mm (0.0118 inch).

End By:

a. Install the flywheel housing. Refer to Disassembly and Assembly, "Flywheel Housing - Remove and Install".
b. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

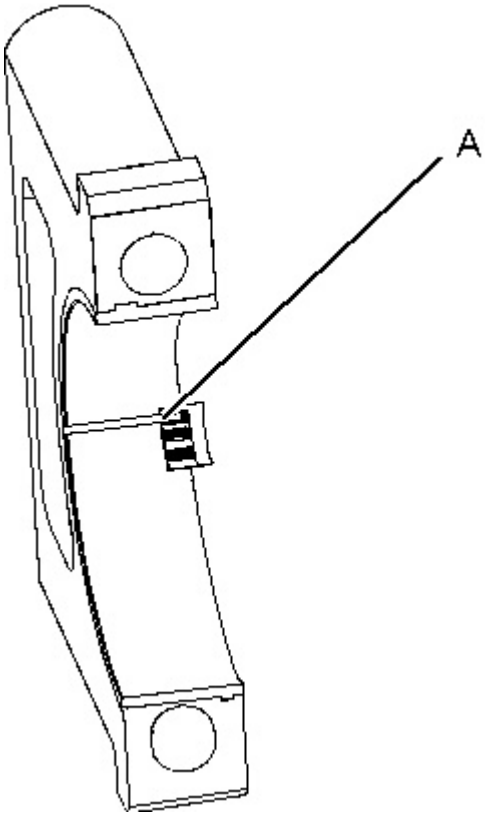


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

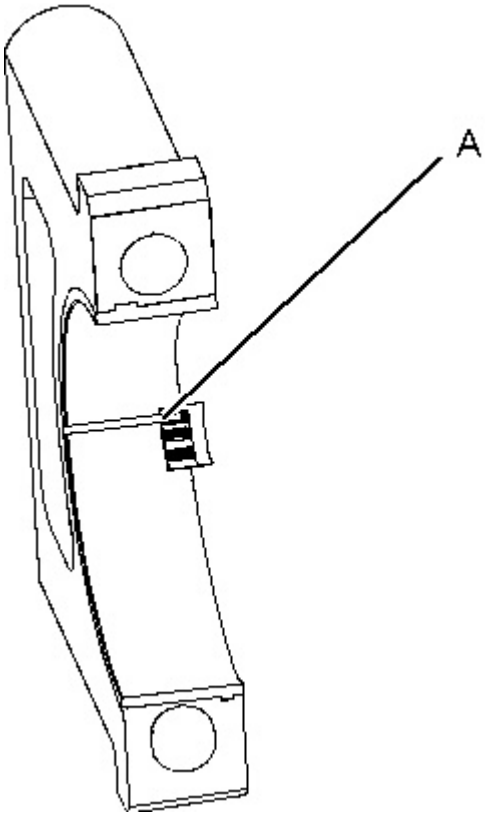


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02507999

Fuel Injection Nozzles

SMCS - 1254

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Naturally Aspirated Engines

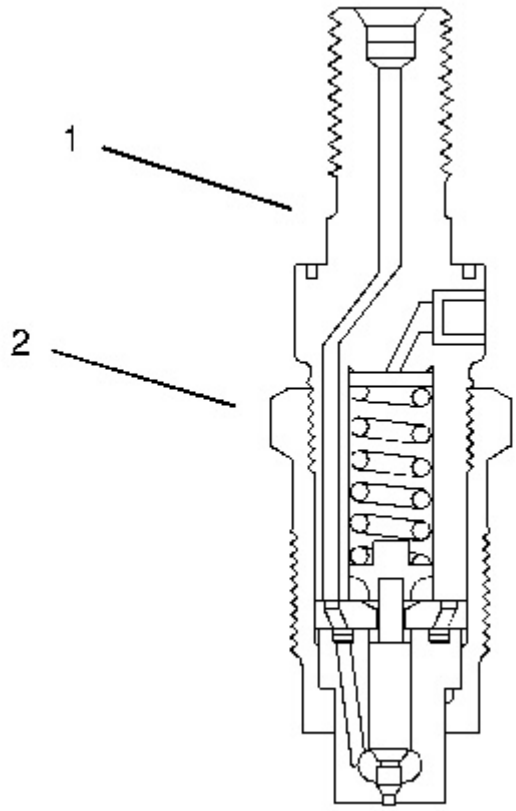


Illustration 1 g01010241

(1) Tighten the body in the retaining nut to the following torque. ... 34 to 39 N·m (25 to 29 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

(2) Tighten the fuel injection nozzle in the engine to the following torque. ... 53 to 65 N·m (39 to 48 lb ft)

Type of fuel injection nozzle ... single orifice

Injection pressure

Standard at assembly ... 11.77 to 12.75 MPa (1707 to 1849 psi)

Turbocharged Engines

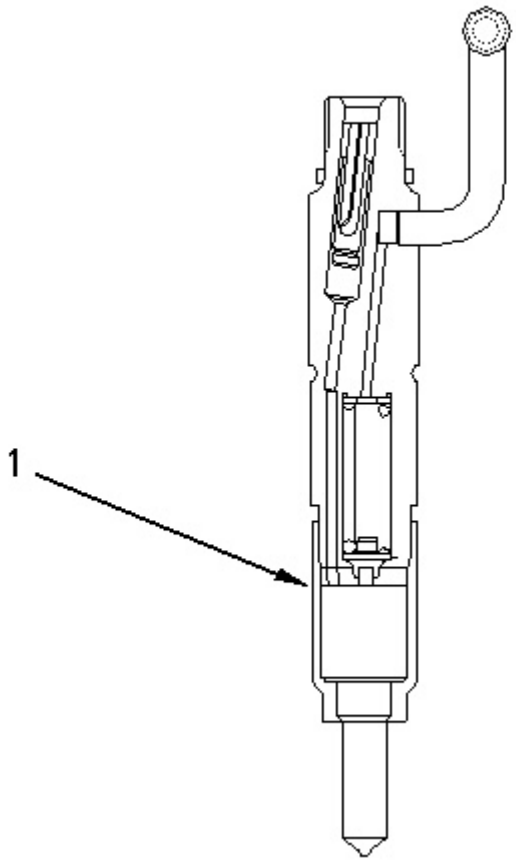


Illustration 2 g00993511

(1) Tighten the retaining nut to the following torque. ... 25 to 34 N·m (18 to 25 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

Tighten the clamp bolt that secures the fuel injection nozzle in the cylinder head to the following torque. ... 21 to 23 N·m (15 to 17 lb ft)

Type of fuel injection nozzle ... multiple orifice

Injection pressure

Standard at assembly ... 18.14 to 19.12 MPa (2631 to 2773 psi)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01892207

Cylinder Head Valves

SMCS - 1105

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

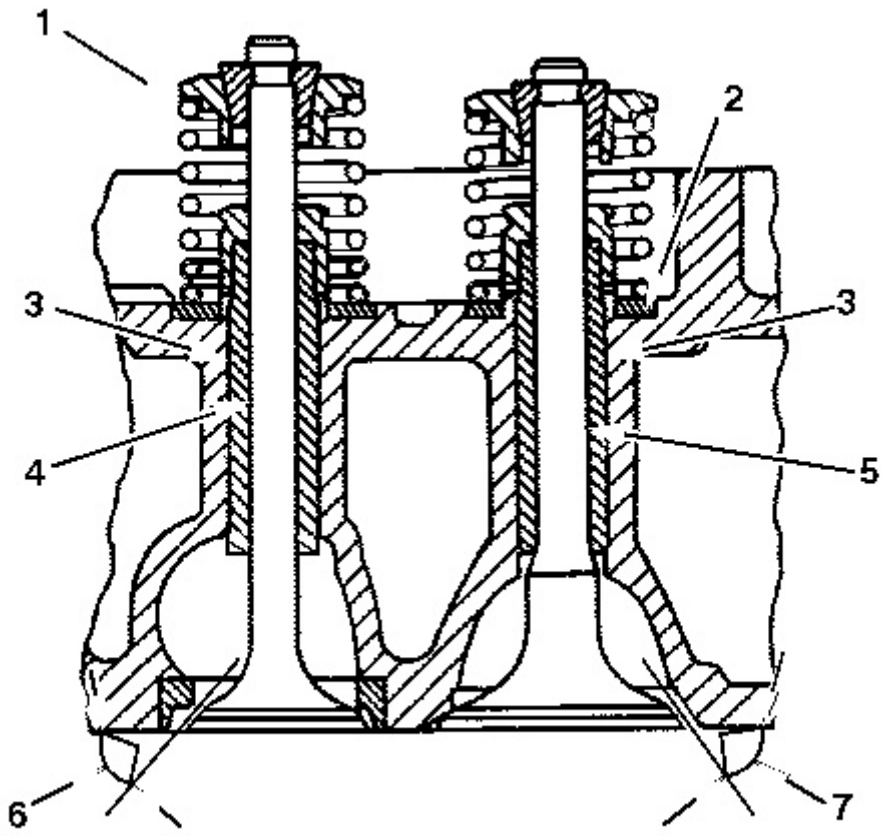


Illustration 1 g01010358

(1) Valve spring

Free length of the valve springs ... 48.85 mm (1.92 inch)
Service limit for free length of the valve springs ... 47.60 mm (1.87 inch)
Length of the valve springs under set force ... 43 mm (1.69 inch)
Set force of the valve springs ... 176 to 196 N (40 to 44 lb)
Service limit for set force of the valve springs ... 147 N (33 lb)

(2) Valve spring recess

(3) Valve guides

Projection of the valve guide above the valve spring recess ... 14 ± 0.1 mm (0.55 ± 0.004 inch)

(4) Exhaust valve

Diameter of the exhaust valve stem ... 7.920 to 7.940 mm (0.3118 to 0.3126 inch)
Service limit diameter of the exhaust valve stem ... 7.850 mm (0.3091 inch)
Clearance of the exhaust valve stem in the exhaust valve guide ... 0.080 to 0.115 mm (0.0031 to 0.0045 inch)
Maximum allowable clearance of the exhaust valve stem in the exhaust valve guide ... 0.200 mm (0.0079 inch)

Valve depth of the exhaust valve below the cylinder head face

Standard at assembly ... 0.4 to 0.6 mm (0.016 to 0.024 inch)
Service limit ... 1.0 mm (0.039 inch)

(5) Inlet valve

Diameter of the inlet valve stem ... 7.940 to 7.955 mm (0.3126 to 0.3132 inch)
Service limit diameter of the inlet valve stem ... 7.900 mm (0.3110 inch)
Clearance of the inlet valve stem in the inlet valve guide ... 0.065 to 0.095 mm (0.0026 to 0.0037 inch)
Maximum allowable clearance of the inlet valve stem in the inlet valve guide ... 0.150 mm (0.0059 inch)

Valve depth of the inlet valve below the cylinder head face

Standard at assembly ... 0.3 to 0.5 mm (0.012 to 0.020 inch)
Service limit ... 1.0 mm (0.039 inch)

(6) Angle of the exhaust valve face from the horizontal axis

Valve face angle ... 30 degrees
Valve seat angle ... 30 degrees

(7) Angle of the inlet valve face from the horizontal axis

Valve face angle ... 30 degrees
Valve seat angle ... 30 degrees

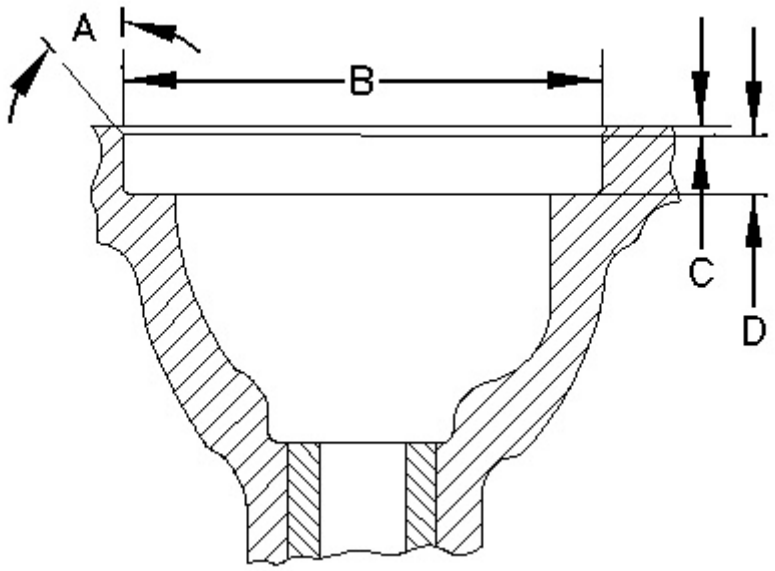


Illustration 2 g00985069

Bore in the cylinder head for the valve seats

Bore for the inlet valve seat

A ... 45 degrees
B ... 46 to 46.0025 mm (1.8110 to 1.8111 inch)
C ... 2 ± 0.1 mm (0.079 ± 0.004 inch)
D ... 8 ± 0.1 mm (0.315 ± 0.004 inch)

Bore for the exhaust valve seat

A ... 45 degrees
B ... 37 to 37.0025 mm (1.457 to 1.458 inch)
C ... 2 ± 0.1 mm (0.079 ± 0.004 inch)
D ... 8 ± 0.1 mm (0.315 ± 0.004 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01892090

Cylinder Head

SMCS - 1100

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

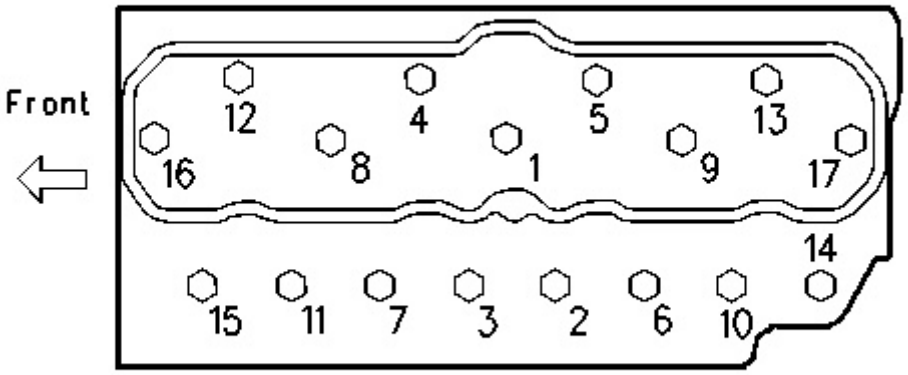


Illustration 1 g00984896

Tighten the cylinder head bolts in the sequence that is shown to the following torque. ... 113 to 123 N·m (83 to 91 lb ft)

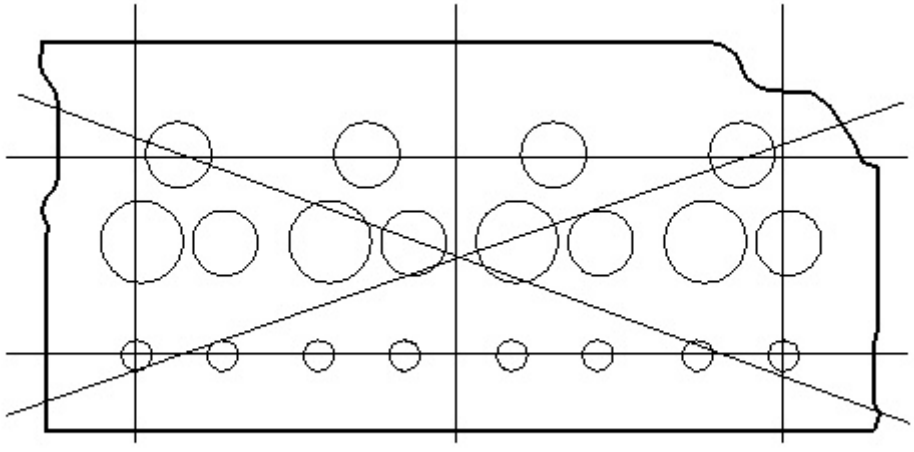


Illustration 2 g00984909

The permissible distortion of the cylinder head is given below.

Maximum at assembly ... 0.05 mm (0.0020 inch)
Repair limit ... 0.20 mm (0.0079 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02507999

Fuel Injection Nozzles

SMCS - 1254

S/N - -

Naturally Aspirated Engines

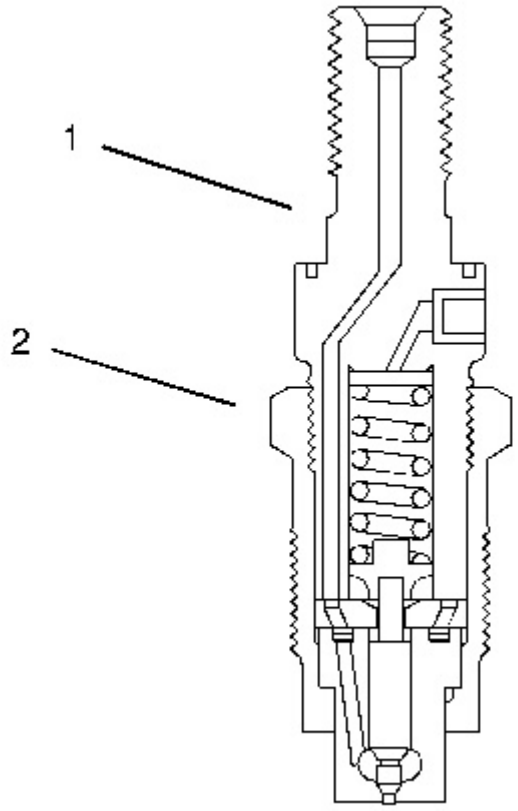


Illustration 1 g01010241

(1) Tighten the body in the retaining nut to the following torque. ... 34 to 39 N·m (25 to 29 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

(2) Tighten the fuel injection nozzle in the engine to the following torque. ... 53 to 65 N·m (39 to 48 lb ft)

Type of fuel injection nozzle ... single orifice

Injection pressure

Standard at assembly ... 11.77 to 12.75 MPa (1707 to 1849 psi)

Turbocharged Engines

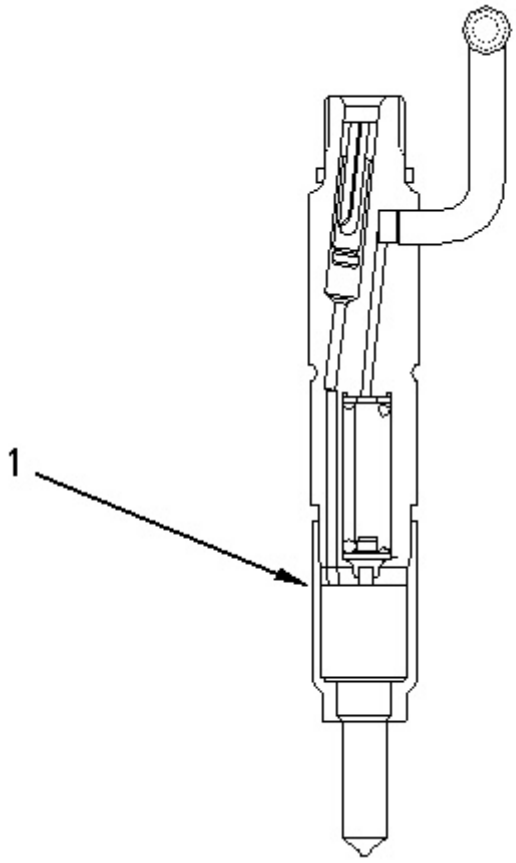


Illustration 2 g00993511

(1) Tighten the retaining nut to the following torque. ... 25 to 34 N·m (18 to 25 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

Tighten the clamp bolt that secures the fuel injection nozzle in the cylinder head to the following torque. ... 21 to 23 N·m (15 to 17 lb ft)

Type of fuel injection nozzle ... multiple orifice

Injection pressure

Standard at assembly ... 18.14 to 19.12 MPa (2631 to 2773 psi)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01892207

Cylinder Head Valves

SMCS - 1105

S/N - -

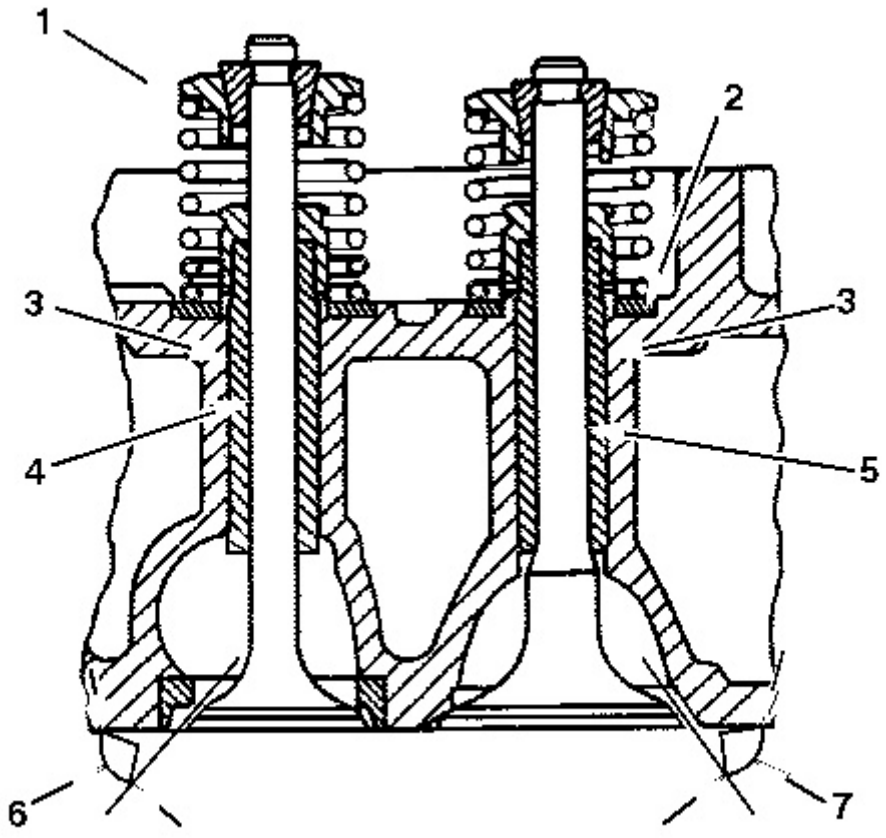


Illustration 1 g01010358

(1) Valve spring

Free length of the valve springs ... 48.85 mm (1.92 inch)

Service limit for free length of the valve springs ... 47.60 mm (1.87 inch)
Length of the valve springs under set force ... 43 mm (1.69 inch)
Set force of the valve springs ... 176 to 196 N (40 to 44 lb)
Service limit for set force of the valve springs ... 147 N (33 lb)

(2) Valve spring recess

(3) Valve guides

Projection of the valve guide above the valve spring recess ... 14 ± 0.1 mm (0.55 ± 0.004 inch)

(4) Exhaust valve

Diameter of the exhaust valve stem ... 7.920 to 7.940 mm (0.3118 to 0.3126 inch)
Service limit diameter of the exhaust valve stem ... 7.850 mm (0.3091 inch)
Clearance of the exhaust valve stem in the exhaust valve guide ... 0.080 to 0.115 mm (0.0031 to 0.0045 inch)
Maximum allowable clearance of the exhaust valve stem in the exhaust valve guide ... 0.200 mm (0.0079 inch)

Valve depth of the exhaust valve below the cylinder head face

Standard at assembly ... 0.4 to 0.6 mm (0.016 to 0.024 inch)
Service limit ... 1.0 mm (0.039 inch)

(5) Inlet valve

Diameter of the inlet valve stem ... 7.940 to 7.955 mm (0.3126 to 0.3132 inch)
Service limit diameter of the inlet valve stem ... 7.900 mm (0.3110 inch)
Clearance of the inlet valve stem in the inlet valve guide ... 0.065 to 0.095 mm (0.0026 to 0.0037 inch)
Maximum allowable clearance of the inlet valve stem in the inlet valve guide ... 0.150 mm (0.0059 inch)

Valve depth of the inlet valve below the cylinder head face

Standard at assembly ... 0.3 to 0.5 mm (0.012 to 0.020 inch)
Service limit ... 1.0 mm (0.039 inch)

(6) Angle of the exhaust valve face from the horizontal axis

Valve face angle ... 30 degrees
Valve seat angle ... 30 degrees

(7) Angle of the inlet valve face from the horizontal axis

Valve face angle ... 30 degrees
Valve seat angle ... 30 degrees

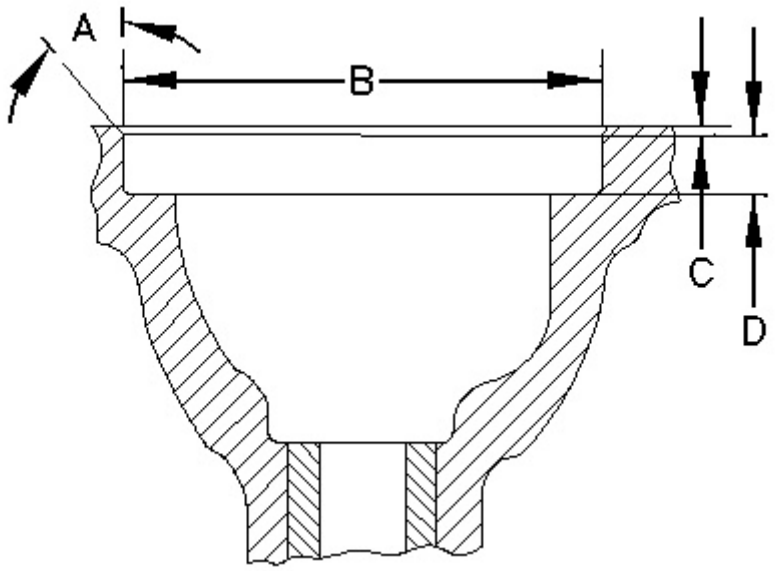


Illustration 2 g00985069

Bore in the cylinder head for the valve seats

Bore for the inlet valve seat

A ... 45 degrees
B ... 46 to 46.0025 mm (1.8110 to 1.8111 inch)
C ... 2 ± 0.1 mm (0.079 ± 0.004 inch)
D ... 8 ± 0.1 mm (0.315 ± 0.004 inch)

Bore for the exhaust valve seat

A ... 45 degrees
B ... 37 to 37.0025 mm (1.457 to 1.458 inch)
C ... 2 ± 0.1 mm (0.079 ± 0.004 inch)
D ... 8 ± 0.1 mm (0.315 ± 0.004 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01892090

Cylinder Head

SMCS - 1100

S/N - -

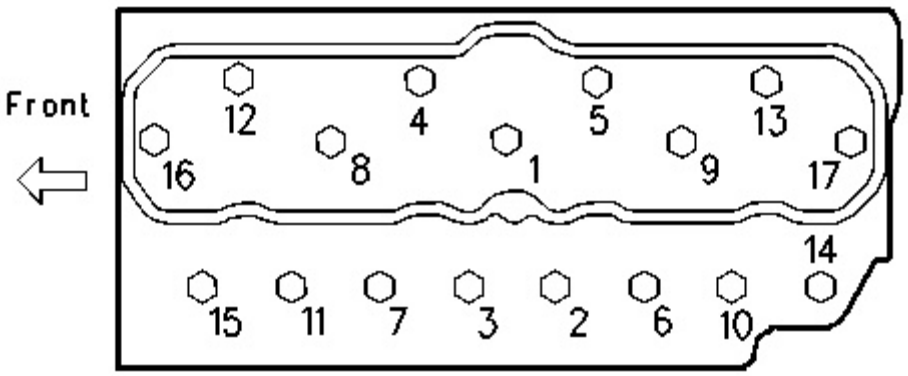


Illustration 1 g00984896

Tighten the cylinder head bolts in the sequence that is shown to the following torque. ... 113 to 123 N·m (83 to 91 lb ft)

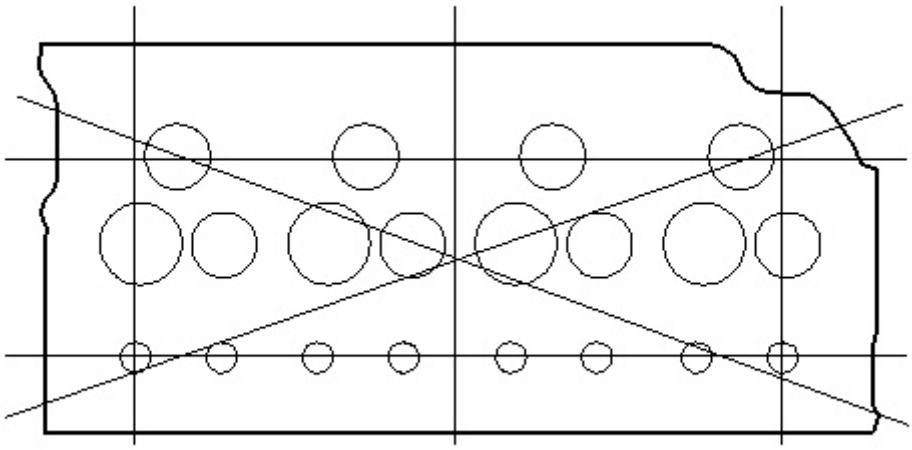


Illustration 2 g00984909

The permissible distortion of the cylinder head is given below.

Maximum at assembly ... 0.05 mm (0.0020 inch)
Repair limit ... 0.20 mm (0.0079 inch)

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i02000605

Inlet and Exhaust Valve Springs - Remove and Install

SMCS - 1108-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector (1)	1
B	-	Rod (M12 X 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1
D	8S-2263	Spring Tester	1

(1) The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

Start By:

A. Remove the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. Remove the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

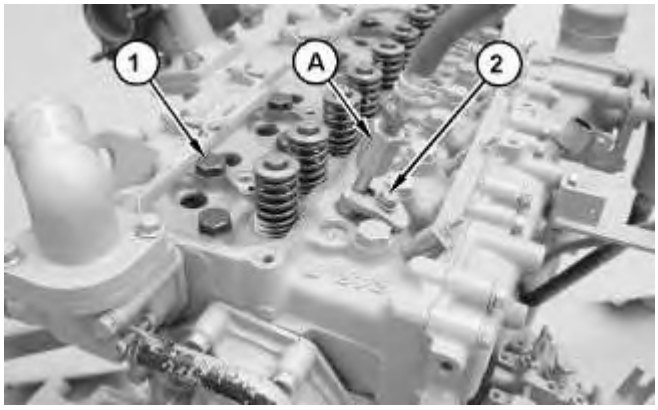


Illustration 1 g01035126

1. Install Tooling (A). Install the bolt and bracket (2). Remove bolt (1) .

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are removed and installed.

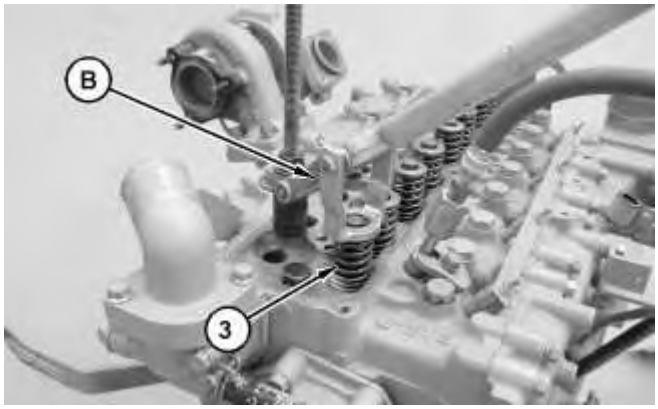


Illustration 2 g01035165

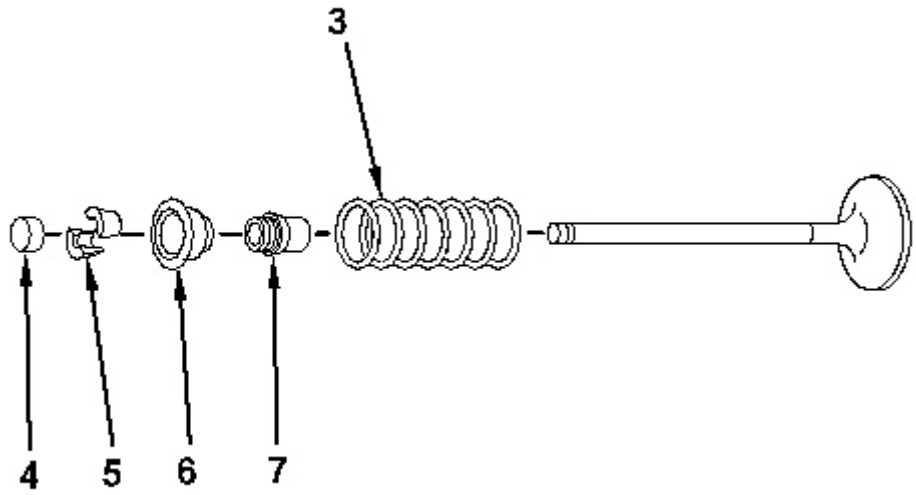


Illustration 3 g01035176

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

2. Install Tooling (B). Use Tooling (B) to compress valve spring (3). Remove cap (4) and retainers (5) .
3. Release the pressure from Tooling (B) and remove Tooling (B). Remove retainer (6) .
4. If necessary, use Tooling (C) to remove seal (7) .
5. Use Tooling (D) to check the valve spring force. Refer to Specifications, "Cylinder Head Valves".
6. Repeat Steps 1 through 5 for the removal of the remaining valve springs.

NOTICE

Do not turn the crankshaft while the valve springs are removed.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector [1]	1
B	-	Rod (M12 X 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-6373	Seal Installer	1

[1] The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Keep Tooling (B) and an air hose attached in order to force air pressure into the cylinder. This will hold the valves in position while the inlet and exhaust valve springs are installed.

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are installed.

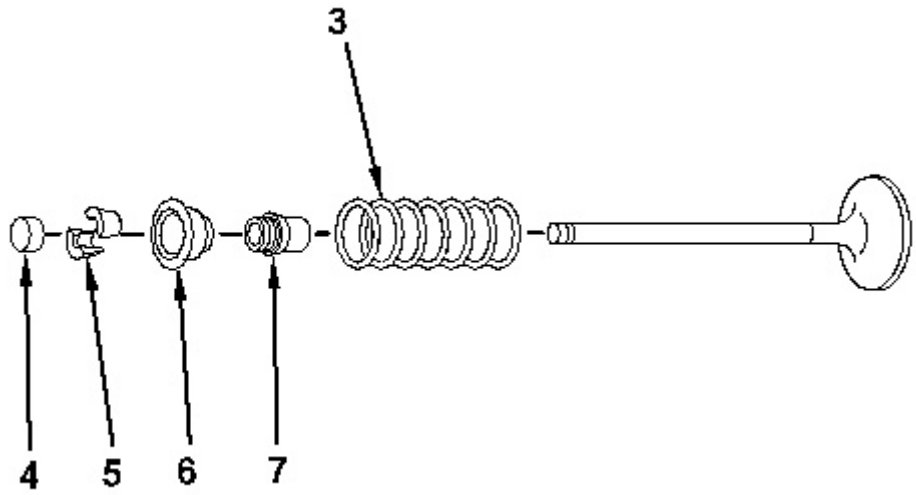


Illustration 4 g01035176

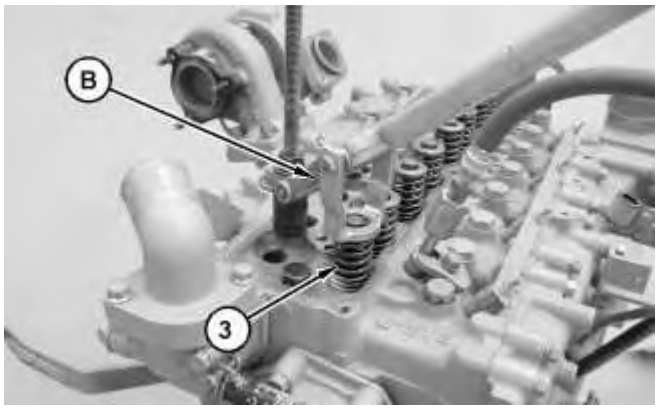


Illustration 5 g01035165

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

2. If necessary, use Tooling (C) to install seal (7) .
3. Position valve spring (3). Position retainer (6) on spring (3) .

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

4. Install Tooling (B) and compress spring (3). Install retainers (5) and cap (4) .
5. Release the pressure and remove Tooling (B) .
6. Tap the top of the valve with a soft hammer in order to ensure that retainers (5) are properly installed.
7. Repeat Steps 1 through 6 in order to install the remaining valve springs.

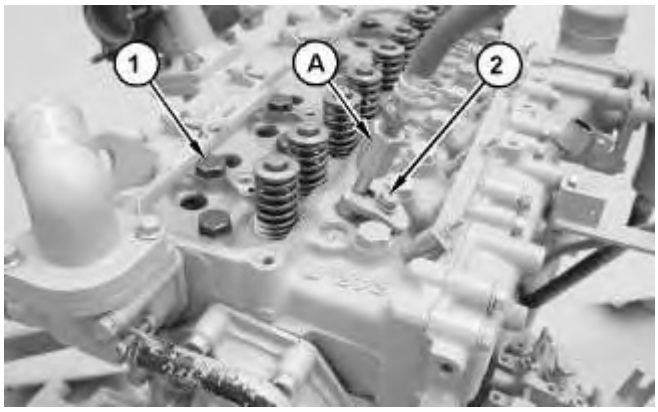


Illustration 6 g01035126

8. Remove the bolt and bracket (2). Remove Tooling (A) and install bolt (1). Tighten bolt (1) to a torque of 113 to 123 N·m (85 to 90 lb ft).

End By:

a. Install the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Install".
b. Install the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02000146

Inlet and Exhaust Valves - Remove and Install

SMCS - 1105-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
B	1U-7262	Telescoping Magnet	1
C	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1
D	8S-2263	Spring Tester	1

Start By:

A. Remove the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Clean the bottom face of the cylinder head. Check the depth of the valves below the face of the cylinder head before the valve springs are removed. Refer to Testing and Adjusting, "Valve Depth - Inspect".

2. Place an index mark on the heads of the inlet valves and the exhaust valves for installation purposes.



Illustration 1 g01034884

3. Remove caps (1) .

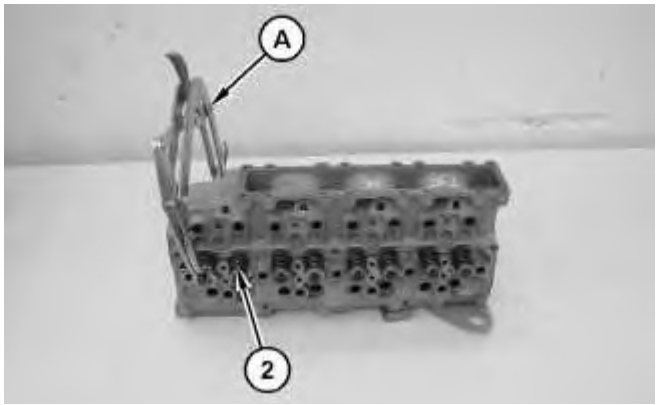


Illustration 2 g01034887

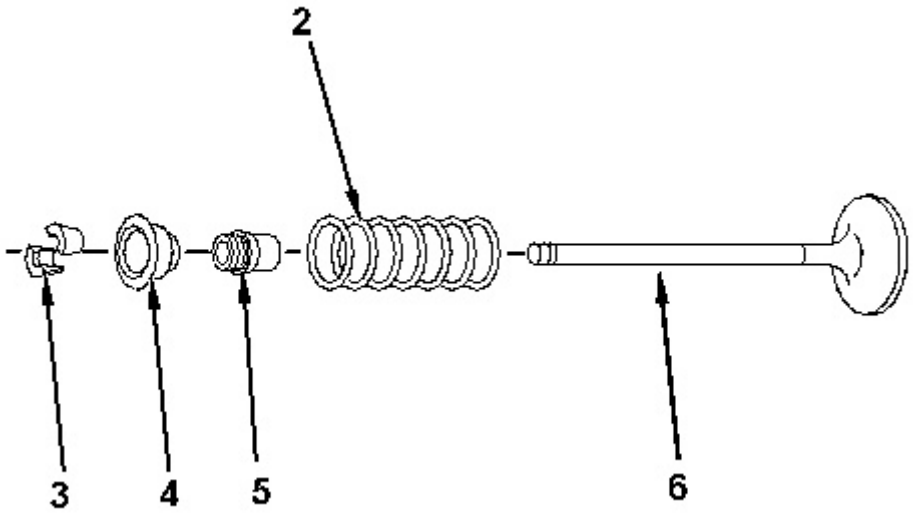


Illustration 3 g01034889

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

4. Use Tooling (A) to compress spring (2) .
5. Use Tooling (B) to remove retainers (3) .
6. Release the pressure from Tooling (A) and remove Tooling (A) .
7. Remove retainer (4) and valve spring (2). Remove valve (6). Use Tooling (C) to remove seal (5) .
8. Repeat Steps 4 through 7 in order to remove the remaining inlet and exhaust valves.

9. Use Tooling (D) to check the valve spring force. Refer to Specifications, "Cylinder Head Valves".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
E	4C-6373	Seal Installer	1
F	4C-6366	Valve Guide Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

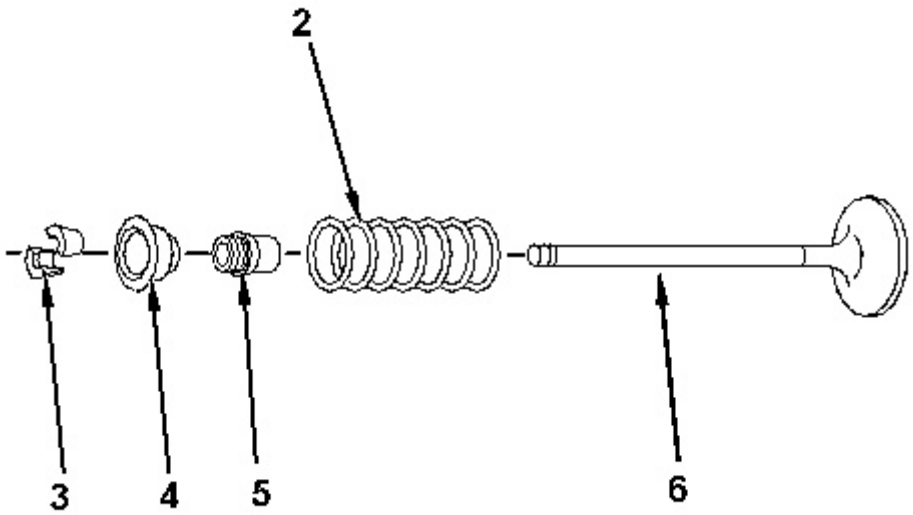


Illustration 4 g01034889

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

1. Use Tooling (E) and Tooling (F) to install seal (5). Lubricate the stem of valve (6) with clean engine oil. Install valve (6). Install valve spring (2) and retainer (4) .

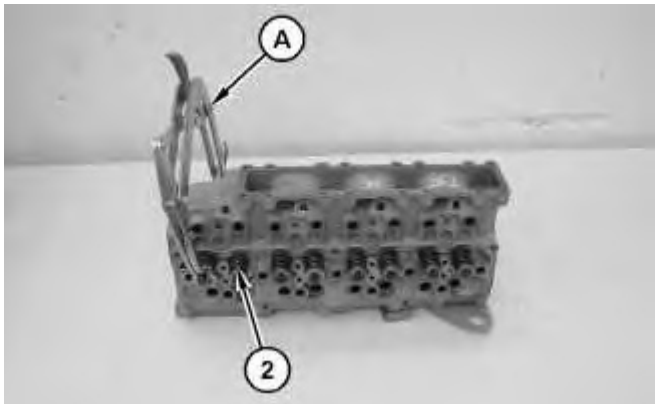


Illustration 5 g01034887

2. Use Tooling (A) to compress spring (2). Install retainers (3). Release pressure on Tooling (A) and remove Tooling (A) .
3. Tap the top of the valves with a soft hammer in order to ensure that retainer (3) is properly installed.
4. Repeat Steps 1 through 3 in order to install the remaining inlet and exhaust valves in the cylinder head.



Illustration 6 g01034884

5. Install caps (1) .

6. Check the depth of the valves below the face of the cylinder head. Refer to Testing and Adjusting, "Valve Depth - Inspect" for the correct procedure. If the depth of the new valves is below the correct depth, the valve seat inserts must be replaced. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

End By: Install the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01998590

Inlet and Exhaust Valve Guides - Remove and Install

SMCS - 1104-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1

Start By:

A. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

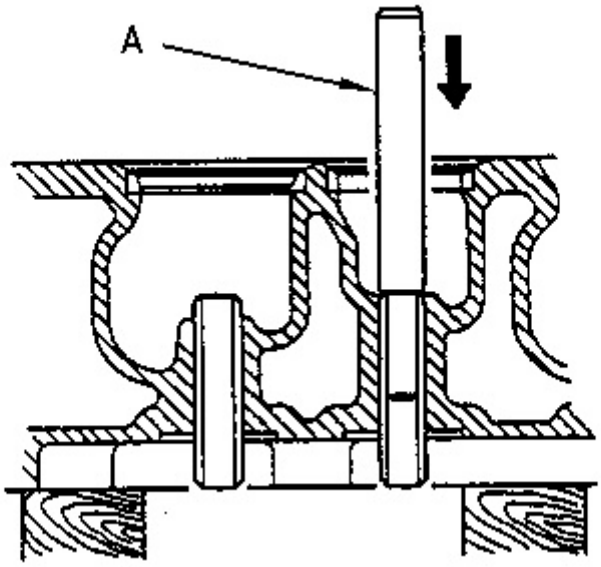


Illustration 1 g01000170

1. Use Tooling (A) to remove the valve guides from the cylinder head.
2. Repeat the procedure for the remaining valve guides.

   Note: When new valve guides are installed, new valves and new valve seat inserts must be installed.
3. Remove the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1
B	4C-6370	Valve Guide Collar	1
C	157-3720	Valve Seat Cutter	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

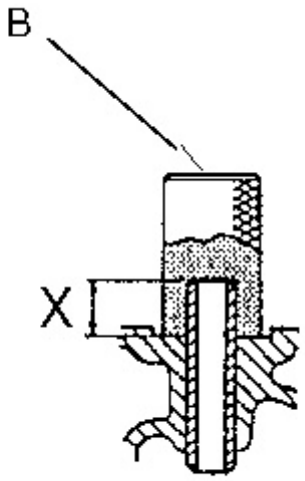


Illustration 2 g01033990

1. Position the valve guide in the cylinder head. Carefully tap the valve guide in order to start the installation. Use Tooling (A) and (B) to seat the valve guide in the cylinder head.

   Note: The counterbore in Tooling (B) installs the valve guide to the correct Height (X) .

2. Check the protrusion of the valve guides. Refer to Specifications, "Cylinder Head Valves" for the protrusion of the valve guide above the valve spring recess.

3. Repeat the procedure to install the remaining valve guides.

4. Install the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

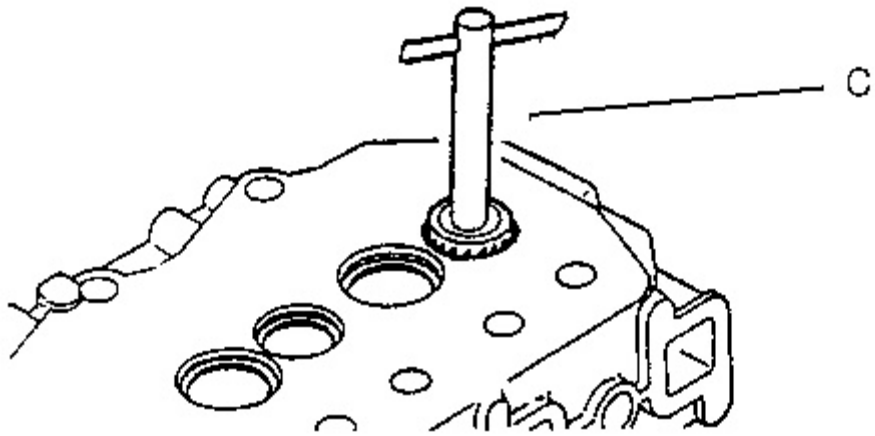


Illustration 3 g01033994

Note: After installing the valve guides and valve seat inserts, the valve guides must be reamed and the valve seat inserts must be cut to the finished diameter. The valve guides and valve seat inserts are cut and reamed in one operation. This procedure ensures the concentricity of the valve seat to the valve guide in order to create a good seal. Refer to Specifications, "Cylinder Head Valves" for the finished diameter of the valve guides and valve seat inserts.

5. Position Tooling (C) into the valve guide. Carefully turn the handle in a clockwise direction and gradually move the reamer into the valve guide until the valve guide is reamed to the finished size.

6. Continue to turn the handle in a clockwise direction in order to cut the valve seat insert. Remove the minimum amount of material in order to ensure a good valve seat. Keep the valve seat as narrow as possible.

7. Remove Tooling (C). Clean the debris from the valve guide and the valve seat.

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
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i01999639

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS - 1103-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	166-7441	Valve Seat Extractor Tool	1

Start By:

A. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

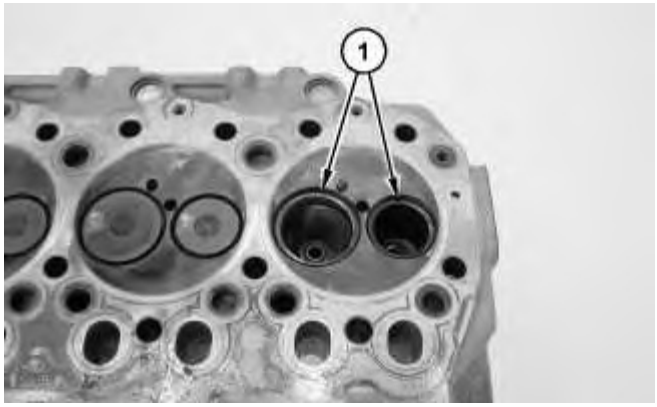


Illustration 1 g01034574

Note: One inlet and one exhaust valve have been removed in the example.

1. Use Tooling (A) to remove the valve seat inserts (1) from the cylinder head.

   Note: Refer to Special Instruction, SMHS7935 for more information on the use of Tooling (A) .

2. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.

3. Remove the valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	4C-6371	Inlet Valve Seat Driver	1
	4C-6372	Exhaust Valve Seat Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

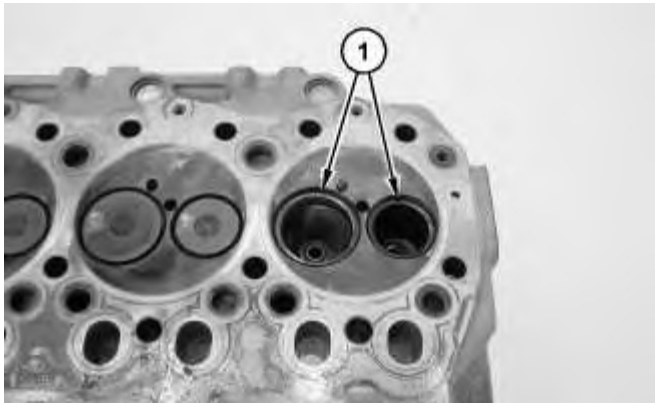


Illustration 2 g01034574

1. Lower the temperature of new valve seat inserts (1) .
2. Position valve seat inserts (1) in the cylinder head. Use Tooling (B) to seat valve seat inserts (1) in the cylinder head.
3. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.
4. Install new valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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i01999901

Cylinder Head - Remove

SMCS - 1100-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2

Start By:

A. Remove the inlet manifold. Refer to Disassembly and Assembly, "Inlet Manifold - Remove".
B. Remove the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
C. Remove the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
D. Remove the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Remove".
E. Remove the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
F. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant and the engine oil from the engine oil cooler into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual for the procedure on draining the engine coolant and the engine oil.

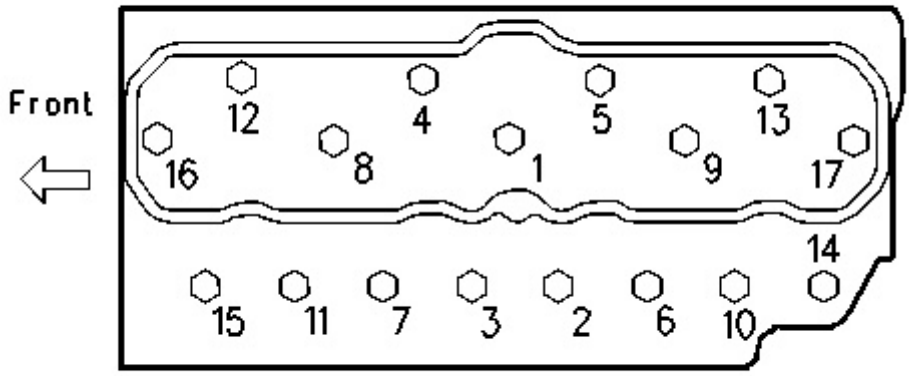


Illustration 1 g01001090

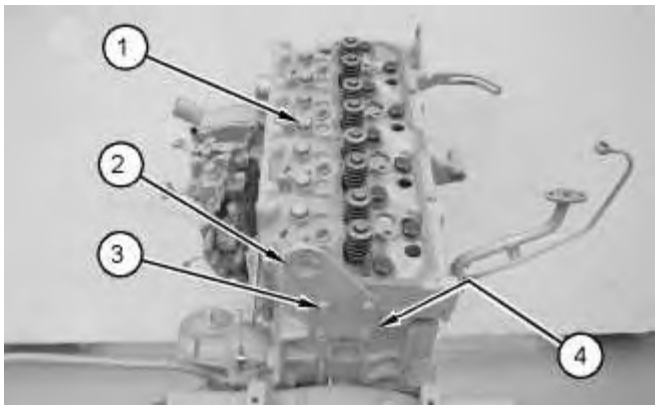


Illustration 2 g01034839

2. Gradually loosen cylinder head bolts (1) in reverse numerical order. Remove bolts (3). Remove bracket (2) and O-ring seal (4) .

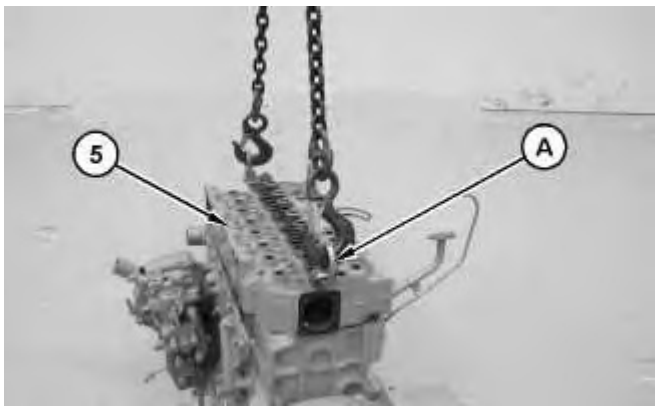


Illustration 3 g01034843

3. Attach Tooling (A) and a suitable lifting device to cylinder head (5). Remove cylinder head (5). The weight of the cylinder head is approximately 34 kg (75 lb).

NOTICE

Place the cylinder head on a surface that will not scratch the face of the cylinder head.

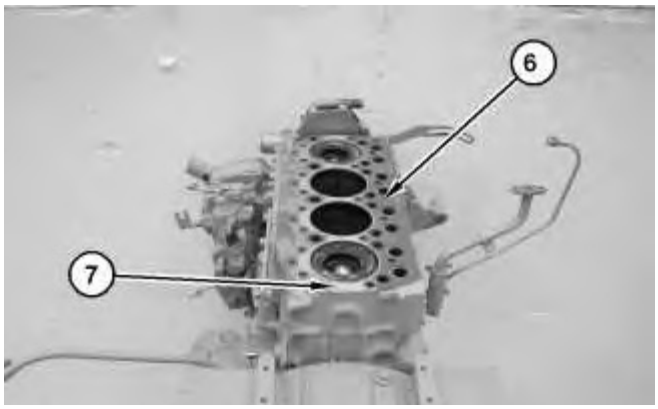


Illustration 4 g01034844

4. Remove gasket (6) .

   Note: Note the location of dowels (7) .

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i01999946

Cylinder Head - Install

SMCS - 1100-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the top of the cylinder block and the bottom of the cylinder head. Ensure that there is no debris in the cylinder bores.

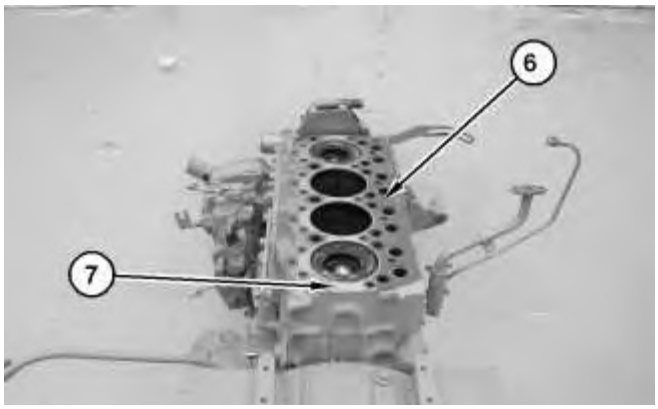


Illustration 1 g01034844

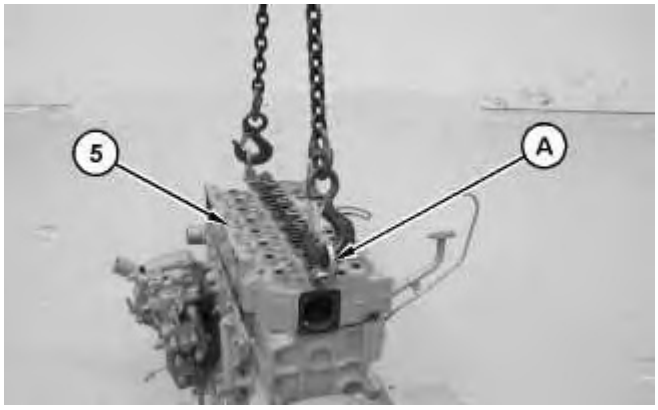


Illustration 2 g01034843

2. Install gasket (6). Use Tooling (A) and a suitable lifting device to position cylinder head (5). The weight of cylinder head (5) is approximately 34 kg (75 lb). Ensure that cylinder head (5) is positioned correctly on dowels (7). Remove Tooling (A) .

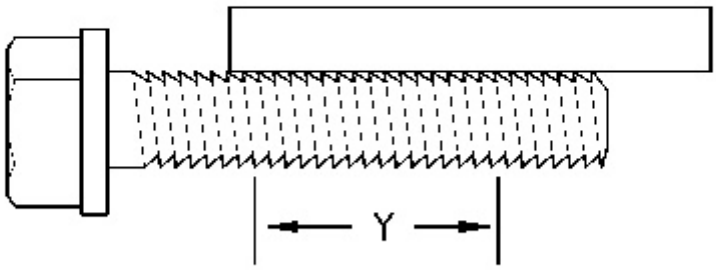


Illustration 3 g00951563

3. Clean the threads and inspect the threads of the cylinder head bolts.

   Note: Do not use the bolts if there is any visual reduction in the diameter of the Threads (Y) that has not been engaged with the cylinder block. Use a straight edge to check the bolts.

4. Lubricate the threads and the shoulder of the cylinder head bolts with clean engine oil before installation.

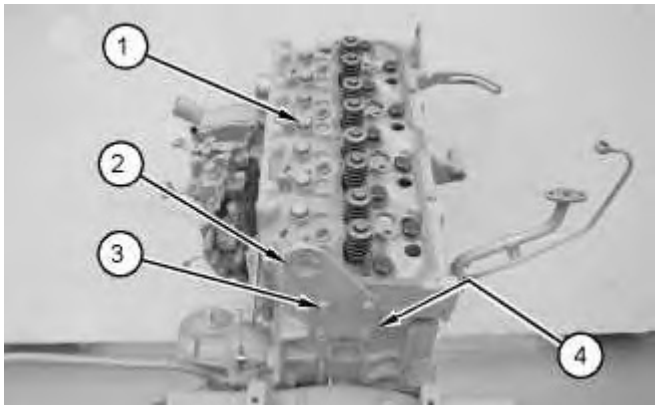


Illustration 4 g01034839

5. Install bracket (2) and O-ring seal (4). Install bolts (3) .

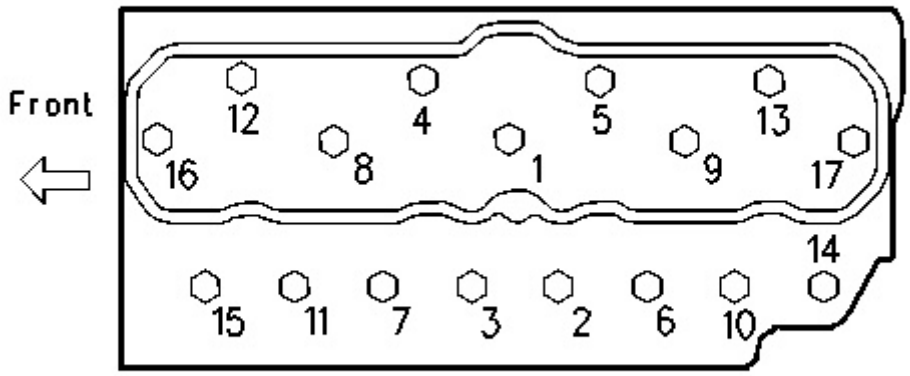


Illustration 5 g01001090

6. Install bolts (1). Tighten bolts (1) in numerical order to a torque of 113 to 123 N·m (83 to 91 lb ft).

7. Fill the cooling system with coolant. Fill the lubrication system with engine oil. Refer to Operation and Maintenance Manual, "Refill Capacities" for the cooling system capacity and the lubrication system capacity of the engine.

End By:

a. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".
b. Install the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
c. Install the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Install".
d. Install the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
e. Install the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
f. Install the inlet manifold. Refer to Disassembly and Assembly, "Inlet Manifold - Install".

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Disassembly and Assembly
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i02009092

Camshaft Bearings - Remove and Install

SMCS - 1211-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

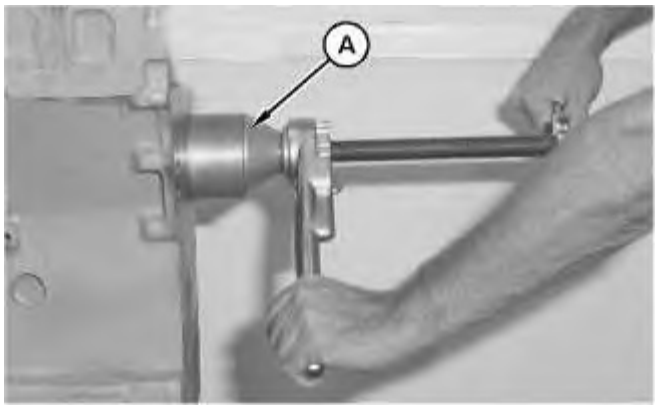


Illustration 1 g01038778

1. Use Tooling (A) to remove the camshaft bearing from the cylinder block.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2241	Camshaft Bearing Tool Group	1
	8H-0684	Ratchet Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the bore in the cylinder block for the camshaft bearing is clean and free of debris.

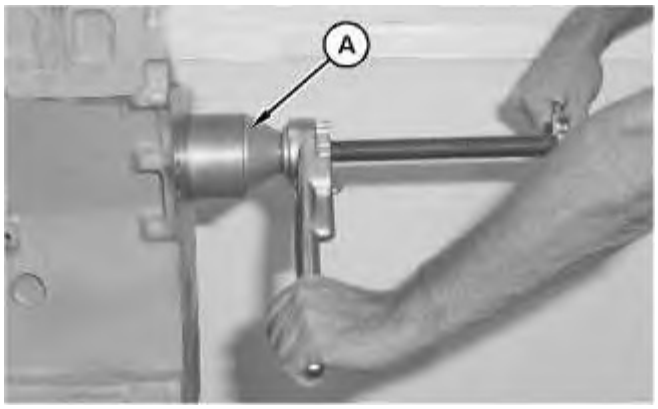


Illustration 2 g01038778

2. Use Tooling (A) to install the camshaft bearing in the cylinder block.

   Note: Align the oil holes in the camshaft bearing and the cylinder block. The camshaft bearing should be installed to a depth that is flush with the face of the recess in the cylinder block.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
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i02000605

Inlet and Exhaust Valve Springs - Remove and Install

SMCS - 1108-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector [1]	1
B	-	Rod (M12 X 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1
D	8S-2263	Spring Tester	1

[1] The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

Start By:

A. Remove the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. Remove the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

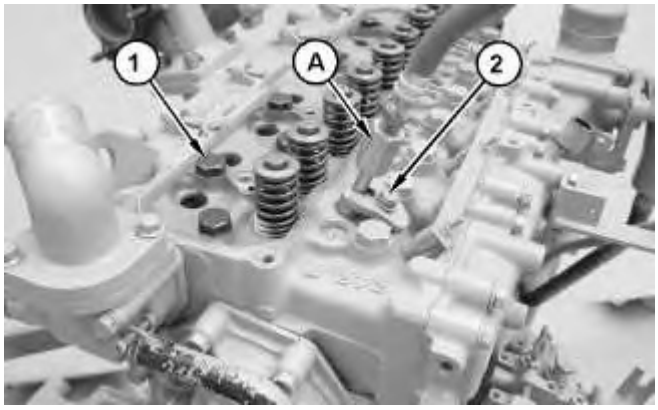


Illustration 1 g01035126

1. Install Tooling (A). Install the bolt and bracket (2). Remove bolt (1) .

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are removed and installed.

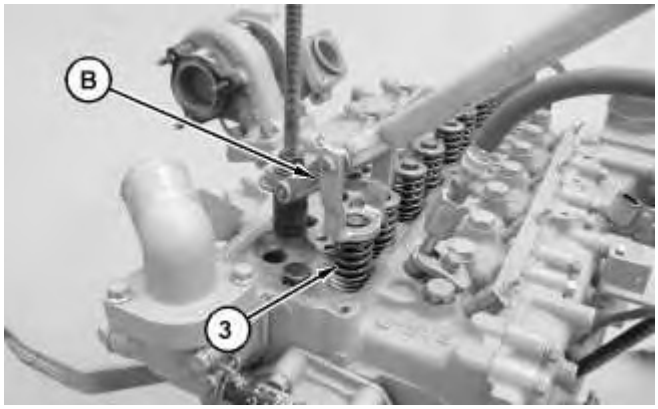


Illustration 2 g01035165

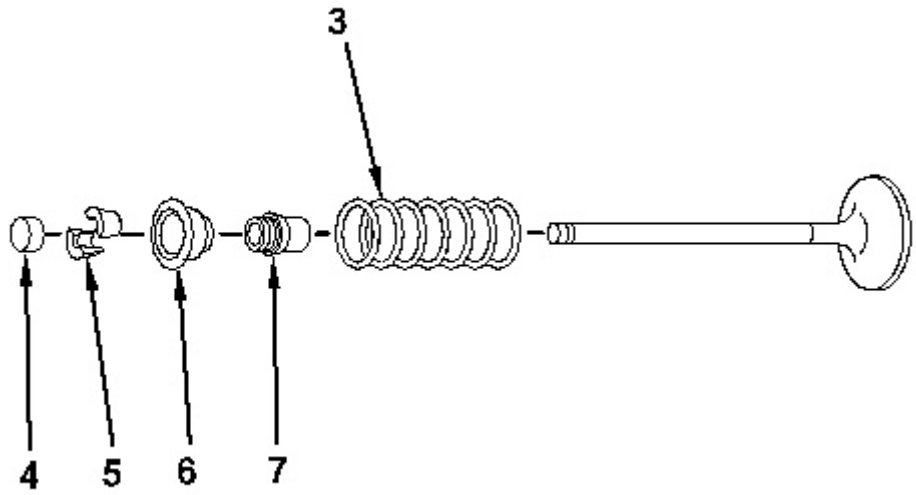


Illustration 3 g01035176

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

2. Install Tooling (B). Use Tooling (B) to compress valve spring (3). Remove cap (4) and retainers (5) .
3. Release the pressure from Tooling (B) and remove Tooling (B). Remove retainer (6) .
4. If necessary, use Tooling (C) to remove seal (7) .
5. Use Tooling (D) to check the valve spring force. Refer to Specifications, "Cylinder Head Valves".
6. Repeat Steps 1 through 5 for the removal of the remaining valve springs.

NOTICE

Do not turn the crankshaft while the valve springs are removed.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector [1]	1
B	-	Rod (M12 X 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-6373	Seal Installer	1

[1] The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Keep Tooling (B) and an air hose attached in order to force air pressure into the cylinder. This will hold the valves in position while the inlet and exhaust valve springs are installed.

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are installed.

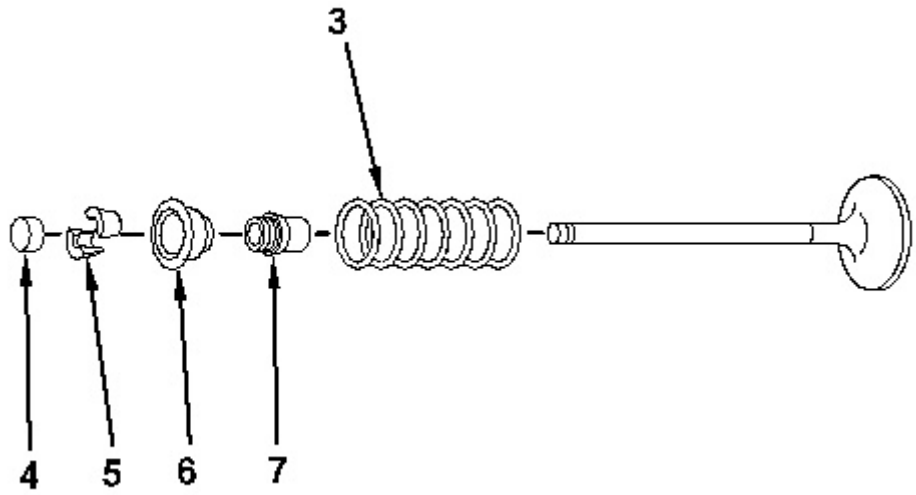


Illustration 4 g01035176

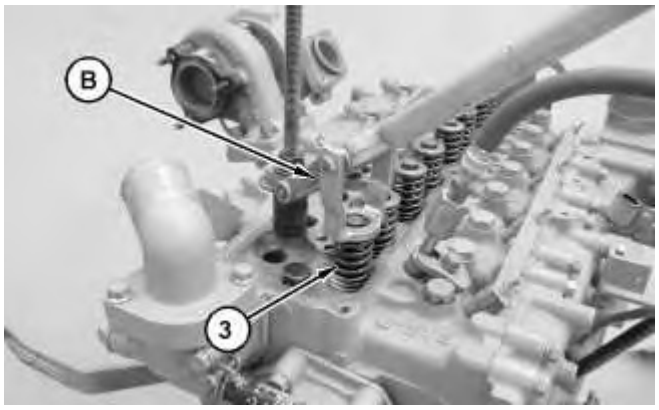


Illustration 5 g01035165

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

2. If necessary, use Tooling (C) to install seal (7) .
3. Position valve spring (3). Position retainer (6) on spring (3) .

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

4. Install Tooling (B) and compress spring (3). Install retainers (5) and cap (4) .
5. Release the pressure and remove Tooling (B) .
6. Tap the top of the valve with a soft hammer in order to ensure that retainers (5) are properly installed.
7. Repeat Steps 1 through 6 in order to install the remaining valve springs.

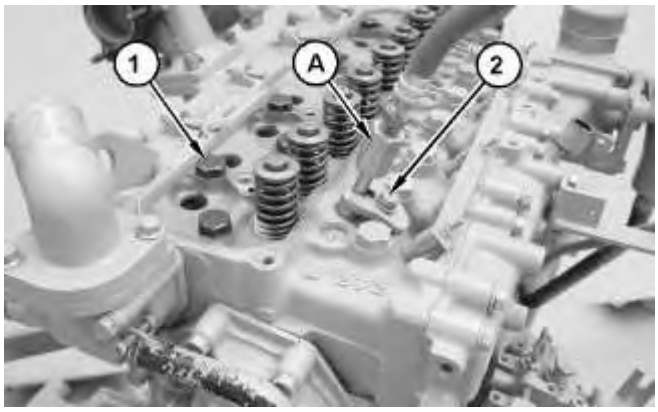


Illustration 6 g01035126

8. Remove the bolt and bracket (2). Remove Tooling (A) and install bolt (1). Tighten bolt (1) to a torque of 113 to 123 N·m (85 to 90 lb ft).

End By:

a. Install the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Install".
b. Install the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i02000146

Inlet and Exhaust Valves - Remove and Install

SMCS - 1105-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
B	1U-7262	Telescoping Magnet	1
C	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1
D	8S-2263	Spring Tester	1

Start By:

A. Remove the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Clean the bottom face of the cylinder head. Check the depth of the valves below the face of the cylinder head before the valve springs are removed. Refer to Testing and Adjusting, "Valve Depth - Inspect".

2. Place an index mark on the heads of the inlet valves and the exhaust valves for installation purposes.



Illustration 1 g01034884

3. Remove caps (1) .

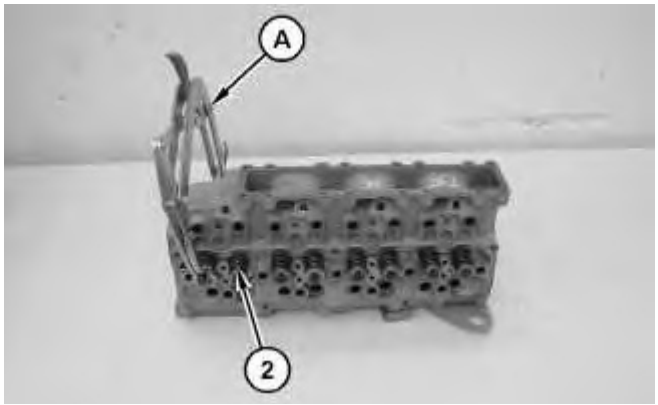


Illustration 2 g01034887

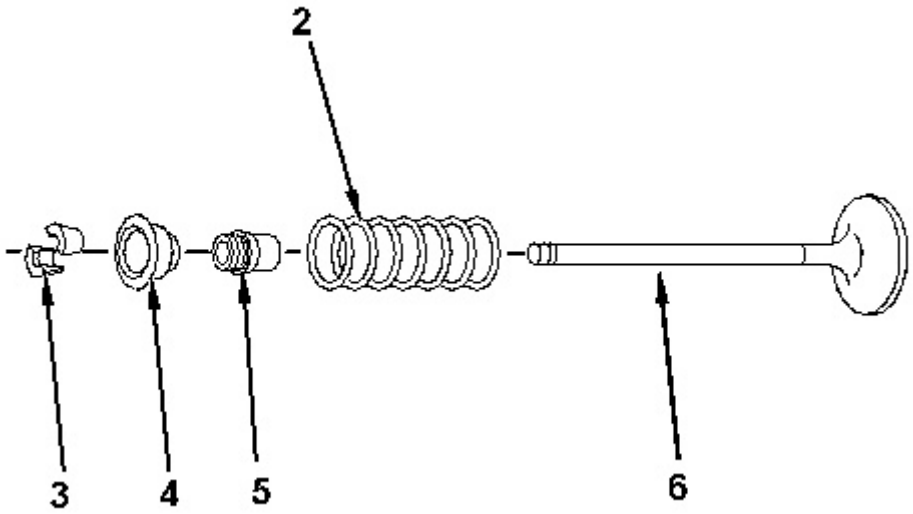


Illustration 3 g01034889

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

4. Use Tooling (A) to compress spring (2) .
5. Use Tooling (B) to remove retainers (3) .
6. Release the pressure from Tooling (A) and remove Tooling (A) .
7. Remove retainer (4) and valve spring (2). Remove valve (6). Use Tooling (C) to remove seal (5) .
8. Repeat Steps 4 through 7 in order to remove the remaining inlet and exhaust valves.

9. Use Tooling (D) to check the valve spring force. Refer to Specifications, "Cylinder Head Valves".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
E	4C-6373	Seal Installer	1
F	4C-6366	Valve Guide Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

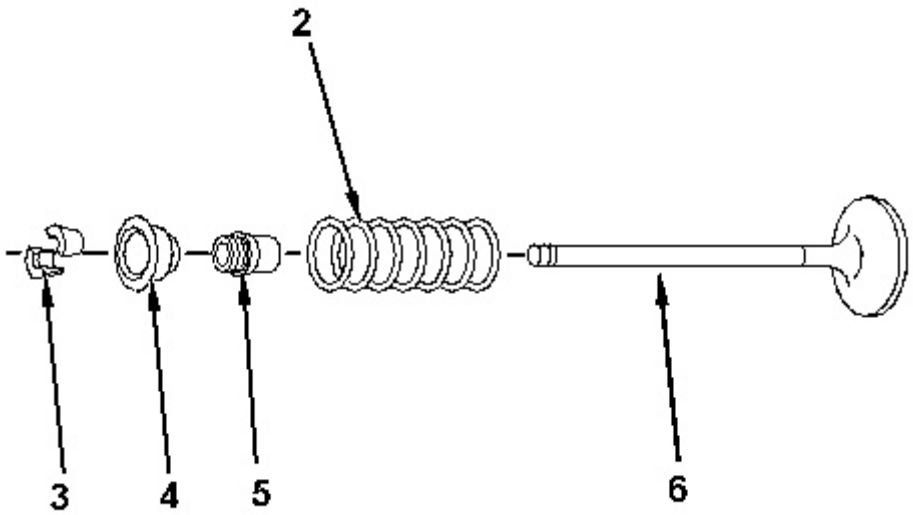


Illustration 4 g01034889

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

1. Use Tooling (E) and Tooling (F) to install seal (5). Lubricate the stem of valve (6) with clean engine oil. Install valve (6). Install valve spring (2) and retainer (4) .

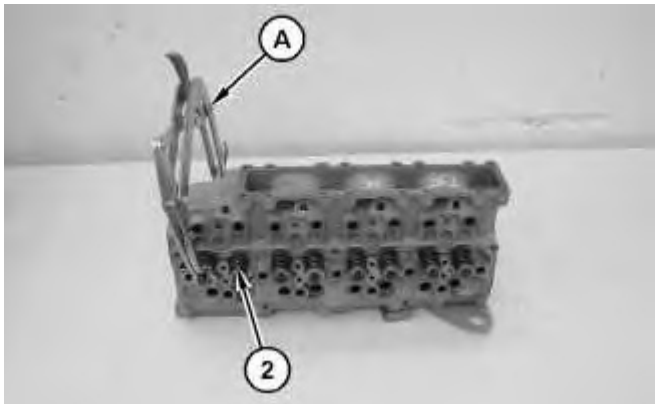


Illustration 5 g01034887

2. Use Tooling (A) to compress spring (2). Install retainers (3). Release pressure on Tooling (A) and remove Tooling (A) .
3. Tap the top of the valves with a soft hammer in order to ensure that retainer (3) is properly installed.
4. Repeat Steps 1 through 3 in order to install the remaining inlet and exhaust valves in the cylinder head.



Illustration 6 g01034884

5. Install caps (1) .

6. Check the depth of the valves below the face of the cylinder head. Refer to Testing and Adjusting, "Valve Depth - Inspect" for the correct procedure. If the depth of the new valves is below the correct depth, the valve seat inserts must be replaced. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

End By: Install the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i01998590

Inlet and Exhaust Valve Guides - Remove and Install

SMCS - 1104-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1

Start By:

A. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

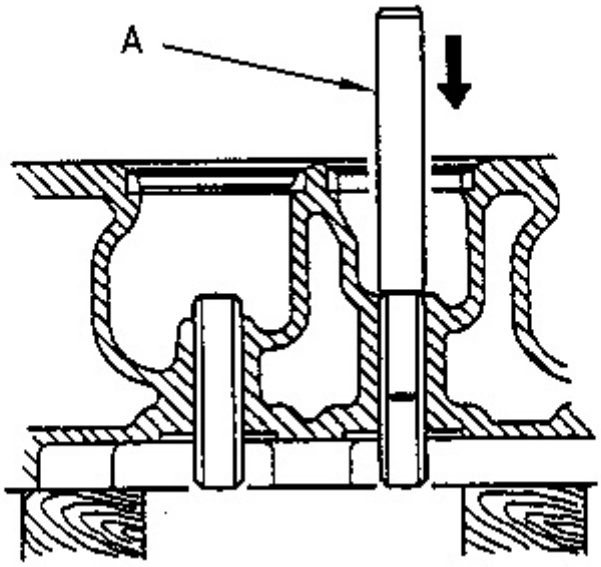


Illustration 1 g01000170

1. Use Tooling (A) to remove the valve guides from the cylinder head.
2. Repeat the procedure for the remaining valve guides.

   Note: When new valve guides are installed, new valves and new valve seat inserts must be installed.
3. Remove the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1
B	4C-6370	Valve Guide Collar	1
C	157-3720	Valve Seat Cutter	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

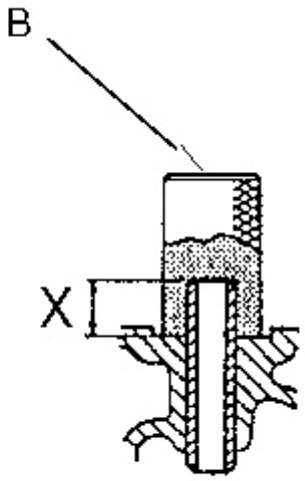


Illustration 2 g01033990

1. Position the valve guide in the cylinder head. Carefully tap the valve guide in order to start the installation. Use Tooling (A) and (B) to seat the valve guide in the cylinder head.

   Note: The counterbore in Tooling (B) installs the valve guide to the correct Height (X) .

2. Check the protrusion of the valve guides. Refer to Specifications, "Cylinder Head Valves" for the protrusion of the valve guide above the valve spring recess.

3. Repeat the procedure to install the remaining valve guides.

4. Install the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

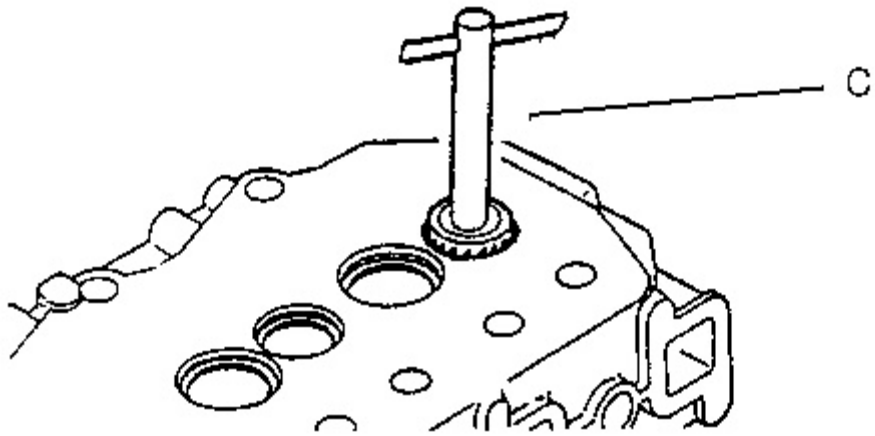


Illustration 3 g01033994

Note: After installing the valve guides and valve seat inserts, the valve guides must be reamed and the valve seat inserts must be cut to the finished diameter. The valve guides and valve seat inserts are cut and reamed in one operation. This procedure ensures the concentricity of the valve seat to the valve guide in order to create a good seal. Refer to Specifications, "Cylinder Head Valves" for the finished diameter of the valve guides and valve seat inserts.

5. Position Tooling (C) into the valve guide. Carefully turn the handle in a clockwise direction and gradually move the reamer into the valve guide until the valve guide is reamed to the finished size.

6. Continue to turn the handle in a clockwise direction in order to cut the valve seat insert. Remove the minimum amount of material in order to ensure a good valve seat. Keep the valve seat as narrow as possible.

7. Remove Tooling (C). Clean the debris from the valve guide and the valve seat.

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i01999639

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS - 1103-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	166-7441	Valve Seat Extractor Tool	1

Start By:

A. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

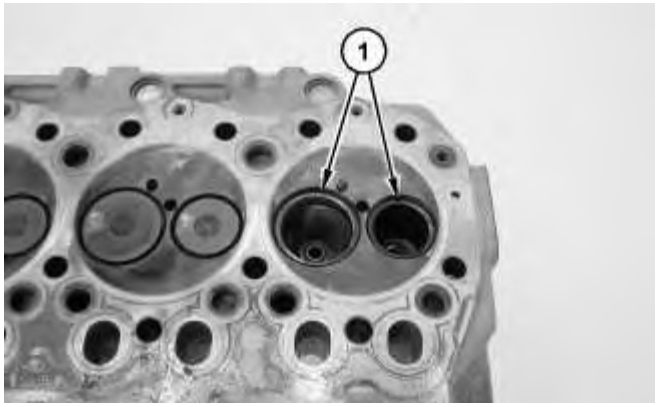


Illustration 1 g01034574

Note: One inlet and one exhaust valve have been removed in the example.

1. Use Tooling (A) to remove the valve seat inserts (1) from the cylinder head.

   Note: Refer to Special Instruction, SMHS7935 for more information on the use of Tooling (A) .

2. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.

3. Remove the valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	4C-6371	Inlet Valve Seat Driver	1
	4C-6372	Exhaust Valve Seat Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

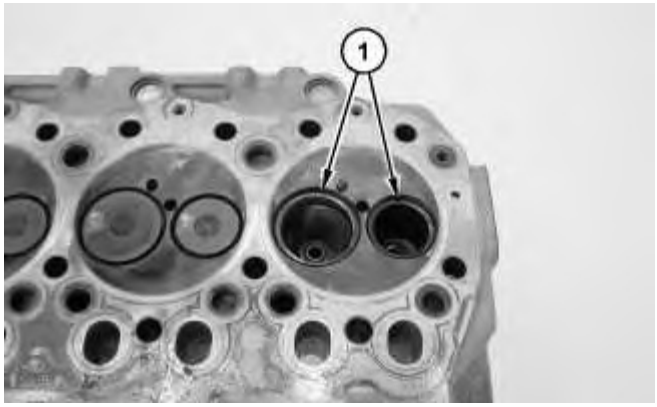


Illustration 2 g01034574

1. Lower the temperature of new valve seat inserts (1) .
2. Position valve seat inserts (1) in the cylinder head. Use Tooling (B) to seat valve seat inserts (1) in the cylinder head.
3. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.
4. Install new valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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i01999901

Cylinder Head - Remove

SMCS - 1100-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2

Start By:

A. Remove the inlet manifold. Refer to Disassembly and Assembly, "Inlet Manifold - Remove".
B. Remove the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
C. Remove the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
D. Remove the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Remove".
E. Remove the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
F. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant and the engine oil from the engine oil cooler into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual for the procedure on draining the engine coolant and the engine oil.

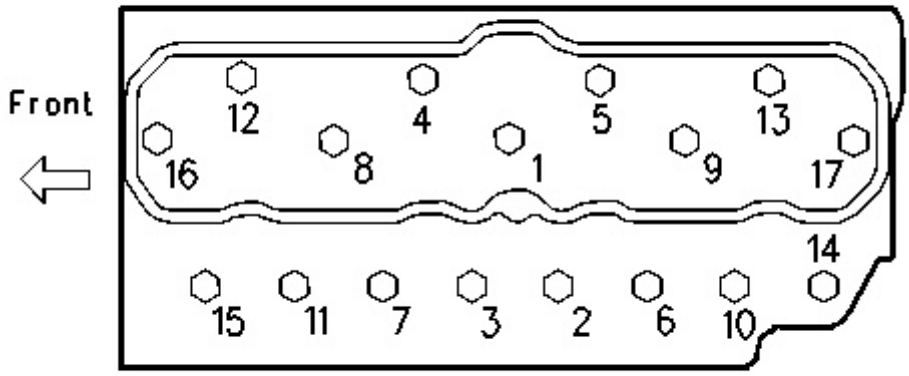


Illustration 1 g01001090

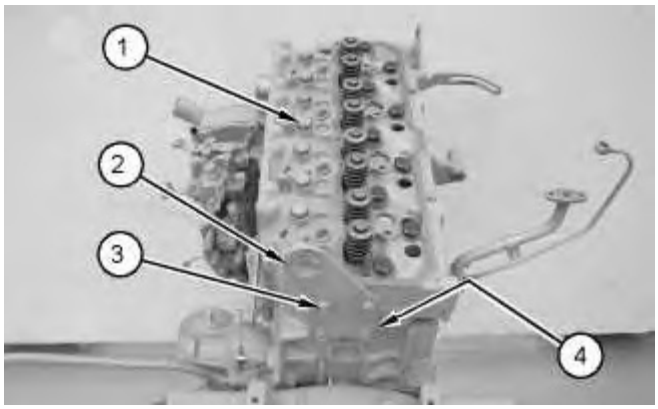


Illustration 2 g01034839

2. Gradually loosen cylinder head bolts (1) in reverse numerical order. Remove bolts (3). Remove bracket (2) and O-ring seal (4) .

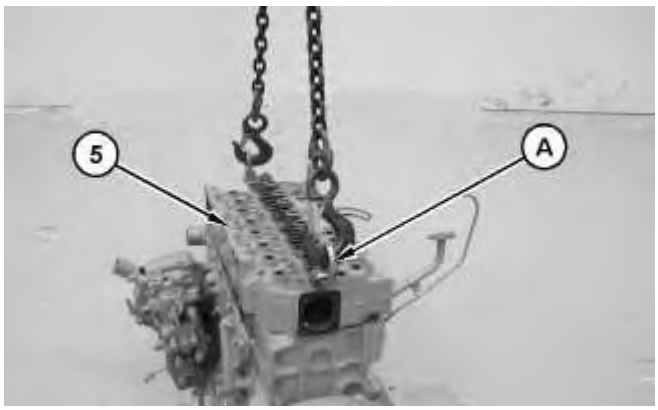


Illustration 3 g01034843

3. Attach Tooling (A) and a suitable lifting device to cylinder head (5). Remove cylinder head (5). The weight of the cylinder head is approximately 34 kg (75 lb).

NOTICE

Place the cylinder head on a surface that will not scratch the face of the cylinder head.

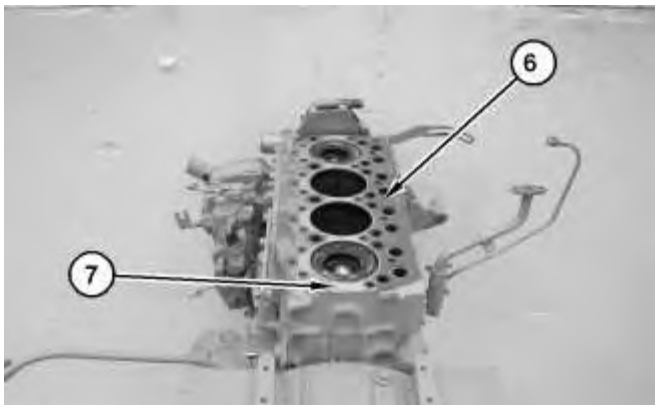


Illustration 4 g01034844

4. Remove gasket (6) .

   Note: Note the location of dowels (7) .

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i01999946

Cylinder Head - Install

SMCS - 1100-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the top of the cylinder block and the bottom of the cylinder head. Ensure that there is no debris in the cylinder bores.

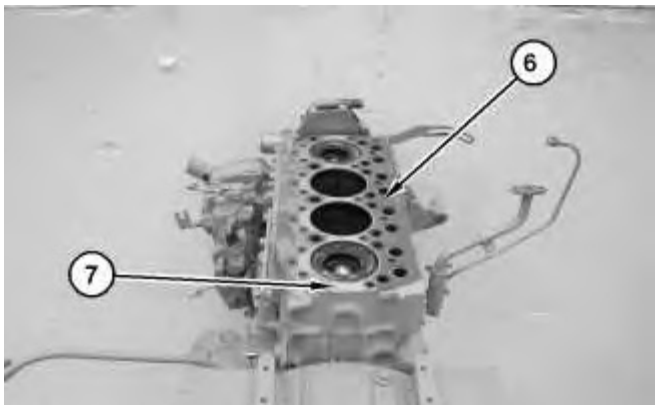


Illustration 1 g01034844

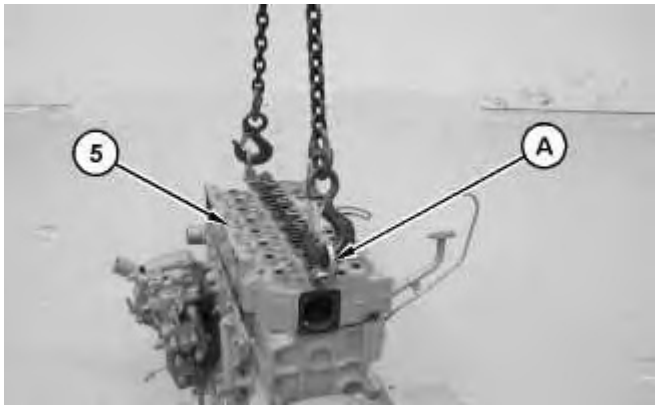


Illustration 2 g01034843

2. Install gasket (6). Use Tooling (A) and a suitable lifting device to position cylinder head (5). The weight of cylinder head (5) is approximately 34 kg (75 lb). Ensure that cylinder head (5) is positioned correctly on dowels (7). Remove Tooling (A) .

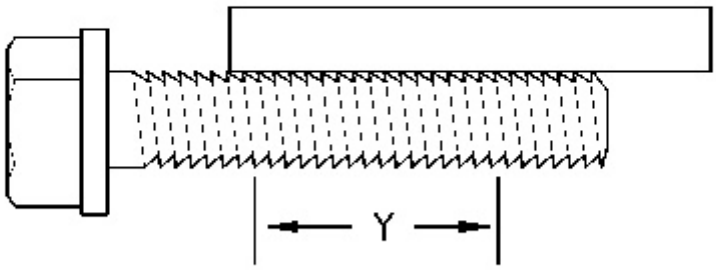


Illustration 3 g00951563

3. Clean the threads and inspect the threads of the cylinder head bolts.

   Note: Do not use the bolts if there is any visual reduction in the diameter of the Threads (Y) that has not been engaged with the cylinder block. Use a straight edge to check the bolts.

4. Lubricate the threads and the shoulder of the cylinder head bolts with clean engine oil before installation.

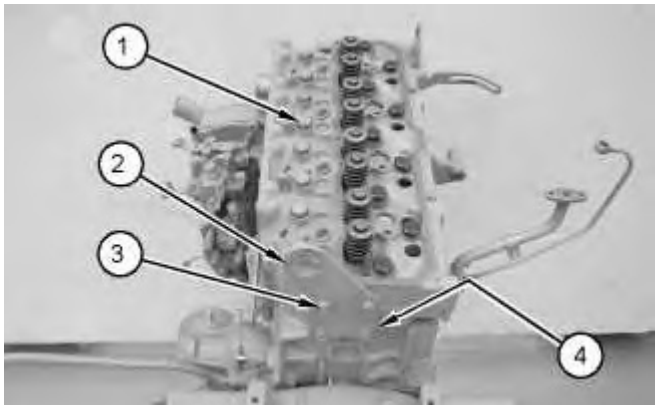


Illustration 4 g01034839

5. Install bracket (2) and O-ring seal (4). Install bolts (3) .

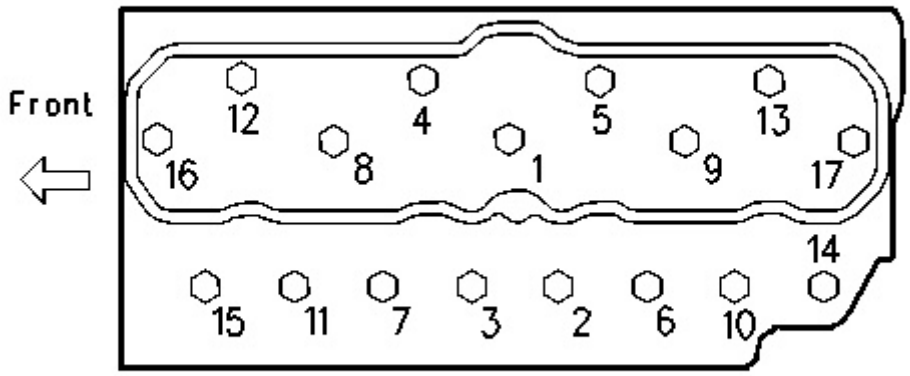


Illustration 5 g01001090

6. Install bolts (1). Tighten bolts (1) in numerical order to a torque of 113 to 123 N·m (83 to 91 lb ft).

7. Fill the cooling system with coolant. Fill the lubrication system with engine oil. Refer to Operation and Maintenance Manual, "Refill Capacities" for the cooling system capacity and the lubrication system capacity of the engine.

End By:

a. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".
b. Install the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
c. Install the fuel injection nozzles. Refer to Disassembly and Assembly, "Fuel Injection Nozzles - Install".
d. Install the water temperature regulator housing. Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
e. Install the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
f. Install the inlet manifold. Refer to Disassembly and Assembly, "Inlet Manifold - Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638779

Inlet and Exhaust Valve Springs - Remove and Install - Alternative Method

SMCS - 1108-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector [1]	1
B	-	Stud (M12 x 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1
D	8S-2263	Spring Tester	1

[1] The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

Start By:

A. Remove the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".
B. Remove the fuel injectors. Refer to Disassembly and Assembly, "Fuel Injectors - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

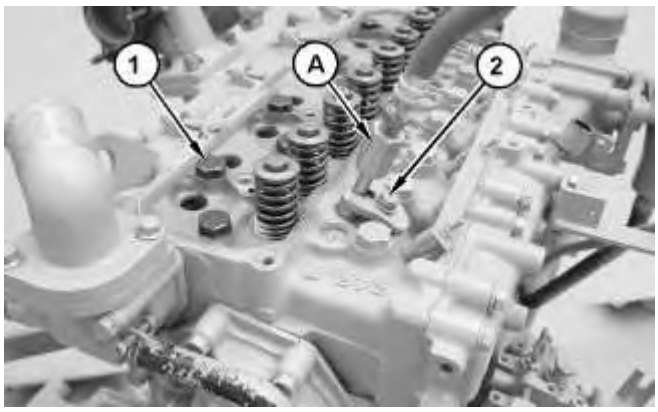


Illustration 1 g01035126

1. Install Tooling (A). Install the bolt and bracket (2). Remove bolt (1) .

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are removed and installed. Do not depress the valves during the removal or the installation process. If the valves are depressed during the removal or the installation process, air pressure will be lost and the valves may fall into the cylinder.

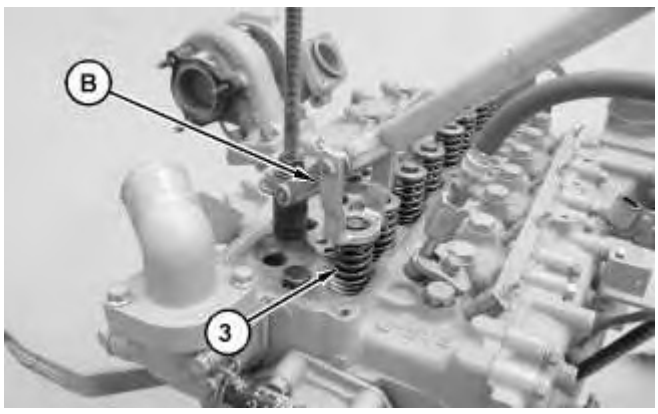


Illustration 2 g01035165

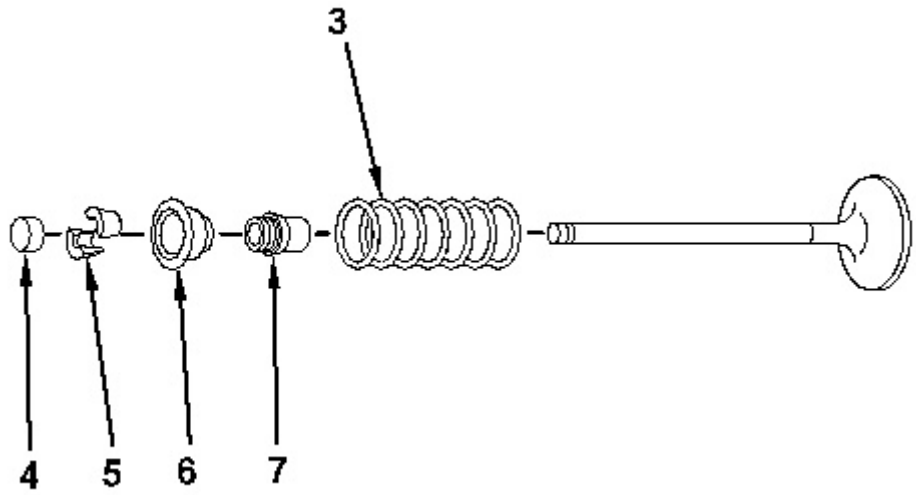


Illustration 3 g01035176

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

2. Install Tooling (B). Use Tooling (B) to compress valve spring (3). Remove cap (4) and retainers (5) .
3. Release the pressure from Tooling (B) and remove Tooling (B). Remove retainer (6) .
4. If necessary, use Tooling (C) to remove seal (7) .
5. Use Tooling (D) to check the valve spring force. Refer to Specifications, "Cylinder Head Valves".
6. Repeat Steps 1 through 5 for the removal of the remaining valve springs.

NOTICE

Do not turn the crankshaft while the valve springs are removed.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6145	Air Connector [1]	1
B	-	Stud (M12 x 1.75 by 380 mm)	1
	9U-6144	Adapter As	1
	6V-8149	Nut	1
	5P-8245	Hard Washer	13
C	4C-6373	Seal Installer	1

[1] The **9U-6145** Air Connector is part of the **9U-6274** Compression Test Tool Gp. The **9U-6145** Air Connector can be ordered separately.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Keep Tooling (B) and an air hose attached in order to force air pressure into the cylinder. This will hold the valves in position while the inlet and exhaust valve springs are installed.

   Note: Maintain air pressure in the cylinder that is being serviced until both of the valve springs are removed and installed. Do not depress the valves during the removal or the installation process. If the valves are depressed during the removal or the installation process, air pressure will be lost and the valves may fall into the cylinder.

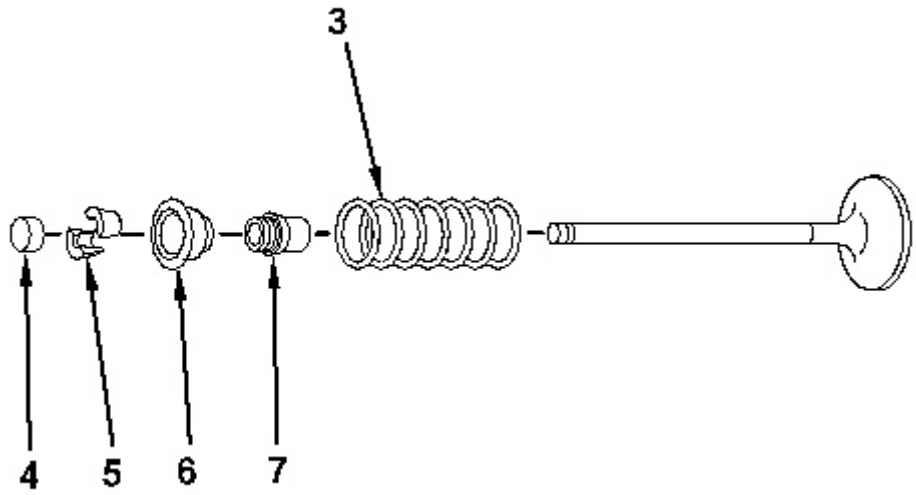


Illustration 4 g01035176

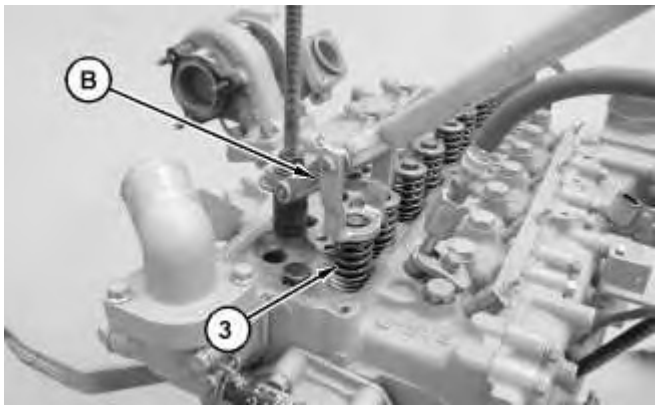


Illustration 5 g01035165

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

2. If necessary, use Tooling (C) to install seal (7) .
3. Position valve spring (3). Position retainer (6) on spring (3) .

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

4. Install Tooling (B) and compress spring (3). Install retainers (5) and cap (4) .
5. Release the pressure and remove Tooling (B) .
6. Tap the top of the valve with a soft hammer in order to ensure that retainers (5) are properly installed.
7. Repeat Steps 1 through 6 in order to install the remaining valve springs.

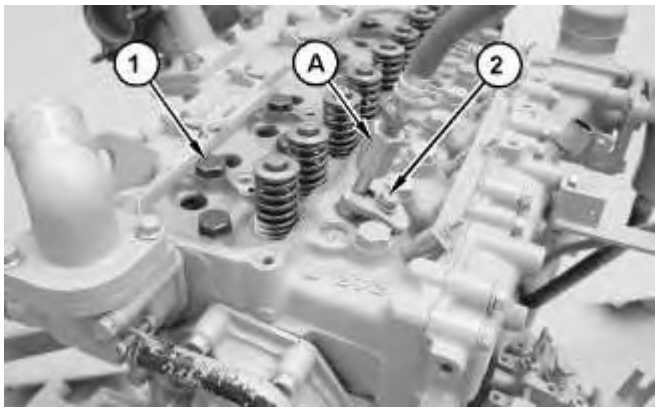


Illustration 6 g01035126

8. Remove the bolt and bracket (2). Remove Tooling (A) and install bolt (1). Tighten bolt (1) to a torque of 118 N·m (87 lb ft).

End By:

a. Install the fuel injectors. Refer to Disassembly and Assembly, "Fuel Injectors - Install".
b. Install the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i02638771

Inlet and Exhaust Valve Springs - Remove and Install

SMCS - 1108-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6195	Valve Spring Compressor	1
B	268-1969	Adapter	1

Start By:

A. Remove the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Plug the apertures for the push rods in the cylinder head in order to prevent the entry of loose parts into the engine.

Note: The following procedure should be adopted in order to remove the valve springs when the cylinder head is installed to the engine. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install" for the procedure to remove the valve springs from a cylinder head that has been removed from the engine.

Note: Ensure that the appropriate piston is at the top center position before the valve spring is removed. Failure to ensure that the piston is at the top center position may allow the valve to drop into the cylinder bore.

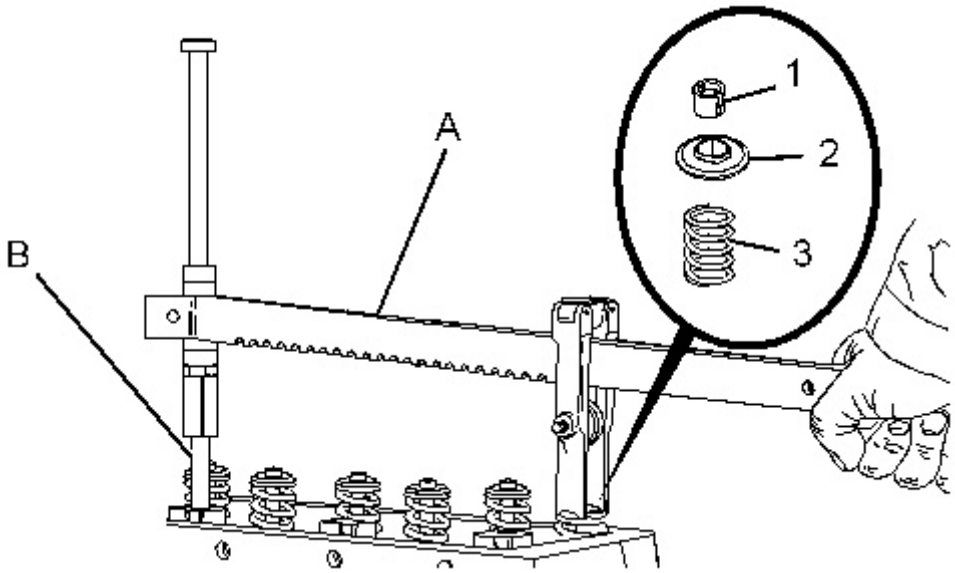


Illustration 1 g01358696

Typical example

1. Follow Steps 1.a through 1.d in order to position the appropriate piston at top center.

    a. Install Tooling (A) and (B) in position on the cylinder head in order to compress a valve spring for the appropriate piston.

    b. Use Tooling (A) in order to compress valve spring (3) and open the valve slightly.

Note: Do not compress the spring so that the valve spring retainer (2) touches the valve stem seal.

c. Carefully rotate the crankshaft until the piston touches the valve.

Note: Do not use excessive force to turn the crankshaft. The use of force can result in bent valve stems.

d. Continue to rotate the crankshaft and gradually release the pressure on Tooling (A) until the piston is at the top center position. The valve is now held in a position that allows the valve spring to be safely removed.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

---

2. Use Tooling (A) in order to compress valve spring (3). Remove valve keepers (1) .

   Note: Do not compress the valve spring so that the valve spring retainer (2) touches the valve stem seal.

3. Slowly release the pressure on Tooling (A) .

4. Remove valve spring retainer (2) and remove valve spring (3) .

NOTICE

Do not turn the crankshaft while the valve springs are removed.

Note: If all valve springs require replacement the procedure can be carried out on two cylinders at the same time. The procedure can be carried out on the following pairs of cylinders. 1 with 4 and 2 with 3. Ensure that all of the valve springs are installed before changing from one pair of cylinders to another pair of cylinders.

5. Remove Tooling (A) and (B) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6195	Valve Spring Compressor	1

B	268-1969	Adapter	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Do not turn the crankshaft while the valve springs are removed.

1. Inspect the valve springs for the correct length. Refer to Specifications, "Cylinder Head Valves ".

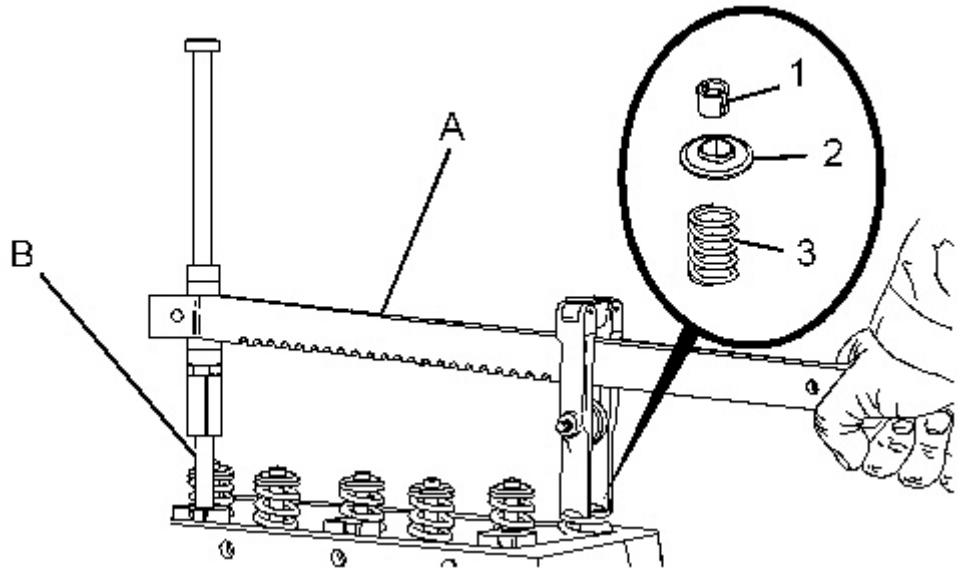


Illustration 2 g01358696

Typical example

2. Install valve spring (3) onto the cylinder head. Position valve spring retainer (2) onto valve spring (3) .

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

3. Install Tooling (A) and (B) in the appropriate position on the cylinder head in order to compress the valve spring.
4. Apply sufficient pressure to Tooling (A) in order to install valve keepers (1) .

   Note: Do not compress the spring so that valve spring retainer (2) touches the valve stem seal.

   Install the valve spring keepers.
5. Carefully release the pressure on Tooling (A) .

   Note: Ensure that the valve keepers are correctly seated.

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Remove Tooling (A). Ensure that all of the valves are secured in place by a valve spring and valve keepers. Rotate the crankshaft through about 45 degrees in order to clear the piston from the valve. Lightly strike the top of the valve with a soft hammer in order to ensure that the valve keepers are properly installed.

End By: Install the rocker shaft assembly. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638780

Inlet and Exhaust Valves - Remove and Install

SMCS - 1105-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
B	4C-8134	Seal Remover	1
	1U-7600	Slide Hammer Puller Gp	1

Start By:

A. Remove the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Clean the bottom face of the cylinder head. Check the depth of the valves below the face of the cylinder head before the valve springs are removed. Refer to Specifications, "Cylinder Head Valves" for the correct dimensions.

2. Place a temporary identification mark on the heads of the valves in order to identify the correct position.

Note: Do not stamp the heads of the valves. Stamping or punching the heads of the valves could cause the valves to fracture.

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

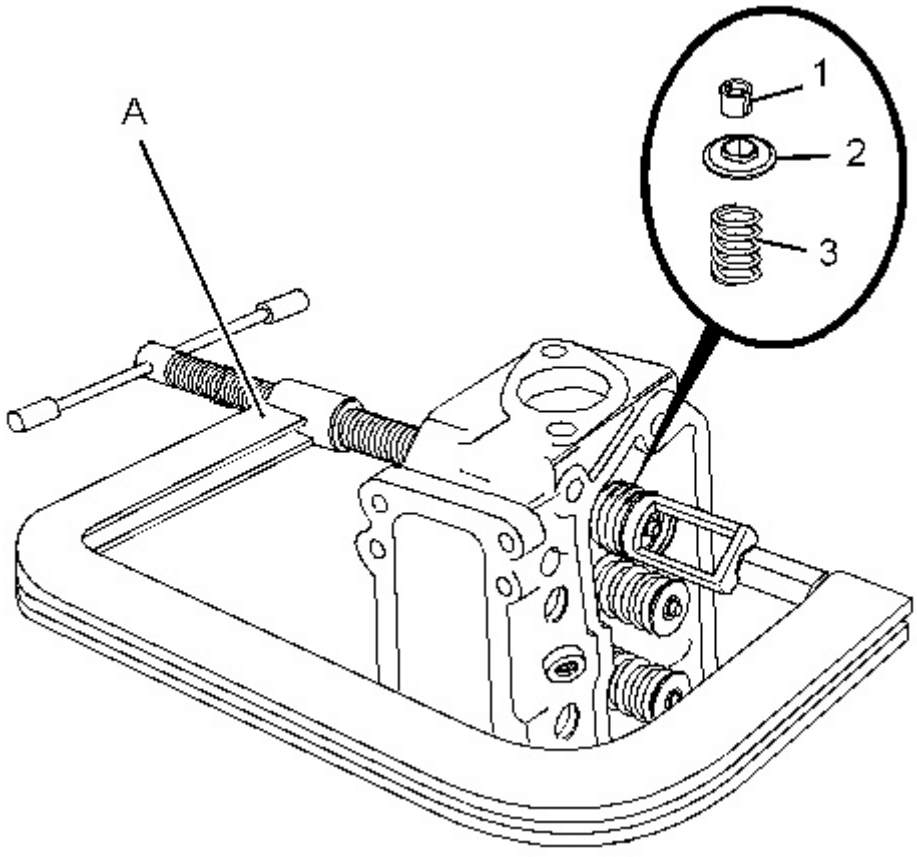


Illustration 1 g01333469

Typical example

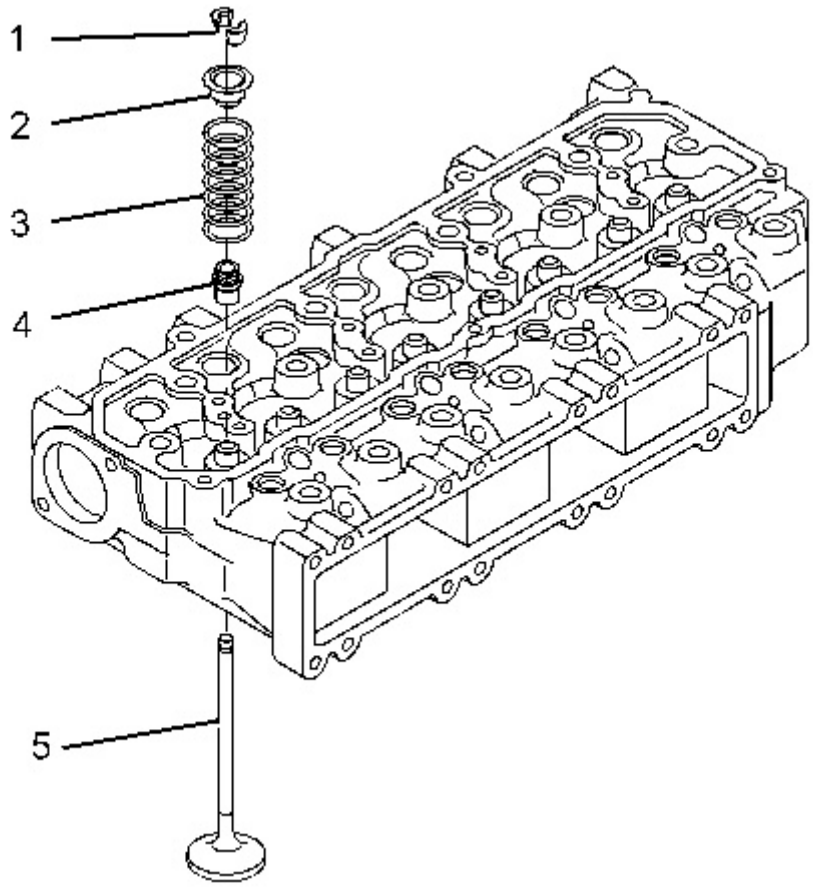


Illustration 2 g01333471

Typical example

3. Use Tooling (A) in order to compress the appropriate valve spring (3). Remove valve keepers (1) .

   Note: Do not compress the valve spring so that valve spring retainer (2) touches valve stem seal (4) .

4. Remove Tooling (A) .
5. Remove valve spring retainer (2). Remove valve spring (3) .
6. Remove valve (5) .
7. Use Tooling (B) to remove valve stem seal (4) .
8. Repeat Steps 3 through 7 in order to remove the remaining inlet and exhaust valves.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-3527	Valve Spring Compressor	1
C	4C-6373	Seal Installer	1
	4C-6366	Valve Guide Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Clean all components of the cylinder head assembly. Ensure that all ports, all coolant passages and all lubrication passages in the cylinder head are free from debris. Follow Steps 1.a through 1.e in order to inspect the components of the cylinder head assembly. Replace any components that are worn or damaged.

    a. Inspect the cylinder head for wear and for damage. Refer to Systems Operation, Testing and Adjusting, "Cylinder Head Inspect".

    b. Inspect the valve seats for wear and for damage. Refer to Specifications, "Cylinder Head Valves" for further information.

    c. Inspect the valve guides for wear and for damage. Refer to Specifications, "Cylinder Head Valves" and Systems Operation, Testing and Adjusting, "Valve Guide - Inspect" for further information.

    d. Inspect the valves for wear and for damage. Refer to Specifications, "Cylinder Head Valves".

    e. Inspect the valve springs for the correct length. Refer to Specifications, "Cylinder Head Valves".

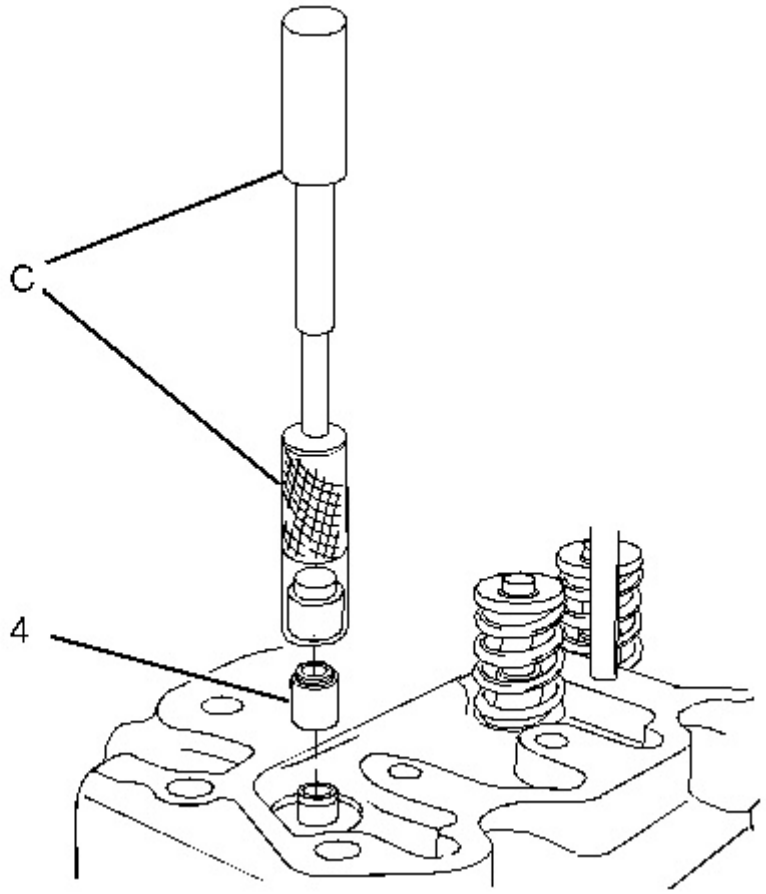


Illustration 3 g01333472

Typical example

2. Use Tooling (C) to install new valve stem seals (4) onto each of the valve guides.

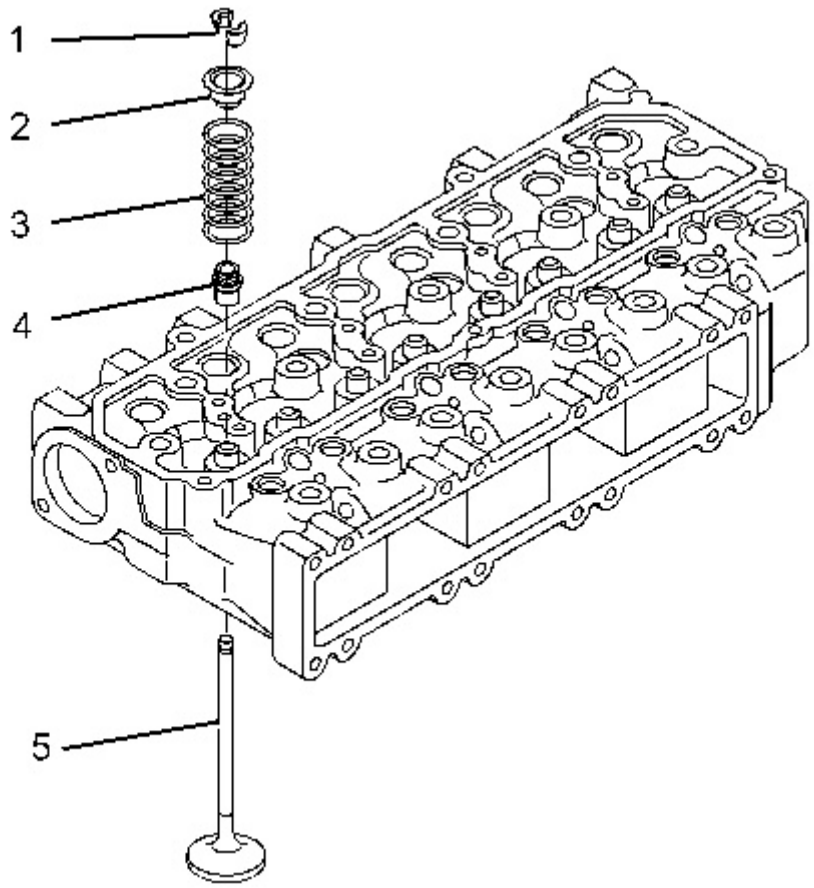


Illustration 4 g01333471

Typical example

3. Lubricate the stem of valve (5) with clean engine oil. Install valve (5) in the appropriate position in the cylinder head. Check the depth of the valve below the face of the cylinder head. Refer to Systems Operation, Testing and Adjusting, "Valve Depth - Inspect" for more information.

4. Install valve spring (3) to the cylinder head. Position valve spring retainer (2) onto valve spring (3) .

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

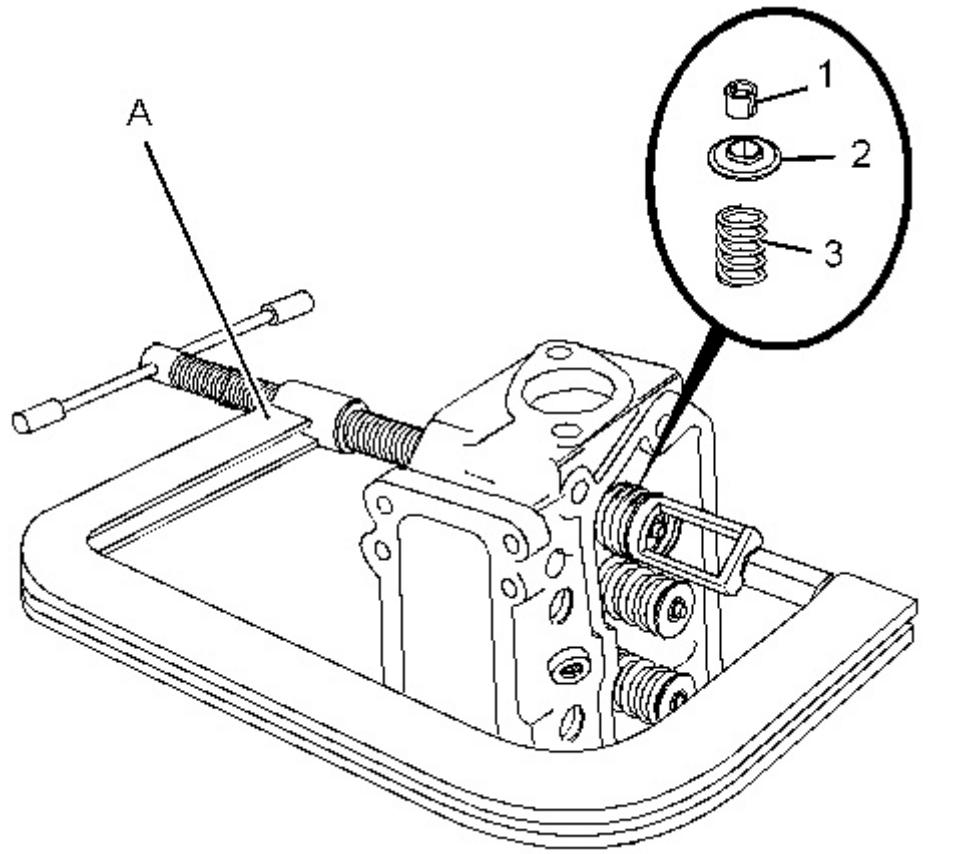


Illustration 5 g01333469

Typical example

5. Use Tooling (A) in order to compress valve spring (3). Install valve keepers (1) .

Note: Do not compress the spring so that valve spring retainer (2) touches valve stem seal (4) .

WARNING

The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury,

keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

6. Remove Tooling (A) .
7. Repeat Steps 3 to 6 for the remaining valves.
8. Place the cylinder head on a suitable support. Ensure that the heads of the valves are not obstructed. Gently strike the top of the valves with a soft hammer in order to ensure that valve keepers (1) are properly installed.

End By: Install the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638782

Inlet and Exhaust Valve Guides - Remove and Install

SMCS - 1104-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1

Start By:

A. Remove the inlet and exhaust valves and remove the valve stem seals. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: When new valve guides are installed, new valves and new valve seat inserts should be installed.

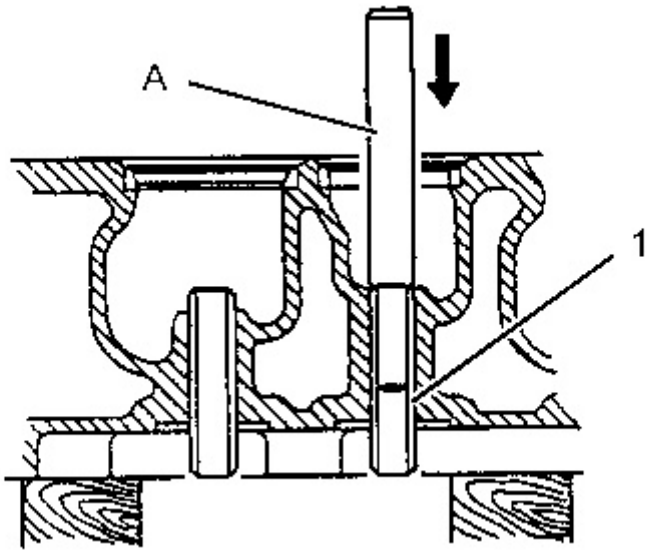


Illustration 1 g01369083

Typical example

1. Use Tooling (A) and a suitable press in order to remove valve guides (1) from the cylinder head. Refer to Illustration 1.
2. Remove the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4C-6366	Valve Guide Driver	1
B	4C-6370	Valve Guide Collar	1
C	157-3720	Valve Seat Cutter	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

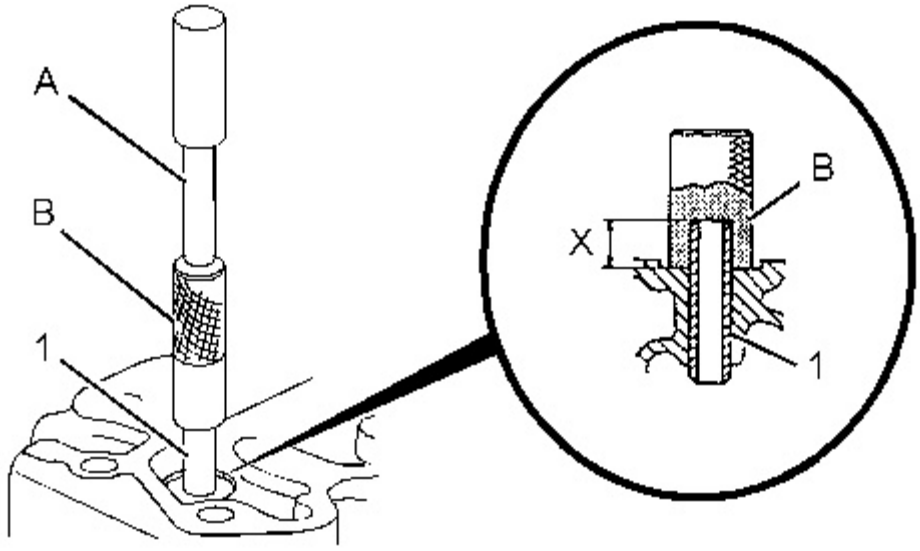


Illustration 2 g01369084

Typical example

1. Position valve guides (1) in the cylinder head. Carefully tap the valve guides with a soft faced hammer in order to locate the valve guides in the cylinder head.

   Note: Ensure that the valve guides are located squarely in the cylinder head.

2. Use Tooling (A), Tooling (B) and a suitable press in order to install the valve guides in the cylinder head. Press the valve guides until Tooling (B) bottoms out on the cylinder head.

   Note: The counterbore in Tooling (B) ensures that the valve guides are installed to the correct height.

3. Check the protrusion (X) of the valve guides. Refer to Specifications, "Cylinder Head Valves" for the protrusion of the valve guide above the valve spring recess in the cylinder head.

4. Install the valve seat inserts. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Seat Inserts - Remove and Install".

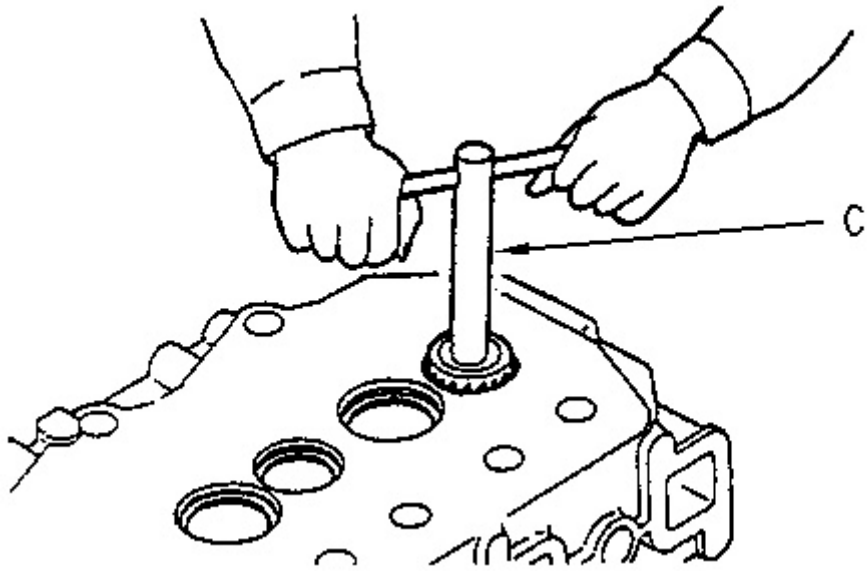


Illustration 3 g01000177

Note: After installing the valve guides and valve seat inserts, the valve guides must be reamed and the valve seat inserts must be cut to the finished diameter. The valve guides and valve seat inserts are cut and reamed in one operation. This procedure ensures the concentricity of the valve seat to the valve guide in order to create a good seal. Refer to Specifications, "Cylinder Head Valves" for the finished diameter of the valve guides and valve seat inserts.

5. Position Tooling (C) into the valve guide. Carefully turn Tooling (C) in a clockwise direction and gradually move the reamer into the valve guide until the valve guide is reamed to the finished size.

6. Continue to turn Tooling (C) in a clockwise direction in order to cut the valve seat insert. Remove the minimum amount of material in order to ensure a good valve seat. Keep the valve seat as narrow as possible.

7. Remove Tooling (C). Clean the debris from the valve guide and the valve seat.

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
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i01999639

Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS - 1103-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	166-7441	Valve Seat Extractor Tool	1

Start By:

A. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

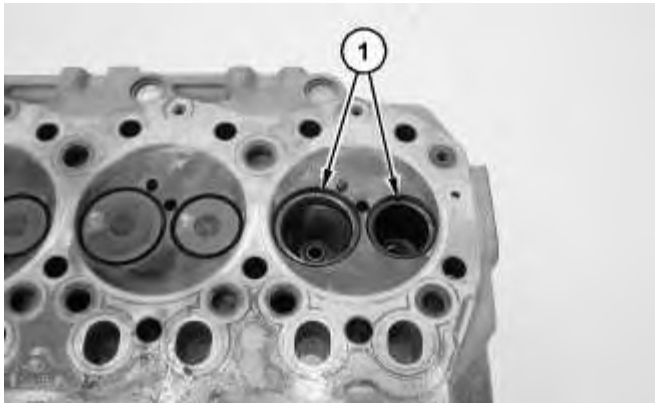


Illustration 1 g01034574

Note: One inlet and one exhaust valve have been removed in the example.

1. Use Tooling (A) to remove the valve seat inserts (1) from the cylinder head.

   Note: Refer to Special Instruction, SMHS7935 for more information on the use of Tooling (A) .

2. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.

3. Remove the valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	4C-6371	Inlet Valve Seat Driver	1
	4C-6372	Exhaust Valve Seat Driver	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

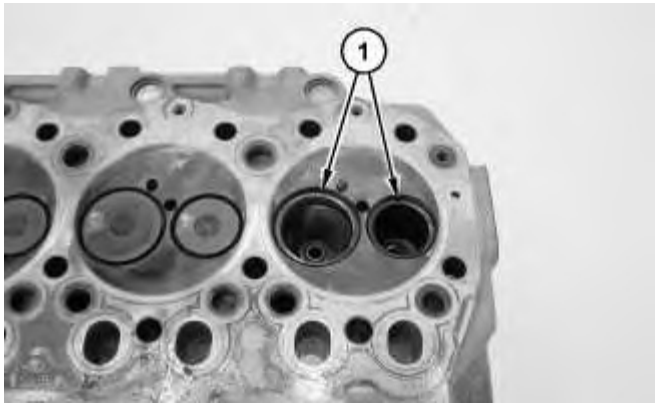


Illustration 2 g01034574

1. Lower the temperature of new valve seat inserts (1) .
2. Position valve seat inserts (1) in the cylinder head. Use Tooling (B) to seat valve seat inserts (1) in the cylinder head.
3. Repeat the procedure for the remaining valve seat inserts.

   Note: When new valve seat inserts are installed, new valves and new valve guides must be installed.
4. Install new valve guides. Refer to Disassembly and Assembly, "Inlet and Exhaust Valve Guides - Remove and Install".

End By: Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

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i02639291

Cylinder Head - Remove

SMCS - 1100-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2

Start By:

A. Remove the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".
B. Remove the fuel injectors. Refer to Disassembly and Assembly, "Fuel Injectors - Remove and Install".
C. Remove the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
D. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

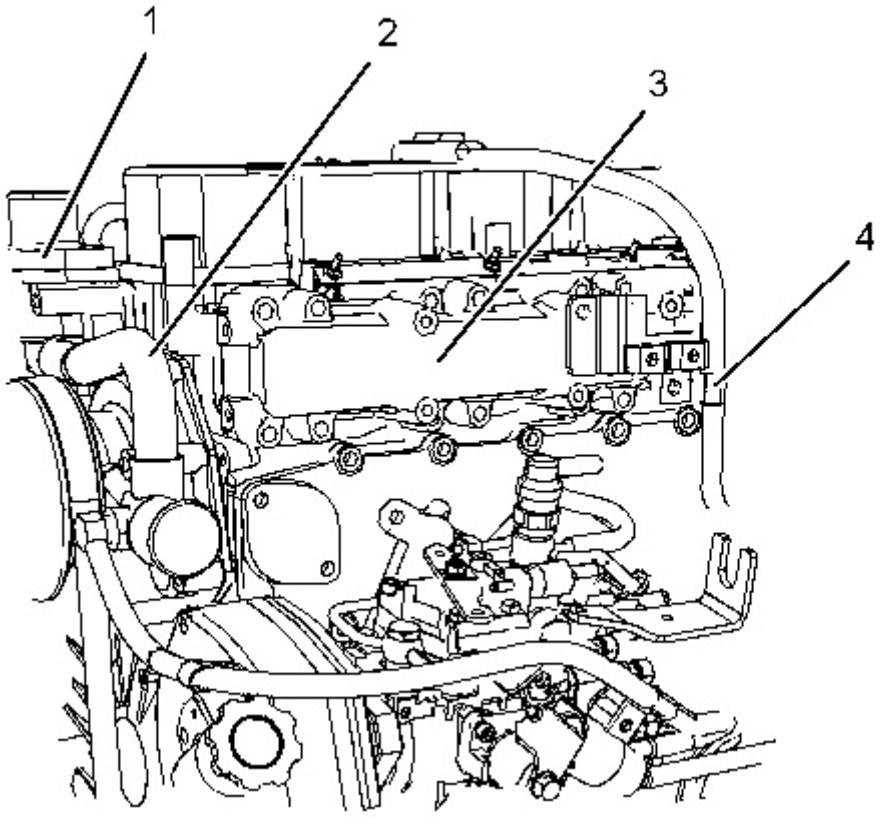


Illustration 1 g01362487

Typical example

2. Disconnect hose (2) from water temperature regulator housing (1) .
3. Remove breather hose (4) .

4. If necessary, remove inlet manifold (3). Refer to Disassembly and Assembly, "Inlet Manifold - Remove and Install".

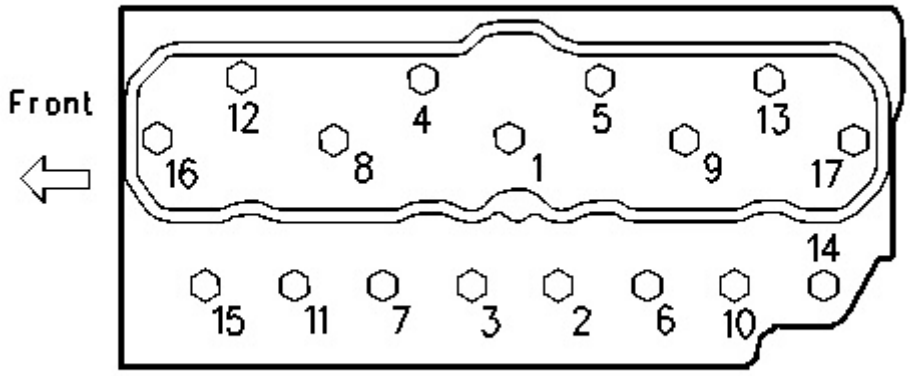


Illustration 2 g01001090

The cylinder head tightening sequence

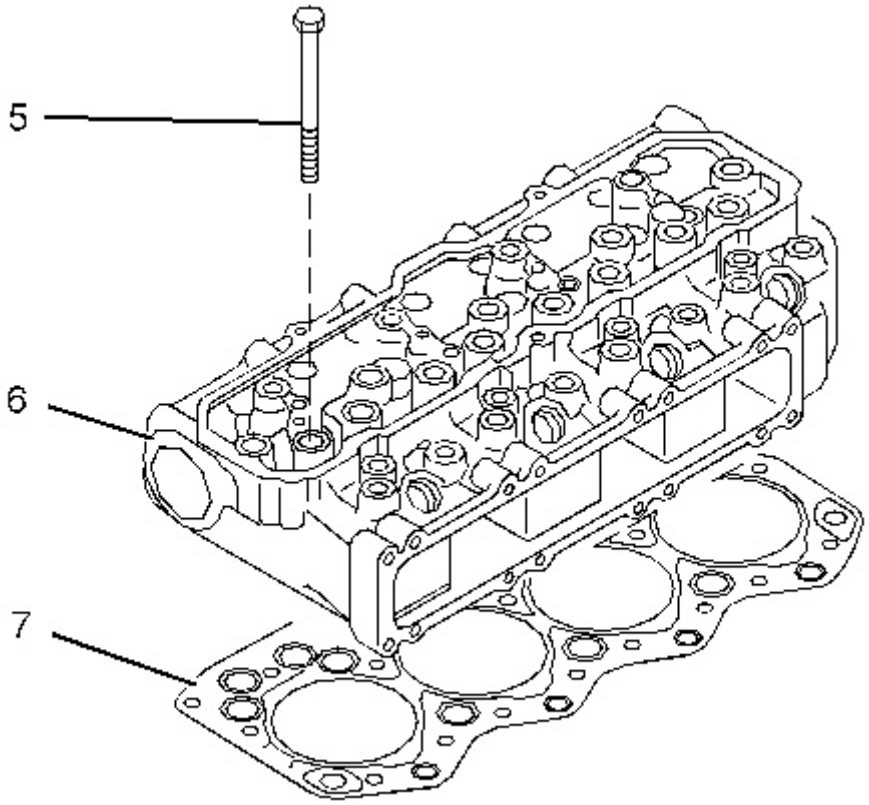


Illustration 3 g01346253

5. Gradually loosen cylinder head bolts (5) in reverse numerical order to the sequence that is shown in Illustration 2. This will prevent distortion of the cylinder head.
6. Remove cylinder head bolts (5) from cylinder head (6) .
7. Attach Tooling (A) and a suitable lifting device to cylinder head (6). Carefully lift the cylinder head off the cylinder block. The weight of the cylinder head is approximately 34 kg (75 lb).

   Note: Do not use a lever to separate the cylinder head from the cylinder block. Take care not to damage the machined surfaces of the cylinder head during the removal procedure. Avoid contamination of the cylinder bores with coolant or with debris.

NOTICE

Place the cylinder head on a surface that will not scratch the face of the cylinder head.

8. Remove gasket (7) .

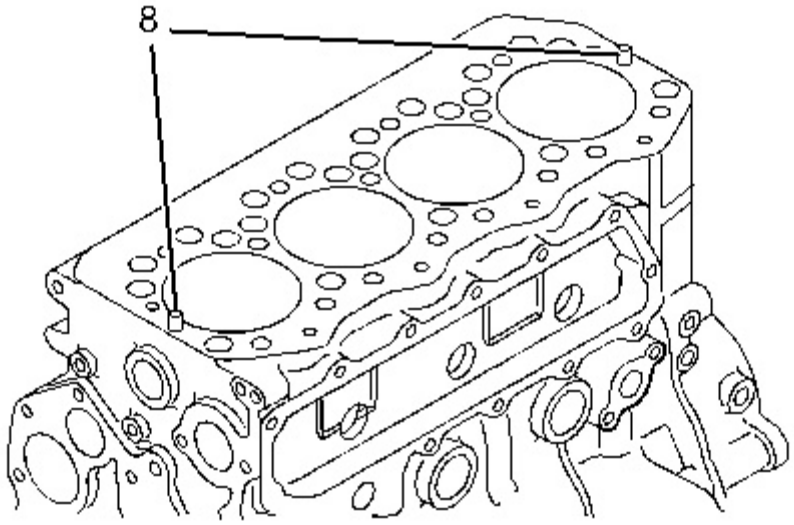


Illustration 4 g01352734

9. Note the position of dowels (8) in the cylinder block. Do not remove the dowels unless the dowels are damaged.

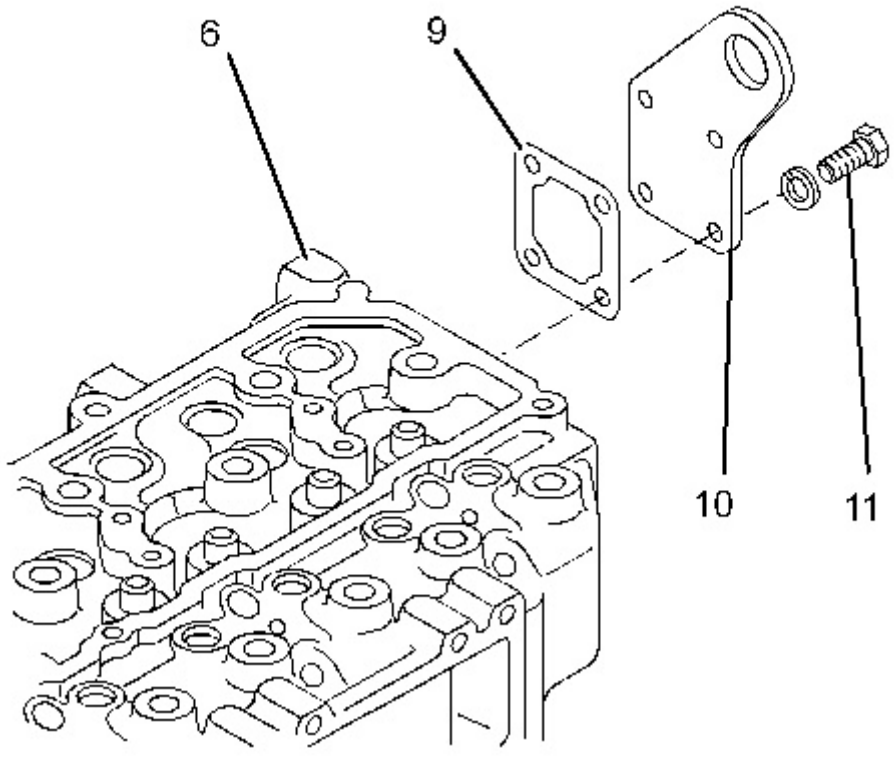


Illustration 5 g01346658

Typical example

10. If necessary, remove bolts (11) and remove lifting bracket (10). Remove joint (9) .

11. If necessary, remove water temperature regulator housing (1). Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".

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i05228990

Cylinder Head - Install

SMCS - 1100-012

Installation Procedure

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	138-7575	Link Bracket	2
	8T-4189	Bolt	2
	8T-4121	Hard Washer	2
B	-	Guide Bolt (M12 x 1.75 by 100 mm)	2
C	-	Straight Edge	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the mating surfaces of the cylinder head and the cylinder block. Ensure that there is no debris in the cylinder bores, the coolant passages, or the lubricant passages.
2. Inspect the mating surface of the cylinder head for distortion. Refer to Specifications, "Cylinder Head" for more information.

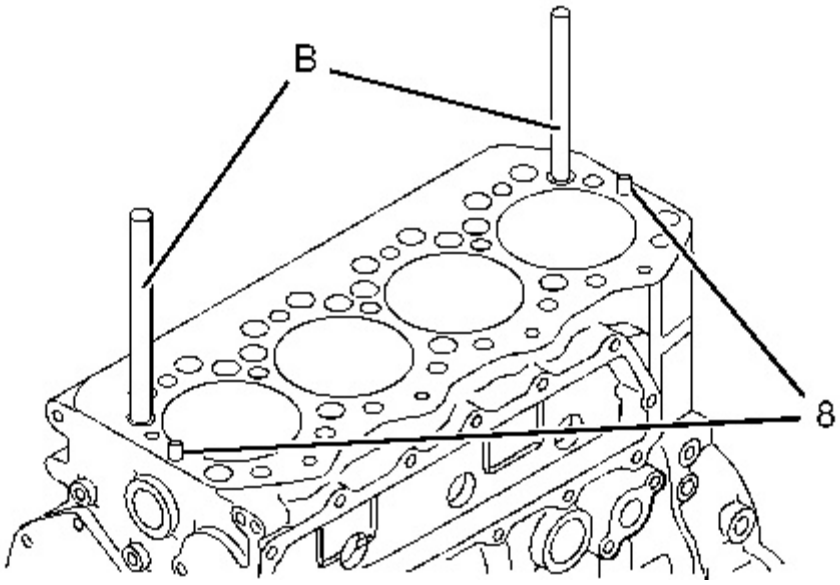


Illustration 1 g01352861

3. Inspect dowels (8) for damage. If necessary, replace the dowels in the cylinder block.
4. Install Tooling (B) to the cylinder block. Refer to Illustration 1.

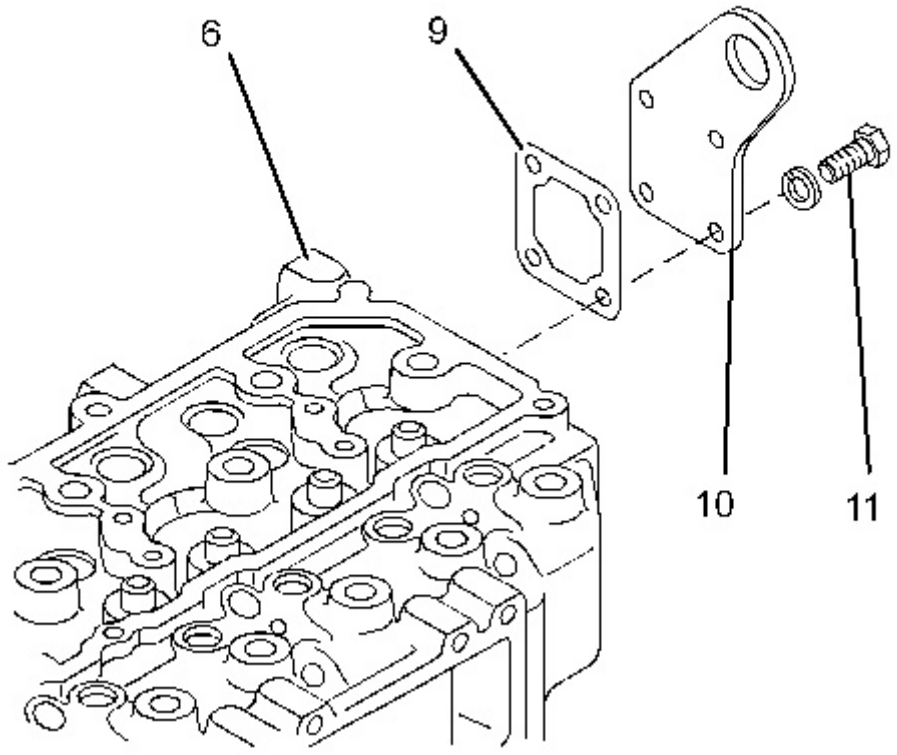


Illustration 2 g01346658

Typical example

5. If necessary, install a new joint (9) , lifting bracket (10) and bolts (11) to cylinder head (6) . Tighten the bolts to a torque of 11 N·m (97 lb in).

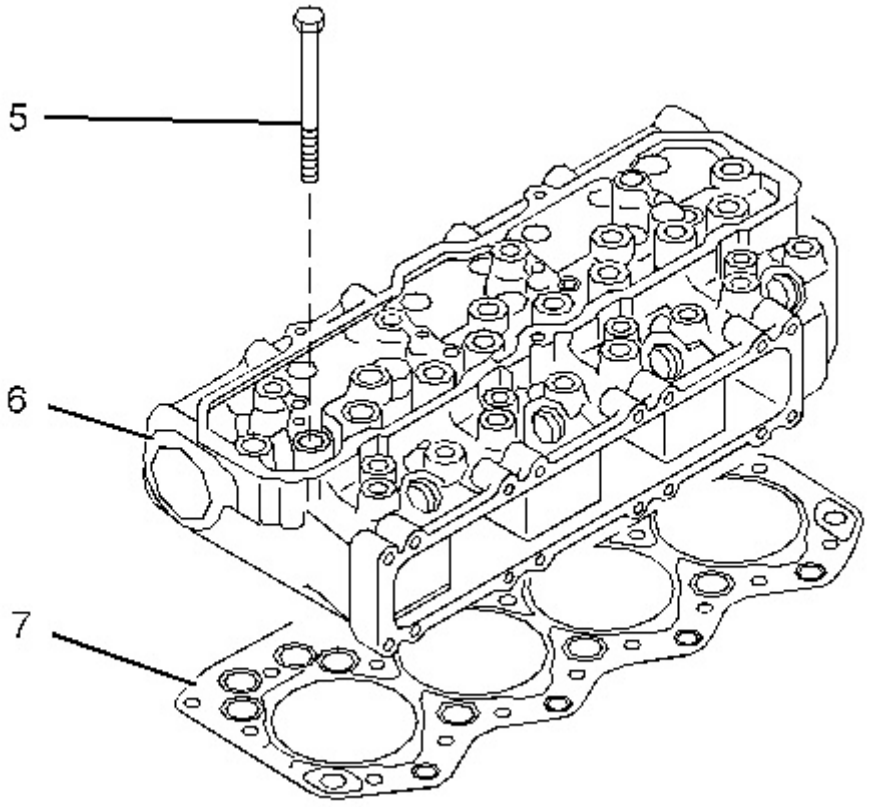


Illustration 3 g01346253

6. Align cylinder head gasket (7) with Tooling (B) and install the cylinder head gasket onto the cylinder block.

   Note: Ensure that the word UP on the cylinder head gasket is upward.

7. Use Tooling (A) and a suitable lifting device to lift cylinder head (6) . The weight of the cylinder head is approximately 34 kg (75 lb). Align cylinder head (6) with Tooling (B) and install the cylinder head to the cylinder block.

   Note: Ensure that the cylinder head is correctly seated on dowels (8) .

8. Remove Tooling (B) .

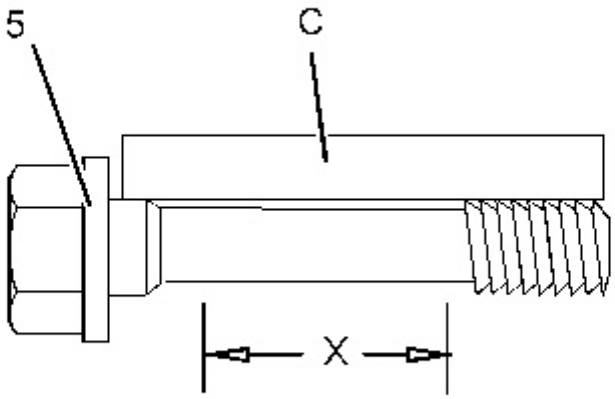


Illustration 4 g01346700

9. Clean cylinder head bolts (5) . Inspect the threads of the bolts. Use Tooling (C) in order to check the bolts. The bolts must be renewed if there is any visual reduction in the diameter over area (X) .

10. Lubricate the threads and the shoulder of cylinder head bolts (5) with clean engine oil before installation.

11. Install cylinder head bolts (5) to cylinder head (6) .

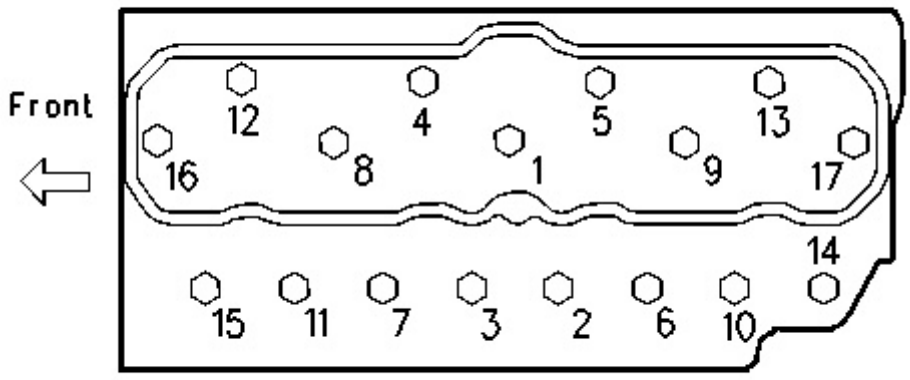


Illustration 5 g01001090

The cylinder head tightening sequence

12. Tighten cylinder head bolts (5) in numerical order to the sequence that is shown in Illustration 5. Tighten the cylinder head bolts to a torque of 118 ± 5 N·m (87 ± 4 lb ft).

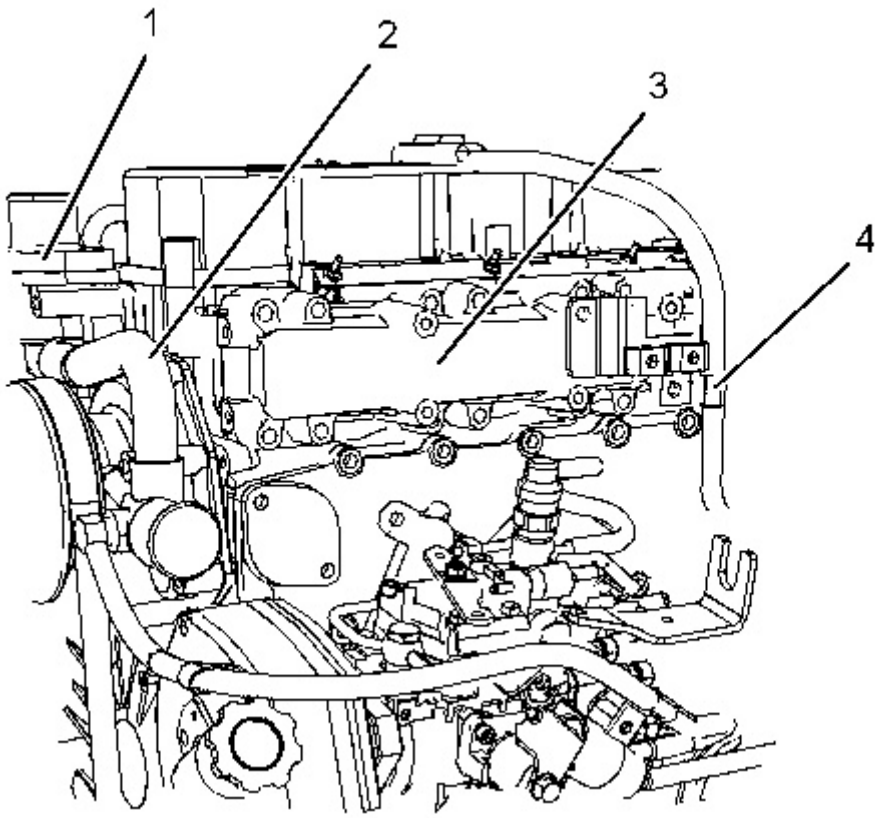


Illustration 6 g01362487

Typical example

13. If necessary, install water temperature regulator housing (1) . Refer to Disassembly and Assembly, "Water Temperature Regulator Housing - Remove and Install".
14. Connect hose (2) to water temperature regulator housing (1) .
15. If necessary, install inlet manifold (3) . Refer to Disassembly and Assembly, "Inlet Manifold - Remove and Install".
16. Install breather hose (4) .
17. Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".
18. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

End By:

a. Install the glow plugs. Refer to Disassembly and Assembly, "Glow Plugs - Remove and Install".
b. Install the fuel injectors. Refer to Disassembly and Assembly, "Fuel Injectors - Remove and Install".
c. Install the exhaust manifold. Refer to Disassembly and Assembly, "Exhaust Manifold - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01896629

Flywheel

SMCS - 1156

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Flatness of friction surface of the flywheel

Maximum at assembly ... 0.15 mm (0.0059 inch)
Repair limit ... 0.50 mm (0.020 inch)

Face and bore runout's of flywheel

Maximum at assembly ... 0.15 mm (0.0059 inch)
Repair limit ... 0.50 mm (0.020 inch)

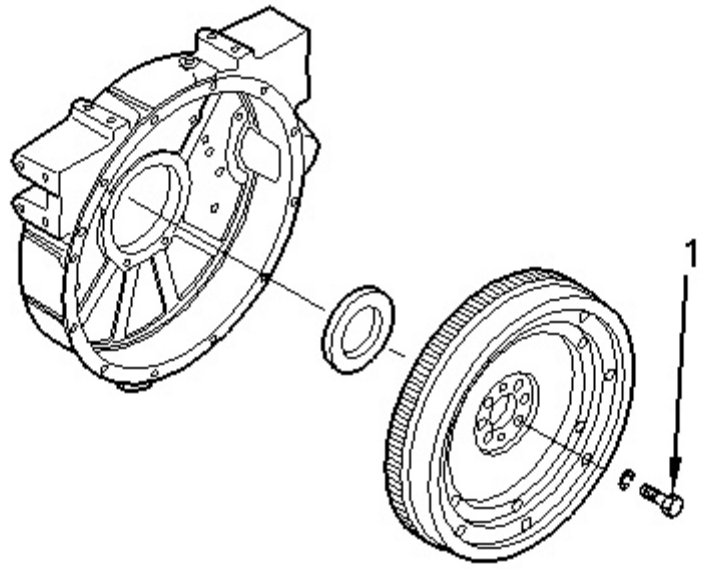


Illustration 1 g00988073

(1) Tighten the bolts for the flywheel to the following torque. ... 79 to 88 N·m (58 to 65 lb ft)

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i01896629

Flywheel

SMCS - 1156

S/N - -

Flatness of friction surface of the flywheel

Maximum at assembly ... 0.15 mm (0.0059 inch)
Repair limit ... 0.50 mm (0.020 inch)

Face and bore runout's of flywheel

Maximum at assembly ... 0.15 mm (0.0059 inch)
Repair limit ... 0.50 mm (0.020 inch)

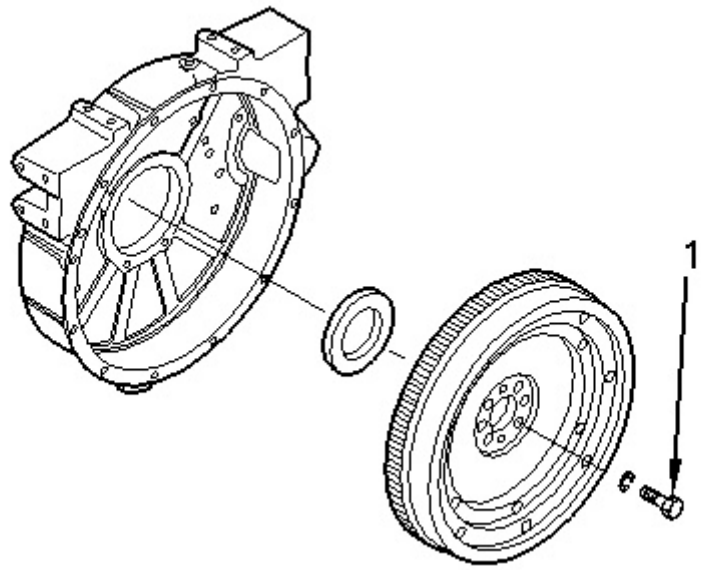


Illustration 1 g00988073

(1) Tighten the bolts for the flywheel to the following torque. ... 79 to 88 N·m (58 to 65 lb ft)

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i01999282

Flywheel - Remove

SMCS - 1156-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

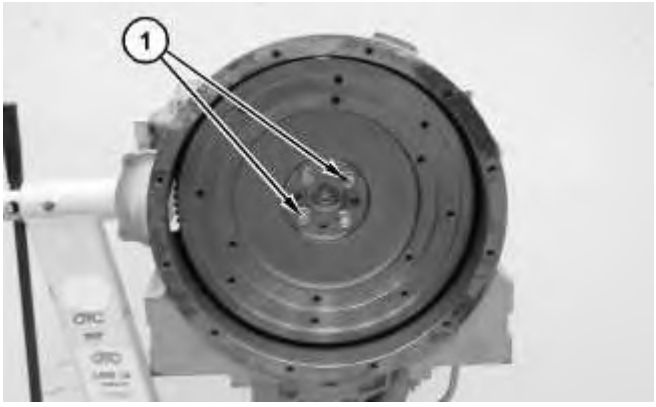


Illustration 1 g01034497

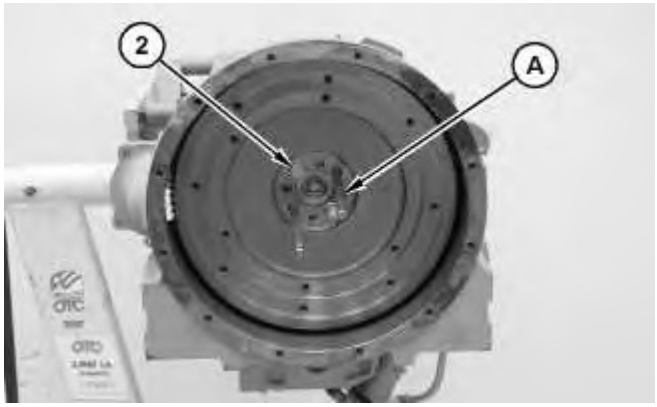


Illustration 2 g01034498

1. Remove bolts (1) and install Tooling (A) .

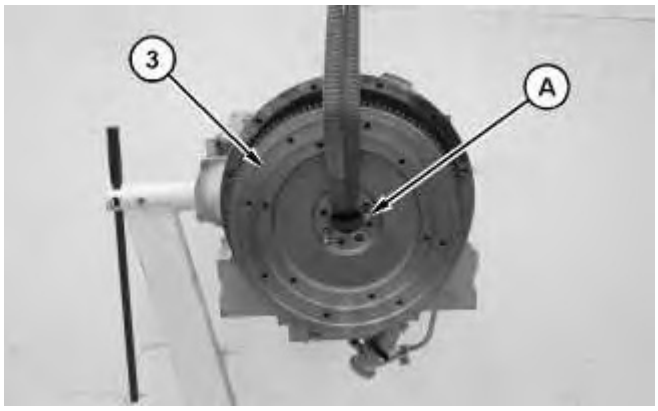


Illustration 3 g01034499

2. Remove bolts (2). Attach a suitable lifting device to flywheel (3). Remove flywheel (3). The weight of the flywheel is approximately 23 kg (50 lb).

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i01999586

Flywheel - Install

SMCS - 1156-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

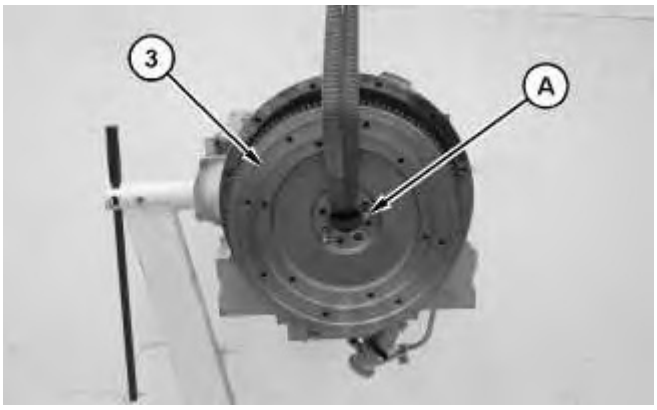


Illustration 1 g01034499

1. Install a suitable lifting device and Tooling (A) on the flywheel. Position flywheel (3) in the flywheel housing.

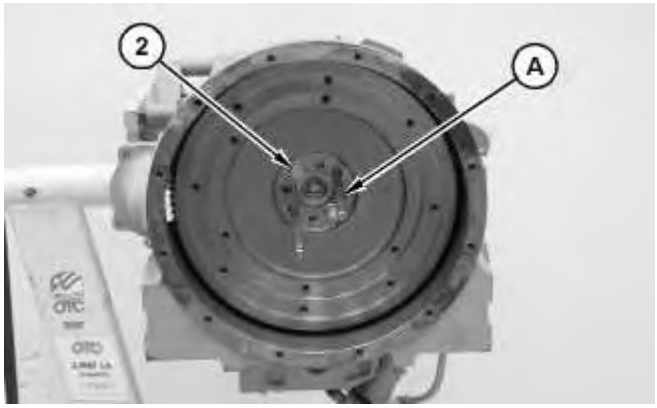


Illustration 2 g01034498

2. Install bolts (2). Tighten bolts (2) to a torque of 79 to 88 N·m (58 to 65 lb ft).

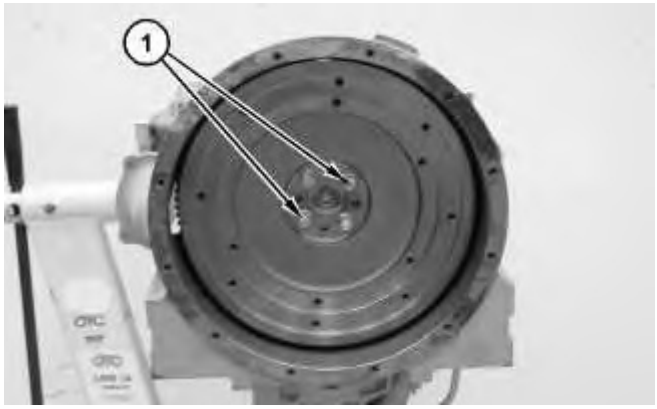


Illustration 3 g01034497

3. Remove Tooling (A). Install bolts (1). Tighten bolts (1) to a torque of 79 to 88 N·m (58 to 65 lb ft).

4. Check the radial eccentricity of the flywheel. Refer to Testing and Adjusting, "Flywheel - Inspect".

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i01999282

Flywheel - Remove

SMCS - 1156-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

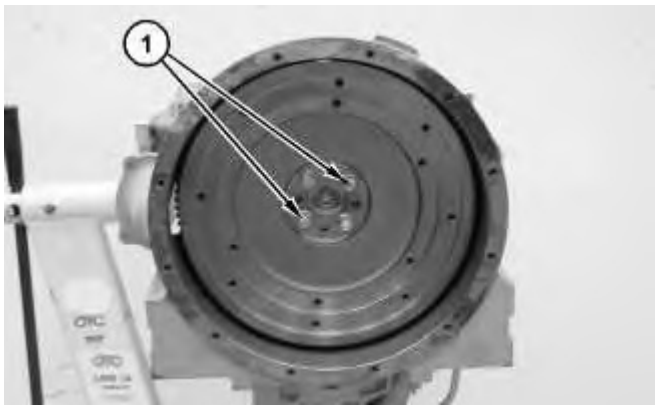


Illustration 1 g01034497

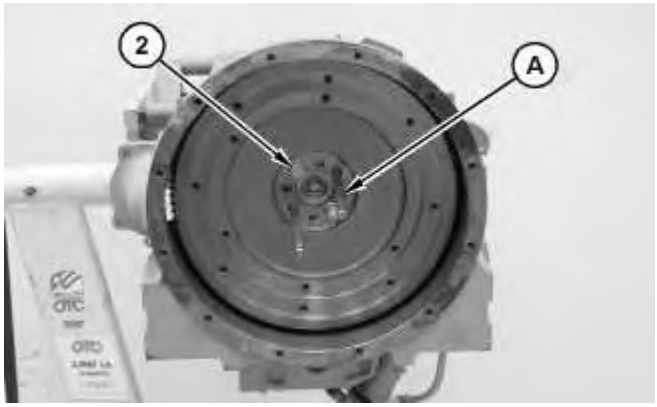


Illustration 2 g01034498

1. Remove bolts (1) and install Tooling (A) .

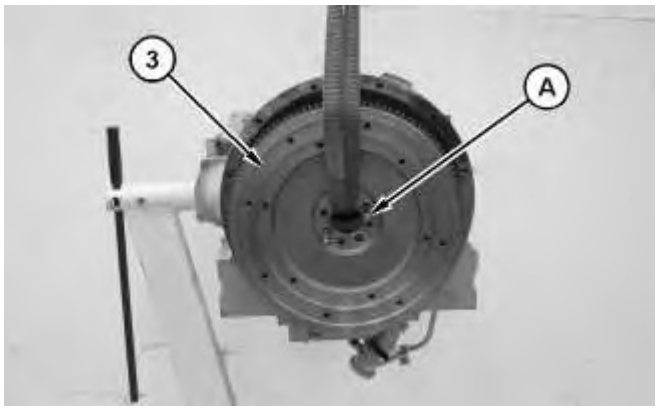


Illustration 3 g01034499

2. Remove bolts (2). Attach a suitable lifting device to flywheel (3). Remove flywheel (3). The weight of the flywheel is approximately 23 kg (50 lb).

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i01999586

Flywheel - Install

SMCS - 1156-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

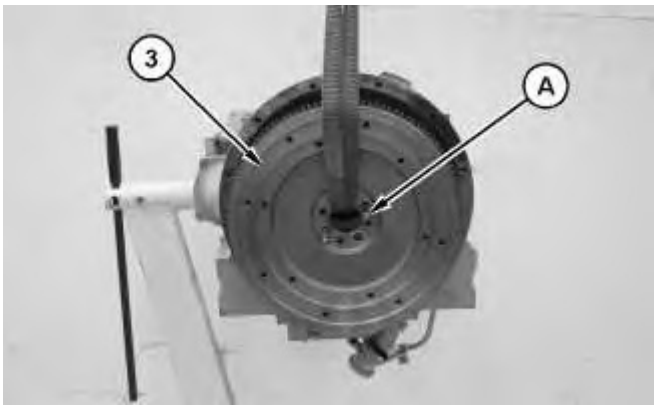


Illustration 1 g01034499

1. Install a suitable lifting device and Tooling (A) on the flywheel. Position flywheel (3) in the flywheel housing.

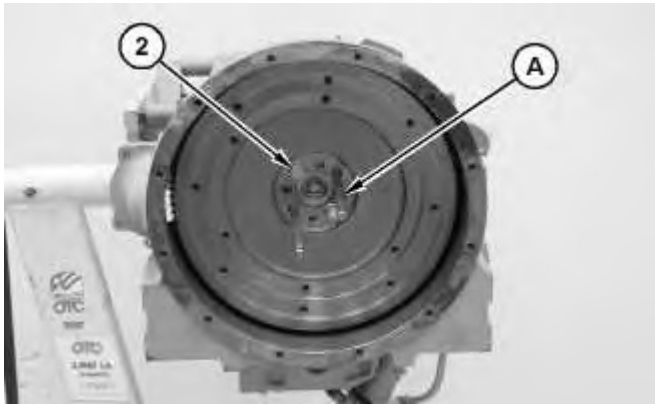


Illustration 2 g01034498

2. Install bolts (2). Tighten bolts (2) to a torque of 79 to 88 N·m (58 to 65 lb ft).

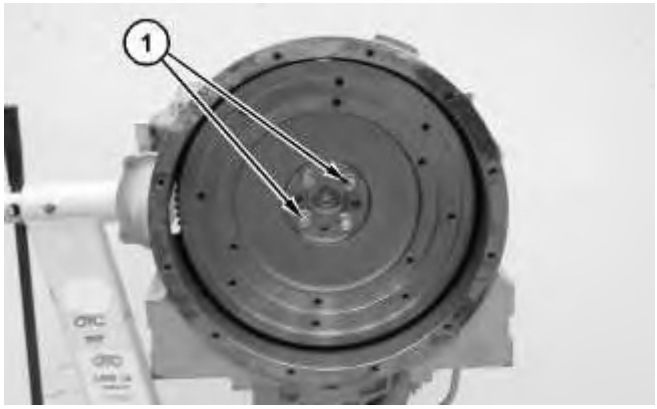


Illustration 3 g01034497

3. Remove Tooling (A). Install bolts (1). Tighten bolts (1) to a torque of 79 to 88 N·m (58 to 65 lb ft).

4. Check the radial eccentricity of the flywheel. Refer to Testing and Adjusting, "Flywheel - Inspect".

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i02638862

Flywheel - Remove

SMCS - 1156-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

Start By:

A. Remove the starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

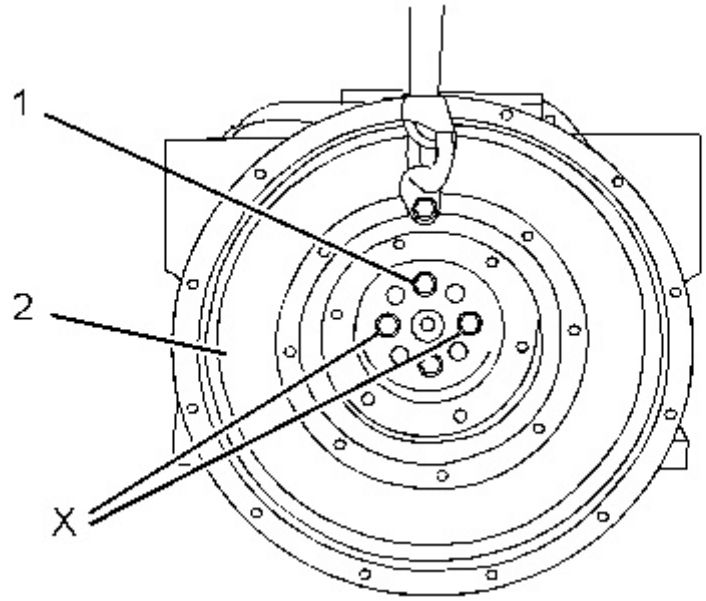


Illustration 1 g01335288

Typical example

1. Make a temporary mark in order to show the orientation of the flywheel on the crankshaft.
2. Install a suitable lifting device to flywheel (2). The weight of the flywheel is approximately 23 kg (50 lb).
3. Remove two bolts (1) from Positions (X) on the flywheel.
4. Install Tooling (A) in positions (X) on the flywheel.
5. Remove the remaining bolts (1) and remove flywheel (2) .

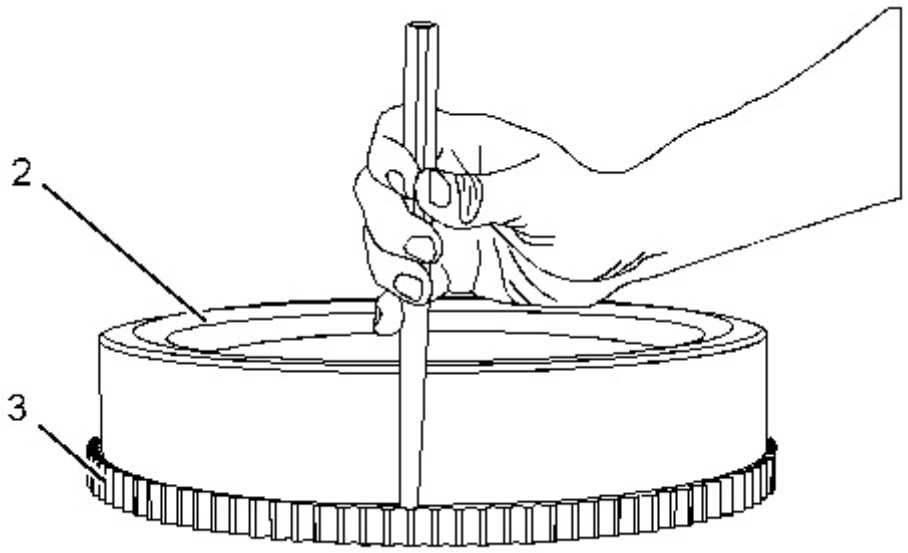


Illustration 2 g01360927

Typical example

6. Inspect ring gear (3) and flywheel (2) for wear or damage. If the ring gear or the flywheel is worn or damaged, use new parts for replacement.

7. To remove ring gear (3) from flywheel (2), place the flywheel on a suitable support. Use a hammer and a punch in order to remove the ring gear from the flywheel.

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i02638867

Flywheel - Install

SMCS - 1156-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7994	Guide Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

WARNING

Always wear protective gloves when handling parts that have been heated.

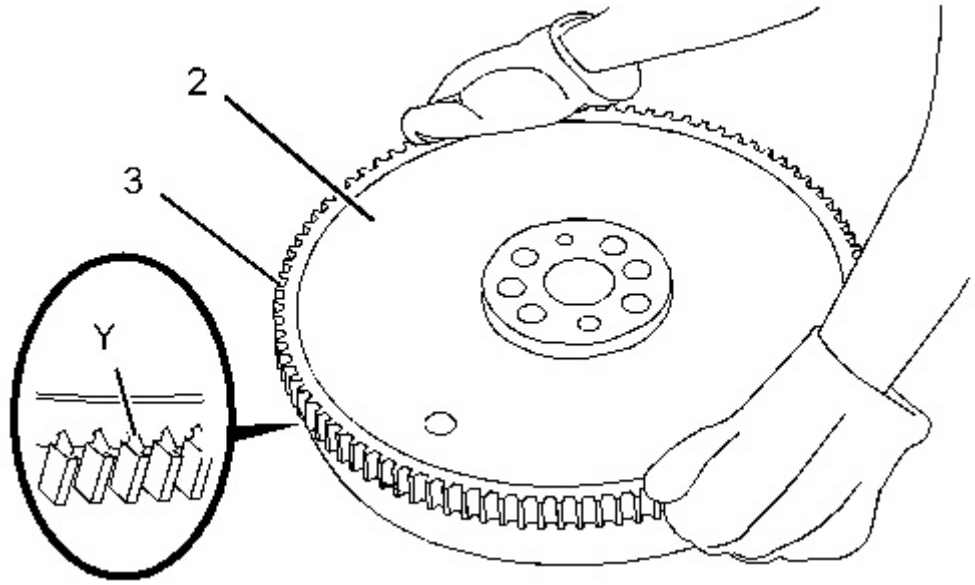


Illustration 1 g01369129

Typical example

1. If the ring gear was removed, follow Steps 1.a through 1.c in order to install ring gear (3) to flywheel (2).

   a. Identify the orientation of the new ring gear in order to install the ring gear correctly onto the flywheel.

      Note: The chamfered side of gear teeth (Y) must face toward the starting motor when the flywheel is installed. This will ensure the correct engagement of the starting motor.

   b. Heat ring gear (3) in an oven to a maximum temperature of 150°C (302°F) prior to installation.

      Note: Do not use a torch to heat the ring gear.

   c. Ensure that the orientation of ring gear (3) is correct and quickly install the ring gear onto flywheel (2) .

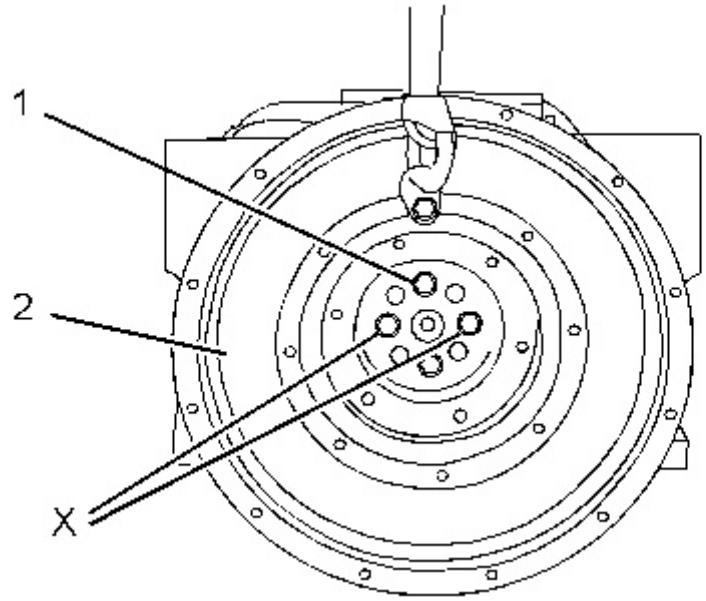


Illustration 2 g01335288

Typical example

2. Thoroughly clean the flywheel housing. Inspect the crankshaft rear seal for leaks. If there are any oil leaks replace the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove and Install".

3. Ensure that the dowels are installed to the crankshaft. Install Tooling (A) to positions (X) in the crankshaft.

4. Install a suitable lifting device to flywheel (2). The weight of the flywheel is approximately 23 kg (50 lb).

5. Align flywheel (2) with Tooling (A). Install the flywheel to the crankshaft.

   Note: Ensure the correct orientation of the flywheel on the crankshaft.

6. Install bolts (1) finger tight.

7. Remove Tooling (A) and install the two remaining bolts (1) .

8. Remove the lifting device from the flywheel.

9. Use a suitable tool to prevent flywheel (2) from rotating. Tighten bolts (1) to a torque of 83 N·m (61 lb ft).

10. Check the concentricity of the flywheel. Refer to Systems Operation, Testing and Adjusting, "Flywheel - Inspect".

End By: Install the starting motor. Refer to Disassembly and Assembly, "Electric Starting Motor - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01896267

Gear Group (Front)

SMCS - 1206

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - ZSA1-UP

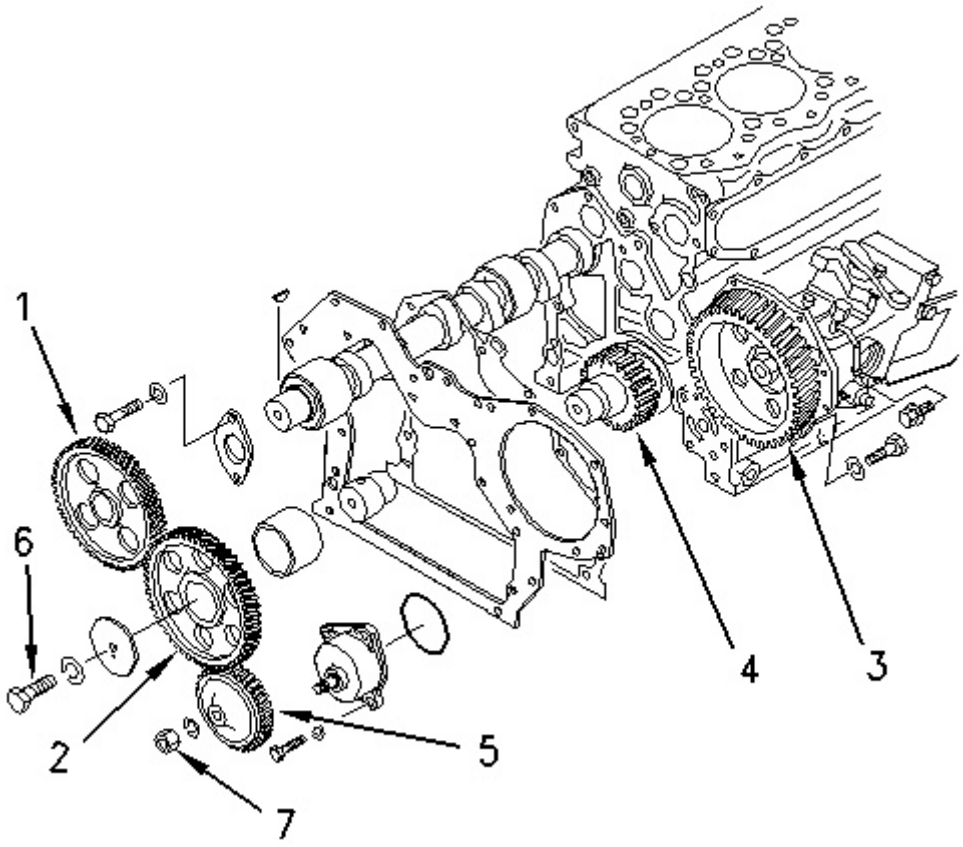


Illustration 1 g00988013

(1) Camshaft gear

(2) Idler gear

End play of idler gear
Standard at assembly ... 0.05 to 0.20 mm (0.0020 to 0.0079 inch)
Service limit ... 0.35 mm (0.0138 inch)

Clearance between idler gear bushing and shaft

Standard at assembly ... 0.009 to 0.050 mm (0.0004 to 0.0020 inch)
Service limit ... 0.100 mm (0.0039 inch)

(3) Fuel Injection pump gear

Tighten the bolts for the fuel injection pump gear to the following torque.

Naturally aspirated engines ... 59 to 69 N·m (43 to 51 lb ft)
Turbocharged engines ... 83 to 98 N·m (62 to 72 lb ft)

(4) Crankshaft gear

(5) Oil pump gear

(6) Tighten the thrust plate bolts for the idler gear to the following torque. ... 29 to 39 N·m (21 to 29 lb ft)

(7) Tighten the jam nut for the oil pump gear to the following torque. ... 28 to 38 N·m (21 to 28 lb ft)

Backlash for all gears

Standard at assembly ... 0.03 to 0.18 mm (0.0012 to 0.0071 inch)
Service Limit ... 0.25 mm (0.0098 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01896267

Gear Group (Front)

SMCS - 1206

S/N - -

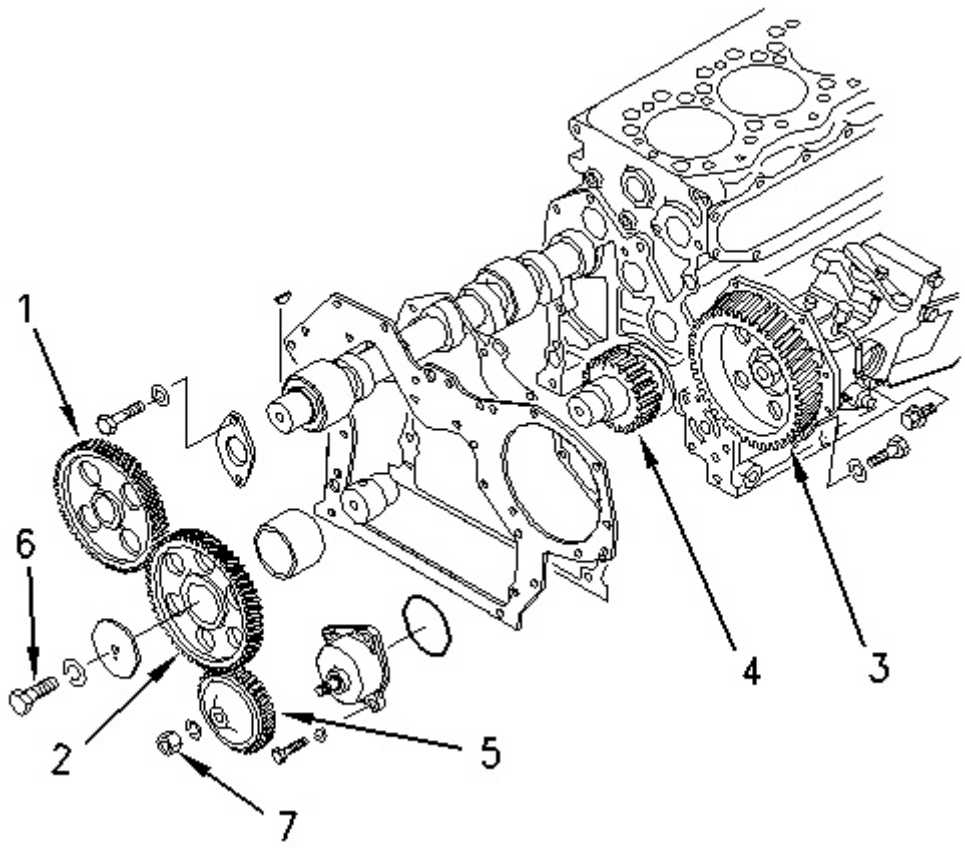


Illustration 1 g00988013

(1) Camshaft gear

(2) Idler gear

End play of idler gear

Standard at assembly ... 0.05 to 0.20 mm (0.0020 to 0.0079 inch)
Service limit ... 0.35 mm (0.0138 inch)

Clearance between idler gear bushing and shaft

Standard at assembly ... 0.009 to 0.050 mm (0.0004 to 0.0020 inch)
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(3) Fuel Injection pump gear

Tighten the bolts for the fuel injection pump gear to the following torque.

Naturally aspirated engines ... 59 to 69 N·m (43 to 51 lb ft)
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(5) Oil pump gear

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Backlash for all gears

Standard at assembly ... 0.03 to 0.18 mm (0.0012 to 0.0071 inch)
Service Limit ... 0.25 mm (0.0098 inch)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01998999

Idler Gear - Remove and Install

SMCS - 1206

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

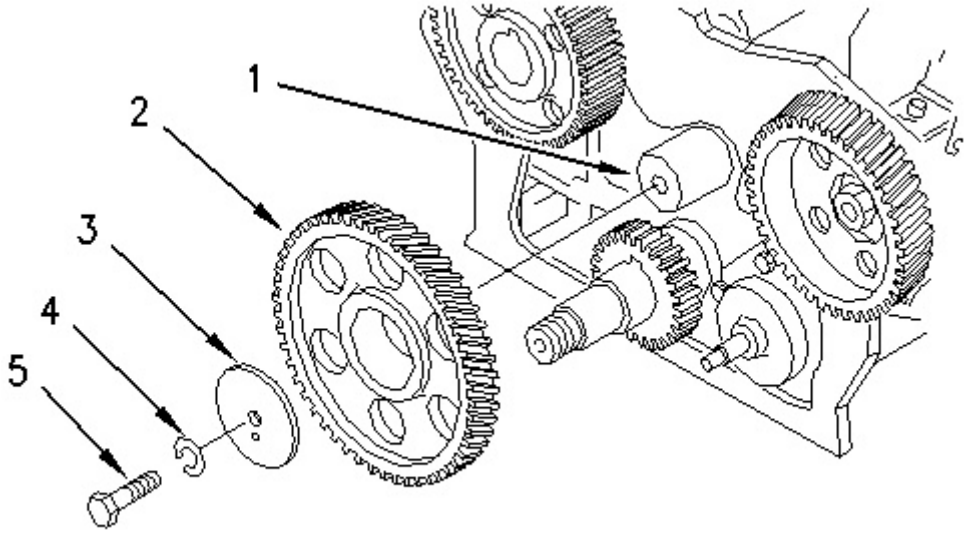


Illustration 1 g01000849

2. Remove bolt (5), washer (4), and retaining plate (3). Remove idler gear (2) from idler gear hub (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

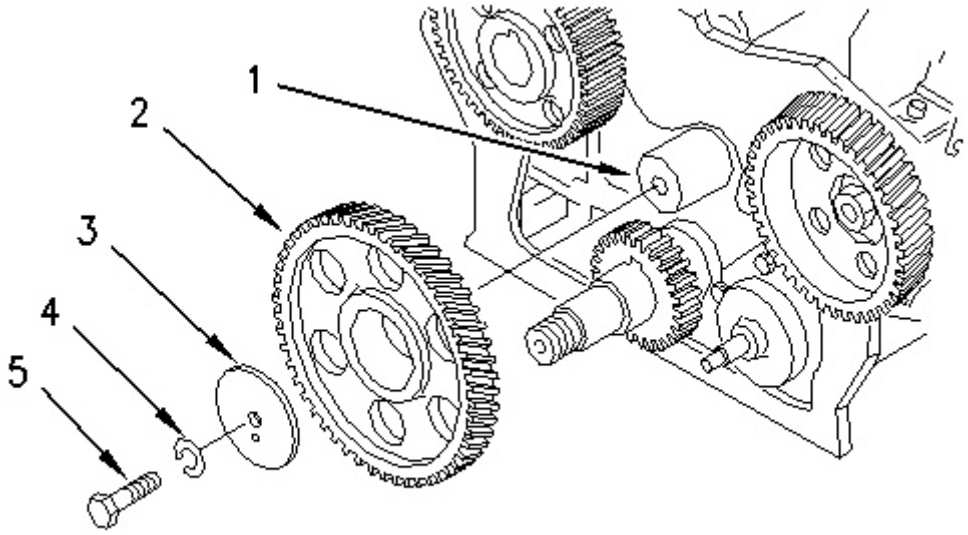


Illustration 2 g01000849

Note: The lubrication hole of idler gear hub (1) must be positioned at the top.

1. Install idler gear hub (1) in the cylinder block. Use a soft hammer to seat idler gear hub (1) .

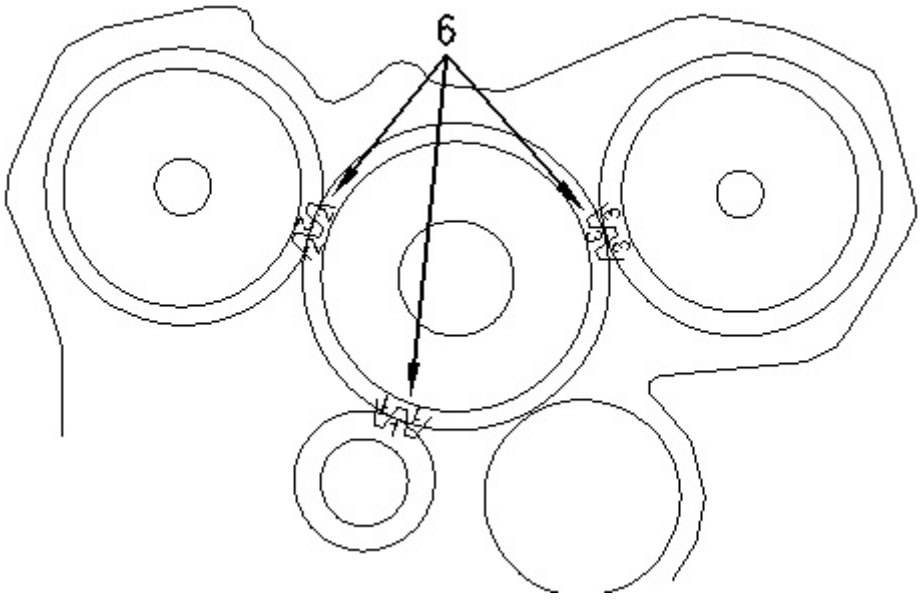


Illustration 3 g01000859

Note: When you install idler gear (2), ensure that the marked teeth are facing toward the front.

2. Align timing marks (6) on the teeth with the timing marks on the crankshaft gear, the fuel injection pump gear, and the camshaft gear. Position idler gear (2) on idler gear hub (1) .

3. Install retaining plate (3), washer (4), and bolt (5) and tighten to a torque of 29 to 39 N·m (21 to 29 lb ft).

4. Inspect the backlash and end play of the gear group. Refer to Testing and Adjusting, "Gear Group - Inspect".

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i01998999

Idler Gear - Remove and Install

SMCS - 1206

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

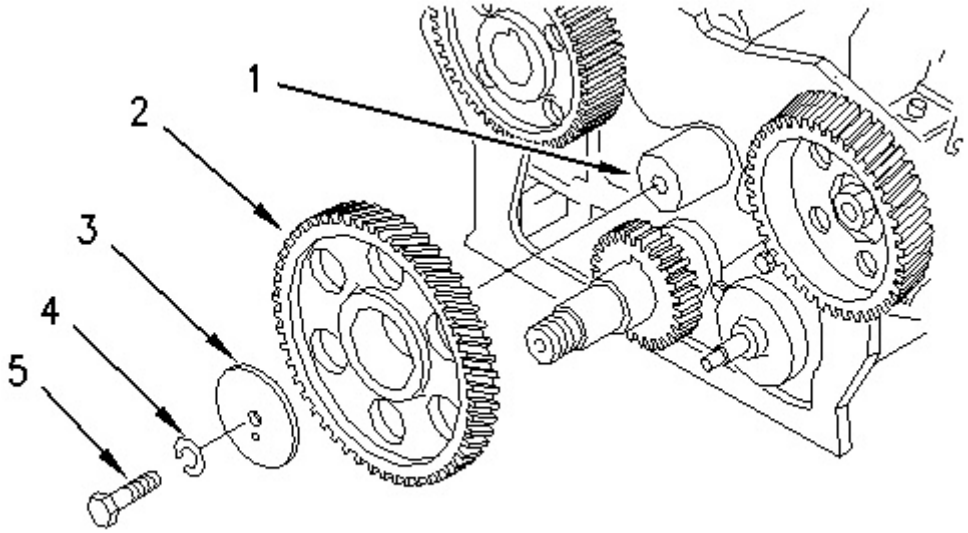


Illustration 1 g01000849

2. Remove bolt (5), washer (4), and retaining plate (3). Remove idler gear (2) from idler gear hub (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

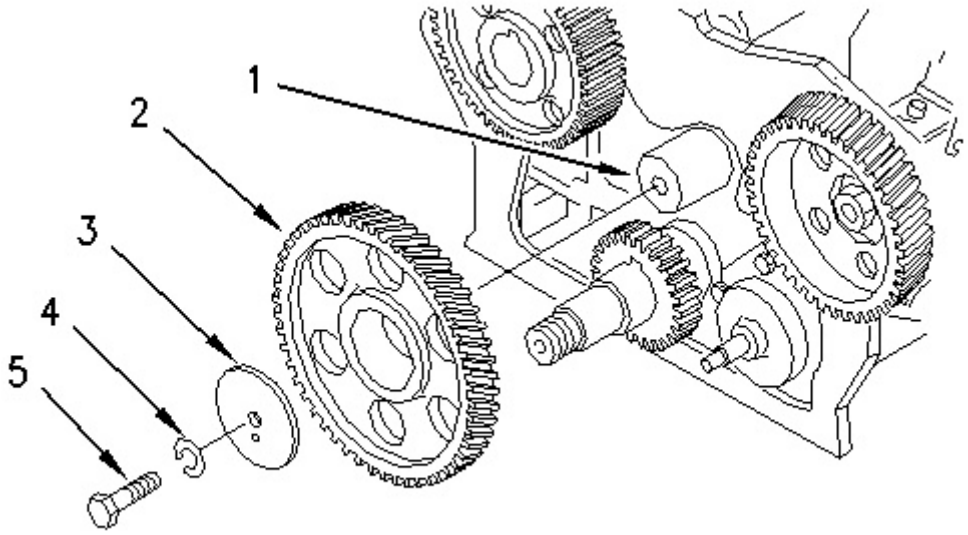


Illustration 2 g01000849

Note: The lubrication hole of idler gear hub (1) must be positioned at the top.

1. Install idler gear hub (1) in the cylinder block. Use a soft hammer to seat idler gear hub (1) .

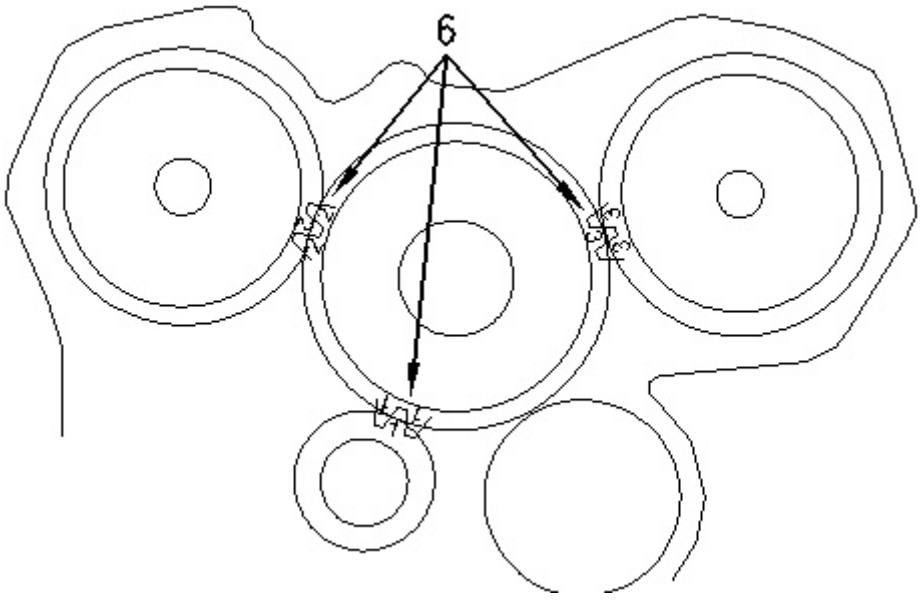


Illustration 3 g01000859

Note: When you install idler gear (2), ensure that the marked teeth are facing toward the front.

2. Align timing marks (6) on the teeth with the timing marks on the crankshaft gear, the fuel injection pump gear, and the camshaft gear. Position idler gear (2) on idler gear hub (1) .

3. Install retaining plate (3), washer (4), and bolt (5) and tighten to a torque of 29 to 39 N·m (21 to 29 lb ft).

4. Inspect the backlash and end play of the gear group. Refer to Testing and Adjusting, "Gear Group - Inspect".

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i02639281

Idler Gear - Remove and Install

SMCS - 1206

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-6148	Idler Shaft Puller	1

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".
B. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

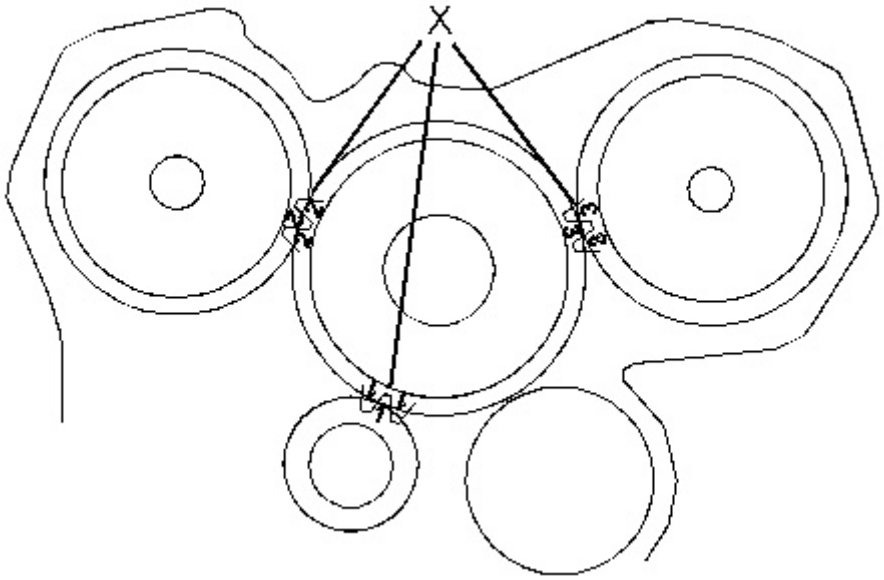


Illustration 1 g01337345

Alignment of timing marks

2. Ensure that timing marks (X) on the gears are aligned. Refer to Illustration 1.

   Alternatively, make temporary timing marks on the gears in order to show alignment.

3. Loosen the nuts on all rocker arms. Unscrew the adjusters on all rocker arms until all valves are fully closed.

   Note: Failure to ensure that ALL adjusters are fully unscrewed can result in contact between the valves and pistons.

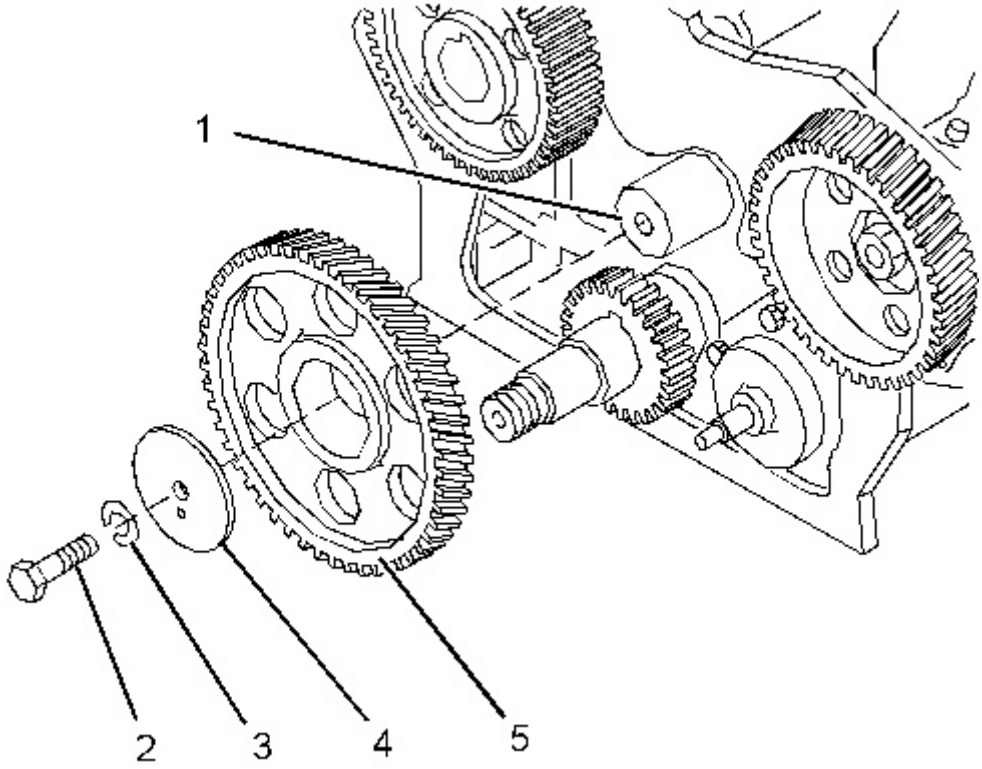


Illustration 2 g01337783

Typical example

4. Remove bolt (2), washer (3), and plate (4) .
5. Remove idler gear (5) from shaft (1) .

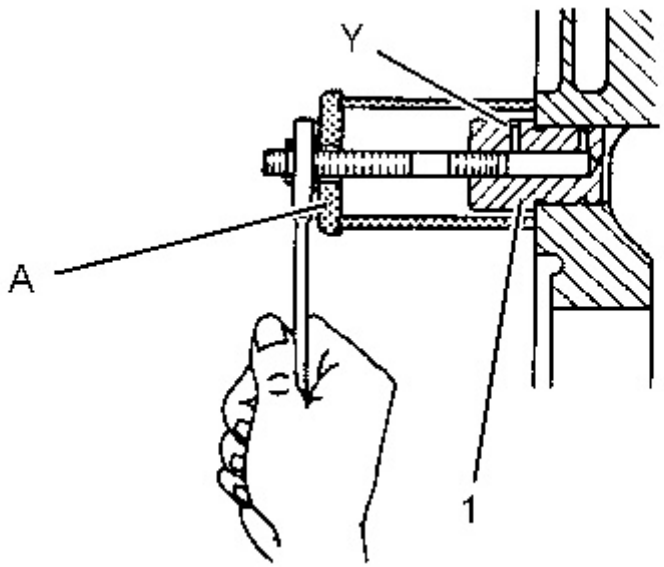


Illustration 3 g01337810

Extracting the shaft from the cylinder block

6. If necessary, follow Steps 6.a and 6.b in order to remove shaft (1) .

   a. Make a temporary mark on the cylinder block in order to show the position of oil hole (Y) .

   b. Use Tooling (A) to extract shaft (1) from the cylinder block.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	9U-7324	Indicator Bracket	1
	7H-1942	Dial Indicator	1
	3S-3268	Indicator Contact Point	1
	7H-1940	Universal Attachment	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

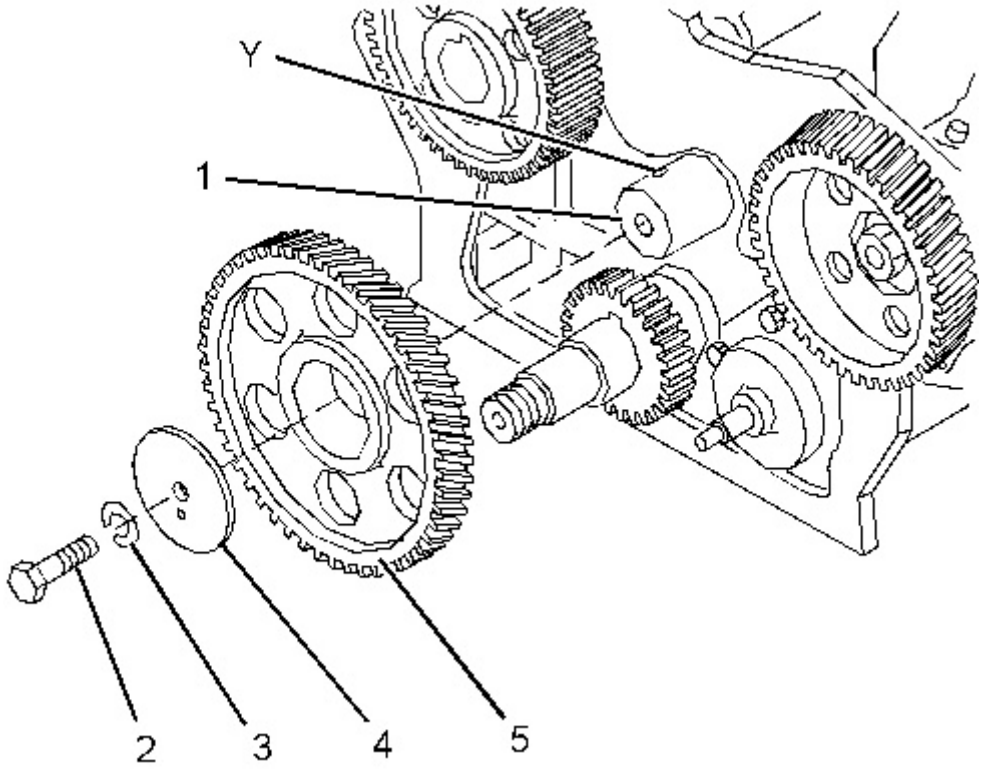


Illustration 4 g01364486

Typical example

1. If necessary, follow Steps 1.a and 1.b in order to install shaft (1) .
   a. Align oil hole (Y) on shaft (1) with the temporary mark on the cylinder block.
   b. Use a soft faced hammer and a hard wooden drift to install shaft (1) into the cylinder block.

      Note: Install shaft (1) squarely into the cylinder block. Ensure that oil hole (Y) is aligned with the temporary mark and that the shoulder on the shaft is seated against the face of the cylinder block.
2. Ensure that plate (4) and idler gear (5) are clean and free from wear or damage. If necessary, replace any components that are worn or damaged.
3. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

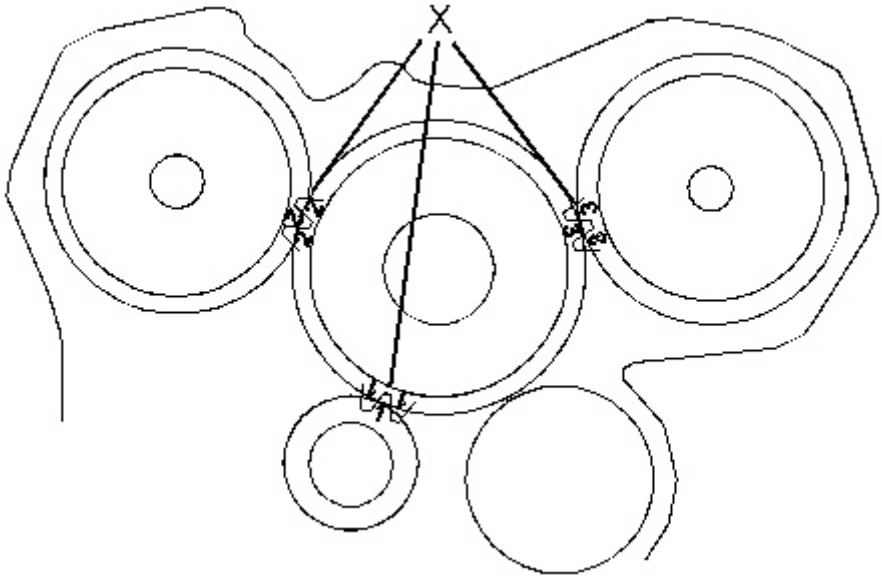


Illustration 5 g01337345

Alignment of timing marks

4. Lubricate shaft (1) with clean engine oil. Position idler gear (5) onto shaft (1). Ensure that timing marks (X) on the gears are aligned. Refer to Illustration 5.
5. Lubricate the bearing surface of plate (4) with clean engine oil. Install plate (4), washer (3), and bolt (2) .

   Note: Ensure that the bearing surface of the plate is toward the idler gear.
6. Tighten bolt (2) to a torque of 34 N·m (25 lb ft).
7. Use a feeler gauge in order to check the end play of idler gear (2). Refer to Specifications, "Gear Group (Front)" for more information.
8. Use Tooling (B) in order to inspect the backlash of the gear group. Refer to Systems Operation, Testing and Adjusting, "Gear Group - Inspect".
9. Lightly lubricate all of the gears with clean engine oil.
10. Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".
11. Adjust the engine valve lash. Refer to Systems Operation, Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".

End By: Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

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i01999238

Flywheel Housing - Remove and Install

SMCS - 1157-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
	8T-4184	Bolt	1
	8T-4244	Nut	1
	8T-4225	Washer	2

Start By:

A. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

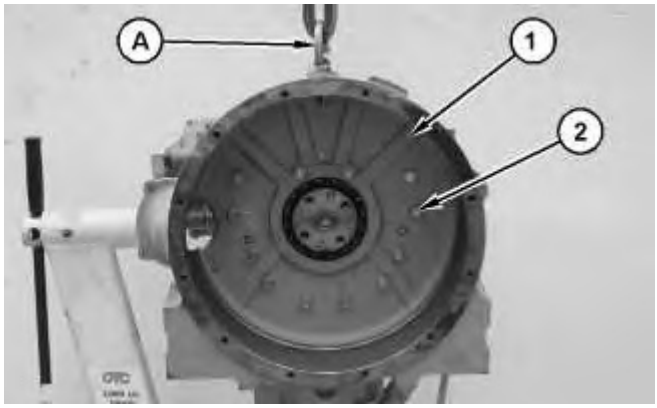


Illustration 1 g01034440

1. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). Remove bolts (2) and flywheel housing (1). The weight of the flywheel housing is approximately 32 kg (70 lb).

2. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
	8T-4184	Bolt	1
	8T-4244	Nut	1
	8T-4225	Washer	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

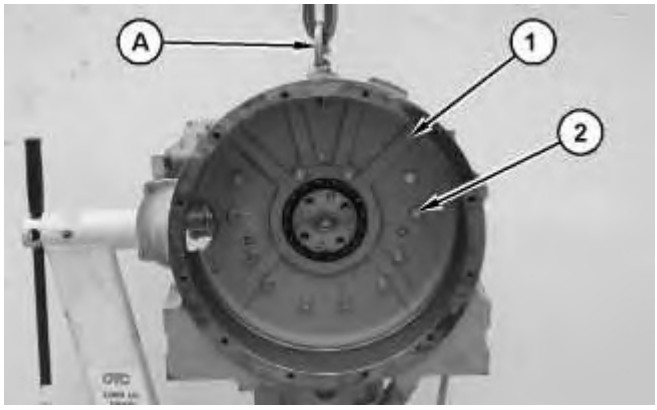


Illustration 2 g01034440

1. Use Tooling (A) and a suitable lifting device to position flywheel housing (1). The weight of the flywheel housing is approximately 32 kg (70 lb).
2. Install bolts (2) .
3. Install a new crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

End By: Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

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i01999238

Flywheel Housing - Remove and Install

SMCS - 1157-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
	8T-4184	Bolt	1
	8T-4244	Nut	1
	8T-4225	Washer	2

Start By:

A. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

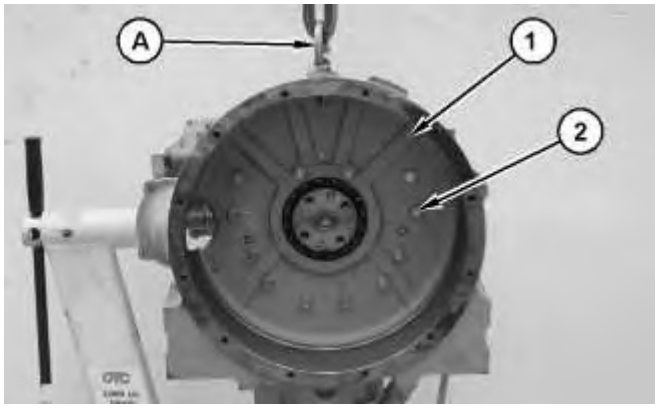


Illustration 1 g01034440

1. Attach Tooling (A) and a suitable lifting device to flywheel housing (1). Remove bolts (2) and flywheel housing (1). The weight of the flywheel housing is approximately 32 kg (70 lb).

2. Remove the crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Remove".

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	138-7575	Link Bracket	1
	8T-4184	Bolt	1
	8T-4244	Nut	1
	8T-4225	Washer	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

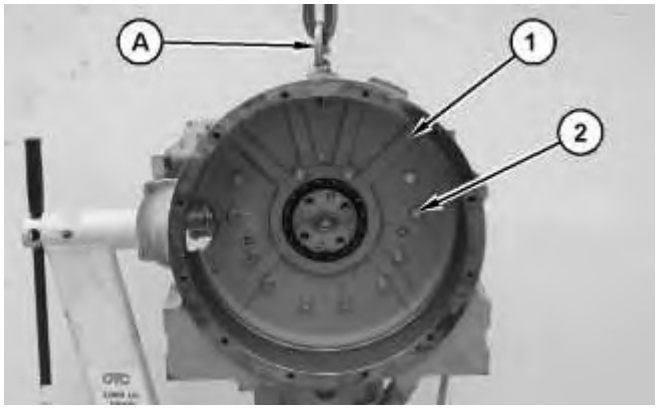


Illustration 2 g01034440

1. Use Tooling (A) and a suitable lifting device to position flywheel housing (1). The weight of the flywheel housing is approximately 32 kg (70 lb).
2. Install bolts (2) .
3. Install a new crankshaft rear seal. Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

End By: Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

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i02639276

Flywheel Housing - Remove and Install

SMCS - 1157-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud (M10 x 1.25 by 100 mm)	2

Start By:

A. Remove the flywheel. Refer to Disassembly and Assembly, "Flywheel - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

1. Support the engine.

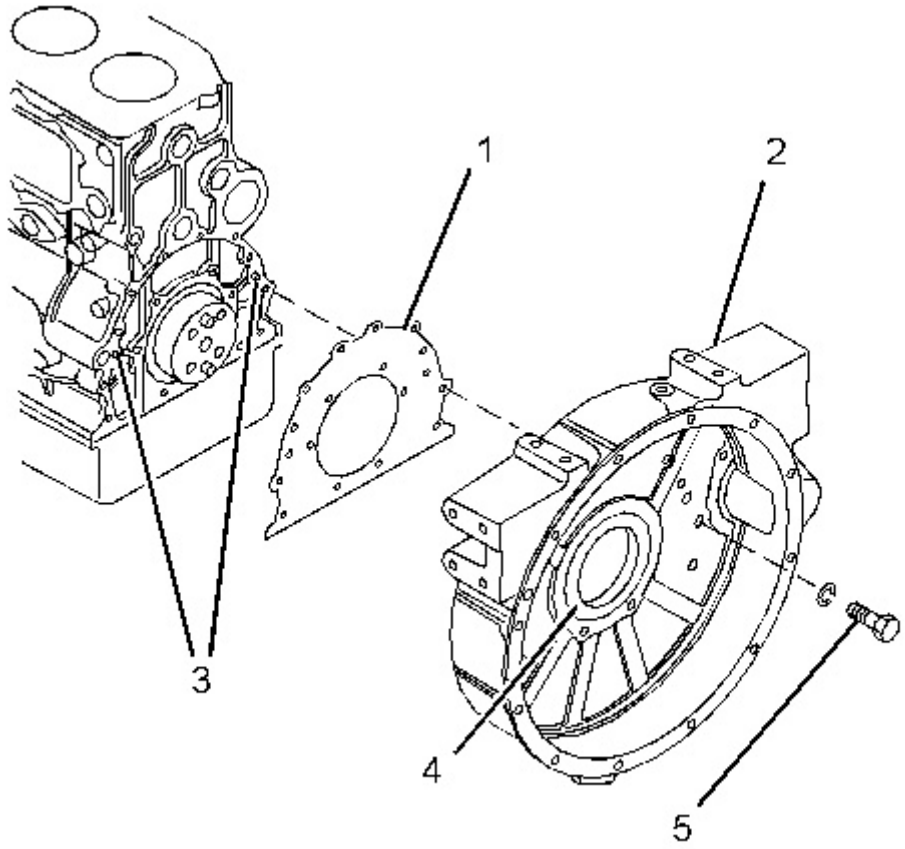


Illustration 1 g01335374

Typical example

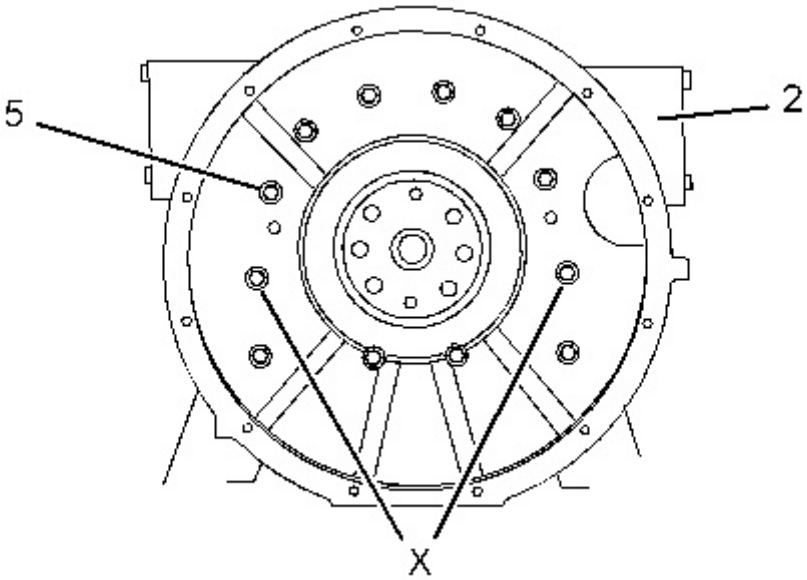


Illustration 2 g01366220

Typical example

2. Remove two bolts (5) from positions (X) on flywheel housing (2) .
3. Install Tooling (A) to positions (X) on flywheel housing (2) .
4. Attach a suitable lifting device to flywheel housing (2). The weight of the flywheel housing is approximately 32 kg (71 lb).
5. Remove the remaining bolts (5) .
6. Carefully remove flywheel housing (2) from dowels (3) and from the cylinder block.

   Note: If necessary, tap the flywheel housing with a soft faced hammer in order to separate the flywheel housing from the cylinder block.
7. Remove joint (1) .
8. Remove crankshaft rear seal (4) from flywheel housing (2) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud (M10 x 1.25 by100 mm)	2
B	8T-5096	Dial Indicator Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the mating surfaces of the cylinder block and the flywheel housing are clean and free from damage.

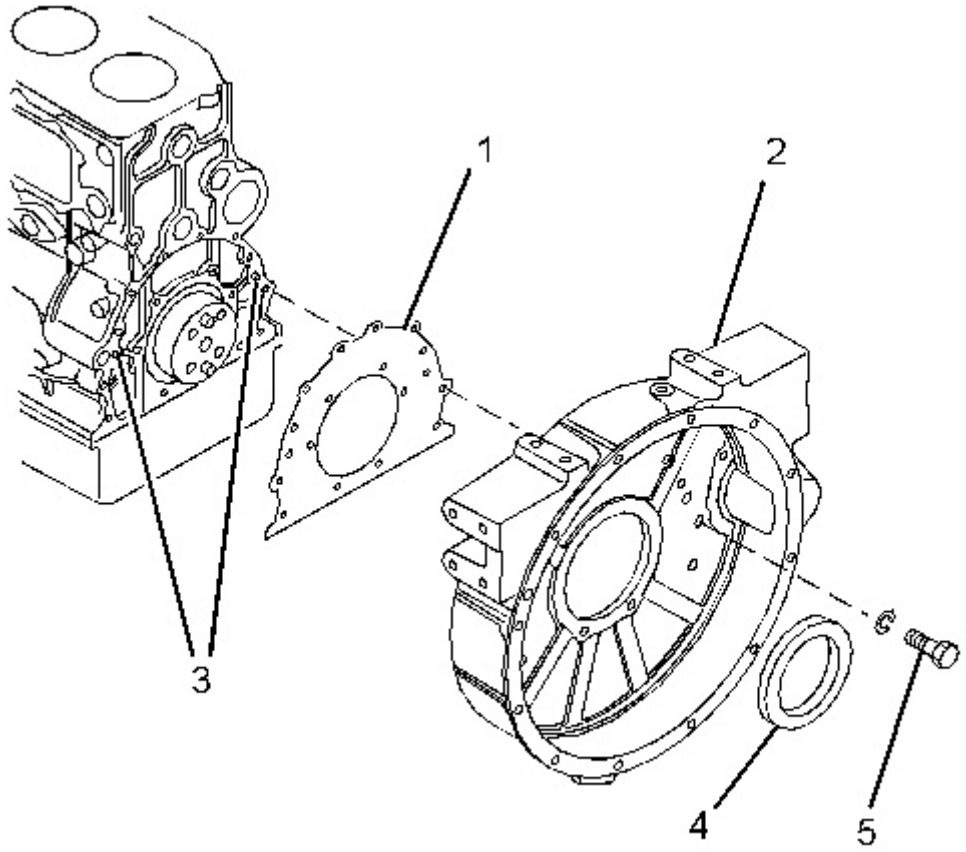


Illustration 3 g01335383

Typical example

2. Inspect dowels (3) in the cylinder block. If necessary, replace the dowels.

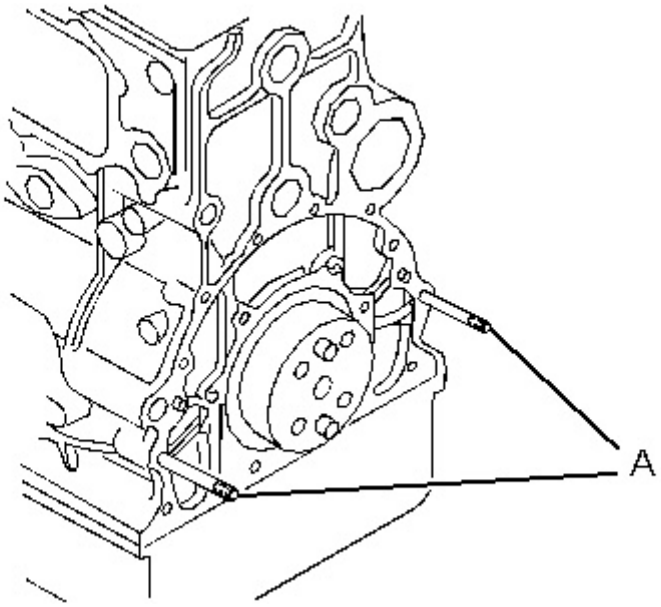


Illustration 4 g01335381

3. Install Tooling (A) to the cylinder block.
4. Install a new joint (1) to the cylinder block.
5. Install a suitable lifting device to flywheel housing (2). The weight of the flywheel housing is approximately 32 kg (71 lb).
6. Use the lifting device to align flywheel housing (2) with Tooling (A). Install the flywheel housing to the cylinder block.
7. Install bolts (5) finger tight.
8. Remove Tooling (A). Install the remaining bolts (5) .
9. Tighten bolts (5) to a torque of 35 N·m (26 lb ft).
10. Remove the lifting device.
11. Use Tooling (B) to check the alignment of the flywheel housing with the crankshaft. Refer to Systems Operation, Testing and Adjusting, "Flywheel Housing - Inspect".
12. Install a new crankshaft rear seal (4). Refer to Disassembly and Assembly, "Crankshaft Rear Seal - Install".

End By: Install the flywheel. Refer to Disassembly and Assembly, "Flywheel - Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01059939

Crankshaft Seals

SMCS - 1160; 1161

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

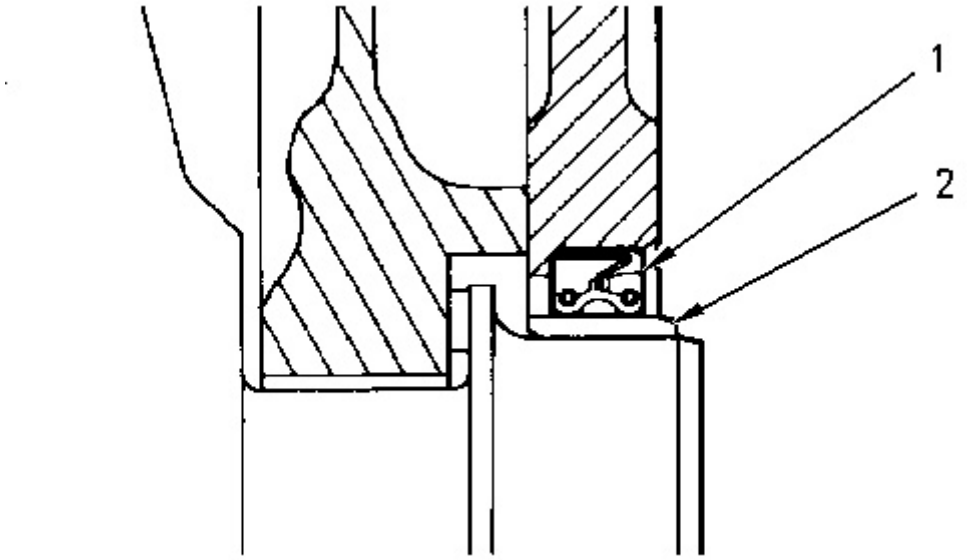


Illustration 1 g00554030

(1) Oil seal

(2) Oil seal sleeve

Inspect the contact surface between the oil seal and the crankshaft for wear. If the crankshaft is worn, replace the oil seal with an oil seal and a sleeve assembly.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02506518

Front Housing and Covers

SMCS - 1162; 1166

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

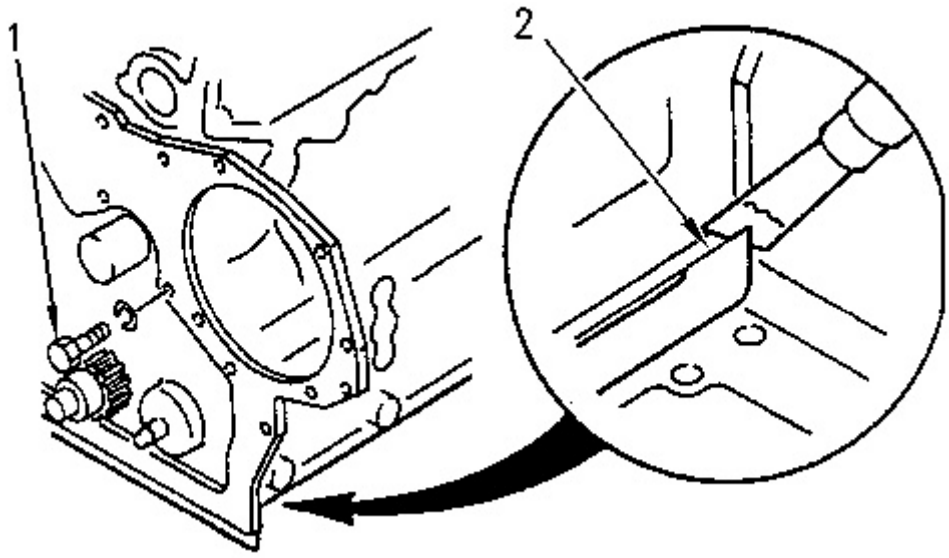


Illustration 1 g00987995

(1) Tighten the bolts that fasten the front plate to the cylinder block to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

(2) Remove the excess gasket with a cutter.

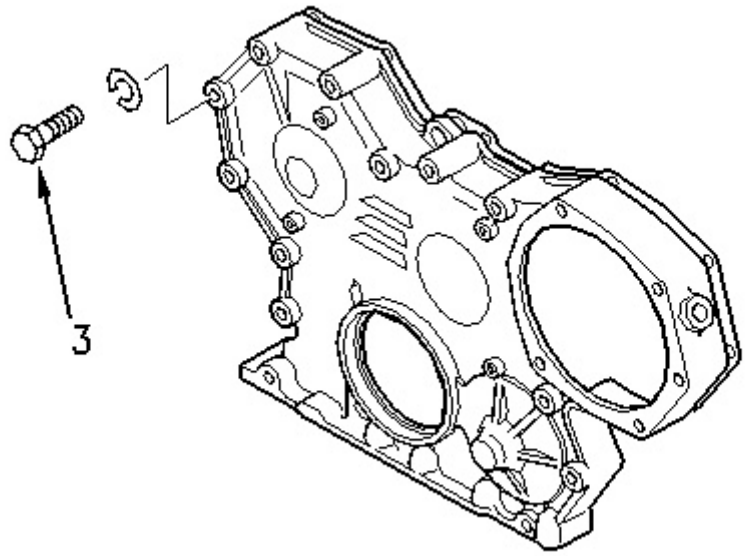


Illustration 2 g00987996

(3) Tighten the bolts that fasten the timing gear case to the front plate to the following torque. ... 17 to 20 N·m (12 to 15 lb ft)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697791

Crankshaft Seals

SMCS - 1160; 1161

S/N - -

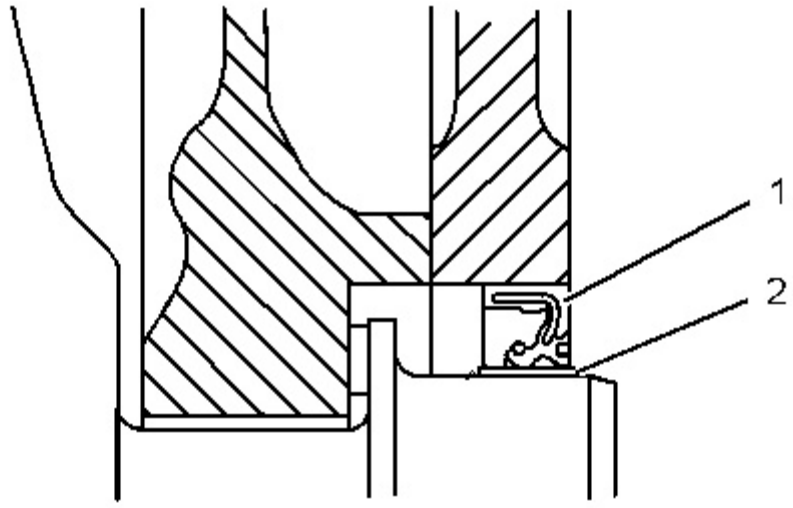


Illustration 1 g01353567

Typical example

(1) Oil seal

(2) Oil seal sleeve

Inspect the contact surface between the oil seal and the crankshaft for wear. If the crankshaft is worn, replace the oil seal with an oil seal and a sleeve assembly.

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02506518

Front Housing and Covers

SMCS - 1162; 1166

S/N - -

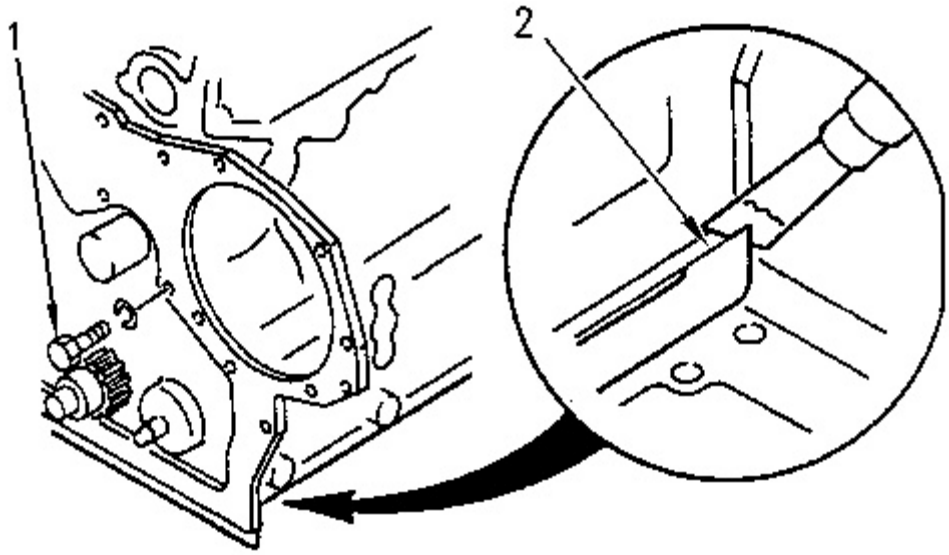


Illustration 1 g00987995

(1) Tighten the bolts that fasten the front plate to the cylinder block to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

(2) Remove the excess gasket with a cutter.

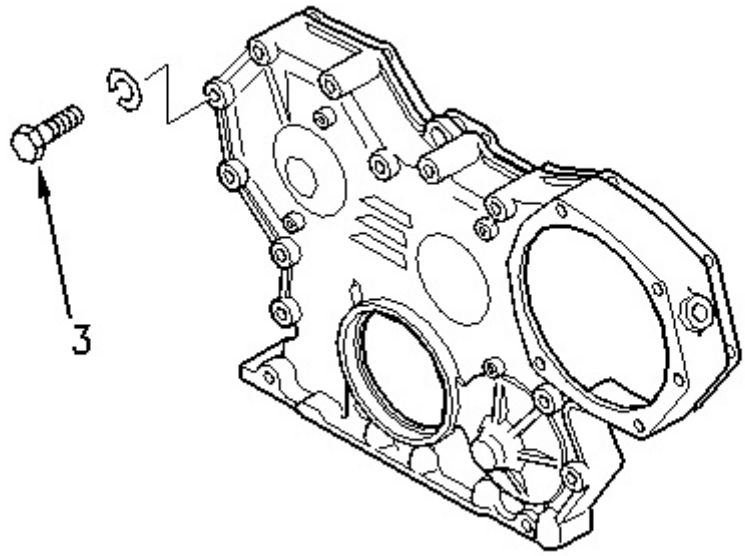


Illustration 2 g00987996

(3) Tighten the bolts that fasten the timing gear case to the front plate to the following torque. ... 17 to 20 N·m (12 to 15 lb ft)

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i01999078

Housing (Front) - Remove

SMCS - 1151-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
C. Remove the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

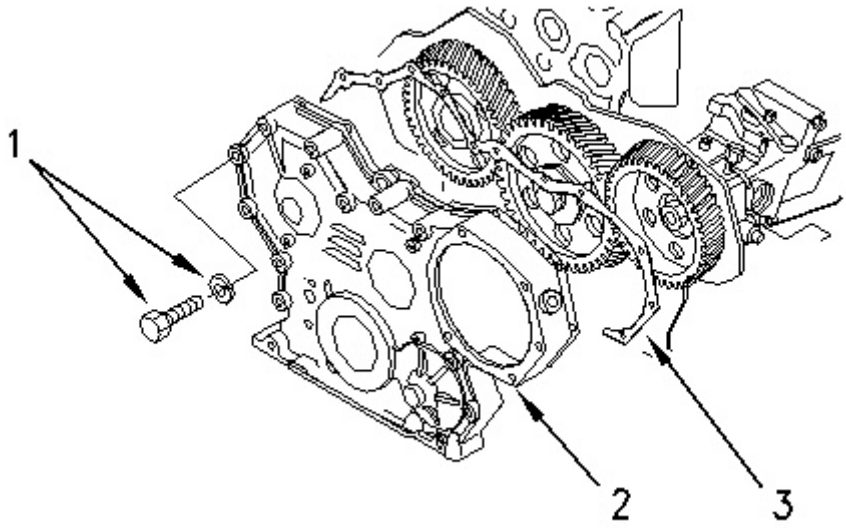


Illustration 1 g01000873

1. Remove bolts (1) from front housing (2) .

   Note: Be careful not to damage the crankshaft front seal when you remove front housing (2) from the cylinder block.

2. Remove front housing (2) and gasket (3). Discard gasket (3) .

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01999086

Housing (Front) - Install

SMCS - 1151-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all mating surfaces thoroughly.

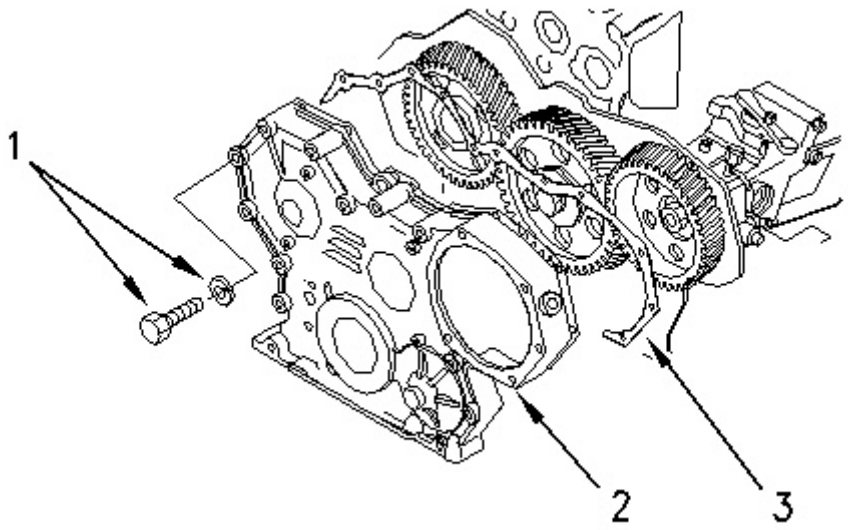


Illustration 1 g01000873

2. Install a new gasket (3) on the front plate. Be sure that gasket (3) properly fits on the dowel pins.

   Note: Do not use sealant on the gasket.

3. Apply clean engine oil to the lip of the crankshaft front seal.

   Note: If a new crankshaft front seal needs to be installed, refer to Disassembly and Assembly, "Crankshaft Front Seal - Install".

4. Position front housing (2) on the front of the cylinder block.

5. Install bolts (1) and tighten to a torque of 10 to 13 N·m (7 to 10 lb ft).

End By:

a. Install the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".
b. Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
c. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i01999049

Front Cover - Remove and Install

SMCS - 1166-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

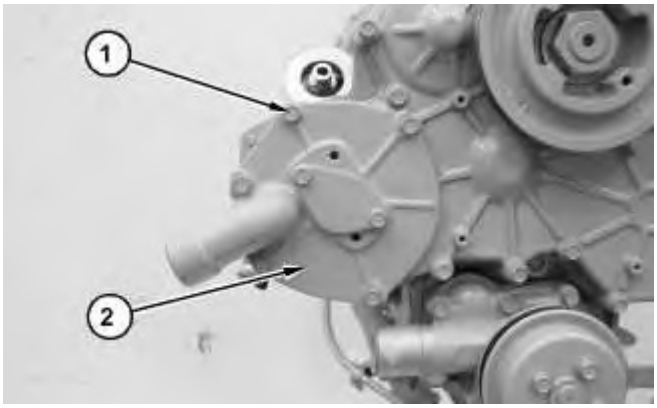


Illustration 1 g01034292

1. Remove bolts (1) .
2. Remove cover (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

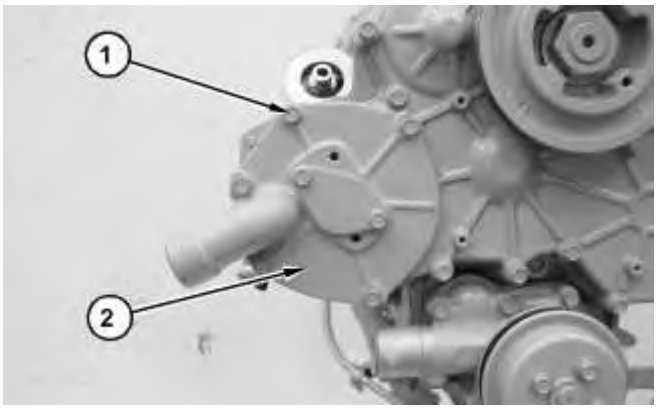


Illustration 2 g01034292

1. Position cover (2) .
2. Install bolts (1) .

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i01999078

Housing (Front) - Remove

SMCS - 1151-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
C. Remove the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

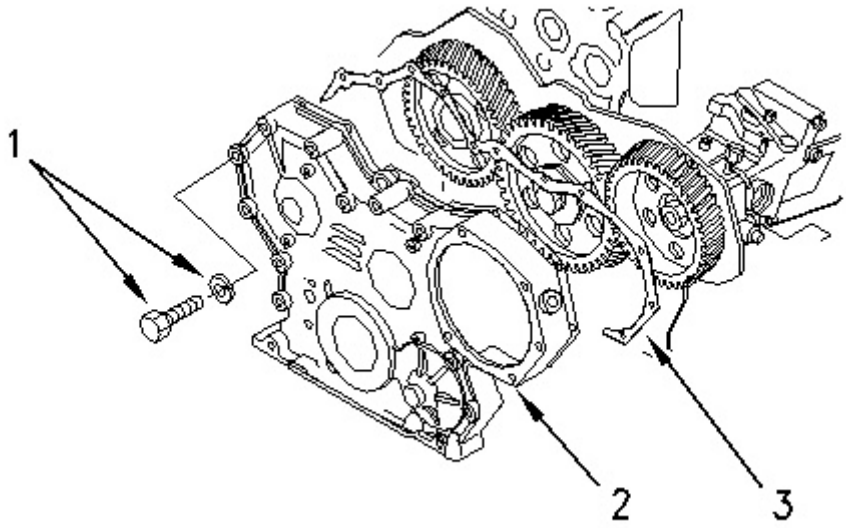


Illustration 1 g01000873

1. Remove bolts (1) from front housing (2) .

   Note: Be careful not to damage the crankshaft front seal when you remove front housing (2) from the cylinder block.

2. Remove front housing (2) and gasket (3). Discard gasket (3) .

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i01999086

Housing (Front) - Install

SMCS - 1151-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all mating surfaces thoroughly.

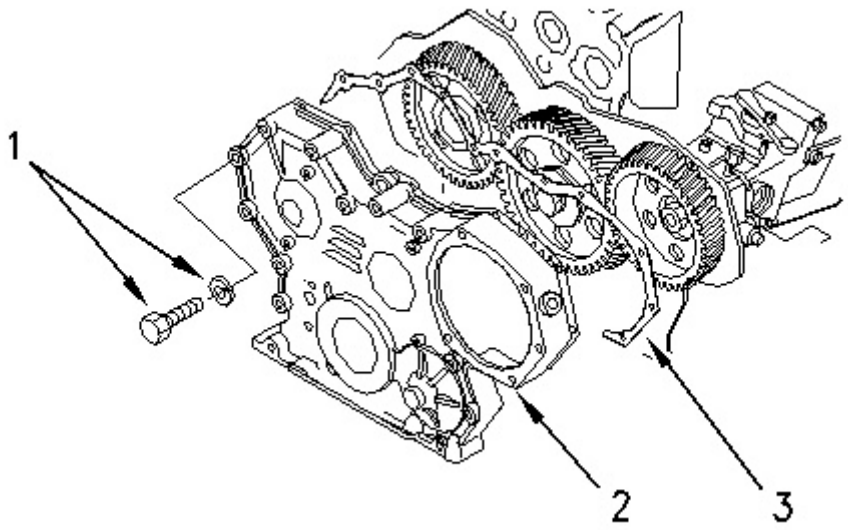


Illustration 1 g01000873

2. Install a new gasket (3) on the front plate. Be sure that gasket (3) properly fits on the dowel pins.

   Note: Do not use sealant on the gasket.

3. Apply clean engine oil to the lip of the crankshaft front seal.

   Note: If a new crankshaft front seal needs to be installed, refer to Disassembly and Assembly, "Crankshaft Front Seal - Install".

4. Position front housing (2) on the front of the cylinder block.

5. Install bolts (1) and tighten to a torque of 10 to 13 N·m (7 to 10 lb ft).

End By:

a. Install the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".
b. Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
c. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639280

Front Cover - Remove and Install

SMCS - 1166-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

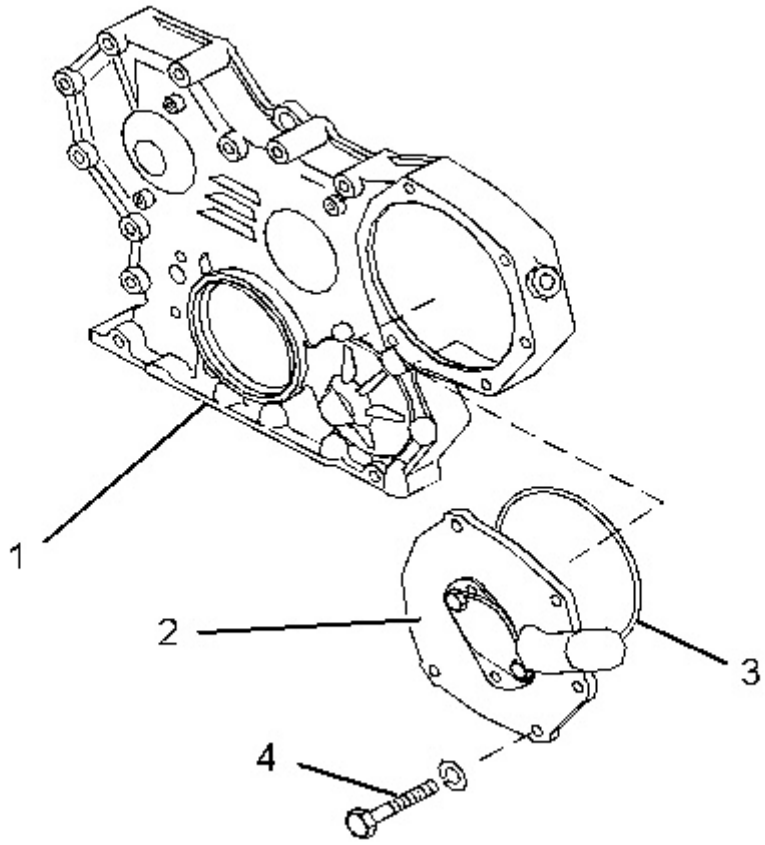


Illustration 1 g01335768

Typical example

1. Remove bolts (4) .
2. Remove plate (2) from front housing (1) .
3. Remove O-ring seal (3) from plate (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

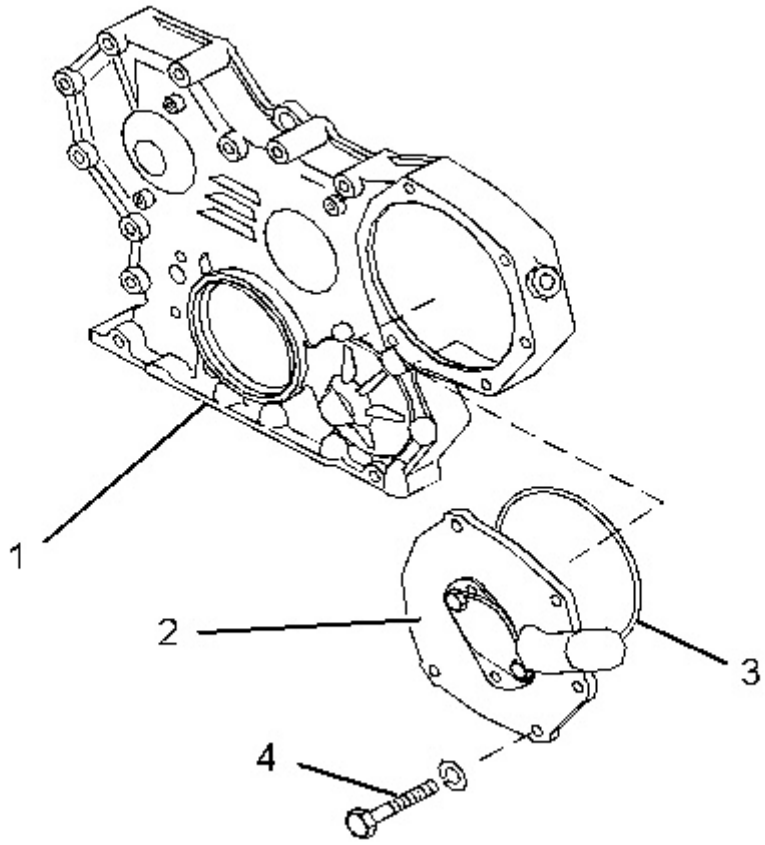


Illustration 2 g01335768

Typical example

1. Ensure that the mating surface of front housing (1) and plate (2) are clean and free from damage.
2. Install a new O-ring seal (3) to plate (2) .
3. Position plate (2) onto front housing (1) .
4. Install bolts (4) and tighten to 18 N·m (13 lb ft).

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639282

Housing (Front) - Remove and Install

SMCS - 1151-010

Removal Procedure

Start By:

A. Remove the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".
B. Remove the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".
C. Remove the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
D. Remove the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".
E. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

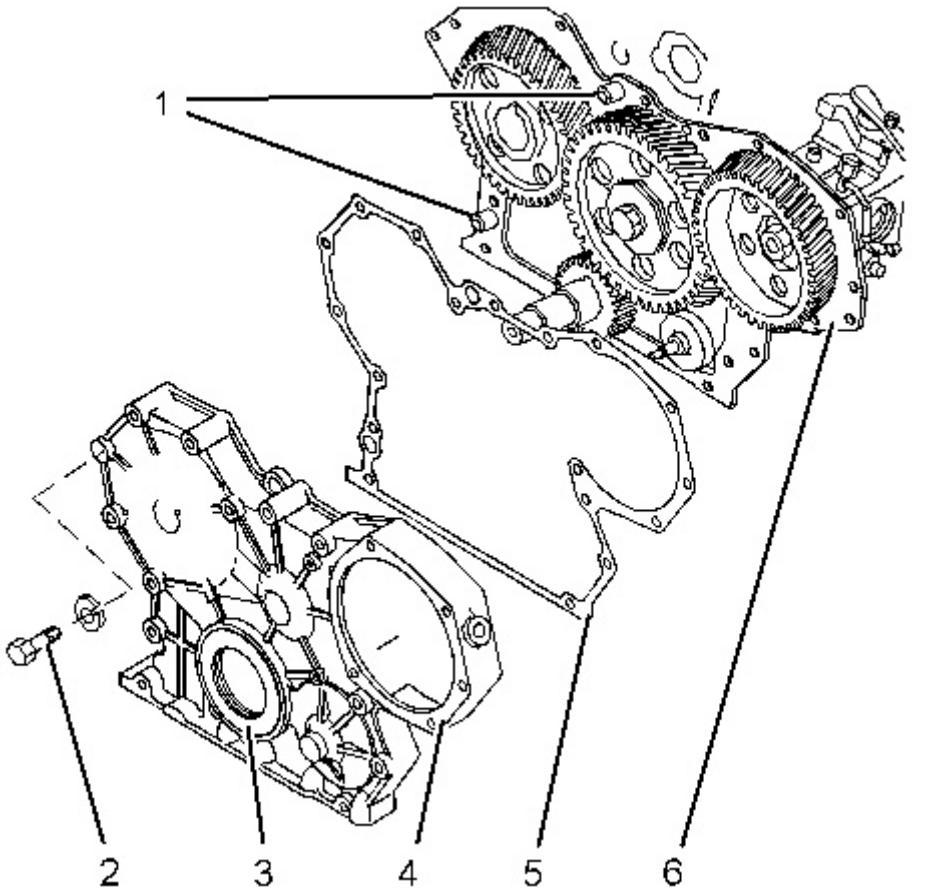


Illustration 1 g01349330

Typical example

1. Remove bolts (2) .
2. Remove front housing (4) from plate (6) .

   Note: Avoid damage to crankshaft front seal (3) when the front housing is removed.
3. Remove joint (5) .

   Note: It is not necessary to remove dowels (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

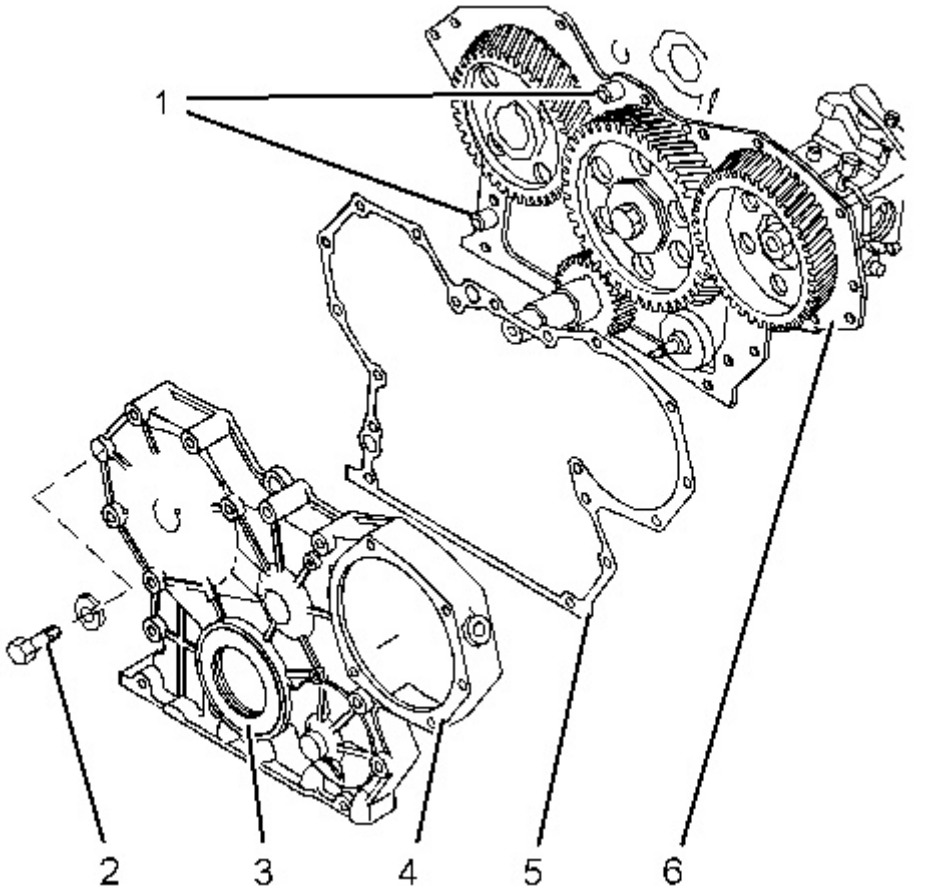


Illustration 2 g01349330

Typical example

1. Ensure that front housing (4) and the nose of the crankshaft are clean and free from damage. Clean the mating surface of plate (6) .
2. Inspect crankshaft front seal (3) for wear or damage. If necessary, replace the crankshaft front seal. Refer to Disassembly and Assembly, "Crankshaft Front Seal - Remove and Install". Apply clean engine oil to the lip of the crankshaft front seal.
3. Install a new joint (5) to plate (6). Ensure that the joint is correctly seated on dowels (1) .
4. Align front housing (4) with dowels (1). Install the front housing to plate (6) .

   Note: Ensure that the crankshaft front seal is not damaged when the front housing is installed.
5. Install bolts (2). Tighten the bolts to a torque of 18 N·m (13 lb ft).

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
b. Install the front cover. Refer to Disassembly and Assembly, "Front Cover - Remove and Install".
c. Install the crankshaft pulley. Refer to Disassembly and Assembly, "Crankshaft Pulley - Remove and Install".
d. Install the alternator. Refer to Disassembly and Assembly, "Alternator - Remove and Install".
e. Install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install".

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i02719940

Front Plate - Remove

SMCS - 1163-011

Removal Procedure

Start By:

A. Remove the fuel injection pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Remove".
B. Remove the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".
C. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

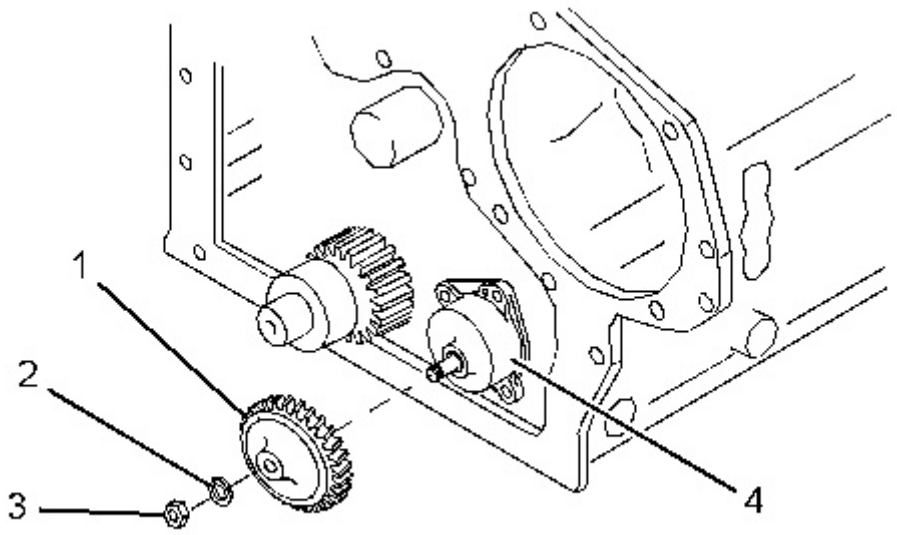


Illustration 1 g01365310

1. Remove nut (3) and washer (2) .
2. Remove gear (1) from the shaft of engine oil pump (4) .

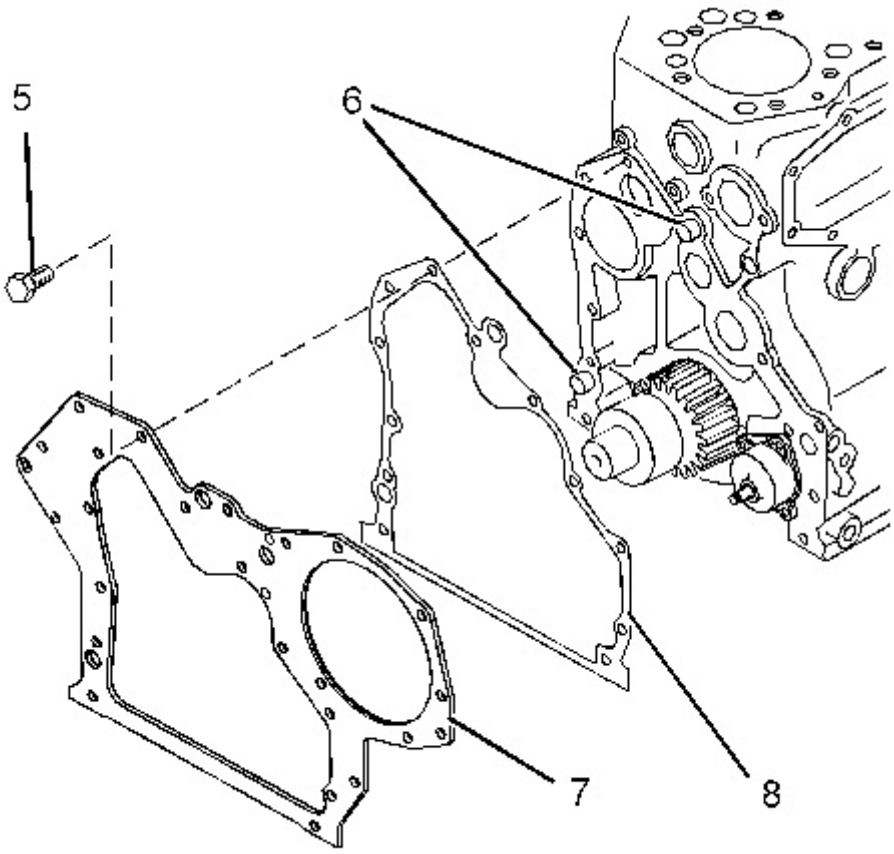


Illustration 2 g01365307

Typical example

3. Remove bolts (5) .
4. Remove plate (7) from the cylinder block.
5. Remove joint (8) .

   Note: It is not necessary to remove dowels (6) .

6. If necessary, remove the bracket for the alternator (not shown) from plate (7) .

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i02719939

Front Plate - Install

SMCS - 1163-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

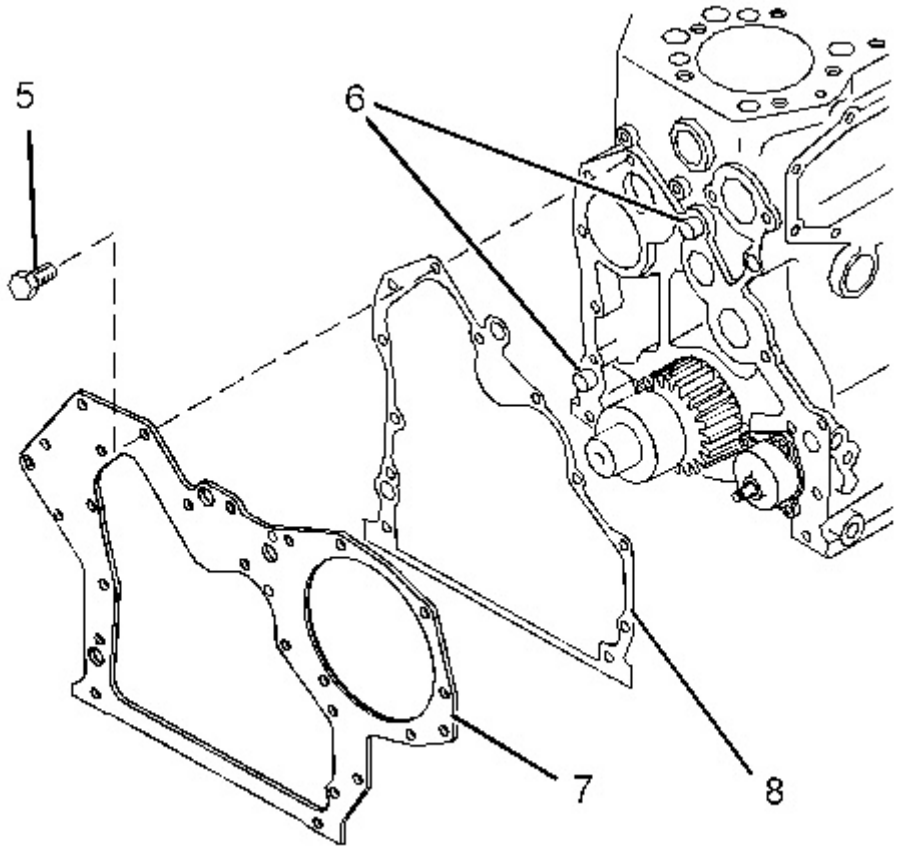


Illustration 1 g01365307

Typical example

1. Ensure that plate (7) and the mating surface of the cylinder block are clean and free from damage. Ensure that dowels (6) are located in the cylinder block.
2. Install a new joint (8) to the cylinder block.
3. Align plate (7) with dowels (6) and install the plate to the cylinder block.
4. Install bolts (5). Tighten the bolts to a torque of 12 N·m (106 lb in).

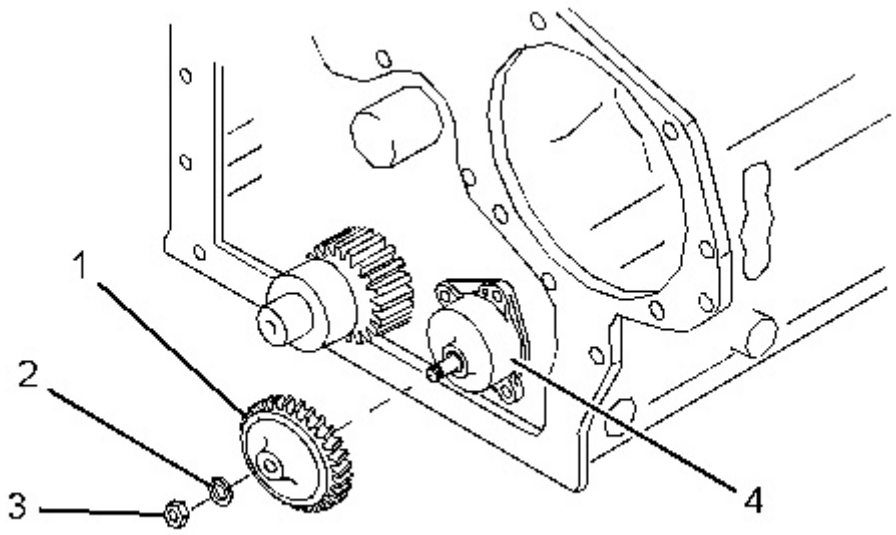


Illustration 2 g01365310

5. Position gear (1) onto the shaft of engine oil pump (4). Ensure that the gear is aligned with the flat on the shaft. Install washer (2) and nut (3). Tighten the nut to a torque of 33 N·m (24 lb ft).

6. If necessary, Install the bracket for the alternator (not shown) to plate (7) .

End By:

a. Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".
b. Install the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".
c. Install the fuel injection pump. Refer to Disassembly and Assembly, "Fuel Injection Pump - Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02697702

Engine Oil Pan

SMCS - 1302

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

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S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

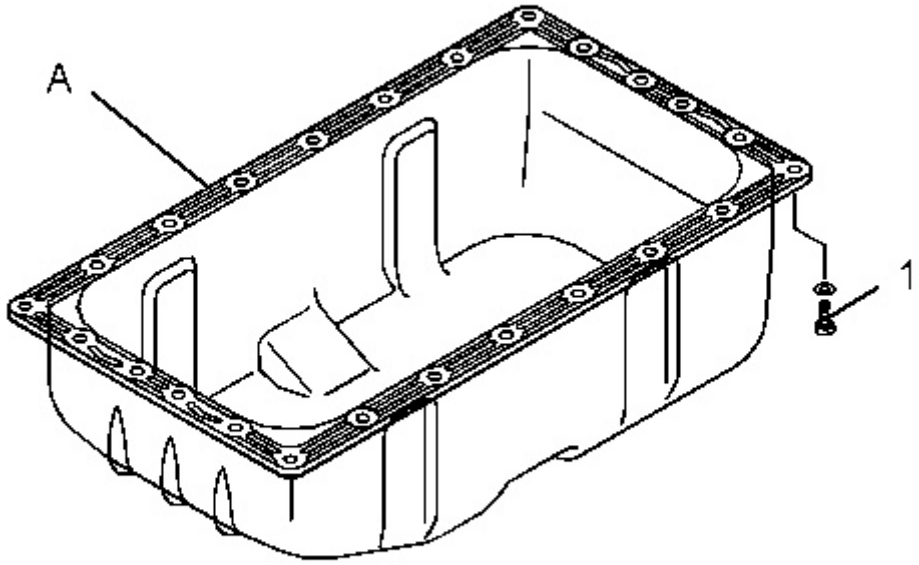


Illustration 1 g01353518

Typical example

For the installation instructions for the engine oil pan, refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

(1) Tighten the oil pan bolts to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

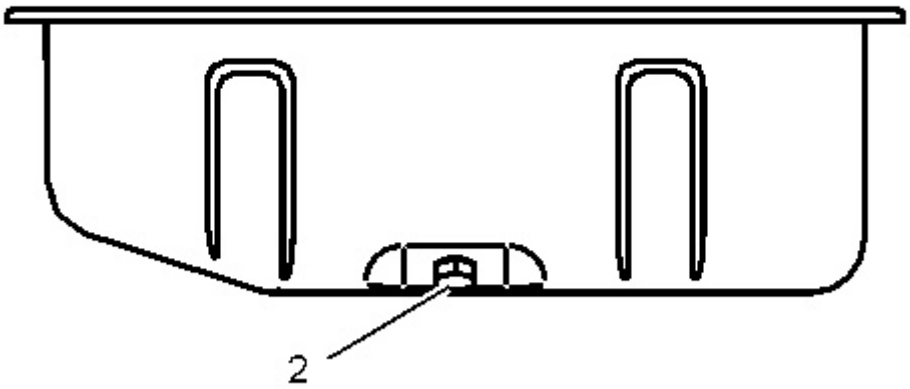


Illustration 2 g01353521

Typical example

(2) Tighten the oil pan drain plug to the following torque. ... 34 to 44 N·m (25 to 33 lb ft)

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i02697702

Engine Oil Pan

SMCS - 1302

S/N - -

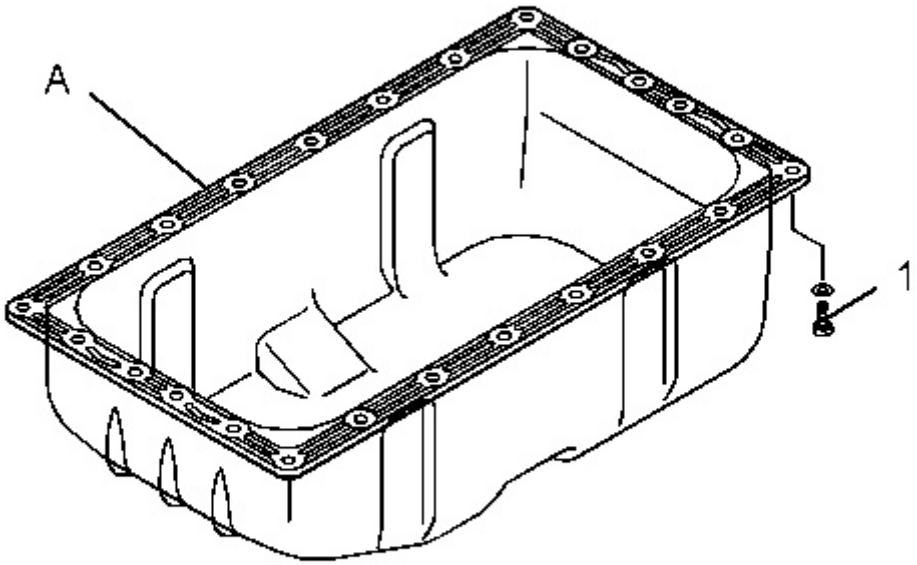


Illustration 1 g01353518

Typical example

For the installation instructions for the engine oil pan, refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

(1) Tighten the oil pan bolts to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

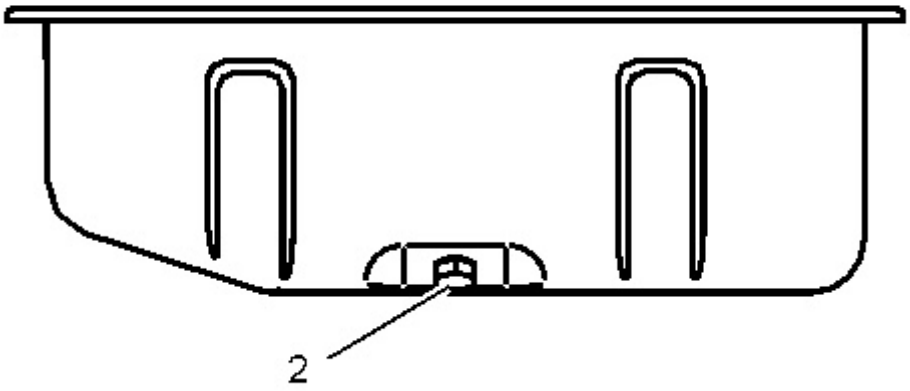


Illustration 2 g01353521

Typical example

(2) Tighten the oil pan drain plug to the following torque. ... 34 to 44 N·m (25 to 33 lb ft)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i05002870

Engine Oil Pan - Remove and Install

SMCS - 1302-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the engine oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendation" for the capacity of the lubrication system.

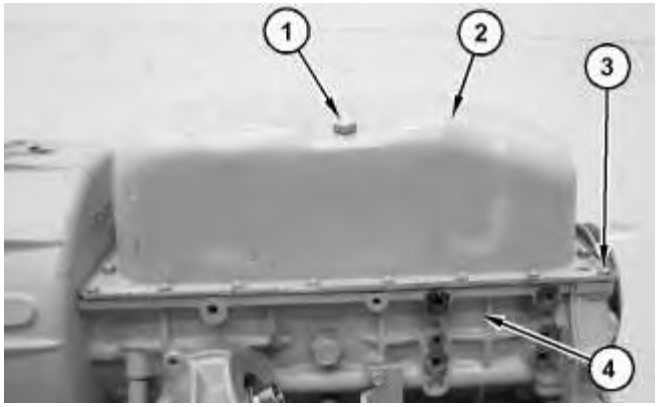


Illustration 1 g01034801

2. Remove drain plug (1) . Remove bolts (3) and pan assembly (2) from cylinder block (4) .

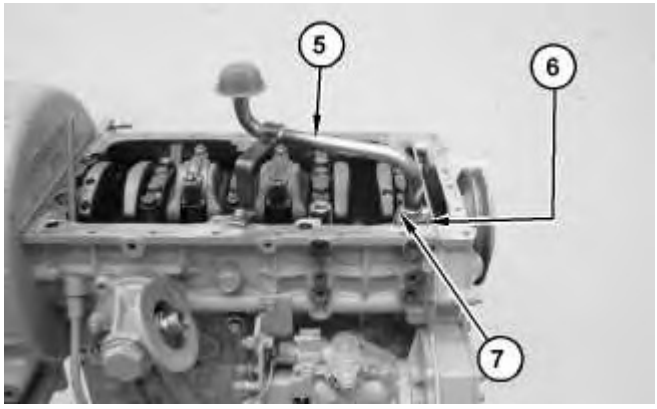


Illustration 2 g01034802

3. Remove bolts (7) . Remove oil strainer (5) and O-ring seal (6) .

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-
B	-	Loctite 243	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all mating surfaces thoroughly.

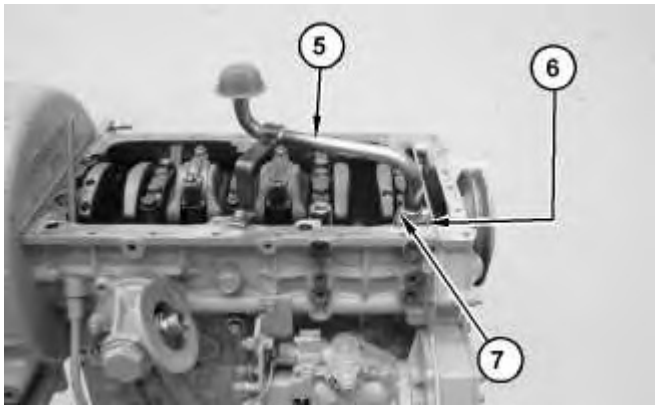


Illustration 3 g01034802

2. Position O-ring seal (6) and oil strainer (5) . Install bolts (7) .

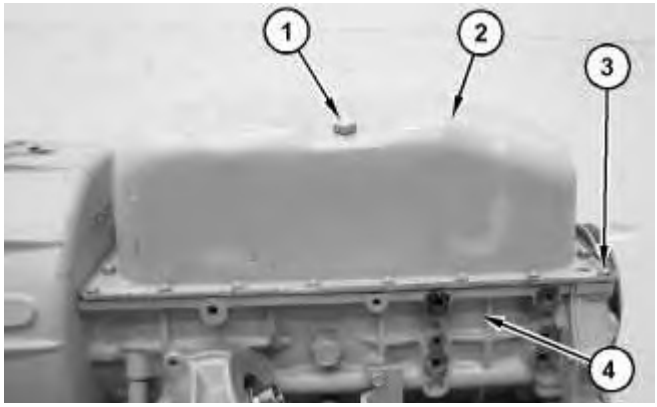


Illustration 4 g01034801

3. Apply Tooling (A) to cylinder block (4) on the inside of the bolt hole pattern.

   Note: Apply Tooling (A) in a continuous bead in order to help prevent an oil leak.

4. Position pan assembly (2) on the cylinder block. Apply Tooling (B) to bolts (3) . Install bolts (3) and tighten to a torque of 10 to 13 N·m (7 to 10 lb ft). Install drain plug (1) and tighten to a torque of 34 to 44 N·m (25 to 32 lb ft).

5. Fill the crankcase with engine oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for the capacity of the lubrication system.

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i05002870

Engine Oil Pan - Remove and Install

SMCS - 1302-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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1. Drain the engine oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendation" for the capacity of the lubrication system.

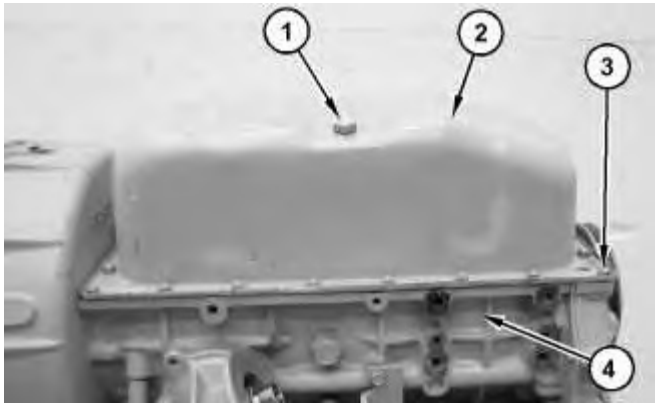


Illustration 1 g01034801

2. Remove drain plug (1) . Remove bolts (3) and pan assembly (2) from cylinder block (4) .

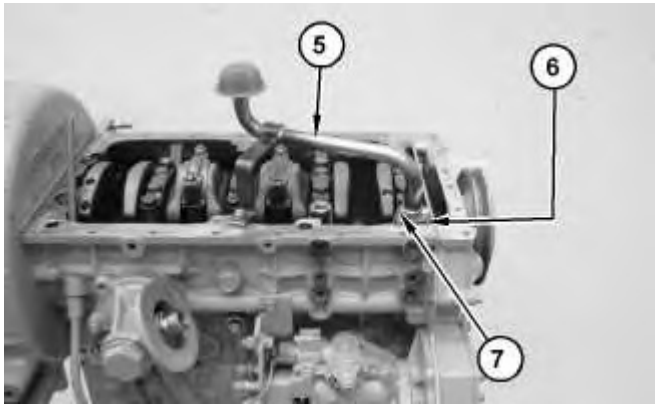


Illustration 2 g01034802

3. Remove bolts (7) . Remove oil strainer (5) and O-ring seal (6) .

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-
B	-	Loctite 243	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all mating surfaces thoroughly.

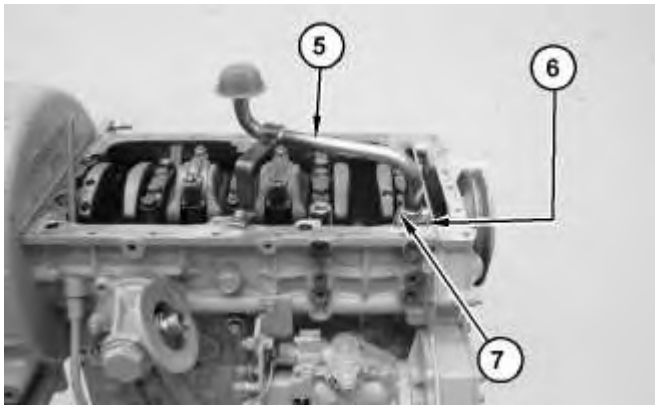


Illustration 3 g01034802

2. Position O-ring seal (6) and oil strainer (5) . Install bolts (7) .

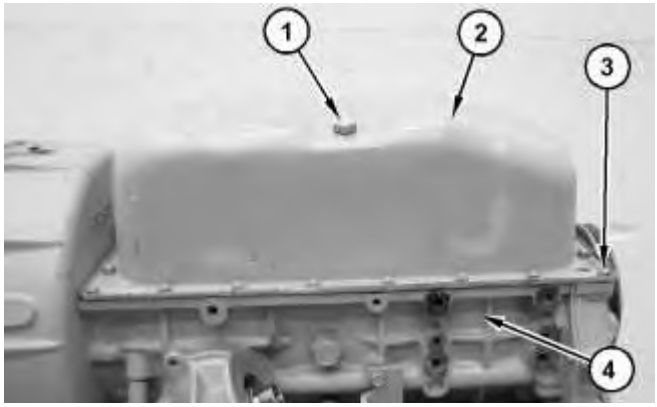


Illustration 4 g01034801

3. Apply Tooling (A) to cylinder block (4) on the inside of the bolt hole pattern.

   Note: Apply Tooling (A) in a continuous bead in order to help prevent an oil leak.

4. Position pan assembly (2) on the cylinder block. Apply Tooling (B) to bolts (3) . Install bolts (3) and tighten to a torque of 10 to 13 N·m (7 to 10 lb ft). Install drain plug (1) and tighten to a torque of 34 to 44 N·m (25 to 32 lb ft).

5. Fill the crankcase with engine oil. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for the capacity of the lubrication system.

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05006169

Engine Oil Pan - Remove and Install

SMCS - 1302-010

Removal Procedure for the Engine Oil Pan

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

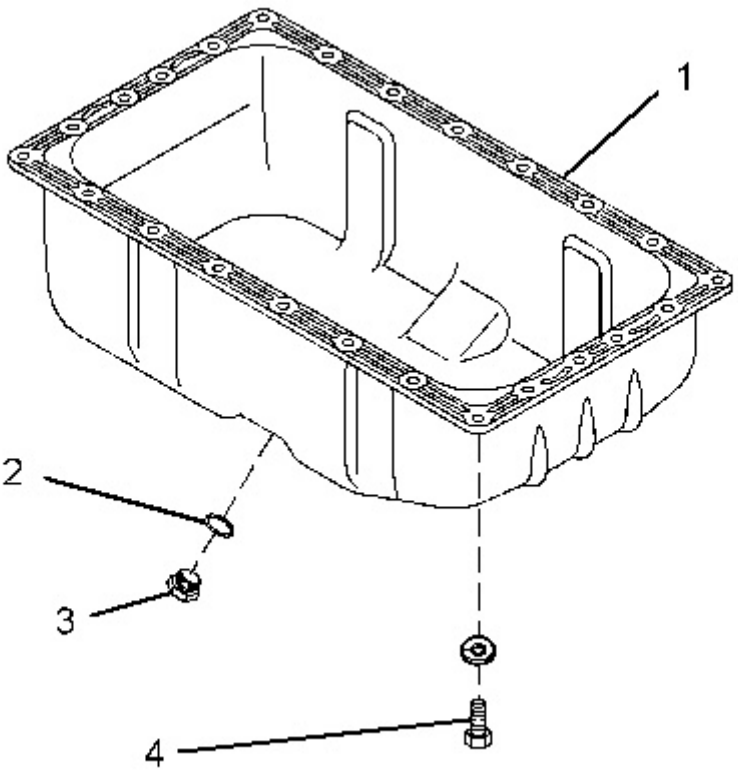


Illustration 1 g01347462

1. Remove oil drain plug (3) . Drain the engine oil into a suitable container for storage or disposal.
2. Remove sealing washer (2) from oil drain plug (3) .
3. Remove bolts (4) from engine oil pan (1) .
4. Carefully separate engine oil pan (1) from the cylinder block.

   Note: Avoid damage to the engine oil pan during removal.

Removal Procedure for the Oil Strainer

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

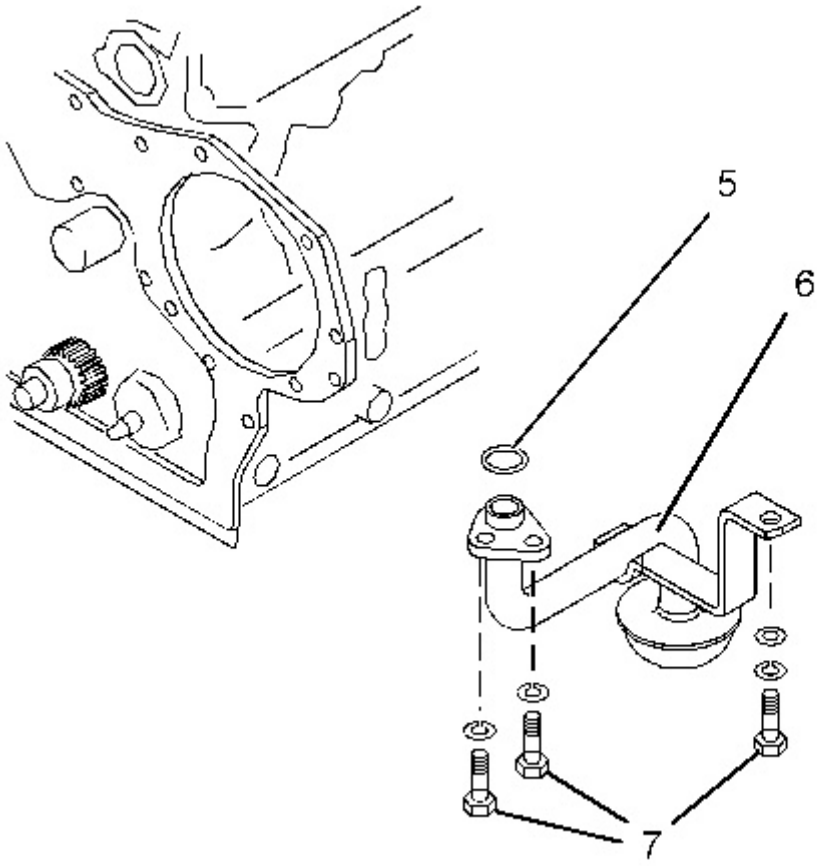


Illustration 2 g01347459

The oil strainer for engines without a balancer

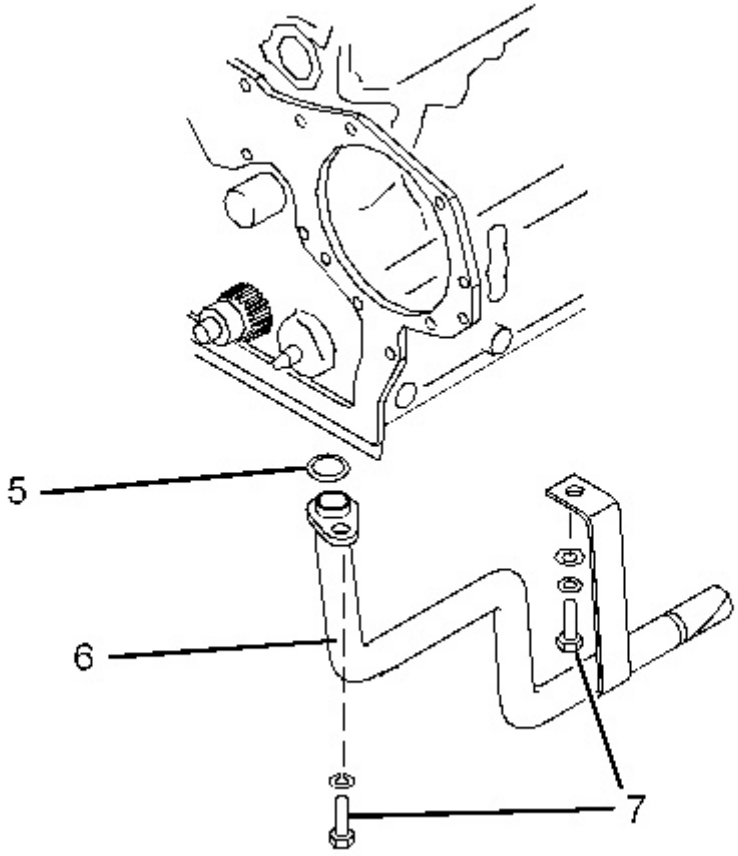


Illustration 3 g01347461

The oil strainer for engines that are equipped with a balancer

1. Remove bolts (7) .
2. Remove oil strainer (6) .
3. Remove O-ring seal (5) from oil strainer (6) .

Installation Procedure for the Oil Strainer

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all mating surfaces thoroughly.

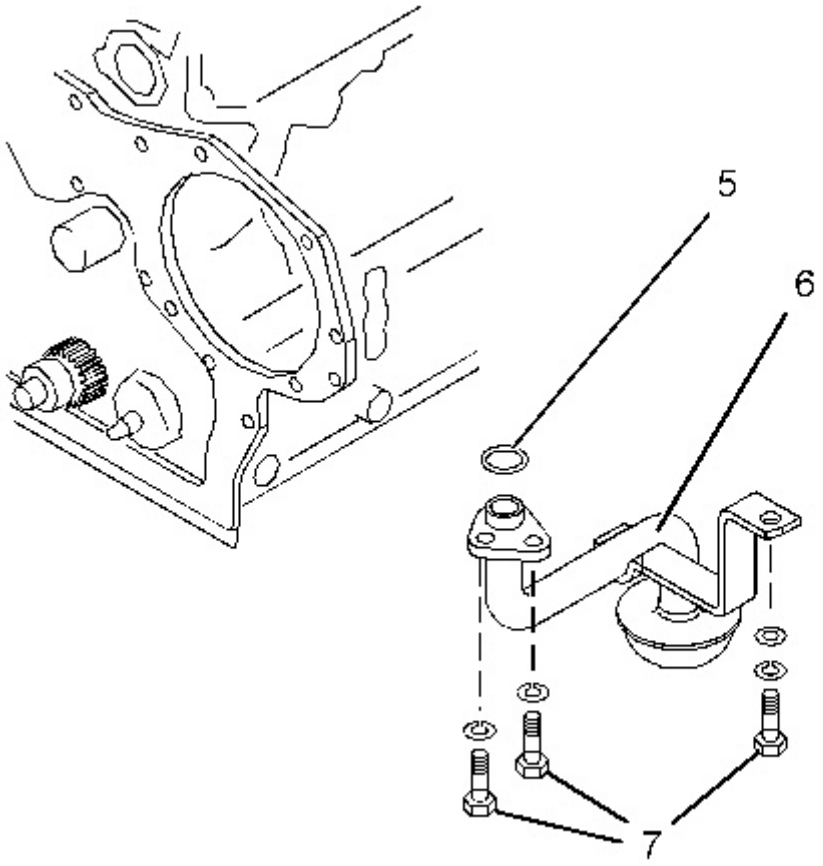


Illustration 4 g01347459

The oil strainer for engines without a balancer

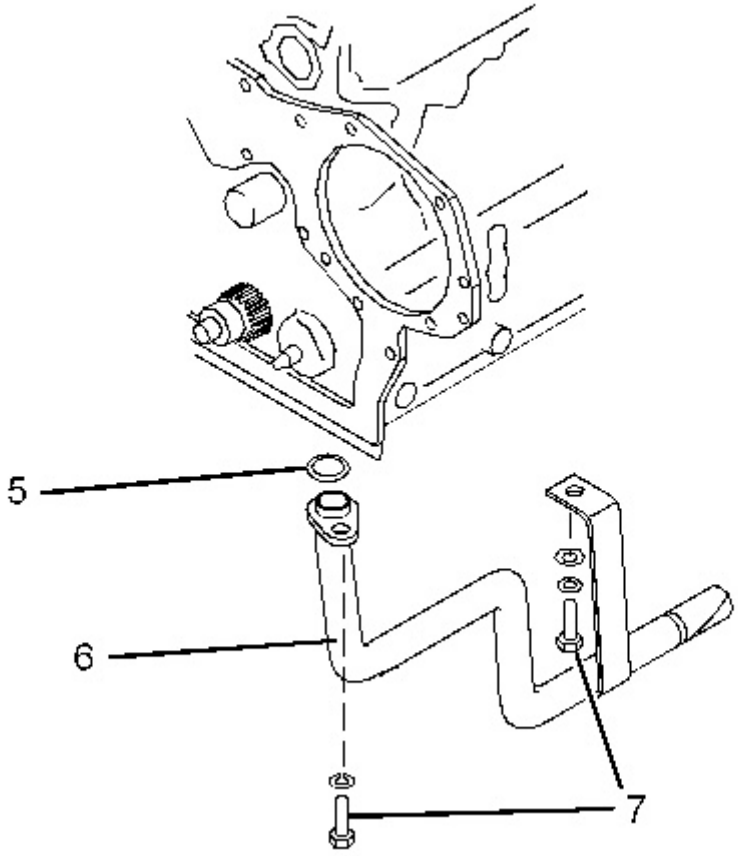


Illustration 5 g01347461

The oil strainer for engines that are equipped with a balancer

2. Install a new O-ring seal (5) to oil strainer (6) .
3. Install oil strainer (6) and install bolts (7) .
4. Tighten bolts (7) to a torque of 18 N·m (13 lb ft).

Installation Procedure for the Engine Oil Pan

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-
B	-	Loctite 243	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the engine oil pan is clean and free from damage. Clean the mating surface of the cylinder block.

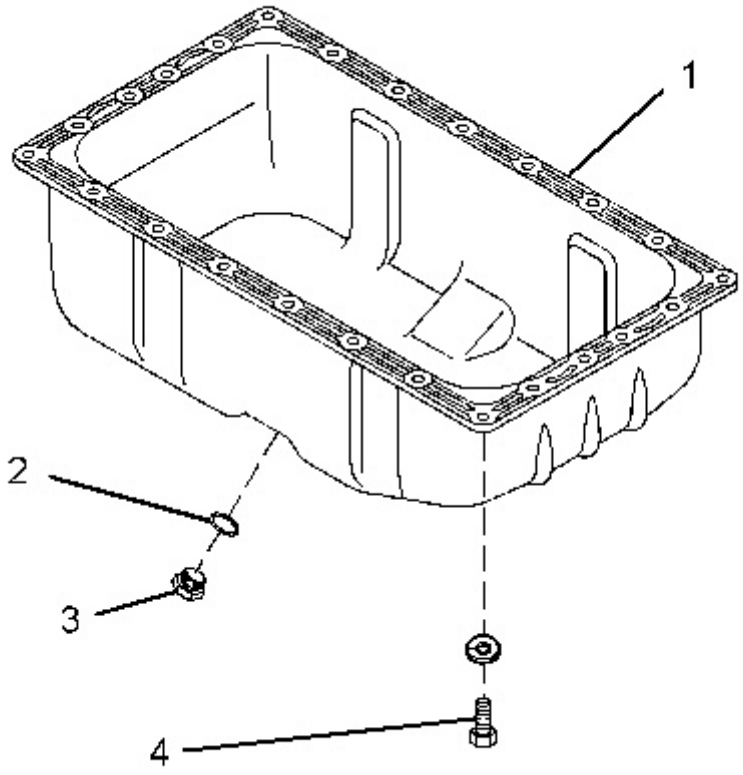


Illustration 6 g01347462

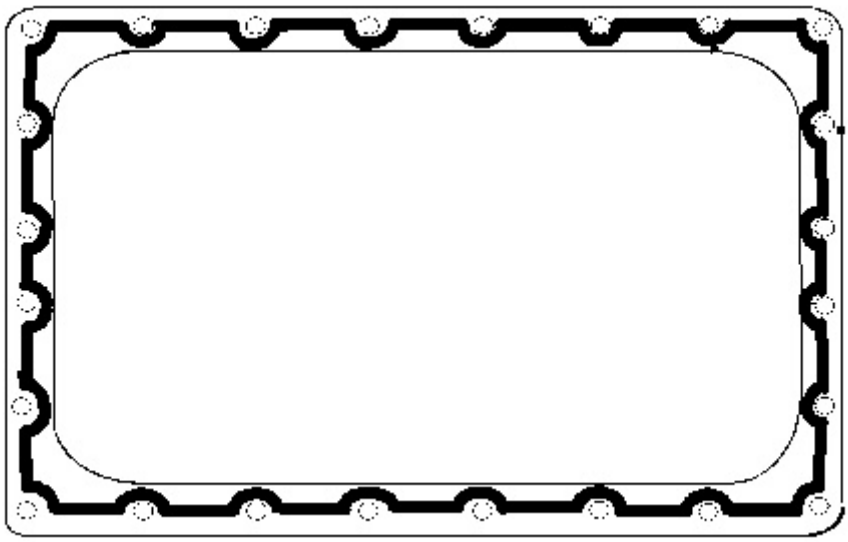


Illustration 7 g01347865

The pattern of application of sealant to the engine oil pan.

2. Apply a continuous bead of Tooling (A) to the mating surface of engine oil pan (1) on the inside of the bolt holes. Refer to Illustration 7 for the correct pattern of application. The bead of Tooling (A) should be approximately 2 mm (0.080 inch) in diameter.
3. Ensure that bolts (4) are clean and dry. Apply Tooling (B) to the threads of the bolts.
4. Position engine oil pan (1) onto the cylinder block and install bolts (4) .
5. Tighten bolts (4) to a torque of 11 N·m (97 lb in).
6. Install a new sealing washer (2) to oil drain plug (3) .
7. Install oil drain plug (3) to engine oil pan (1) . Tighten the oil drain plug to a torque of 39 N·m (29 lb ft).
8. Fill the engine oil pan to the correct level. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the correct procedure.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01907581

Connecting Rod Bearing Journal

SMCS - 1202; 1219; 1225

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod Bearings	
Original Size Journal (1)	57.955 to 57.970 mm (2.2817 to 2.2823 inch)
Undersize Journal 0.25 mm (0.010 inch)	57.705 to 57.720 mm (2.2718 to 2.2724 inch)
Undersize Journal 0.50 mm (0.020 inch)	57.455 to 57.470 mm (2.2620 to 2.2626 inch)
Undersize Journal 0.75 mm (0.030 inch)	57.205 to 57.220 mm (2.2522 to 2.2528 inch)

(1) Regrind the connecting rod bearing journals to the next undersize dimension if the repair limit of 57.800 mm (2.2756 inch) is exceeded.

The clearance between a new connecting rod bearing and a new connecting rod bearing journal is the following value. ... 0.030 to 0.090 mm (0.0012 to 0.0035 inch)

Service limit for clearance between a connecting rod bearing and a connecting rod bearing journal ... 0.200 mm (0.0079 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01895665

Connecting Rod

SMCS - 1218

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

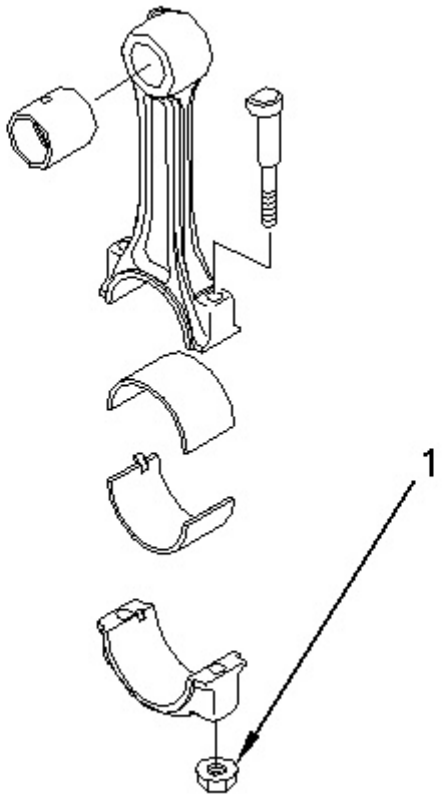


Illustration 1 g00987949

Prior to assembly, apply engine oil to the bearing.

(1) Install the bearing cap to the connecting rod and tighten the cap nuts to the following torque. ... 49 to 59 N·m (36 to 44 lb ft)

Inside diameter of the piston pin bearing

Nominal value ... 30 mm (1.18 inch)
Standard at assembly ... 30.020 to 30.045 mm (1.1819 to 1.1829 inch)

Clearance between the piston pin and the piston pin bearing

Standard at assembly ... 0.020 to 0.051 mm (0.0008 to 0.0020 inch)
Service limit ... 0.080 mm (0.0031 inch)

End play of the connecting rod that is attached to the crankshaft.

Standard at assembly ... 0.15 to 0.35 mm (0.0059 to 0.0138 inch)
Service limit ... 0.50 mm (0.020 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02510695

Piston and Rings

SMCS - 1214; 1215

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8H-8581	Feeler Gauge	1
B	8T-5096	Dial Indicator Group	1

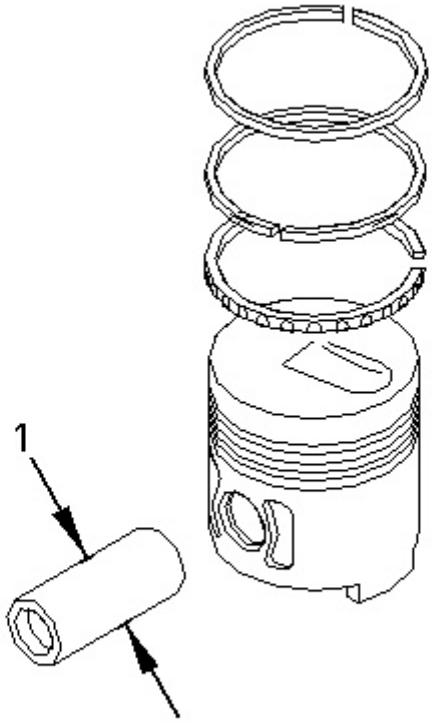


Illustration 1 g00996359

(1) Diameter of the piston pin

Nominal value ... 30 mm (1.18 inch)
Standard at assembly ... 29.994 to 30.000 mm (1.1809 to 1.1811 inch)

Clearance between the piston pin and the bore

Standard at assembly ... 0.000 to 0.016 mm (0.0000 to 0.0006 inch)
Service limit ... 0.050 mm (0.0020 inch)

Refer to table 2 for the outside diameters of the pistons.

Table 2

Item	Standard at Assembly	Service Limit
Standard	93.955 to 93.985 mm (3.6990 to 3.7002 inch)	93.770 mm (3.6917 inch)
0.25 mm (0.0098 inch) oversize	94.205 to 94.235 mm (3.7089 to 3.7100 inch)	94.020 mm (3.7016 inch)
0.50 mm (0.0197 inch) oversize	94.455 to 94.485 mm (3.7187 to 3.7199 inch)	94.270 mm (3.7114 inch)

Maximum difference in weight of the piston per engine ... 0.005 kg (0.0110 lb)

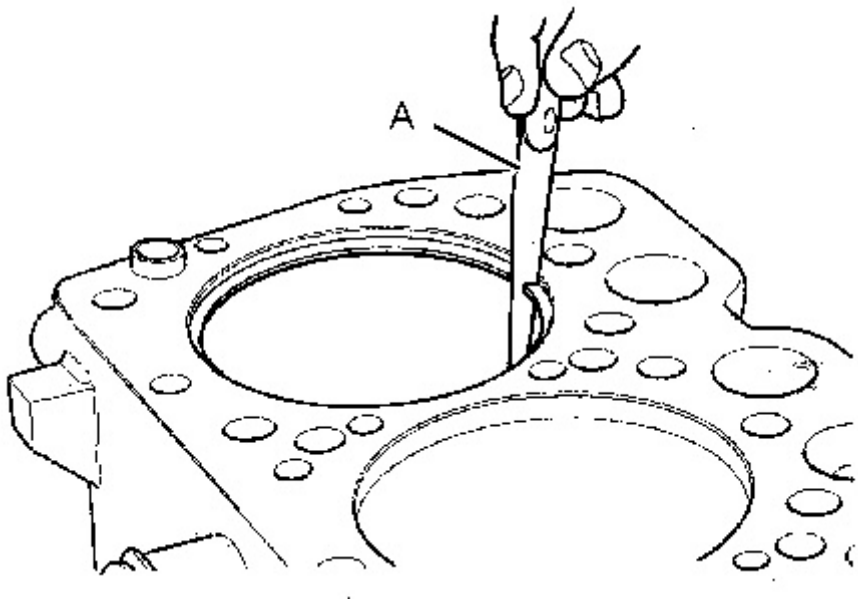


Illustration 2 g01256915

Use Tooling (A) in order to measure the piston ring end gap.

Standard at assembly ... 0.30 to 0.50 mm (0.0118 to 0.0197 inch)
Service limit ... 1.50 mm (0.0591 inch)

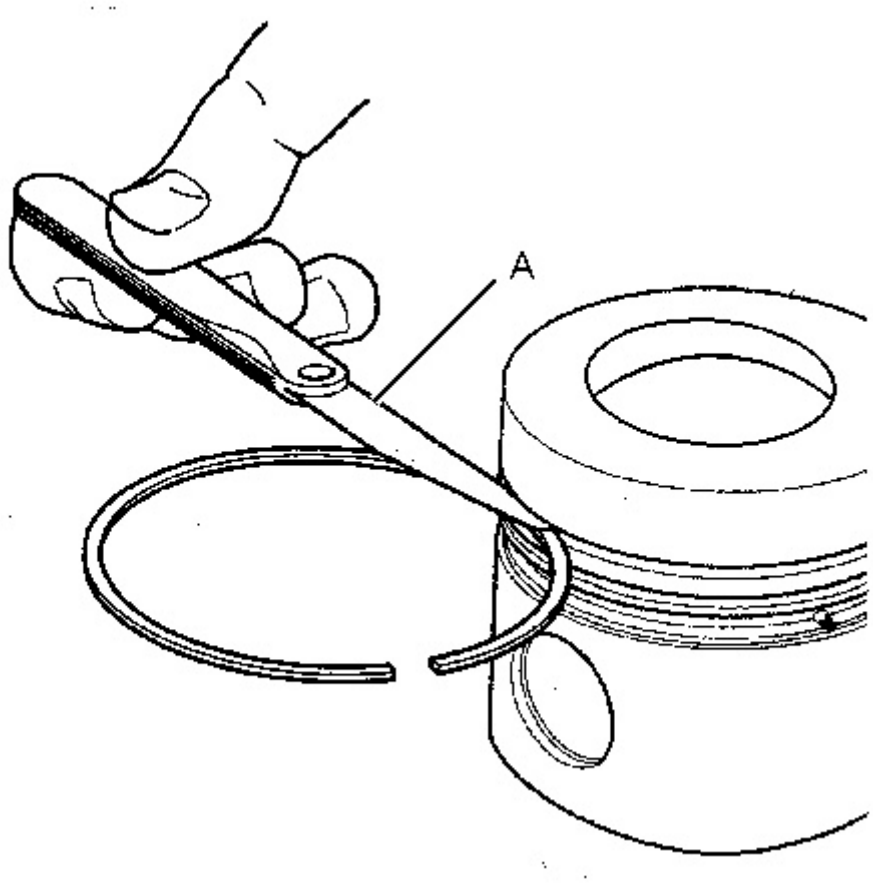


Illustration 3 g01256914

Use Tooling (A) in order to measure the clearance between the piston groove and a new piston ring.

No. 1 ring
Standard at assembly ... 0.07 to 0.11 mm (0.0028 to 0.0043 inch)
Repair limit ... 0.200 mm (0.0079 inch)

No. 2 ring
Standard at assembly ... 0.045 to 0.085 mm (0.0018 to 0.0033 inch)
Repair limit ... 0.150 mm (0.0059 inch)

Oil ring
Standard at assembly ... 0.025 to 0.065 mm (0.0010 to 0.0026 inch)
Repair limit ... 0.150 mm (0.0059 inch)

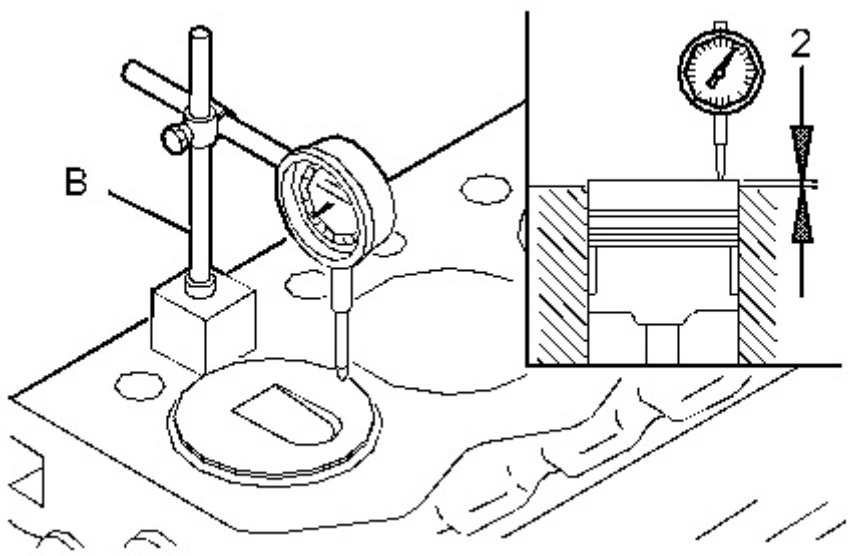


Illustration 4 g01256913

Use Tooling (B) in order to measure the protrusion of the piston (2) .

Standard at Assembly
Naturally aspirated engines ... −0.25 to 0.15 mm (−0.0098 to 0.0059 inch)
Turbocharged engines ... 0.05 to 0.45 mm (0.0020 to 0.0177 inch)

Compressed thickness of cylinder head gasket ... 1.2 ± 0.05 mm (0.05 ± 0.002 inch)

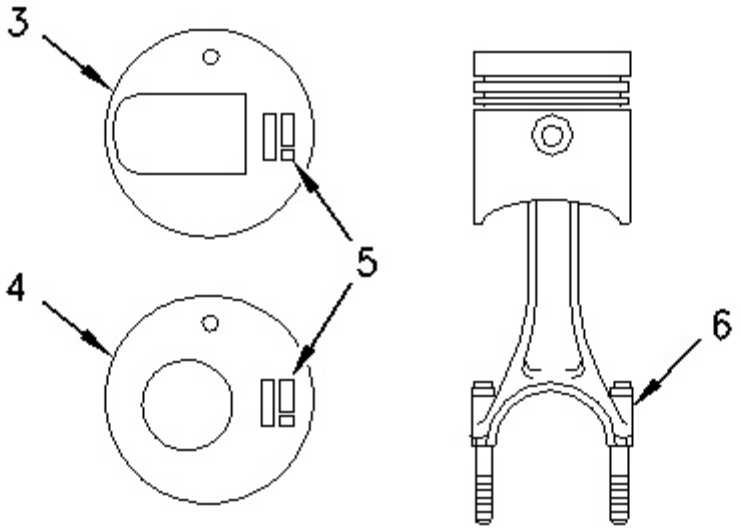


Illustration 5 g00987977

(3) Piston from naturally aspirated engines

(4) Piston from turbocharged engines

(5) "WEIGHT" mark

(6) "MATCHING" mark

Note: Assemble the piston and the connecting rod with the "WEIGHT" mark on the piston and with the "MATCHING" mark on the rod on the same side.

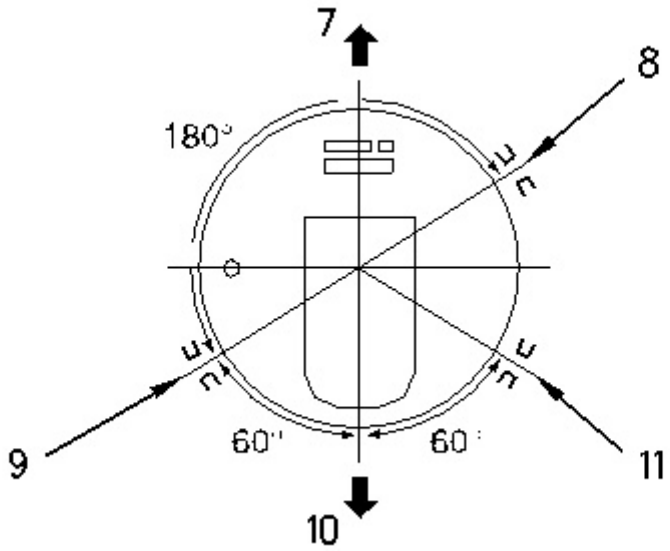


Illustration 6 g00987981

(7) Camshaft side

(8) End gap of No. 1 compression ring

(9) End gap of No. 2 compression ring

(10) Side with the inlet valve

(11) End gap of oil ring

Apply engine oil to the piston rings. Refer to Illustration 6 for the assembled configuration of the ends of the piston rings.

Note: Install the piston with the "O" mark toward the front of the engine.

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i01907581

Connecting Rod Bearing Journal

SMCS - 1202; 1219; 1225

S/N - -

Table 1

Diameter of Crankshaft Journal (Bearing Surface) For Connecting Rod Bearings	
Original Size Journal (1)	57.955 to 57.970 mm (2.2817 to 2.2823 inch)
Undersize Journal 0.25 mm (0.010 inch)	57.705 to 57.720 mm (2.2718 to 2.2724 inch)
Undersize Journal 0.50 mm (0.020 inch)	57.455 to 57.470 mm (2.2620 to 2.2626 inch)
Undersize Journal 0.75 mm (0.030 inch)	57.205 to 57.220 mm (2.2522 to 2.2528 inch)

(1) Regrind the connecting rod bearing journals to the next undersize dimension if the repair limit of 57.800 mm (2.2756 inch) is exceeded.

The clearance between a new connecting rod bearing and a new connecting rod bearing journal is the following value. ... 0.030 to 0.090 mm (0.0012 to 0.0035 inch)

Service limit for clearance between a connecting rod bearing and a connecting rod bearing journal ... 0.200 mm (0.0079 inch)

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i02697820

Connecting Rod

SMCS - 1218

S/N - -

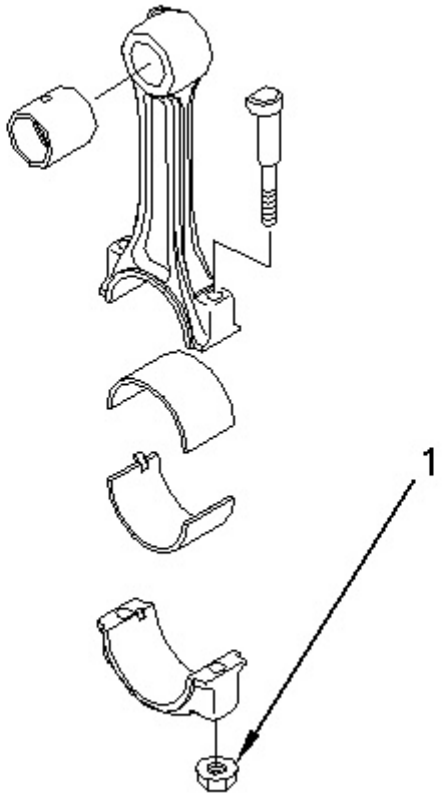


Illustration 1 g00987949

Prior to assembly, apply engine oil to the bearing.

(1) Install the bearing cap to the connecting rod and tighten the cap nuts to the following torque. ... 49 to 59 N·m (36 to 44 lb ft)

Inside diameter of the piston pin bearing

Nominal value ... 30 mm (1.18 inch)
Standard at assembly ... 30.020 to 30.045 mm (1.1819 to 1.1829 inch)

Clearance between the piston pin and the piston pin bearing

Standard at assembly ... 0.020 to 0.051 mm (0.0008 to 0.0020 inch)
Service limit ... 0.120 mm (0.0047 inch)

End play of the connecting rod that is attached to the crankshaft.

Standard at assembly ... 0.15 to 0.35 mm (0.0059 to 0.0138 inch)
Service limit ... 0.50 mm (0.020 inch)

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Piston and Rings

SMCS - 1214; 1215

S/N - -

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8H-8581	Feeler Gauge	1
B	8T-5096	Dial Indicator Group	1

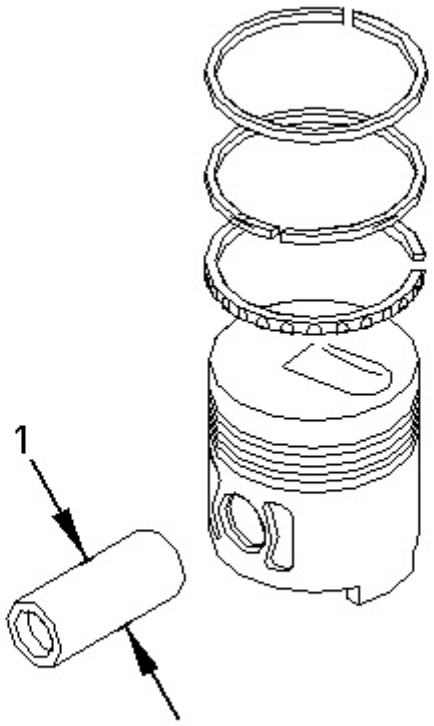


Illustration 1 g00996359

(1) Diameter of the piston pin

Nominal value ... 30 mm (1.18 inch)
Standard at assembly ... 29.994 to 30.000 mm (1.1809 to 1.1811 inch)

Clearance between the piston pin and the bore

Standard at assembly ... 0.000 to 0.016 mm (0.0000 to 0.0006 inch)
Service limit ... 0.050 mm (0.0020 inch)

Refer to table 2 for the outside diameters of the pistons.

Table 2

Item	**Standard at Assembly**	**Service Limit**
Standard	93.955 to 93.985 mm (3.6990 to 3.7002 inch)	93.770 mm (3.6917 inch)
0.25 mm (0.0098 inch) oversize	94.205 to 94.235 mm (3.7089 to 3.7100 inch)	94.020 mm (3.7016 inch)
0.50 mm (0.0197 inch) oversize	94.455 to 94.485 mm (3.7187 to 3.7199 inch)	94.270 mm (3.7114 inch)

Maximum difference in weight of the piston per engine ... 0.005 kg (0.0110 lb)

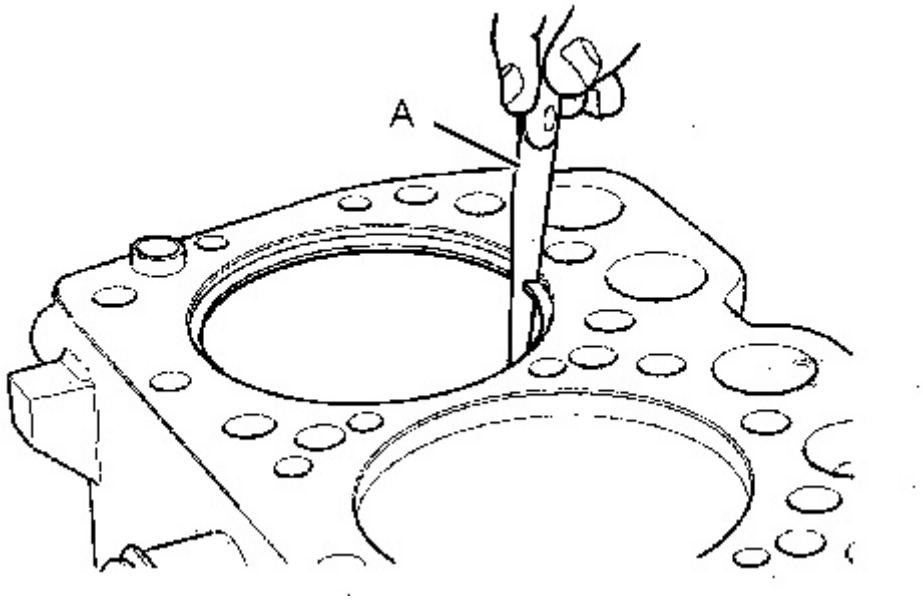


Illustration 2 g01256915

Use Tooling (A) in order to measure the piston ring end gap.

Standard at assembly ... 0.30 to 0.50 mm (0.0118 to 0.0197 inch)
Service limit ... 1.50 mm (0.0591 inch)

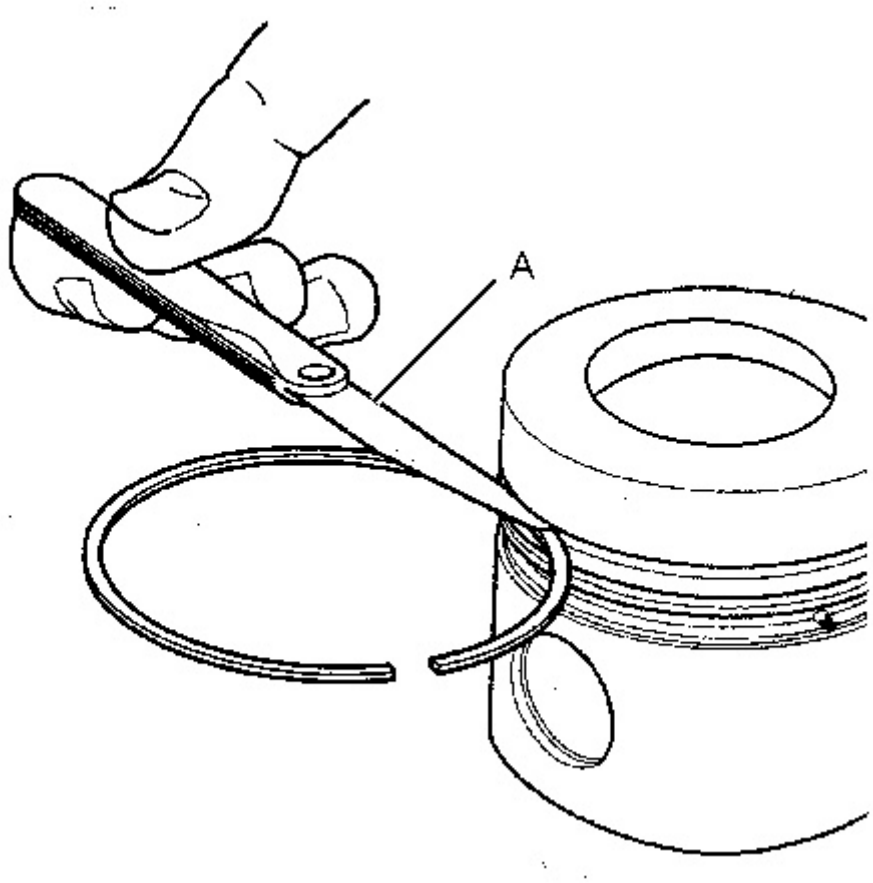


Illustration 3 g01256914

Use Tooling (A) in order to measure the clearance between the piston groove and a new piston ring.

No. 1 ring
Standard at assembly ... 0.036 to 0.076 mm (0.0014 to 0.0030 inch)
Repair limit ... 0.150 mm (0.0059 inch)

No. 2 ring
Standard at assembly ... 0.045 to 0.085 mm (0.0018 to 0.0033 inch)
Repair limit ... 0.150 mm (0.0059 inch)

Oil ring
Standard at assembly ... 0.025 to 0.065 mm (0.0010 to 0.0026 inch)
Repair limit ... 0.150 mm (0.0059 inch)

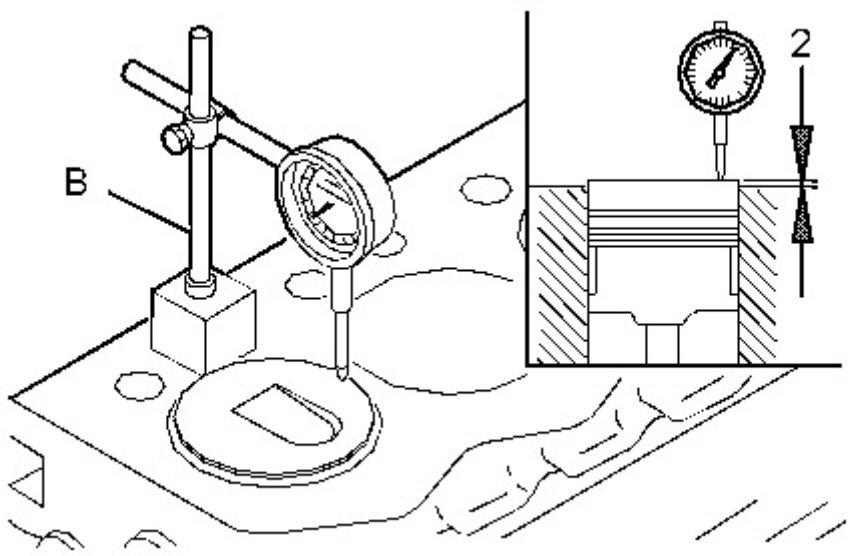


Illustration 4 g01256913

Use Tooling (B) in order to measure the protrusion of the piston (2) .

Standard at Assembly
Naturally aspirated engines ... −0.25 to 0.15 mm (−0.0098 to 0.0059 inch)
Turbocharged engines ... 0.05 to 0.45 mm (0.0020 to 0.0177 inch)

Compressed thickness of cylinder head gasket ... 1.2 ± 0.05 mm (0.05 ± 0.002 inch)

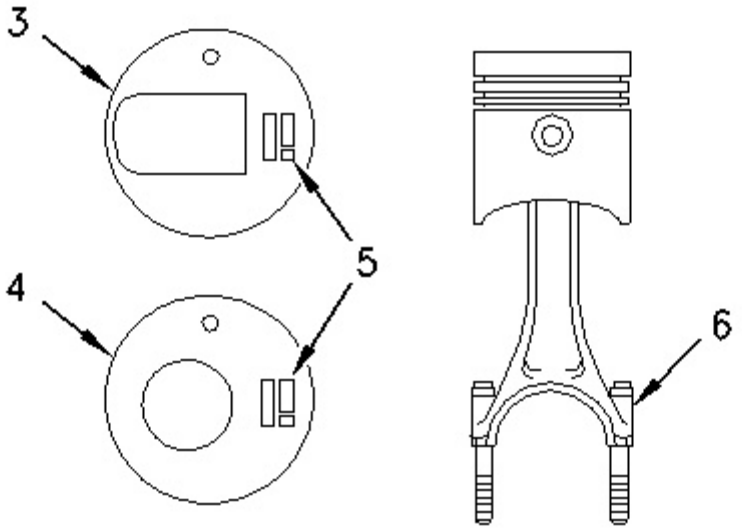


Illustration 5 g00987977

(3) Piston from naturally aspirated engines

(4) Piston from turbocharged engines

(5) "WEIGHT" mark

(6) "MATCHING" mark

Note: Assemble the piston and the connecting rod with the "WEIGHT" mark on the piston and with the "MATCHING" mark on the rod on the same side.

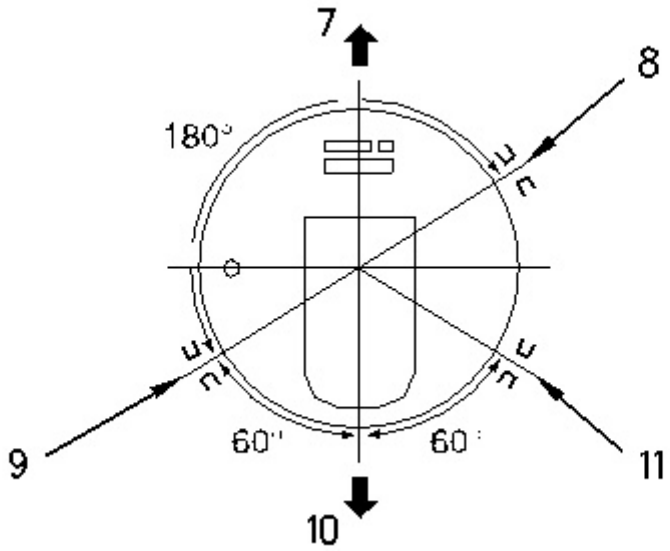


Illustration 6 g00987981

(7) Camshaft side

(8) End gap of No. 1 compression ring

(9) End gap of No. 2 compression ring

(10) Side with the inlet valve

(11) End gap of oil ring

Apply engine oil to the piston rings. Refer to Illustration 6 for the assembled configuration of the ends of the piston rings.

Note: Install the piston with the "O" mark toward the front of the engine.

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i01996583

Pistons and Connecting Rods - Remove

SMCS - 1225-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2269	Ridge Reamer	1

Start By:

A. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".
B. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Use Tooling (A) to remove the carbon ridge from the top inside surface of the cylinders.
2. Rotate the crankshaft in a clockwise direction until the pistons that are being removed are at the bottom center position.
3. Inspect the connecting rod and connecting rod cap for the proper identification marks.

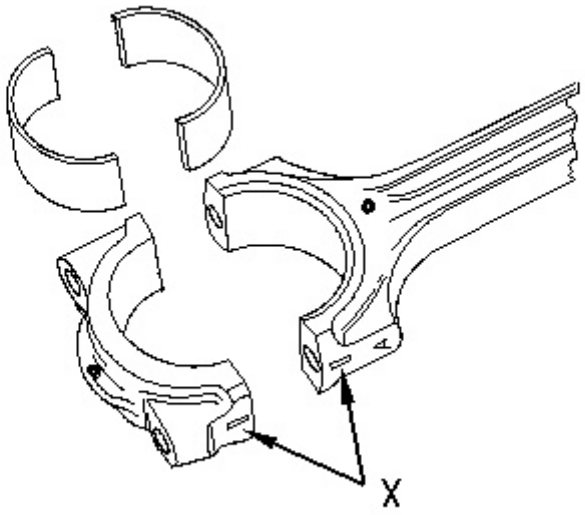


Illustration 1 g01001736

Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Mark the connecting rod and the connecting rod cap, if necessary.

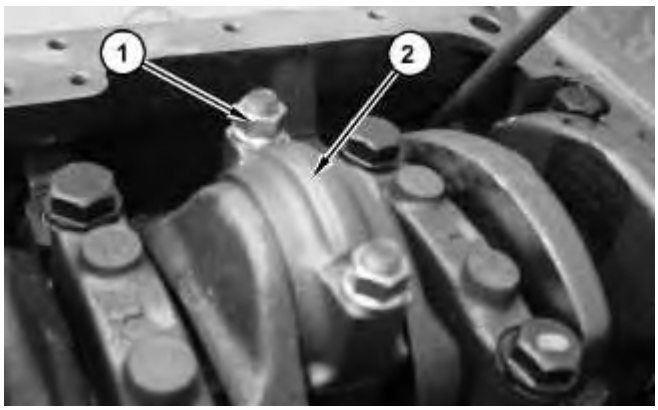


Illustration 2 g01033467

4. Remove nuts (1) that hold connecting rod cap (2) to the connecting rod.
5. Remove connecting rod cap (2) and the lower connecting rod bearing.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the pistons and the connecting rods through the top of the cylinder block.

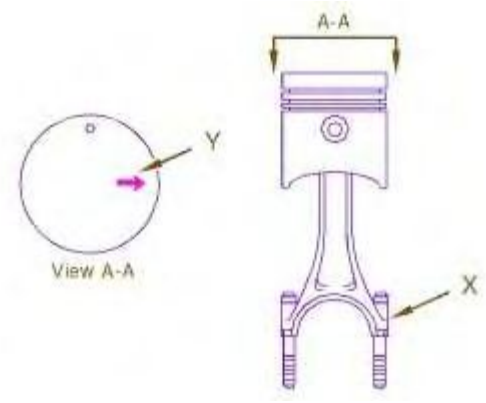


Illustration 3 g01033470

7. Note that Mark (Y) on the top of the piston faces the front. Note that Mark (Y) and Number (X) are on the right side for the purpose of reassembly.

8. Repeat Steps 1 through 7 in order to remove the remaining pistons and connecting rods.

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i01996614

Pistons and Connecting Rods - Disassemble

SMCS - 1225-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-6683	Ring Expander	1
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Group	1

Start By:

A. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

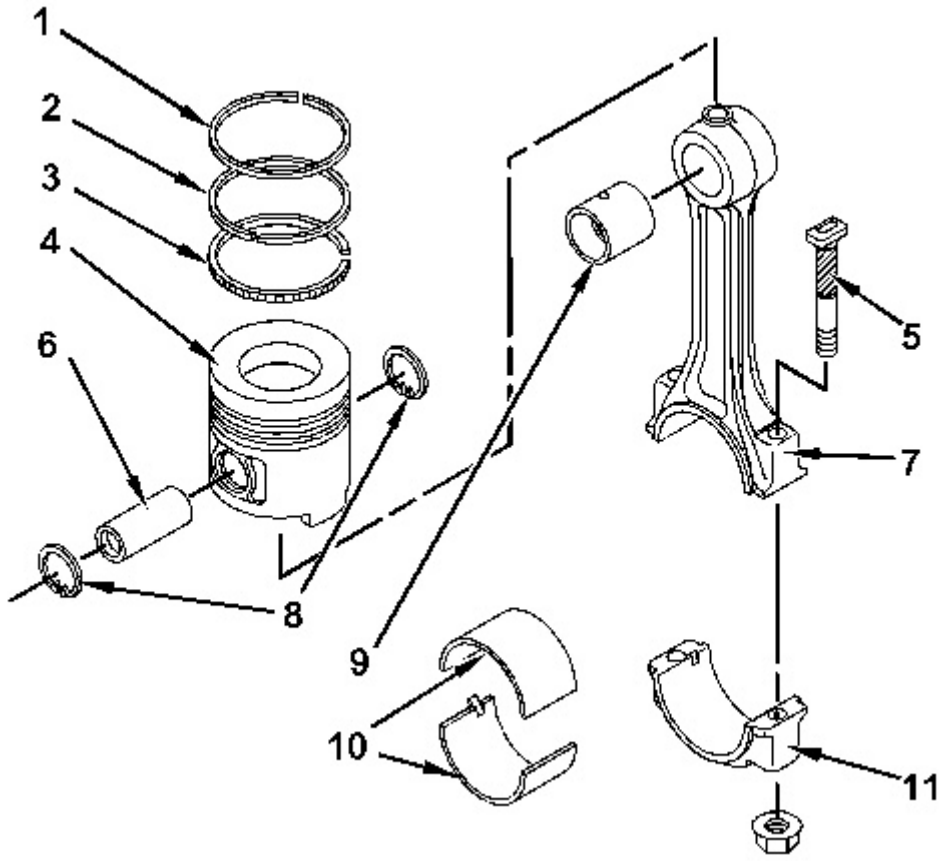


Illustration 1 g01033491

1. Remove connecting rod bolts (5) from connecting rod (7) .
2. Remove connecting rod bearings (10) from connecting rod cap (11) and connecting rod (7) .
3. Use Tooling (A) to remove compression rings (1) and (2), and oil control ring (3) from piston (4) .
4. Use Tooling (B) to remove retaining rings (8) that hold piston pin (6) in position.
5. Remove piston pin (6) from piston (4) .

   Note: If the piston pin cannot be removed by hand, raise the temperature of the piston to 45 ± 5 °C (113 ± 9 °F). Do not use a torch to heat the piston.
6. Use Tooling (C) and a suitable press to remove piston pin bearing (9) from connecting rod (7) .
7. Repeat Steps 1 through 6 in order to disassemble the remaining pistons and connecting rods.

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Pistons and Connecting Rods - Assemble

SMCS - 1225-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-6683	Ring Expander	1
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. The connecting rod controls the piston height above the cylinder block. The connecting rod and the piston must be assembled and installed in the correct cylinder.

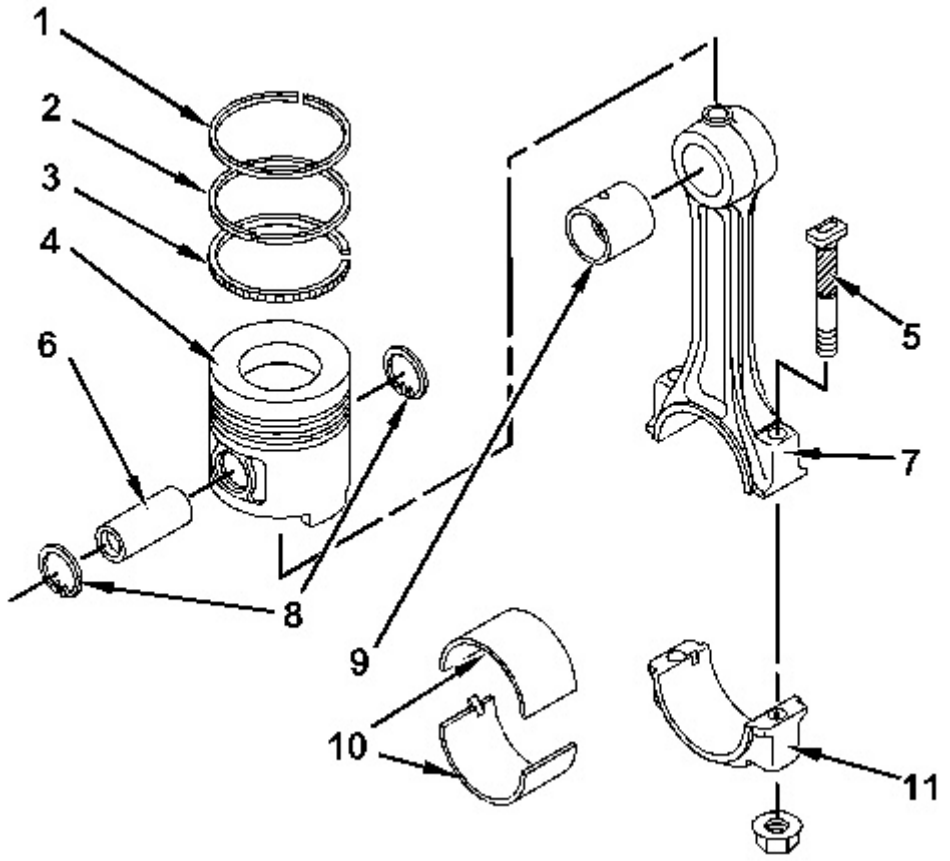


Illustration 1 g01033491

2. Use Tooling (C) and a suitable press to install piston pin bearing (9) into connecting rod (7) .

   Note: Ensure that the oil hole in the piston pin bearing is aligned with the oil hole at the top of the connecting rod.

   Note: If the clearance between piston pin (6) and piston pin bearing (9) exceeds 0.080 mm (0.0031 inch), replace the piston pin or the piston pin bearing with a new part.

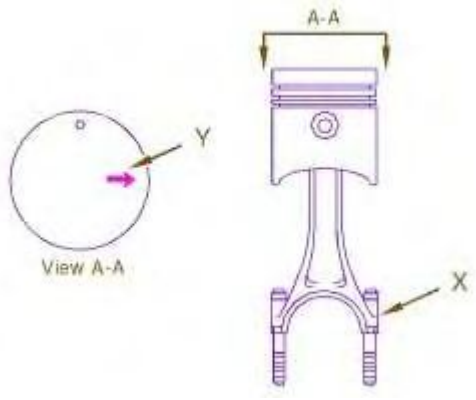


Illustration 2 g01033470

Note: Position the piston and the connecting rod so that Mark (Y) on the top of the piston faces the front. Note that Mark (Y) and Number (X) are on the right sight for the purpose of assembly.

3. Install piston pin (6) into piston (4) and through connecting rod (7) .

   Note: If the piston pin cannot be installed by hand, raise the temperature of the piston to 45° ± 5°C (113° ± 9°F). Do not use a torch to heat the piston.

4. Use Tooling (B) to install retaining rings (8) that hold piston pin (6) in position.

   Note: Position the ends of the retaining rings toward the bottom of the piston.

5. Use Tooling (A) to install the piston rings on piston (4) with the following steps.

   a. Install oil control ring (3) in the groove that is lowest on the piston. The latch pin that is on the oil control ring must be inside the ends of the spring.

      Note: Ensure that the latch pin that is on the oil control ring is 180 degrees from the oil control ring gap.

   b. Install intermediate compression ring (2) with the tapered face into the second groove on the piston.

      Note: The stamp must be toward the top of the piston.

   c. Install top compression ring (1) into the top groove on the piston.

      Note: The stamp must be toward the top of the piston.

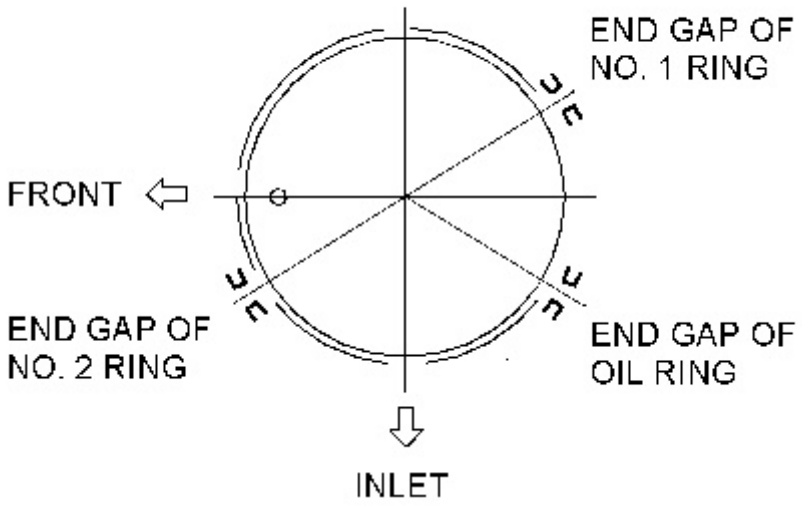


Illustration 3 g01033924

   d. Refer to Illustration 3 in order to position the piston ring gaps.

6. Install connecting rod bearings (10) in connecting rod (7) and in connecting rod cap (11) .
7. Install connecting rod bolts (5) in connecting rod (7) .
8. Repeat Steps 2 through 7 in order to assemble the remaining pistons and connecting rods.

End By: Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Install".

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i01998541

Pistons and Connecting Rods - Install

SMCS - 1225-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1U-6684	Piston Ring Compressor	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean all of the components.
2. Lubricate the piston and the cylinder walls with clean engine oil.

   Note: The piston and connecting rod are matched to a specific cylinder. Ensure that the connecting rod and pistons are installed in the correct cylinder.
3. Rotate the crankshaft until the connecting rod journal is at the bottom center position. Lubricate the connecting rod journal with clean engine oil.
4. Lubricate the upper connecting rod bearing that is installed in the connecting rod with clean engine oil.
5. Install Tooling (B) on the piston. Ensure that Tooling (B) is installed correctly and that the piston can easily slide from the tool.

Note: The arrow that is on the top of the piston must be toward the front of the engine.

Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the piston and the connecting rod assembly into the cylinder and onto the connecting rod journal.
7. Lubricate the lower connecting rod bearing with clean engine oil.

   Note: Do not mix the connecting rod caps and the connecting rods.

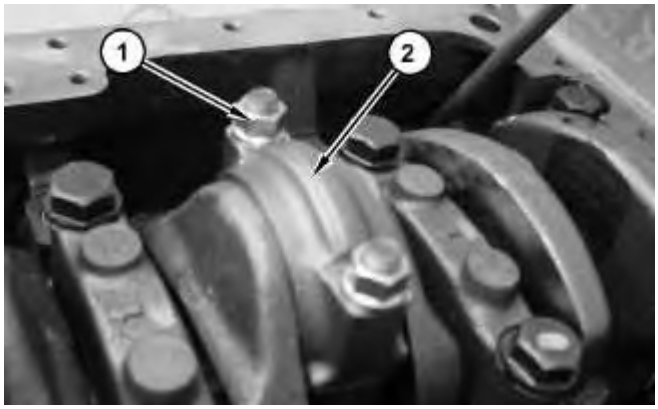


Illustration 1 g01033467

   Note: Remove the tape or rubber tubing on the connecting rod bolts.

8. Install connecting rod cap (2) .

   Note: Ensure that the mark on the connecting rod cap matches the mark on the connecting rod. Ensure that the marks are on the same side.

9. Install nuts (1) and tighten to a torque of 49 to 59 N·m (36 to 44 lb ft).
10. Rotate the crankshaft in order to ensure that there is no binding.
11. Repeat Steps 2 through 10 in order to install the remaining pistons and connecting rods.
12. Refer to Testing and Adjusting, "Piston Height - Inspect" for the correct procedure on checking the height of the piston above the cylinder block.

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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Connecting Rod Bearings - Remove

SMCS - 1219-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. In order to remove the connecting rod caps, rotate the crankshaft in a clockwise direction until the piston is at the bottom center position.

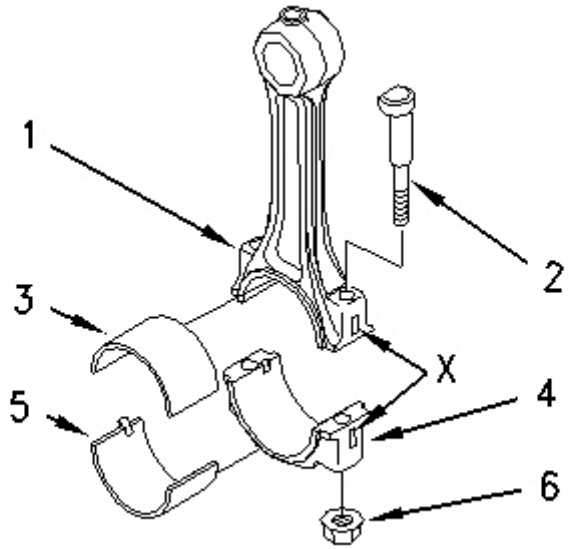


Illustration 1 g01001625

2. Inspect connecting rod (1) and connecting rod cap (4) for the proper identification mark.

   Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Mark the connecting rod and the connecting rod cap, if necessary.

3. Remove nuts (6) from connecting rod bolts (2). Remove connecting rod cap (4). Remove lower connecting rod bearing (5) from connecting rod cap (4) .

4. Carefully push connecting rod (1) into the cylinder bore. Remove upper connecting rod bearing (3) from connecting rod (1) .

5. Repeat Steps 1 through 4 for the remaining connecting rod bearings.

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i01996564

Connecting Rod Bearings - Install

SMCS - 1219-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

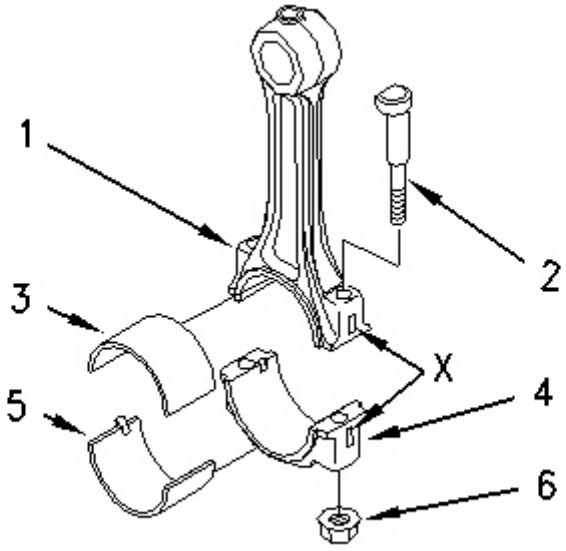


Illustration 1 g01001625

1. Install upper connecting rod bearing (3) in connecting rod (1). The upper connecting rod bearing must be centered in the connecting rod. Lubricate the bearing face with clean engine oil.

2. Pull connecting rod (1) into position against the crankshaft.

3. Install lower connecting rod bearing (5) in connecting rod cap (4). The lower connecting rod bearing must be centered in the connecting rod cap. Lubricate the bearing face with clean engine oil.

   Note: Do not mix the connecting rod caps and the connecting rods.

4. Install connecting rod cap (4) .

   Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Ensure that the marks are on the same side.

5. Install nuts (6) on connecting rod bolts (2). Tighten the nuts evenly to a torque of 49 to 59 N·m (36 to 44 lb ft).

6. Repeat Steps 1 through 5 for the remaining connecting rod bearings.

7. Rotate the crankshaft in order to ensure that there is no binding.

End By: Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

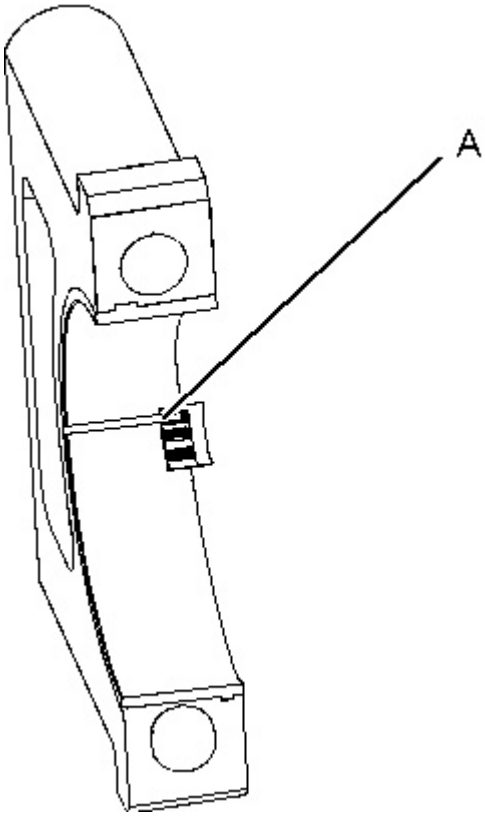


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Pistons and Connecting Rods - Remove

SMCS - 1225-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2269	Ridge Reamer	1

Start By:

A. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".
B. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Use Tooling (A) to remove the carbon ridge from the top inside surface of the cylinders.
2. Rotate the crankshaft in a clockwise direction until the pistons that are being removed are at the bottom center position.
3. Inspect the connecting rod and connecting rod cap for the proper identification marks.

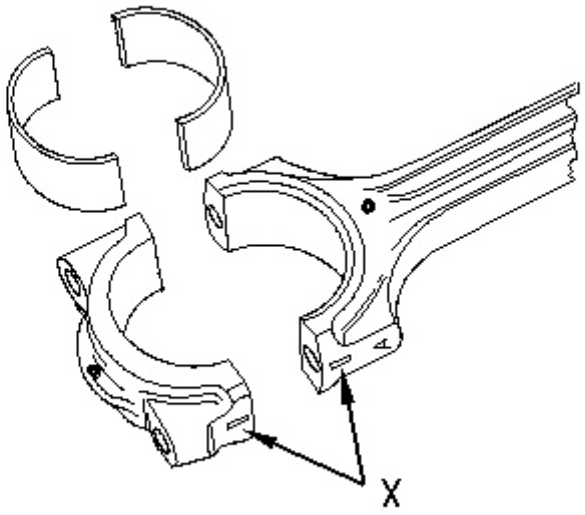


Illustration 1 g01001736

Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Mark the connecting rod and the connecting rod cap, if necessary.

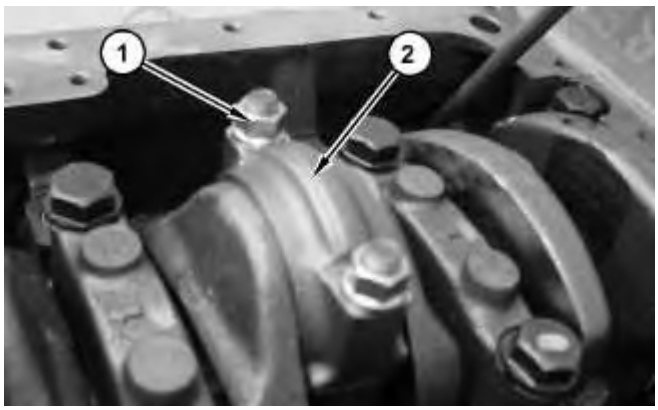


Illustration 2 g01033467

4. Remove nuts (1) that hold connecting rod cap (2) to the connecting rod.
5. Remove connecting rod cap (2) and the lower connecting rod bearing.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the pistons and the connecting rods through the top of the cylinder block.

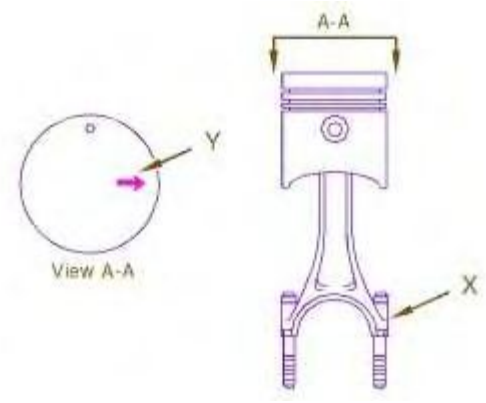


Illustration 3 g01033470

7. Note that Mark (Y) on the top of the piston faces the front. Note that Mark (Y) and Number (X) are on the right side for the purpose of reassembly.

8. Repeat Steps 1 through 7 in order to remove the remaining pistons and connecting rods.

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i01996614

Pistons and Connecting Rods - Disassemble

SMCS - 1225-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-6683	Ring Expander	1
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Group	1

Start By:

A. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

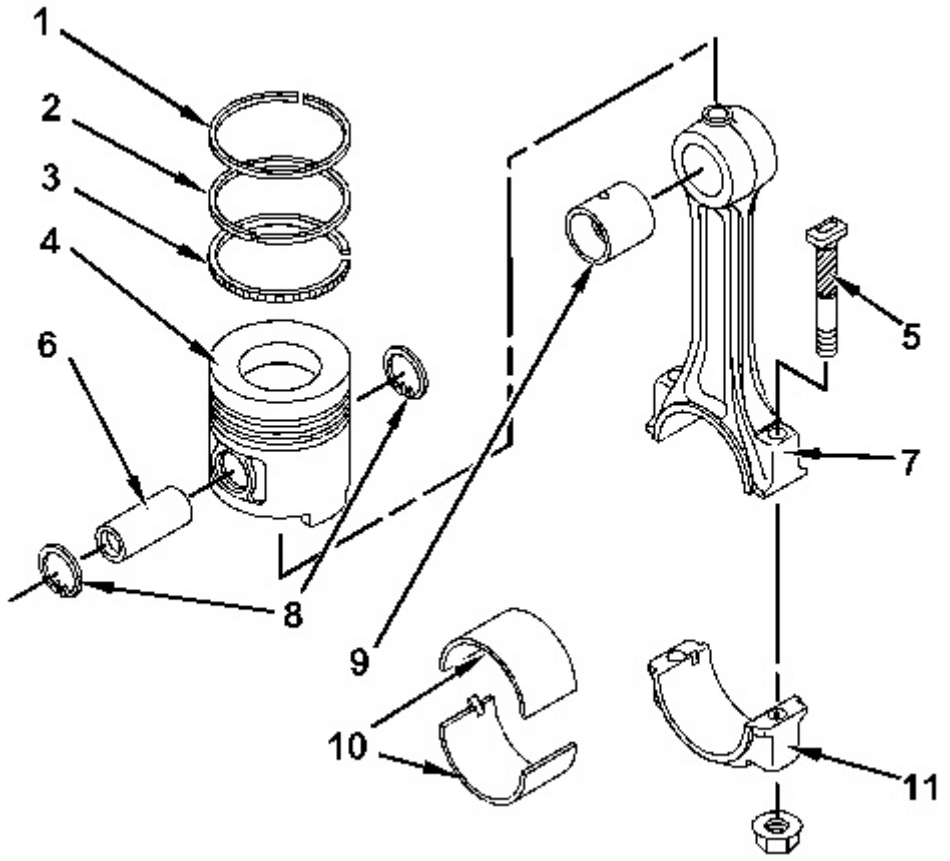


Illustration 1 g01033491

1. Remove connecting rod bolts (5) from connecting rod (7) .
2. Remove connecting rod bearings (10) from connecting rod cap (11) and connecting rod (7) .
3. Use Tooling (A) to remove compression rings (1) and (2), and oil control ring (3) from piston (4) .
4. Use Tooling (B) to remove retaining rings (8) that hold piston pin (6) in position.
5. Remove piston pin (6) from piston (4) .

   Note: If the piston pin cannot be removed by hand, raise the temperature of the piston to 45 ± 5 °C (113 ± 9 °F). Do not use a torch to heat the piston.
6. Use Tooling (C) and a suitable press to remove piston pin bearing (9) from connecting rod (7) .
7. Repeat Steps 1 through 6 in order to disassemble the remaining pistons and connecting rods.

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i01998467

Pistons and Connecting Rods - Assemble

SMCS - 1225-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-6683	Ring Expander	1
B	1P-1857	Retaining Ring Pliers	1
C	1P-0510	Driver Group	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. The connecting rod controls the piston height above the cylinder block. The connecting rod and the piston must be assembled and installed in the correct cylinder.

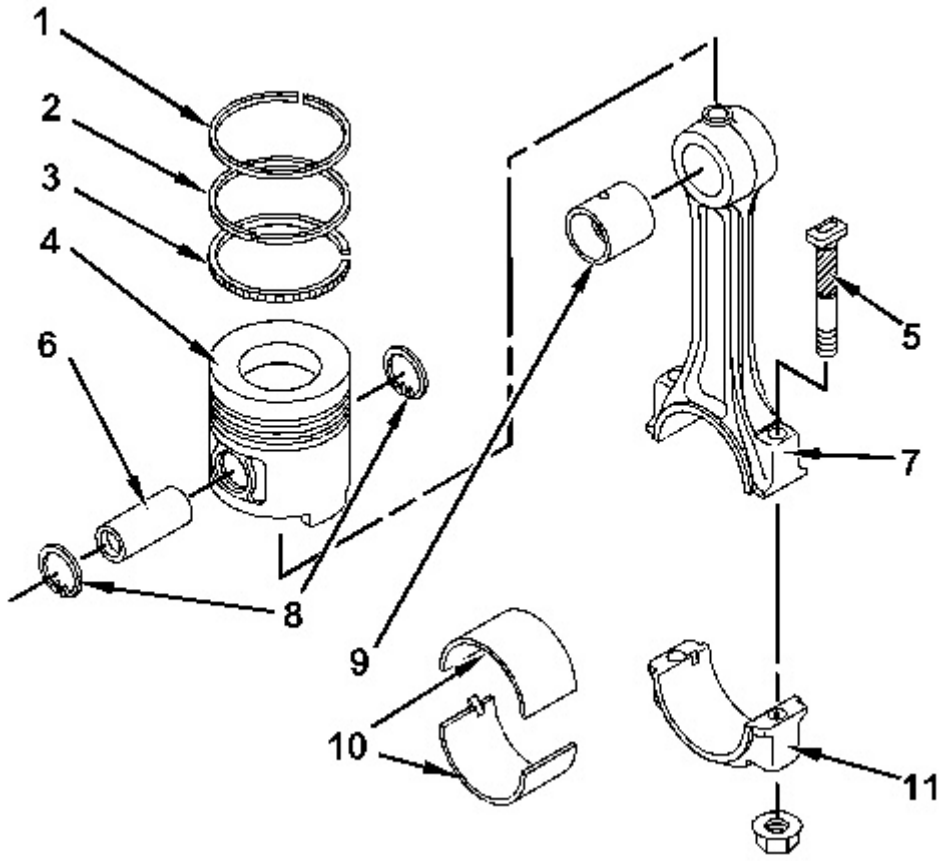


Illustration 1 g01033491

2. Use Tooling (C) and a suitable press to install piston pin bearing (9) into connecting rod (7) .

   Note: Ensure that the oil hole in the piston pin bearing is aligned with the oil hole at the top of the connecting rod.

   Note: If the clearance between piston pin (6) and piston pin bearing (9) exceeds 0.080 mm (0.0031 inch), replace the piston pin or the piston pin bearing with a new part.

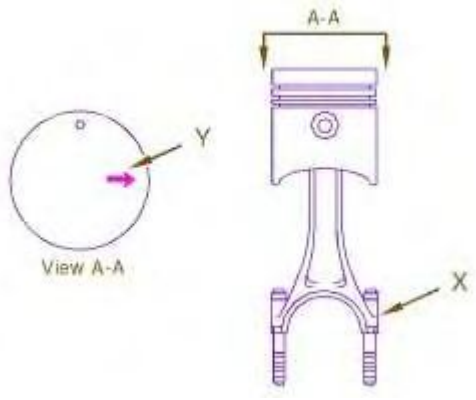


Illustration 2 g01033470

Note: Position the piston and the connecting rod so that Mark (Y) on the top of the piston faces the front. Note that Mark (Y) and Number (X) are on the right sight for the purpose of assembly.

3. Install piston pin (6) into piston (4) and through connecting rod (7) .

   Note: If the piston pin cannot be installed by hand, raise the temperature of the piston to 45° ± 5°C (113° ± 9°F). Do not use a torch to heat the piston.

4. Use Tooling (B) to install retaining rings (8) that hold piston pin (6) in position.

   Note: Position the ends of the retaining rings toward the bottom of the piston.

5. Use Tooling (A) to install the piston rings on piston (4) with the following steps.

   a. Install oil control ring (3) in the groove that is lowest on the piston. The latch pin that is on the oil control ring must be inside the ends of the spring.

      Note: Ensure that the latch pin that is on the oil control ring is 180 degrees from the oil control ring gap.

   b. Install intermediate compression ring (2) with the tapered face into the second groove on the piston.

      Note: The stamp must be toward the top of the piston.

   c. Install top compression ring (1) into the top groove on the piston.

      Note: The stamp must be toward the top of the piston.

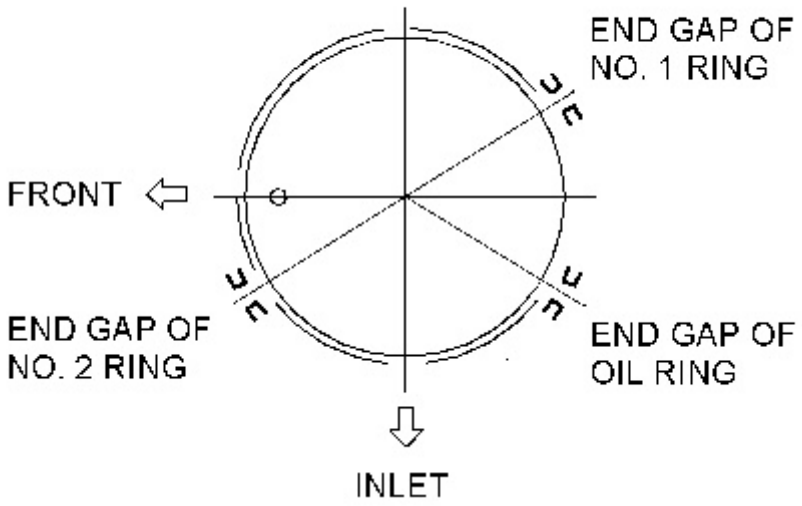


Illustration 3 g01033924

   d. Refer to Illustration 3 in order to position the piston ring gaps.

6. Install connecting rod bearings (10) in connecting rod (7) and in connecting rod cap (11) .
7. Install connecting rod bolts (5) in connecting rod (7) .
8. Repeat Steps 2 through 7 in order to assemble the remaining pistons and connecting rods.

End By: Install the pistons and connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Install".

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i01998541

Pistons and Connecting Rods - Install

SMCS - 1225-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1U-6684	Piston Ring Compressor	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean all of the components.
2. Lubricate the piston and the cylinder walls with clean engine oil.

   Note: The piston and connecting rod are matched to a specific cylinder. Ensure that the connecting rod and pistons are installed in the correct cylinder.
3. Rotate the crankshaft until the connecting rod journal is at the bottom center position. Lubricate the connecting rod journal with clean engine oil.
4. Lubricate the upper connecting rod bearing that is installed in the connecting rod with clean engine oil.
5. Install Tooling (B) on the piston. Ensure that Tooling (B) is installed correctly and that the piston can easily slide from the tool.

Note: The arrow that is on the top of the piston must be toward the front of the engine.

Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

6. Push the piston and the connecting rod assembly into the cylinder and onto the connecting rod journal.
7. Lubricate the lower connecting rod bearing with clean engine oil.

   Note: Do not mix the connecting rod caps and the connecting rods.

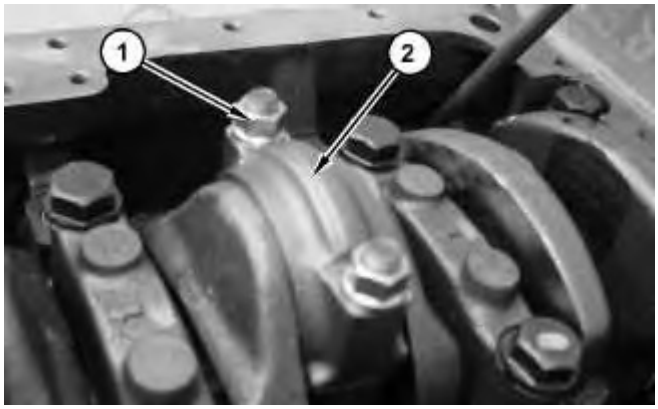


Illustration 1 g01033467

   Note: Remove the tape or rubber tubing on the connecting rod bolts.

8. Install connecting rod cap (2) .

   Note: Ensure that the mark on the connecting rod cap matches the mark on the connecting rod. Ensure that the marks are on the same side.

9. Install nuts (1) and tighten to a torque of 49 to 59 N·m (36 to 44 lb ft).
10. Rotate the crankshaft in order to ensure that there is no binding.
11. Repeat Steps 2 through 10 in order to install the remaining pistons and connecting rods.
12. Refer to Testing and Adjusting, "Piston Height - Inspect" for the correct procedure on checking the height of the piston above the cylinder block.

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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i01996559

Connecting Rod Bearings - Remove

SMCS - 1219-011

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. In order to remove the connecting rod caps, rotate the crankshaft in a clockwise direction until the piston is at the bottom center position.

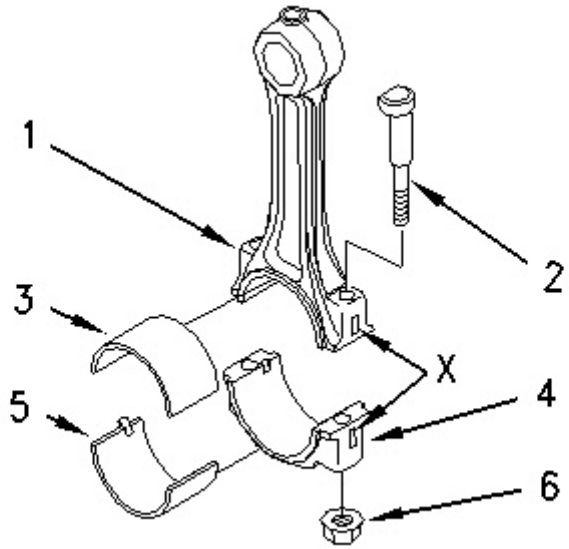


Illustration 1 g01001625

2. Inspect connecting rod (1) and connecting rod cap (4) for the proper identification mark.

   Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Mark the connecting rod and the connecting rod cap, if necessary.

3. Remove nuts (6) from connecting rod bolts (2). Remove connecting rod cap (4). Remove lower connecting rod bearing (5) from connecting rod cap (4) .

4. Carefully push connecting rod (1) into the cylinder bore. Remove upper connecting rod bearing (3) from connecting rod (1) .

5. Repeat Steps 1 through 4 for the remaining connecting rod bearings.

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i01996564

Connecting Rod Bearings - Install

SMCS - 1219-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

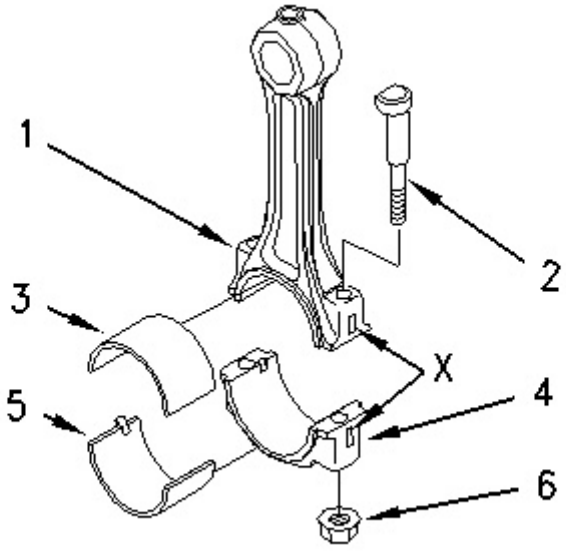


Illustration 1 g01001625

1. Install upper connecting rod bearing (3) in connecting rod (1). The upper connecting rod bearing must be centered in the connecting rod. Lubricate the bearing face with clean engine oil.

2. Pull connecting rod (1) into position against the crankshaft.

3. Install lower connecting rod bearing (5) in connecting rod cap (4). The lower connecting rod bearing must be centered in the connecting rod cap. Lubricate the bearing face with clean engine oil.

   Note: Do not mix the connecting rod caps and the connecting rods.

4. Install connecting rod cap (4) .

   Note: The connecting rod and the connecting rod cap should have matching Numbers (X) on the side. Ensure that the marks are on the same side.

5. Install nuts (6) on connecting rod bolts (2). Tighten the nuts evenly to a torque of 49 to 59 N·m (36 to 44 lb ft).

6. Repeat Steps 1 through 5 for the remaining connecting rod bearings.

7. Rotate the crankshaft in order to ensure that there is no binding.

End By: Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools				
Tool	**Part Number**	**Part Description**	**Qty**	
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1	
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1	
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1	
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1	

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

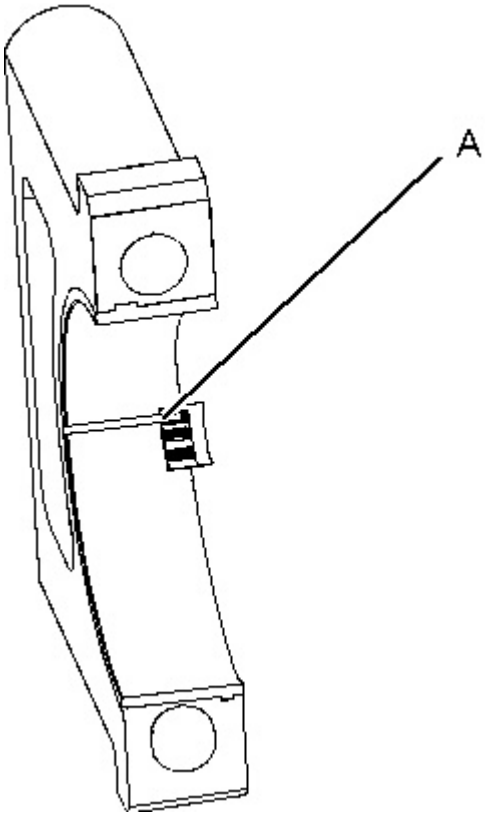


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639300

Pistons and Connecting Rods - Remove

SMCS - 1225-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8S-2269	Ridge Reamer	1

Start By:

A. Remove the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Remove".
B. Remove the engine oil pan and remove the oil strainer. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove".

2. Rotate the crankshaft until the piston that is being removed is at the bottom center position.

3. Use Tooling (A) to remove the carbon ridge from the top inside surface of the cylinder bore.

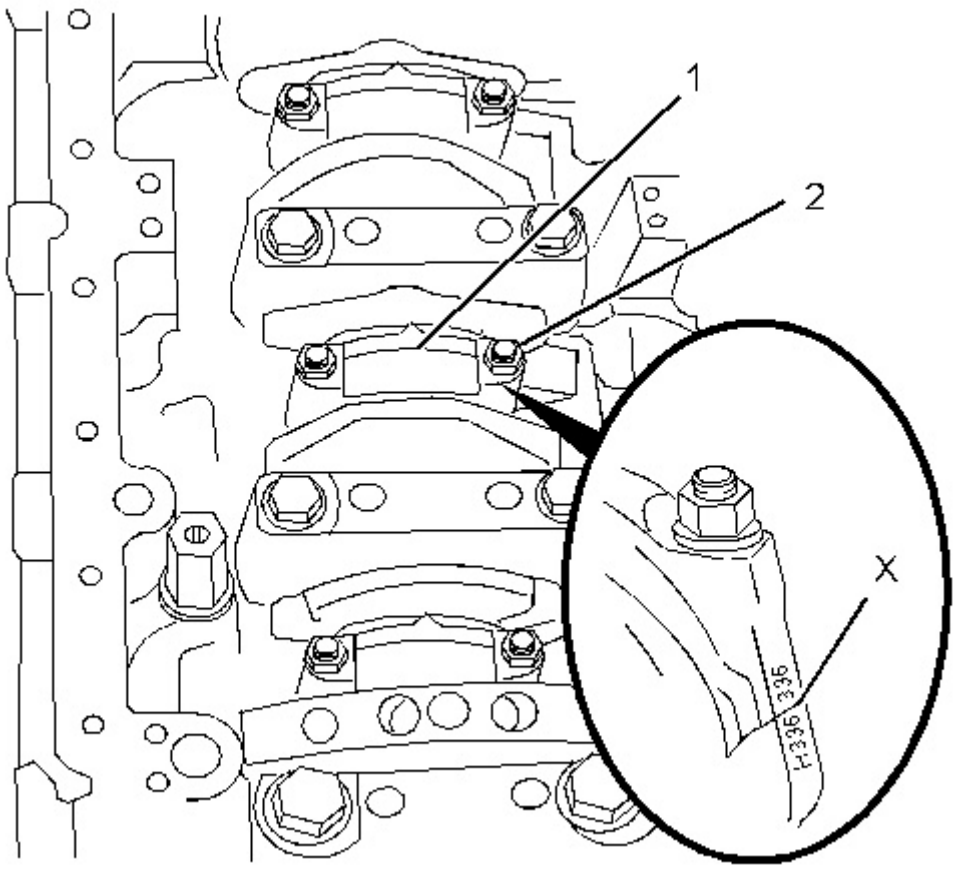


Illustration 1 g01352319

4. The connecting rod and the connecting rod cap have matching numbers (X) on the side. Note the location of the connecting rod for installation. If necessary, make a temporary mark on the connecting rod and the connecting rod cap in order to identify the cylinder number.

5. Remove nuts (2) .

6. Remove connecting rod cap (1) from the connecting rod.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft journals from damage.

7. Carefully push the piston and the connecting rod assembly out of the cylinder bore. Lift the piston out of the top of the cylinder block.

8. Repeat Steps 2 through 7 in order to remove the remaining pistons and connecting rods.

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i02639301

Pistons and Connecting Rods - Disassemble

SMCS - 1225-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1857	Retaining Ring Pliers	1
B	1U-6683	Ring Expander	1
C	1P-0510	Driver Group	1

Start By:

A. Remove the pistons and connecting rods. Refer to Disassembly and Assembly, "Piston and Connecting Rods - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

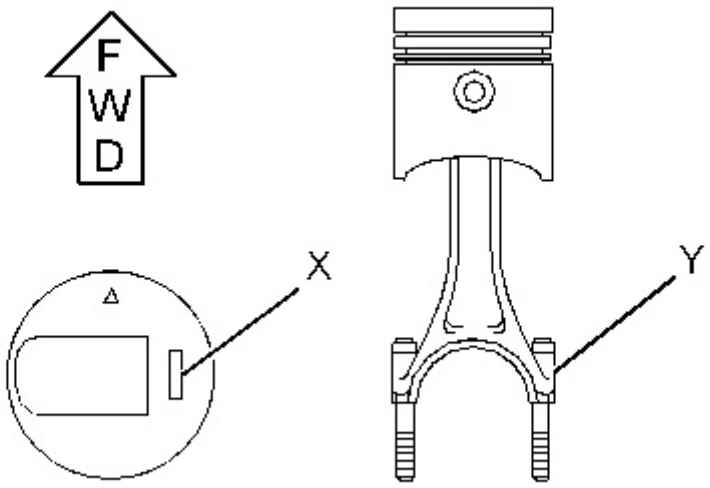


Illustration 1 g01359107

Piston from a naturally aspirated engine

(X) Number

(Y) Number

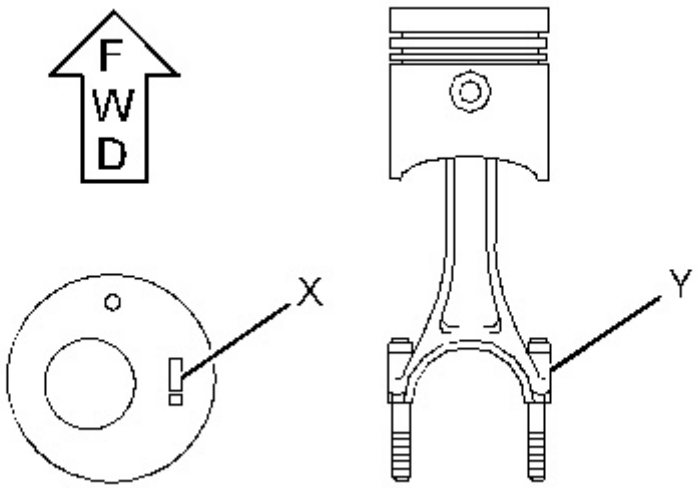


Illustration 2 g01359108

Piston from a turbocharged engine

(X) Number

(Y) Number

1. Make a temporary mark on the components of the piston and connecting rod assembly. This will ensure that the components of each piston and connecting rod assembly can be reinstalled in the original cylinder. Note the correct orientation of the connecting rod in relation to the piston. Number (X) and number (Y) must be on the same side. Refer to Illustration 1. Do not interchange components.

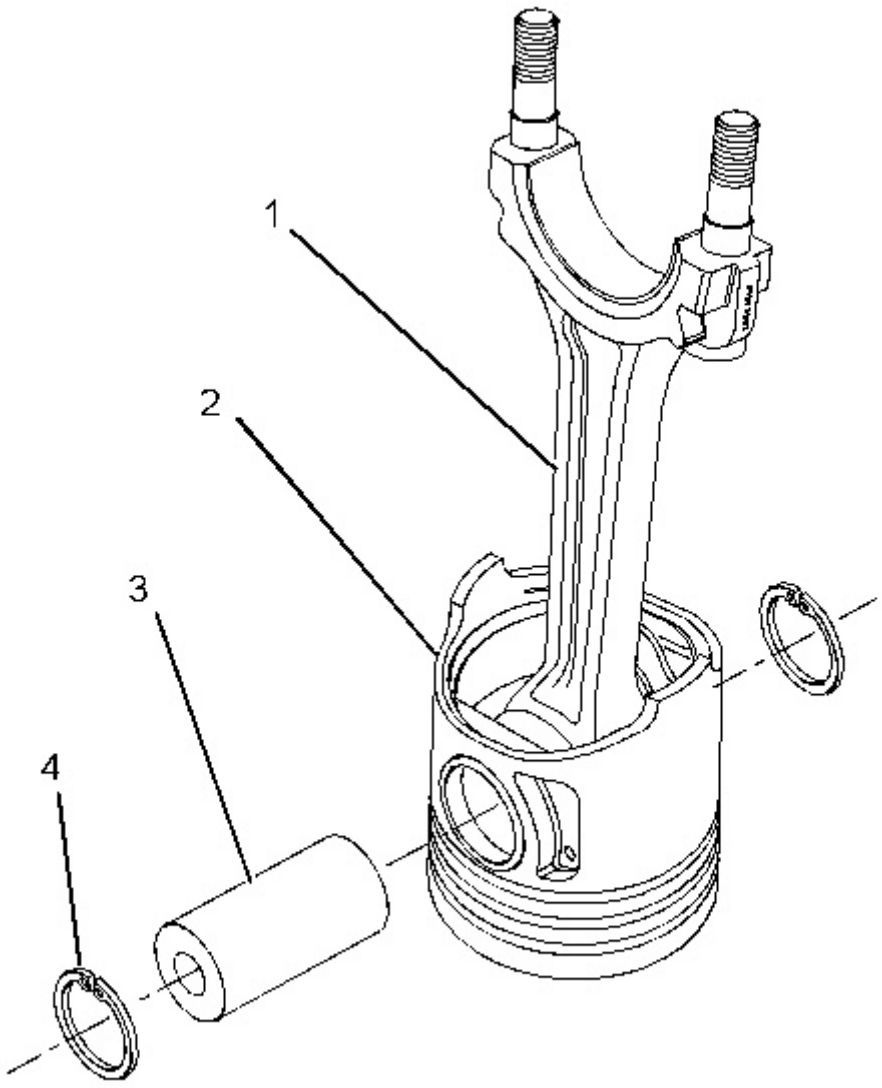


Illustration 3 g01311807

Typical example

2. Place the piston and connecting rod assembly on a suitable surface with the connecting rod upward. Use Tooling (A) in order to remove retaining rings (4) .

3. Remove piston pin (3) and connecting rod (1) from piston (2) .

Note: If the piston pin cannot be removed by hand, heat the piston to a temperature of 45 ± 5 °C (113 ± 9 °F). Do not use a torch to heat the piston.

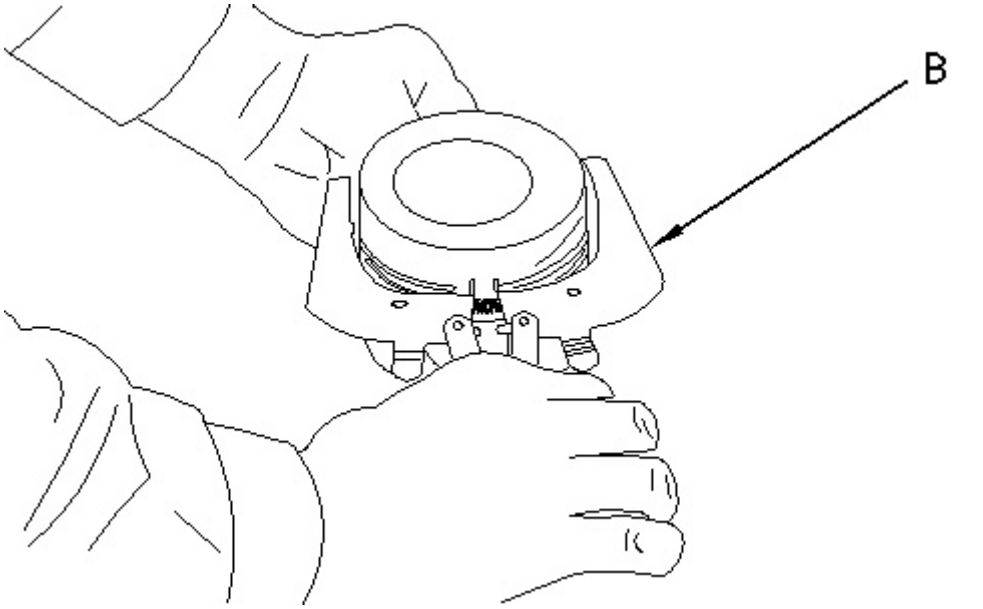


Illustration 4 g00829406

Piston from a turbocharged engine

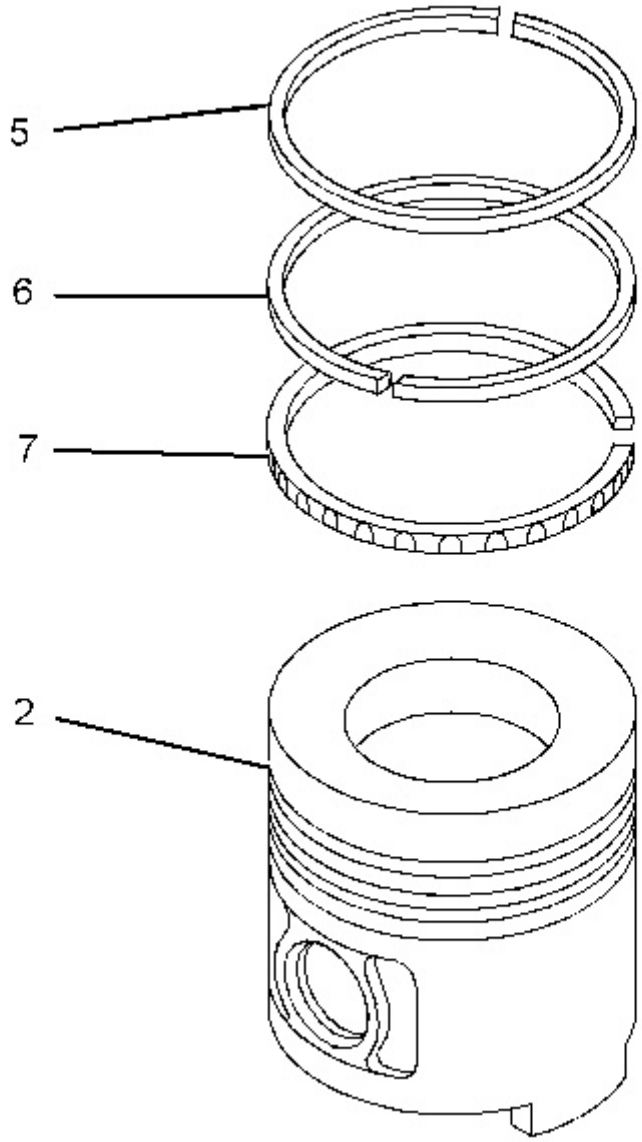


Illustration 5 g01351357

Piston from a turbocharged engine

4. Place piston (2) on a suitable surface with the crown upward. Use Tooling (B) in order to remove compression rings (5) and (6), and oil control ring (7) from the piston.

   Note: Identify the orientation of the piston rings for installation.

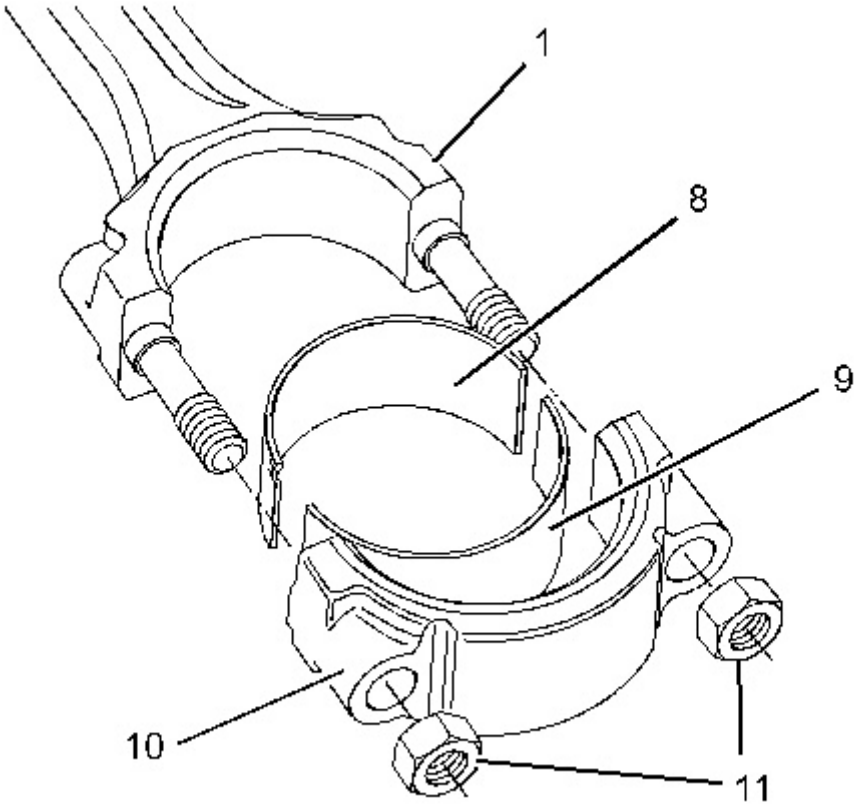


Illustration 6 g01362961

Typical example

5. If necessary, remove nuts (11) and connecting rod cap (10) from connecting rod (1) .
6. Remove the lower half of connecting rod bearing (9) from connecting rod cap (10). Remove the upper half of connecting rod bearing (8) from connecting rod (1). Keep the bearing shells together.

NOTICE

Removal of the piston pin bushing in the connecting rod must be carried out by personnel with the correct training. Also special machinery is required. For more information refer to your authorized Caterpillar dealer.

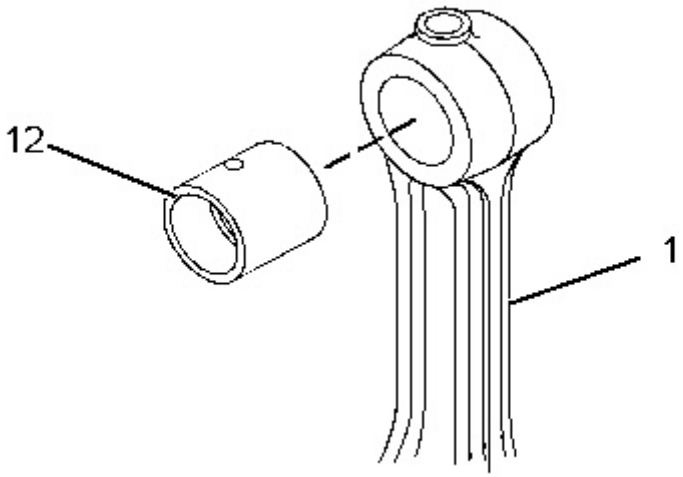


Illustration 7 g01351358

7. Inspect piston pin bearing (12) for wear or damage. Refer to Specifications, "Pistons and Rings" for more information. If necessary, replace connecting rod (1) or replace piston pin bearing (12) .

   If necessary, use Tooling (C) and a suitable press to remove piston pin bearing (12) from connecting rod (1) .

8. Repeat Steps 1 through 7 in order to disassemble the remaining pistons and connecting rods.

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i02639303

Pistons and Connecting Rods - Install

SMCS - 1225-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	1U-6684	Piston Ring Compressor	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the assemblies of the pistons and connecting rods are clean and free from damage.
2. Apply clean engine oil to the cylinder bore, to the piston rings, to the outer surface of the piston and to the connecting rod bearings.

   Note: Install the connecting rod bearings dry when clearance checks are performed. Refer to Disassembly and Assembly, "Bearing Clearance - Check". Apply clean engine oil to the connecting rod bearings during final assembly.
3. Rotate the crankshaft until the crankshaft pin is in the bottom center position. Lubricate the crankshaft pin with clean engine oil.

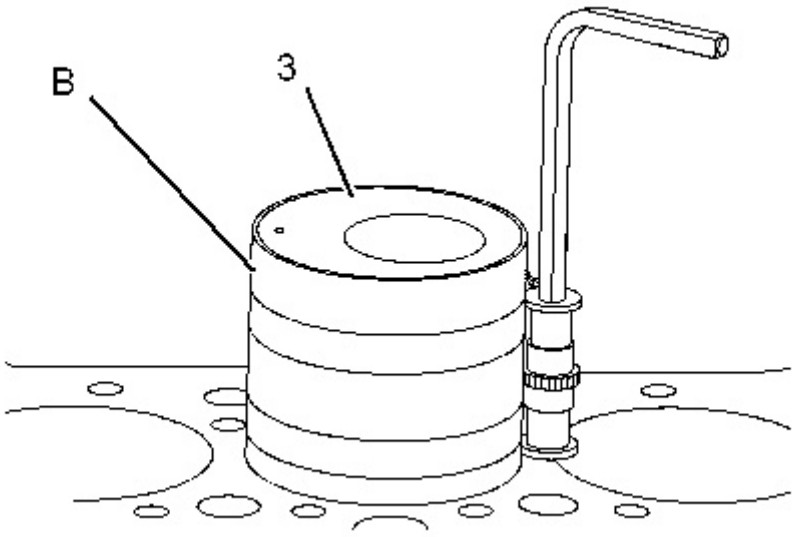


Illustration 1 g01352295

Piston from a turbocharged engine

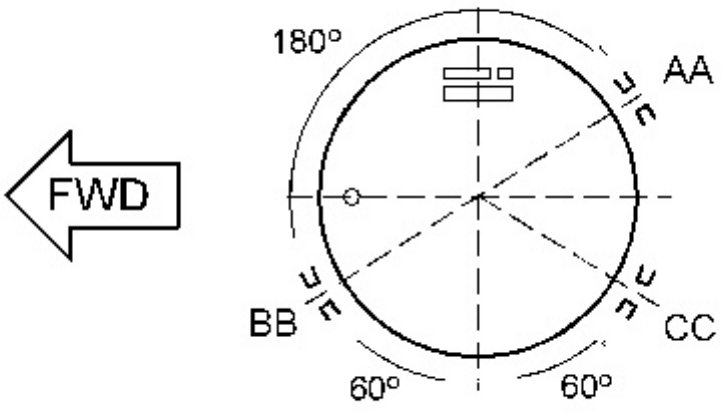


Illustration 2 g01359137

The correct position of the piston ring gaps

(AA) Ring gap of the top compression ring

(BB) Ring gap of the intermediate compression ring

(CC) Ring gap of the oil control ring

4. Align the piston ring gaps to the positions that are shown in Illustration 2. Install Tooling (B) onto piston (3). Ensure that Tooling (B) is installed correctly and that the piston can easily slide from the tool.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft pin from damage. Ensure that the piston and the connecting rod assembly are installed in the correct cylinder.

5. Carefully push the piston and the connecting rod assembly into the cylinder bore and onto the crankshaft pin.

   Note: Use tape or rubber tubing on the connecting rod bolts to protect the crankshaft pin from damage. Ensure that the piston and the connecting rod assembly are installed in the correct cylinder.

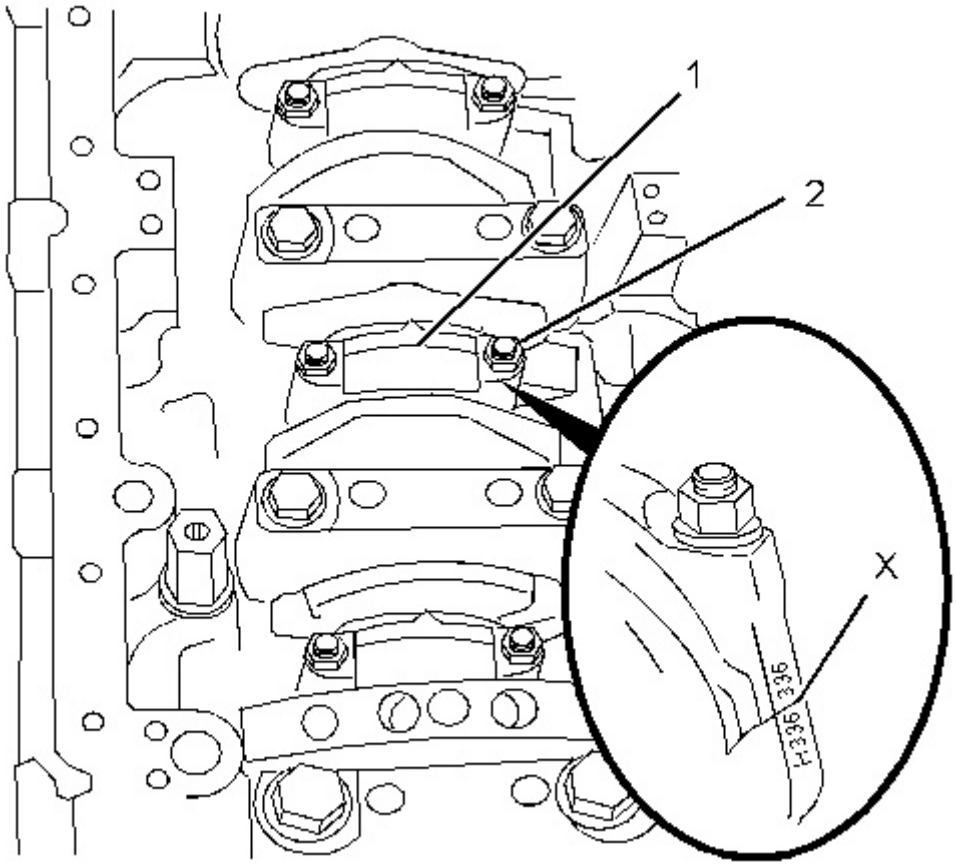


Illustration 3 g01352319

Typical example

6. Remove the tape or rubber tubing on the connecting rod bolts. Install connecting rod cap (1) .

   Note: Ensure that number (X) on the connecting rod cap matches number (X) on the connecting rod. Ensure that the numbers are on the same side.

7. Install nuts (2). Tighten the nuts to a torque of 54 N·m (40 lb ft).

8. Ensure that the installed connecting rod assembly has tactile side play. Rotate the crankshaft in order to ensure that there is no binding.

9. Repeat Steps 2 through 8 in order to install the remaining pistons and connecting rods.

10. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install".

End By:

a. Install the oil strainer and install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
b. Install the cylinder head. Refer to Disassembly and Assembly, "Cylinder Head - Install".

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i02639304

Connecting Rod Bearings - Remove - Connecting rods in position

SMCS - 1219-011

Removal Procedure

Start By:

A. Remove the engine oil pan and remove the oil strainer. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: If all connecting rod bearings require replacement, the procedure can be carried out on two cylinders at the same time. The procedure can be carried out on the following pairs of cylinders. 1 with 4 and 2 with 3. **Ensure that both pairs of the connecting rod bearings are installed before changing from one pair of cylinders to another pair of cylinders.**. Refer to Disassembly and Assembly, "Connecting Rod Bearings - Install" for the correct procedure.

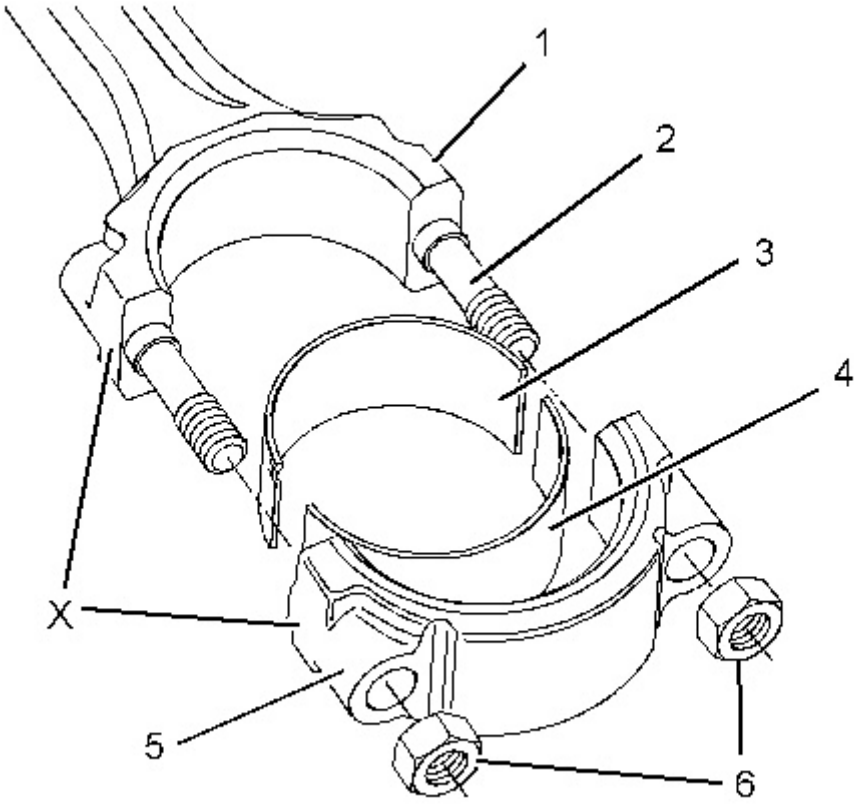


Illustration 1 g01361963

Typical example

Note: The connecting rod and the connecting rod cap have matching numbers at position (X). Note the location of the connecting rod cap (5) for installation.

1. Rotate the crankshaft until the piston is at the bottom center position. Remove nuts (6) and remove connecting rod cap (5) from connecting rod (1) .
2. Remove lower connecting rod bearing (4) from connecting rod cap (5) .

   Note: Use tape or rubber tubing on connecting rod bolts (2) in order to protect the crankshaft journals. The sharp edges of the connecting rod bolts could damage the crankshaft journals.
3. Carefully push connecting rod (1) into the cylinder bore. Remove upper connecting rod bearing (3) from the connecting rod.

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i02639305

Connecting Rod Bearings - Install - Connecting rods in position

SMCS - 1219-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Inspect the pins of the crankshaft for damage. Refer to Specifications, "Connecting Rod Bearing Journals" for more information. If the crankshaft is worn or damaged, replace the crankshaft or recondition the crankshaft. Refer to Disassembly and Assembly, "Crankshaft - Remove" and Disassembly and Assembly, "Crankshaft - Install".

2. Ensure that the connecting rod bearings are clean and free from wear or damage. If necessary, replace the connecting rod bearings.

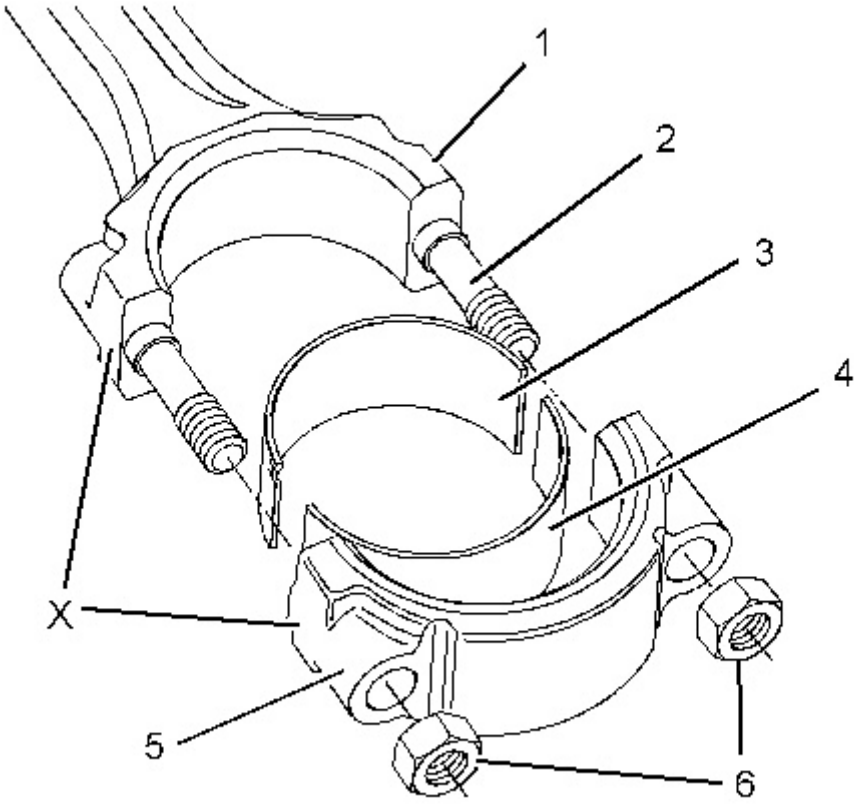


Illustration 1 g01361963

Typical example

3. Clean the bearing surface of connecting rod (1) and connecting rod cap (5) .
4. Install upper connecting rod bearing (3) to connecting rod (1). Lubricate the bearing surface of the connecting rod bearing with clean engine oil.

   Note: Use tape or rubber tubing on connecting rod bolts (2) in order to protect the crankshaft journals. The sharp edges of the connecting rod bolts could damage the crankshaft journals.
5. Carefully pull connecting rod (1) against the crankshaft pin.
6. Install lower connecting rod bearing (4) to connecting rod cap (5) .
7. Lubricate the pin of the crankshaft and lubricate lower connecting rod bearing (4) with clean engine oil.

NOTICE

When the connecting rod caps are installed, ensure that the identification marks are aligned.

8. Ensure that the numbers at position (X) on connecting rod cap (5) and on connecting rod (1) match. Install connecting rod cap (5) .

9. Install nuts (6). Tighten the nuts evenly to a torque of 54 N·m (40 lb ft).

10. Repeat Steps 2 through 9 for the remaining connecting rod bearings.

    Note: If all connecting rod bearings require replacement, the procedure can be carried out on two cylinders at the same time. The procedure can be carried out on the following pairs of cylinders. 1 with 4 and 2 with 3. **Ensure that both pairs of the connecting rod bearings are installed before changing from one pair of cylinders to another pair of cylinders.** Refer to Disassembly and Assembly, "Connecting Rod Bearings - Remove" for the correct procedure.

11. Ensure that the installed connecting rod assemblies have tactile side play. Carefully rotate the crankshaft in order to ensure that there is no binding.

End By:

a. If the engine is equipped with a balancer, Install the balancer. Refer to Disassembly and Assembly, "Balancer - Install".
b. Install the oil strainer and the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02717761

Bearing Clearance - Check

SMCS - 1203-535; 1219-535

Measurement Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	198-9142	Plastic Gauge (Green) 0.025 to 0.076 mm (0.001 to 0.003 inch)	1
	198-9143	Plastic Gauge (Red) 0.051 to 0.152 mm (0.002 to 0.006 inch)	1
	198-9144	Plastic Gauge (Blue) 0.102 to 0.229 mm (0.004 to 0.009 inch)	1
	198-9145	Plastic Gauge (Yellow) 0.230 to 0.510 mm (0.009 to 0.020 inch)	1

Note: Plastic gauge may not be necessary when the engine is in the chassis.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Caterpillar does not recommend the checking of the actual bearing clearances particularly on small engines. This is because of the possibility of obtaining inaccurate results and the possibility of damaging the bearing or the journal surfaces. Each Caterpillar engine bearing is quality checked for specific wall thickness.

Note: The measurements should be within specifications and the correct bearings should be used. If the crankshaft journals and the bores for the block and the rods were measured during disassembly, no further checks are necessary. However, if the technician still wants to measure the bearing clearances, Tooling (A) is an acceptable method. Tooling (A) is less accurate on journals with small diameters if clearances are less than 0.10 mm (0.004 inch).

NOTICE

Lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

The technician must be very careful to use Tooling (A) correctly. The following points must be remembered:

- Ensure that the backs of the bearings and the bores are clean and dry.
- Ensure that the bearing locking tabs are properly seated in the tab grooves.
- The crankshaft must be free of oil at the contact points of Tooling (A) .

1. Put a piece of Tooling (A) on the crown of the bearing that is in the cap.

   Note: Do not allow Tooling (A) to extend over the edge of the bearing.

2. Use the correct torque-turn specifications in order to install the bearing cap. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

   Note: Do not turn the crankshaft when Tooling (A) is installed.

3. Carefully remove the cap, but do not remove Tooling (A) . Measure the width of Tooling (A) while Tooling (A) is in the bearing cap or on the crankshaft journal. Refer to Illustration 1.

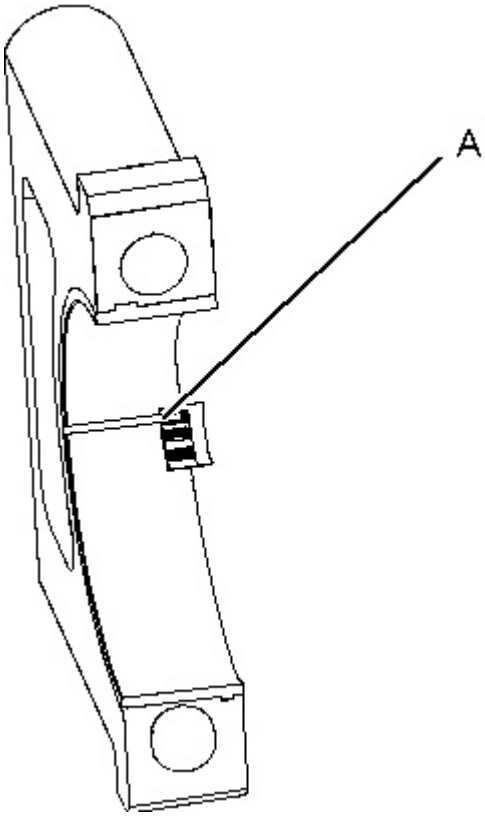


Illustration 1 g01152855

Typical Example

4. Remove all of Tooling (A) before you install the bearing cap.

   Note: When Tooling (A) is used, the readings can sometimes be unclear. For example, all parts of Tooling (A) are not the same width. Measure the major width in order to ensure that the parts are within the specification range. Refer to Specifications Manual, "Connecting Rod Bearing Journal" and Specifications Manual, "Main Bearing Journal" for the correct clearances.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02510697

Crankshaft Pulley

SMCS - 1205

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-9022	Silicone Gasket	1

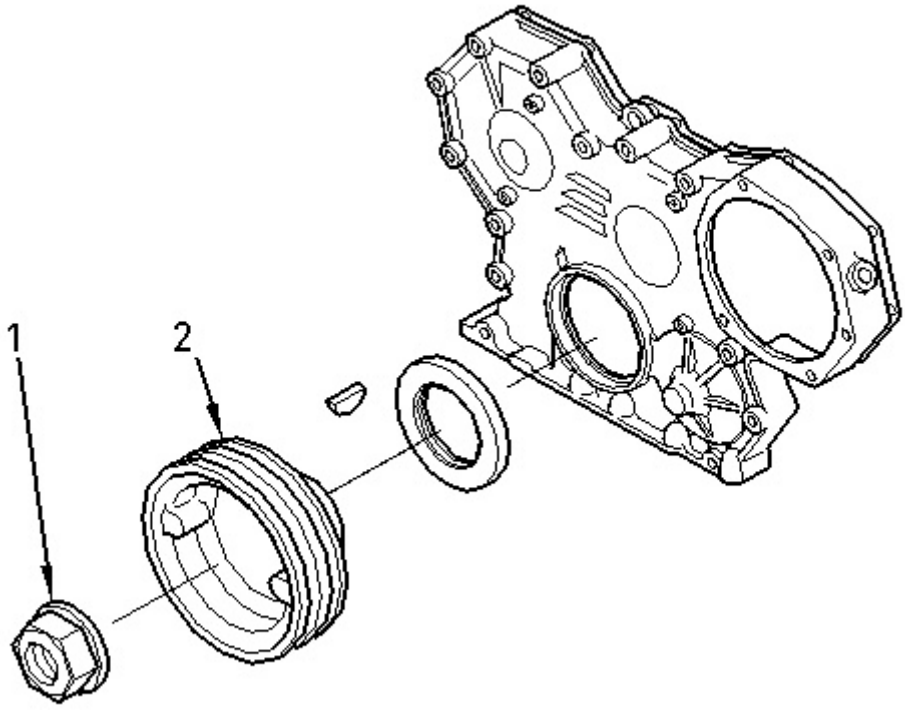


Illustration 1 g00988100

Note: Apply Tooling (A) to the threads of the crankshaft before the pulley nut is installed.

(1) Tighten the nut that fastens the crankshaft pulley to the crankshaft to the following torque. ... 480 to 500 N·m (354 to 369 lb ft)

(2) Crankshaft pulley

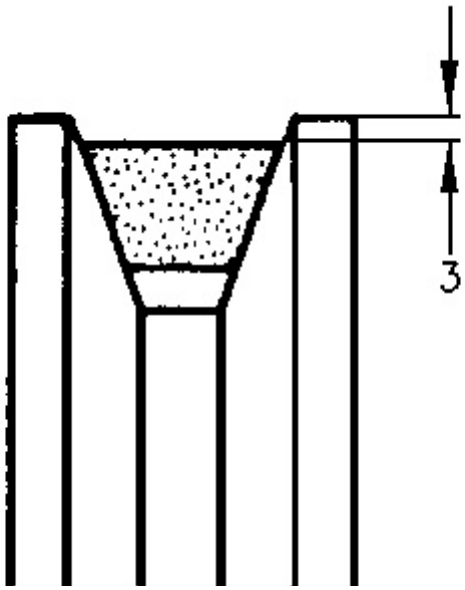


Illustration 2 g00988022

(3) Maximum depth for the top of the V-belt in the groove ... 1.6 mm (0.06 inch)

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i02510697

Crankshaft Pulley

SMCS - 1205

S/N - -

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-9022	Silicone Gasket	1

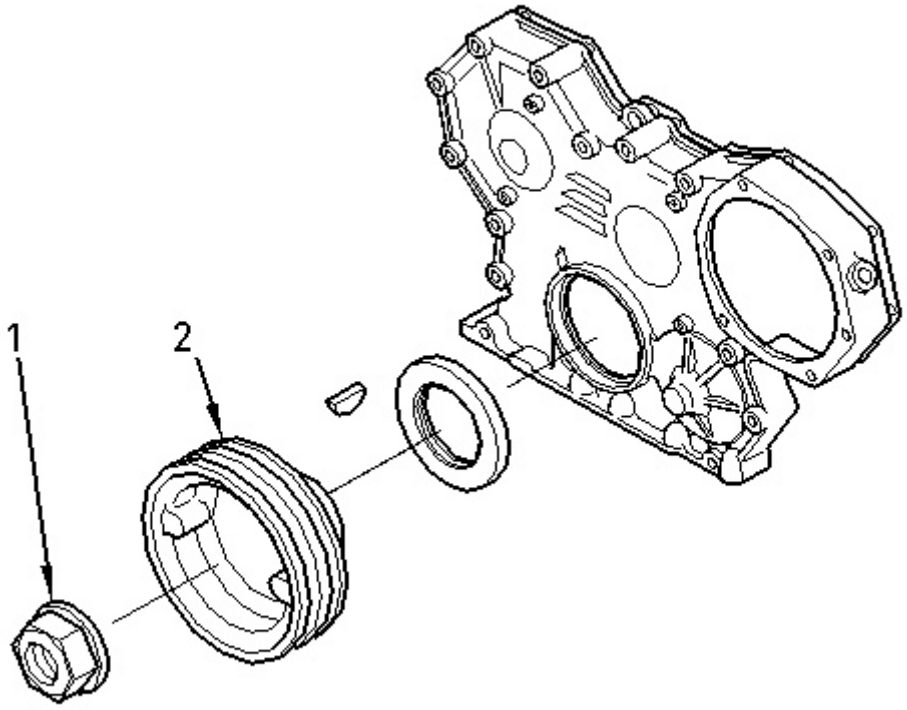


Illustration 1 g00988100

Note: Apply Tooling (A) to the threads of the crankshaft before the pulley nut is installed.

(1) Tighten the nut that fastens the crankshaft pulley to the crankshaft to the following torque. ... 480 to 500 N·m (354 to 369 lb ft)

(2) Crankshaft pulley

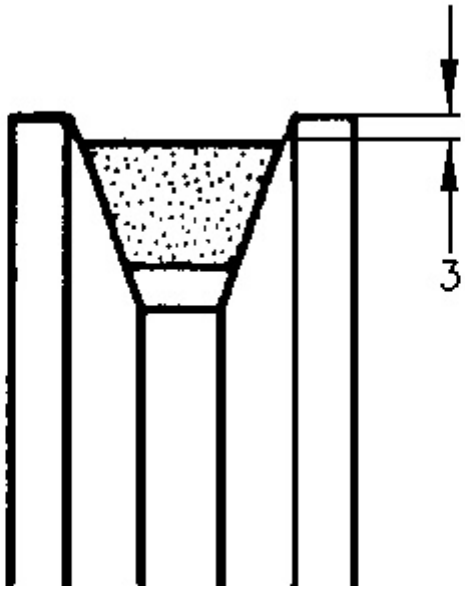


Illustration 2 g00988022

(3) Maximum depth for the top of the V-belt in the groove ... 1.6 mm (0.06 inch)

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i01999219

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

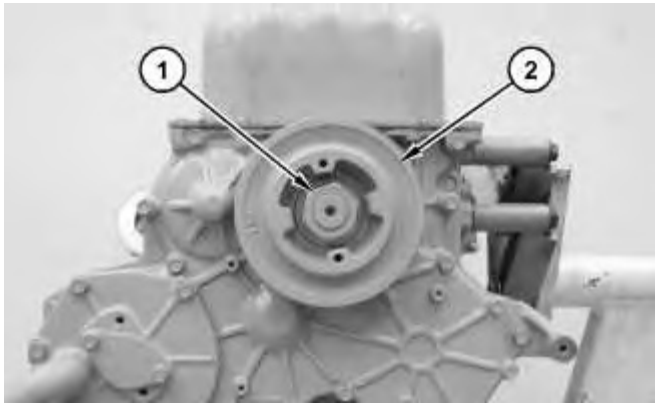


Illustration 1 g01034425

1. Loosen nut (1) .

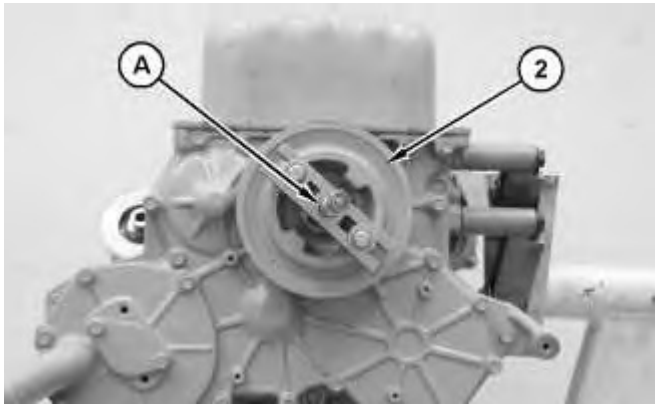


Illustration 2 g01034426

2. Use Tooling (A) to loosen crankshaft pulley (2). Remove Tooling (A). Remove nut (1) and remove pulley (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

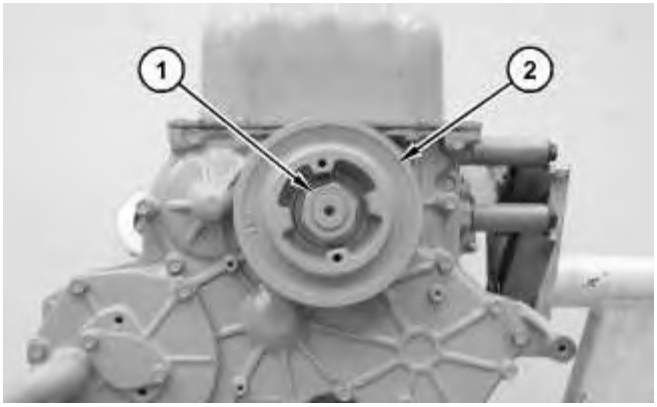


Illustration 3 g01034425

1. Position pulley (2) and install nut (1) .
2. Tighten nut (1) to a torque of 480 to 500 N·m (354 to 369 lb ft).

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i01999219

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

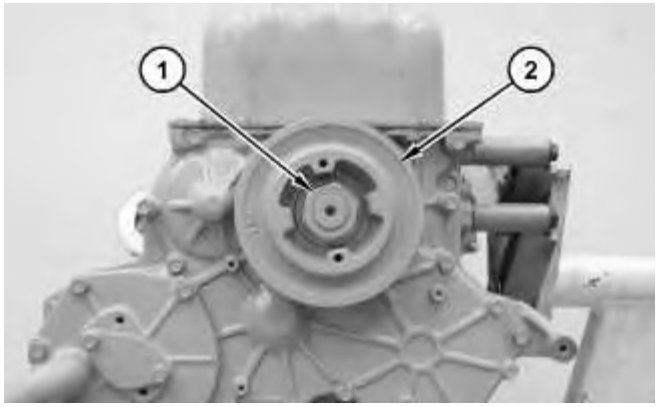


Illustration 1 g01034425

1. Loosen nut (1) .

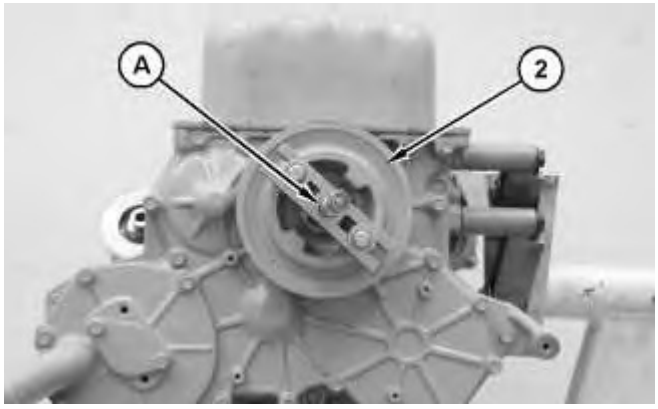


Illustration 2 g01034426

2. Use Tooling (A) to loosen crankshaft pulley (2). Remove Tooling (A). Remove nut (1) and remove pulley (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

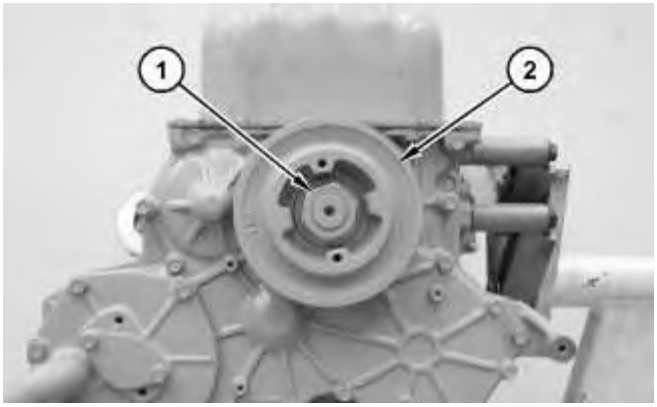


Illustration 3 g01034425

1. Position pulley (2) and install nut (1) .
2. Tighten nut (1) to a torque of 480 to 500 N·m (354 to 369 lb ft).

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05016832

Crankshaft Pulley - Remove and Install

SMCS - 1205-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	6V-9120	Socket	1
B	5F-7465	Puller Gp	1
	8T-4121	Hard Washer	2
	8T-4225	Washer	2
	8T-6912	Bolt	2

Start By:

A. Remove the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Use a suitable method to prevent the crankshaft from rotating.

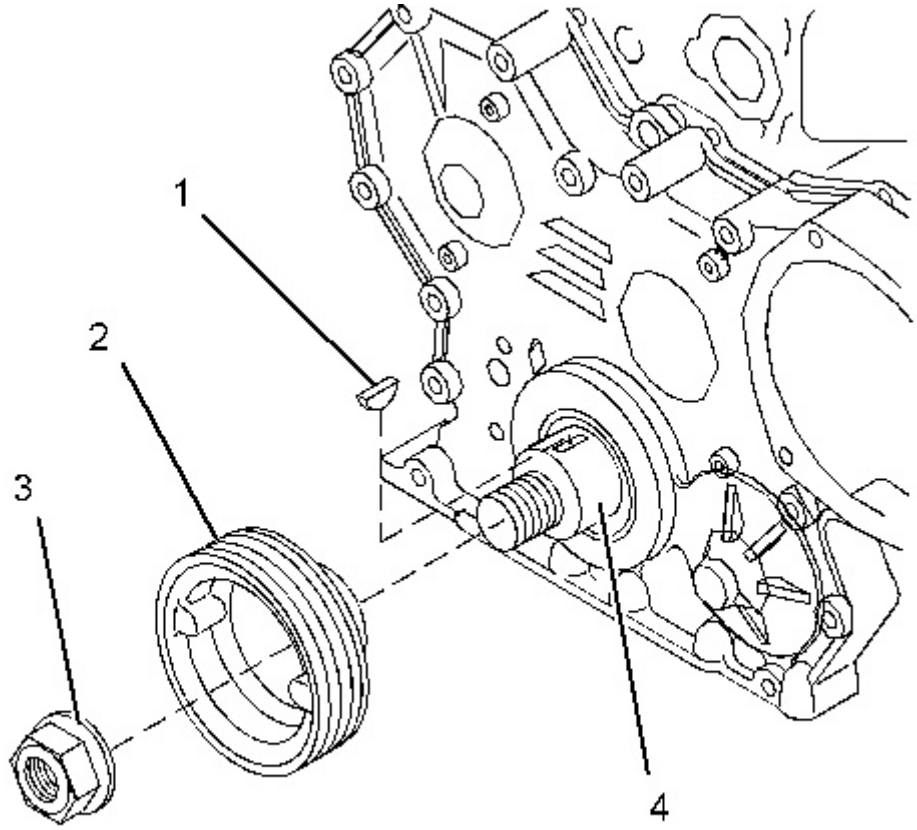


Illustration 1 g01335388

Typical example

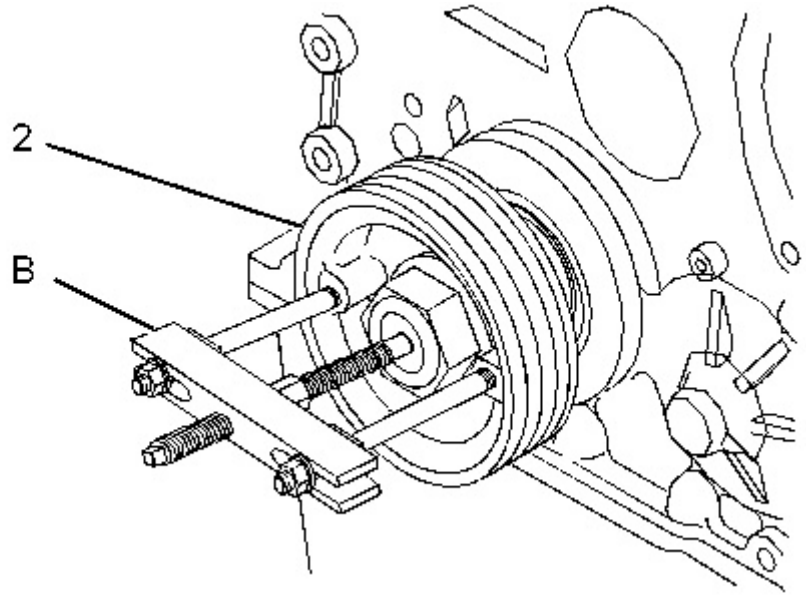


Illustration 2 g01335508

Typical example

2. Use Tooling (A) in order to loosen nut (3) .

   Note: Do not remove the nut at this time.

3. Install Tooling (B) to crankshaft pulley (2) . Use Tooling (B) to loosen the crankshaft pulley. Remove Tooling (B) .

4. Remove nut (3) and remove crankshaft pulley (2) .

5. If necessary, remove woodruff key (1) from crankshaft (4) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	-	Loctite 5900	-

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

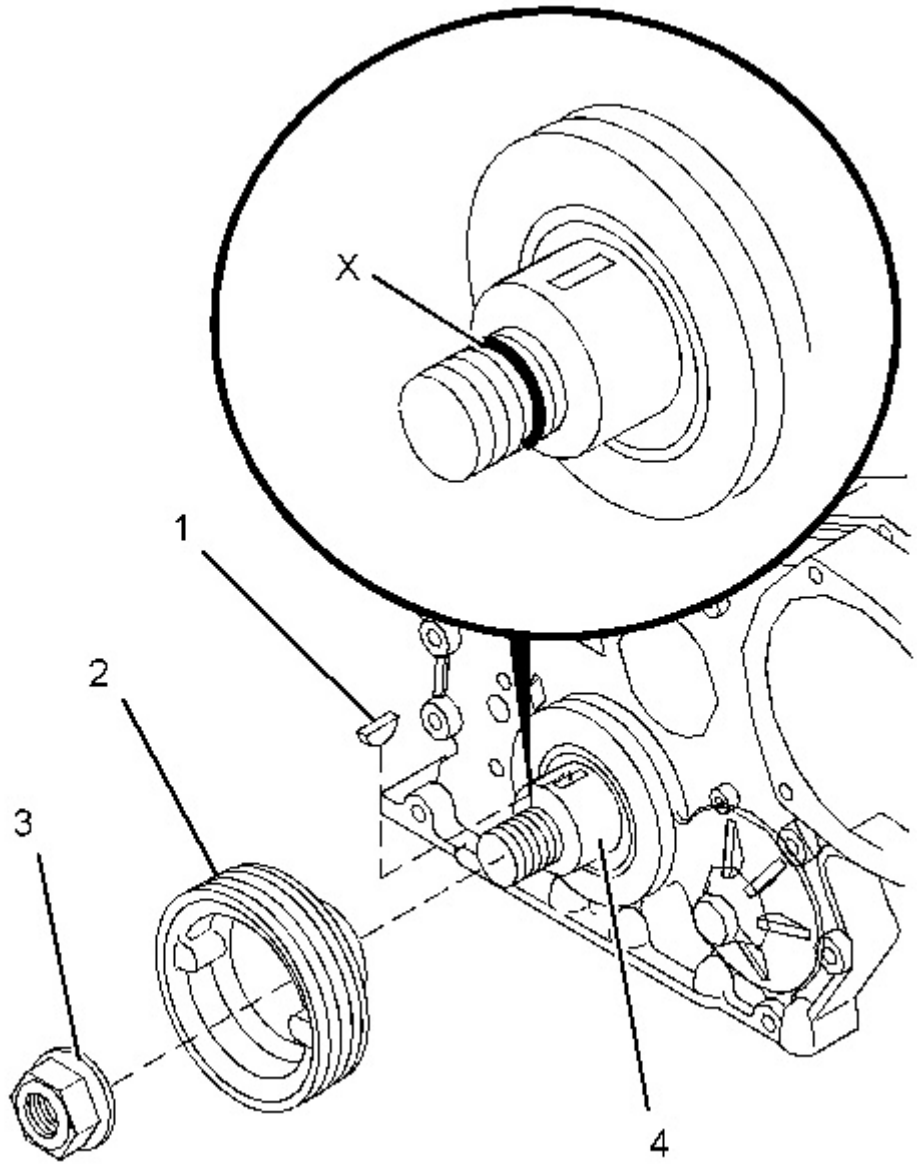


Illustration 3 g01368691

Typical example

1. Ensure that the threads of crankshaft (4) and nut (3) are clean and free from damage. If necessary, install woodruff key (1) to the crankshaft.
2. Apply a continuous bead of Tooling (C) around the threads of crankshaft (4) at position (X) approximately 10 mm (0.4 inch) from the shoulder of the crankshaft.
3. Install pulley (2) to crankshaft (4) .
4. Use a suitable method to prevent the crankshaft from rotating.
5. Install nut (3) . Tighten the nut to a torque of 490 N·m (361 lb ft).

End By: Install the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02506524

Belt Tension Chart

SMCS - 1357

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Note: Do not use the belt tension chart for belts with tensioners that are spring loaded.

Table 1

Belt Tension Chart		
Belt Type	**Deflection**	**Applied Force for Specified Deflection**
Type B	10 to 12 mm (0.4 to 0.6 inch)	98 N (22 lb)

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i02506524

Belt Tension Chart

SMCS - 1357

S/N - -

Note: Do not use the belt tension chart for belts with tensioners that are spring loaded.

Table 1

Belt Tension Chart		
Belt Type	**Deflection**	**Applied Force for Specified Deflection**
Type B	10 to 12 mm (0.4 to 0.6 inch)	98 N (22 lb)

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i02639315

V-Belts - Remove and Install

SMCS - 1357-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

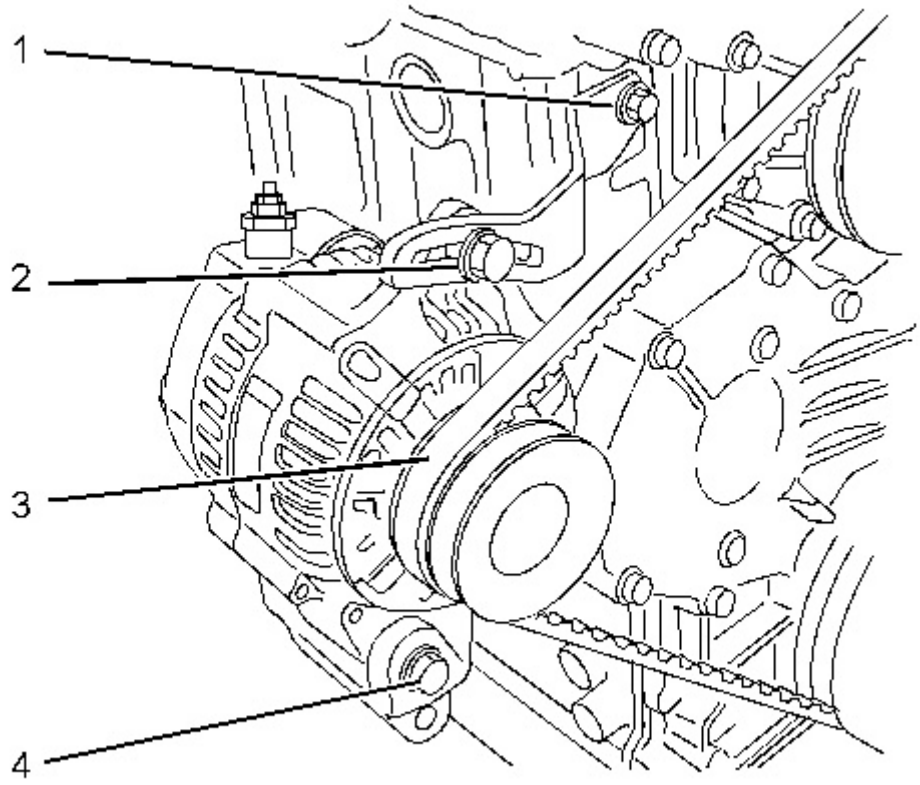


Illustration 1 g01343666

Typical example

1. Loosen bolts (1), (2) and (4). Slide the alternator toward the engine.
2. Remove V-belt (3) .

   Note: Mark the direction of rotation if the V-belt will be reused.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	144-0235	Belt Tension Gauge	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

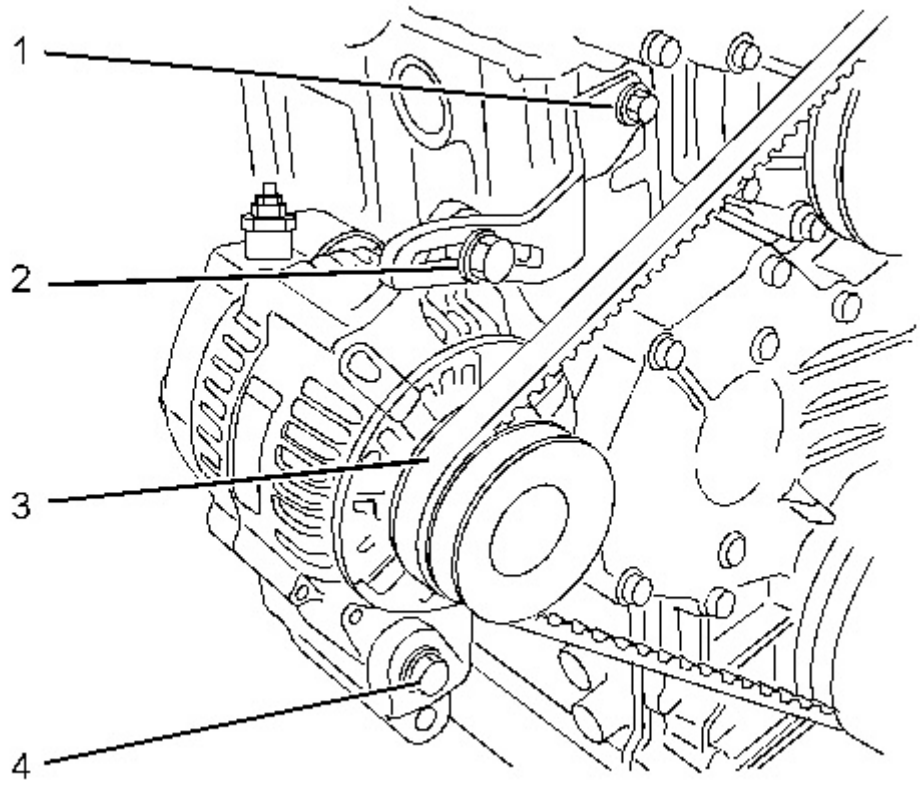


Illustration 2 g01343666

Typical example

1. Install V-belt (3) onto the pulleys.

   Note: A used V-belt should be installed in the original direction of rotation.

2. Adjust the tension of V-belt (3) by moving the alternator away from the engine. Use Tooling (A) in order to achieve the correct belt tension. Refer to Specifications, "Belt Tension Chart" for more information.

3. Tighten bolts (1), and (2) to a torque of 11 N·m (97 lb in). Tighten bolt (4), to a torque of 35 N·m (26 lb ft).

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01900860

Lifter Group

SMCS - 1209

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

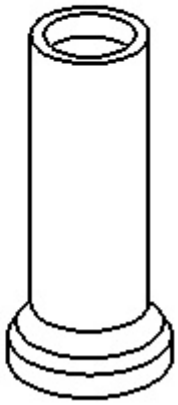


Illustration 1 g00988934

Clearance between the lifter and the bore in the engine for the lifter

Standard at assembly ... 0.016 to 0.052 mm (0.0006 to 0.0020 inch)
Repair limit ... 0.08 mm (0.0031 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02509437

Rocker Shaft

SMCS - 1102

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Group	1
B	-	V Block	2

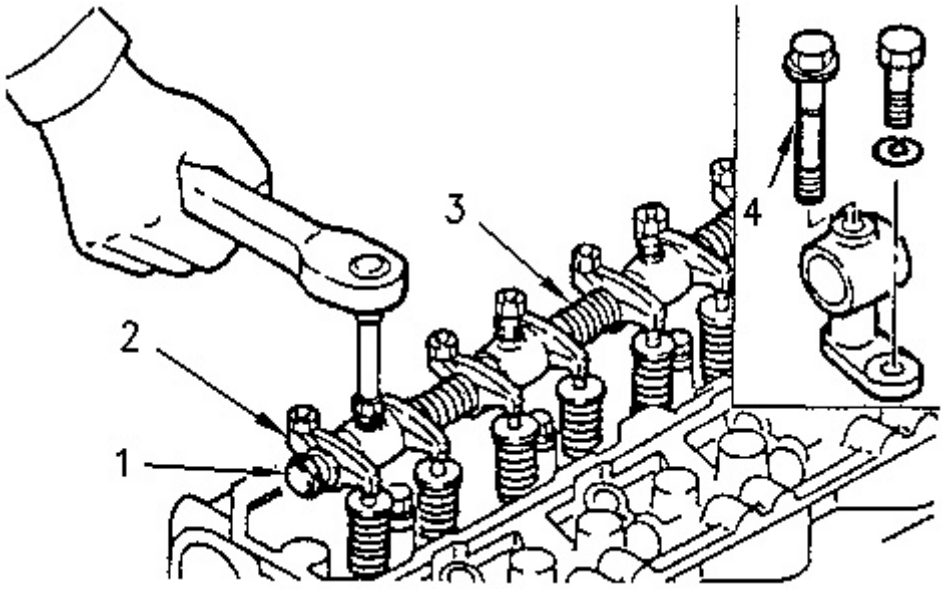


Illustration 1 g00984738

(1) Rocker shaft

Diameter of the rocker shaft ... 18.980 to 19.000 mm (0.7472 to 0.7480 inch)

(2) Rocker arm

Inside diameter of the rocker arm bushings ... 19.010 to 19.030 mm (0.7484 to 0.7492 inch)
Clearance between the rocker arm bushing and the rocker shaft ... 0.010 to 0.050 mm (0.0004 to 0.0020 inch)
Maximum permissible clearance between the rocker arm bushing and the rocker shaft ... 0.070 mm (0.0028 inch)

(3) Spring

(4) Tighten the bolts evenly. Tighten the long bolt first. Tighten the bolts to the following torque. ... 10 to 20 N·m (7 to 15 lb ft)

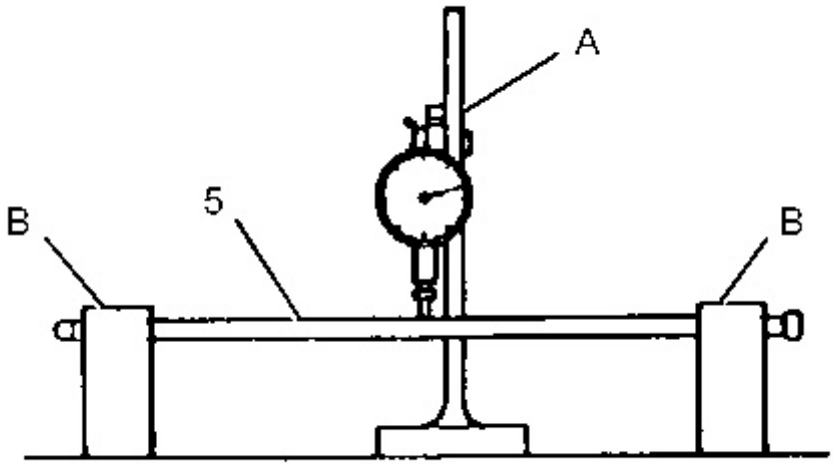


Illustration 2 g01256167

(5) Pushrods

Place the pushrod in Tooling (B). Use Tooling (A) in order to check all pushrods for runout. Replace the pushrod if the runout exceeds the following value. ... 0.30 mm (0.0118 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01892068

Valve Mechanism Cover

SMCS - 1107

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

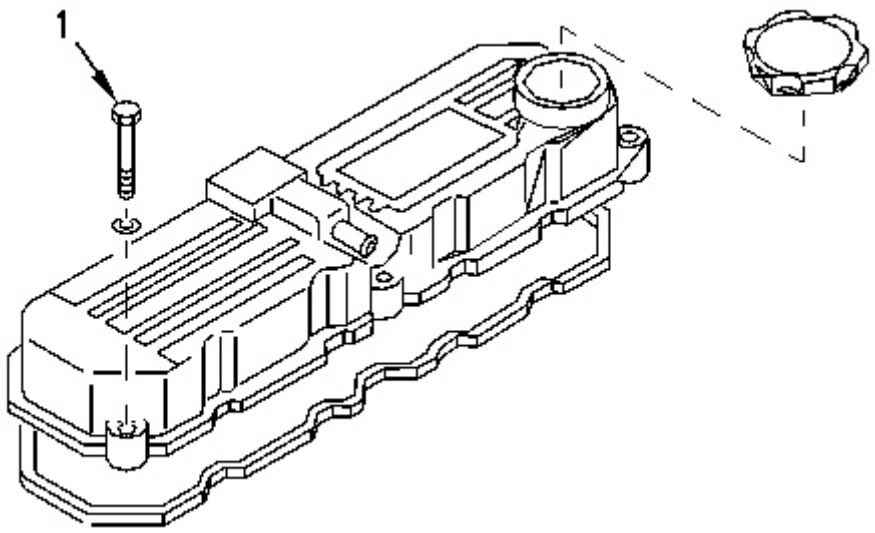


Illustration 1 g00984870

(1) Tighten the bolts for the valve mechanism cover to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01900860

Lifter Group

SMCS - 1209

S/N - -

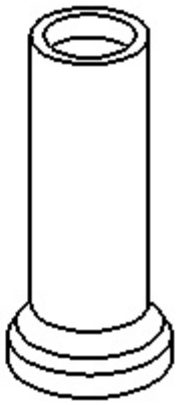


Illustration 1 g00988934

Clearance between the lifter and the bore in the engine for the lifter

Standard at assembly ... 0.016 to 0.052 mm (0.0006 to 0.0020 inch)
Repair limit ... 0.08 mm (0.0031 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02509437

Rocker Shaft

SMCS - 1102

S/N - -

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-5096	Dial Indicator Group	1
B	-	V Block	2

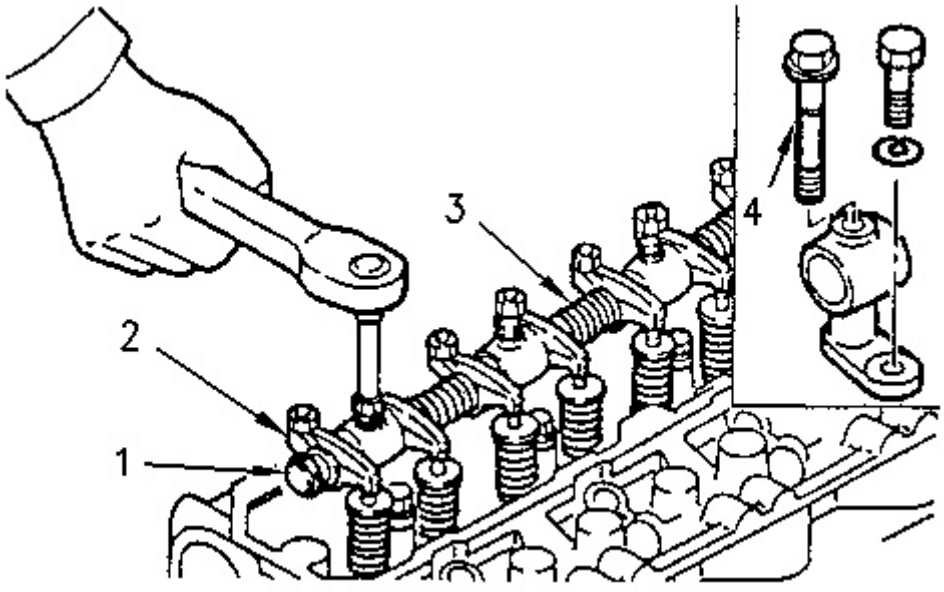


Illustration 1 g00984738

(1) Rocker shaft

Diameter of the rocker shaft ... 18.980 to 19.000 mm (0.7472 to 0.7480 inch)

(2) Rocker arm

Inside diameter of the rocker arm bushings ... 19.010 to 19.030 mm (0.7484 to 0.7492 inch)
Clearance between the rocker arm bushing and the rocker shaft ... 0.010 to 0.050 mm (0.0004 to 0.0020 inch)
Maximum permissible clearance between the rocker arm bushing and the rocker shaft ... 0.070 mm (0.0028 inch)

(3) Spring

(4) Tighten the bolts evenly. Tighten the long bolt first. Tighten the bolts to the following torque. ... 10 to 20 N·m (7 to 15 lb ft)

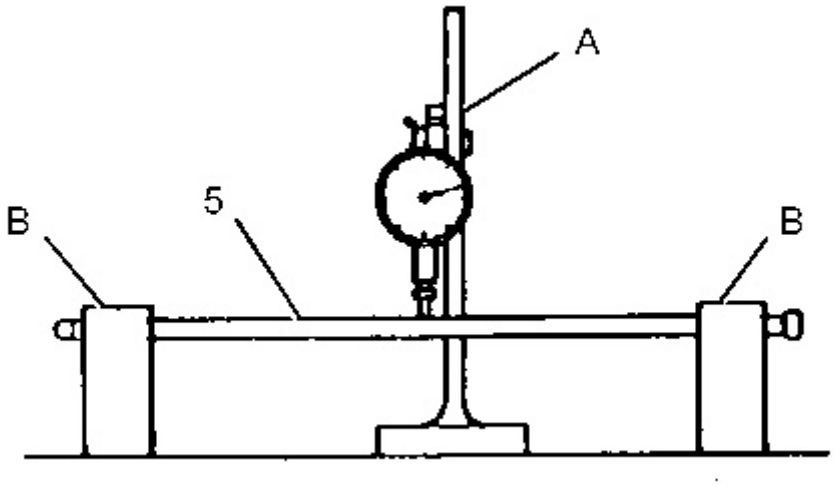


Illustration 2 g01256167

(5) Pushrods

Place the pushrod in Tooling (B). Use Tooling (A) in order to check all pushrods for runout. Replace the pushrod if the runout exceeds the following value. ... 0.30 mm (0.0118 inch)

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Specifications

C3.4 Engines for Caterpillar Built Machines

Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01892068

Valve Mechanism Cover

SMCS - 1107

S/N - -

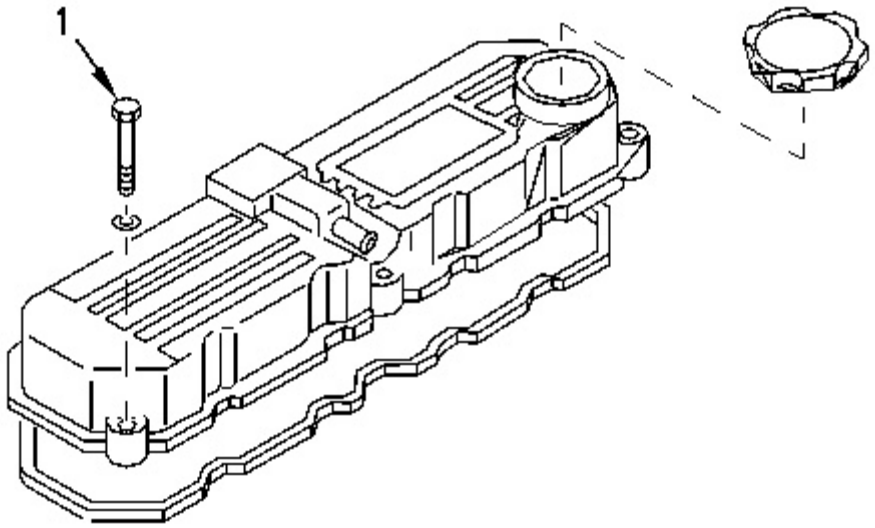


Illustration 1 g00984870

(1) Tighten the bolts for the valve mechanism cover to the following torque. ... 10 to 13 N·m (7 to 10 lb ft)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02003323

Valve Mechanism Cover - Remove and Install

SMCS - 1107-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

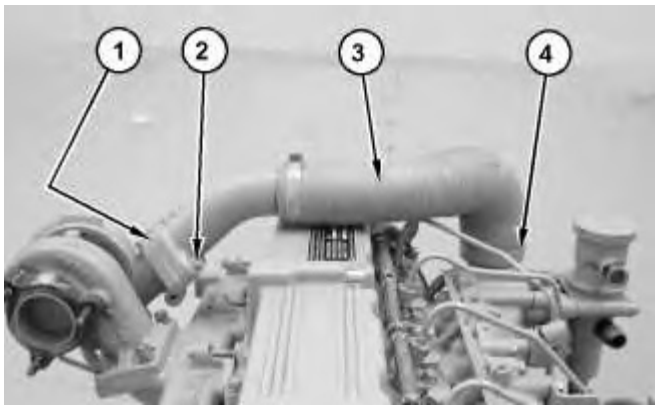


Illustration 1 g01036032

1. Loosen clamp (4). Remove bolts (2). Remove the tube and hose (3), and remove gasket (1) .

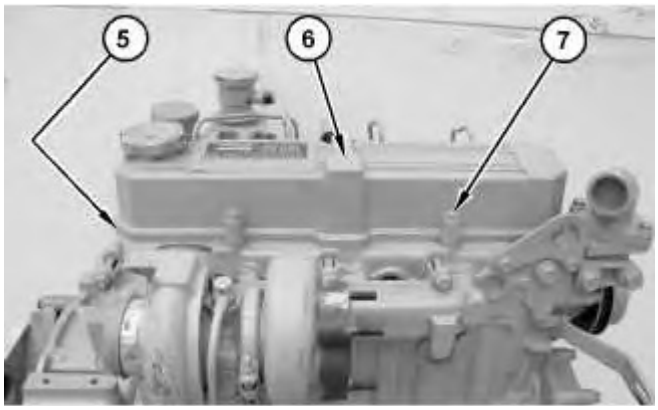


Illustration 2 g01036036

2. Remove bolts (7). Remove valve mechanism cover (6) and gasket (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

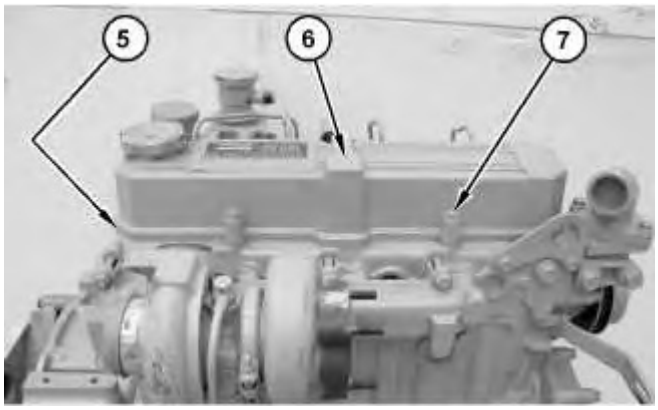


Illustration 3 g01036036

1. Install gasket (5) and position valve mechanism cover (6). Install bolts (7) and tighten to a torque of 10 to 13 N·m (90 to 115 lb in).

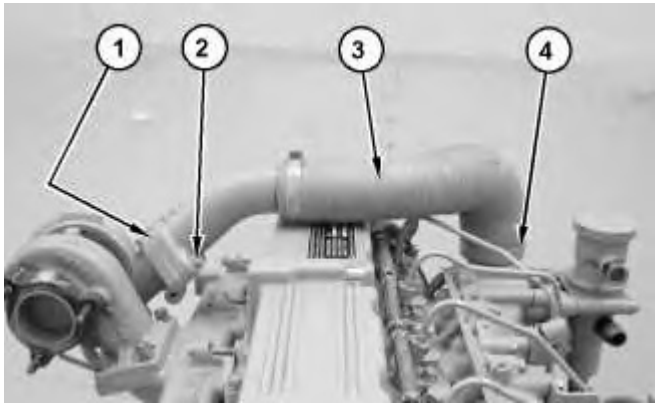


Illustration 4 g01036032

2. Install gasket (1) and position the tube and hose (3). Install bolts (2) and tighten clamp (4) .

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i02000449

Rocker Shaft and Pushrod - Remove

SMCS - 1102-011; 1208-011

Removal Procedure

Start By:

A. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

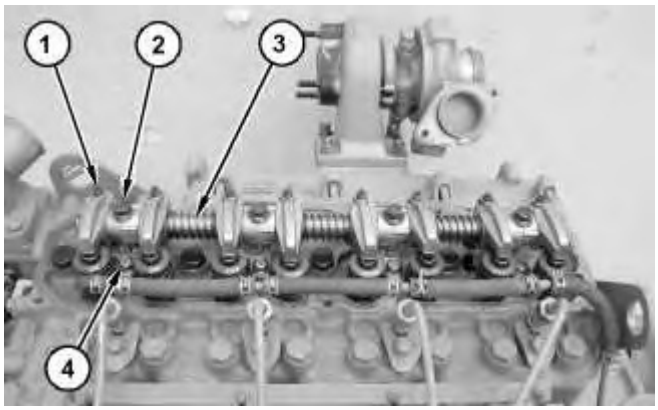


Illustration 1 g01035049

1. Loosen each nut and adjustment screw (1) by one rotation.

2. Remove bolts (4) .
3. Remove bolts (2) .
4. Remove rocker shaft assembly (3) .



Illustration 2 g01035051

5. Remove pushrods (5) .

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i02000461

Rocker Shaft - Disassemble

SMCS - 1102-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

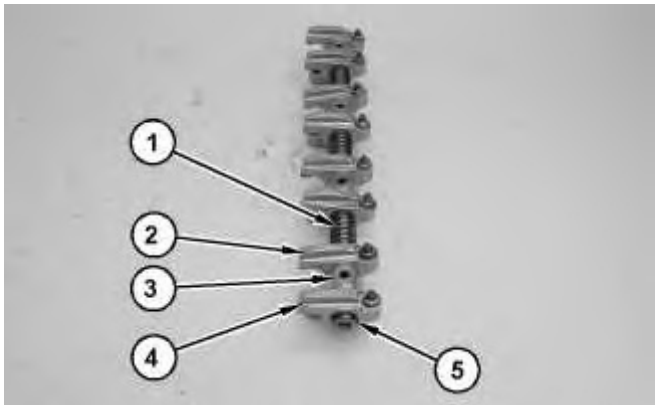


Illustration 1 g01035060

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Use Tooling (A) to remove retaining rings (5) .
2. Place an identification mark on each of the components for installation purposes.
3. Remove rocker arm assembly (4) .
4. Remove bracket (3) .
5. Remove rocker arm assembly (2) .
6. Remove spring (1) .
7. Repeat Steps 3 through 6 in order to completely disassemble the rocker shaft assembly.

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i02000483

Rocker Shaft - Assemble

SMCS - 1102-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

Note: Ensure that all of the oil holes in the rocker shaft and in the rocker arms are not plugged before you begin the assembly procedure.

1. Lubricate all of the components with clean engine oil before assembly.

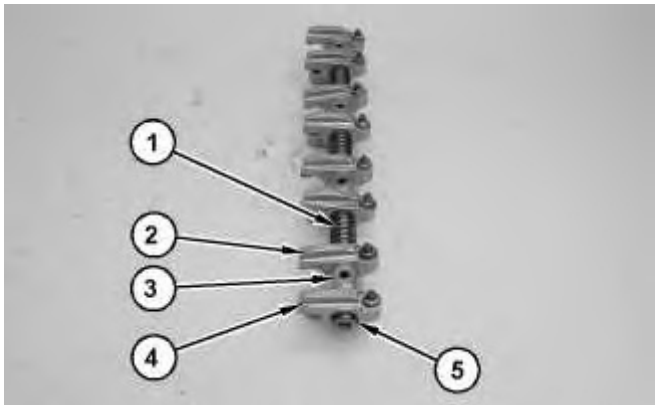


Illustration 1 g01035060

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

2. Install spring (1) .
3. Install rocker arm assembly (2) .
4. Install bracket (3) .
5. Install rocker arm assembly (4) .
6. Repeat Steps 2 through 5 in order to assemble the rocker shaft assembly.
7. Use Tooling (A) to install retaining rings (5) .

End By: Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i04520110

Rocker Shaft and Pushrod - Install

SMCS - 1102-012; 1208-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01035051

1. Install pushrods (5) .

   Note: Ensure that the pushrods are installed in the original location and that the pushrods are seated in the valve lifters correctly.

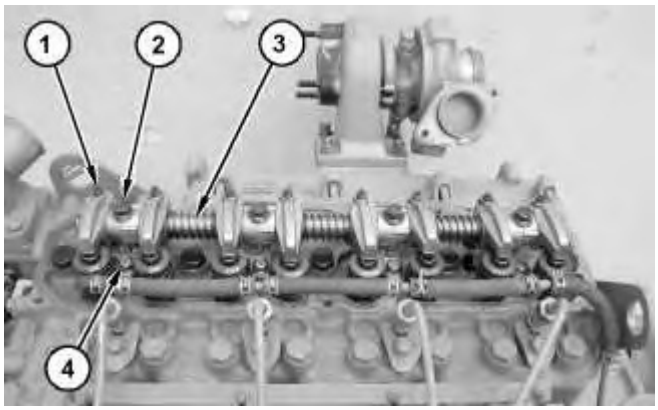


Illustration 2 g01035049

2. Loosen the nut and adjustment screw (1) on each rocker arm to prevent bending a valve or a pushrod during the installation.
3. Position rocker shaft assembly (3) .
4. Install bolts (2) and tighten to a torque of 10 to 20 N·m (89 to 177 lb in).
5. Install bolts (4) and tighten to a torque of 10 to 20 N·m (89 to 177 lb in).
6. Final torque for the nut on adjustment screw (1) is 20 N·m (177 lb in)
7. Adjust the inlet valve lash and the exhaust valve lash to 0.250 mm (0.0098 inch). Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".

End By: Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01998877

Lifter Group - Remove and Install

SMCS - 1209-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

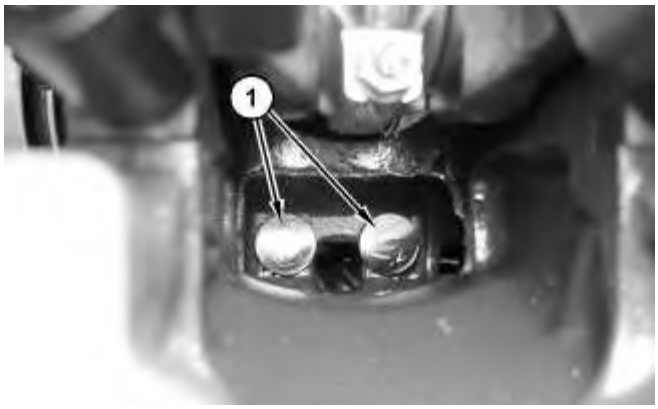


Illustration 1 g01034177

1. Use Tooling (A) to remove lifters (1) .

   Note: Place an identification mark on the lifters for installation purposes.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the lifters with clean engine oil before installing the lifters in the cylinder block.

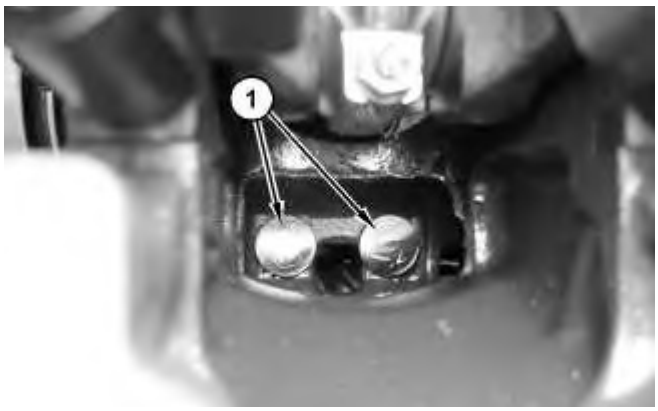


Illustration 2 g01034177

2. Use Tooling (A) to install lifters (1) .

   Note: Ensure that the lifters are installed in the original location and that the lifters are seated correctly.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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i02003323

Valve Mechanism Cover - Remove and Install

SMCS - 1107-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

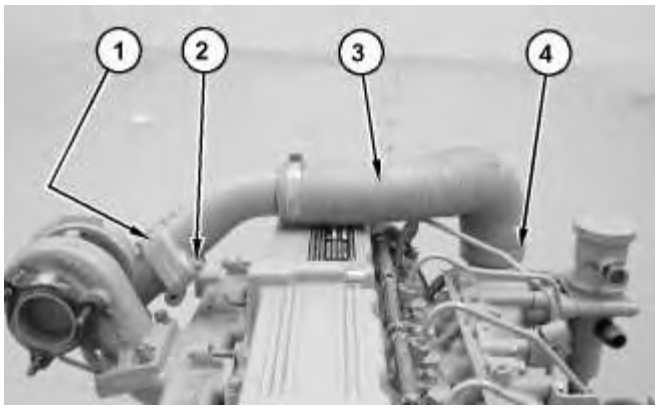


Illustration 1 g01036032

1. Loosen clamp (4). Remove bolts (2). Remove the tube and hose (3), and remove gasket (1) .

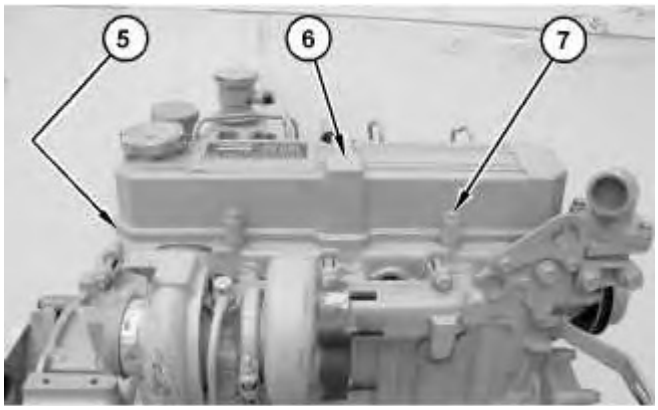


Illustration 2 g01036036

2. Remove bolts (7). Remove valve mechanism cover (6) and gasket (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

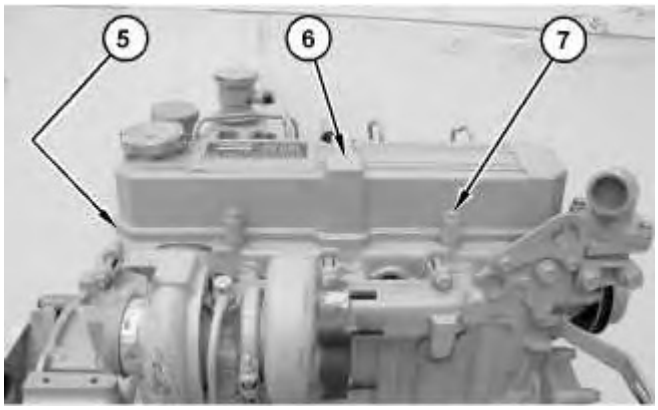


Illustration 3 g01036036

1. Install gasket (5) and position valve mechanism cover (6). Install bolts (7) and tighten to a torque of 10 to 13 N·m (90 to 115 lb in).

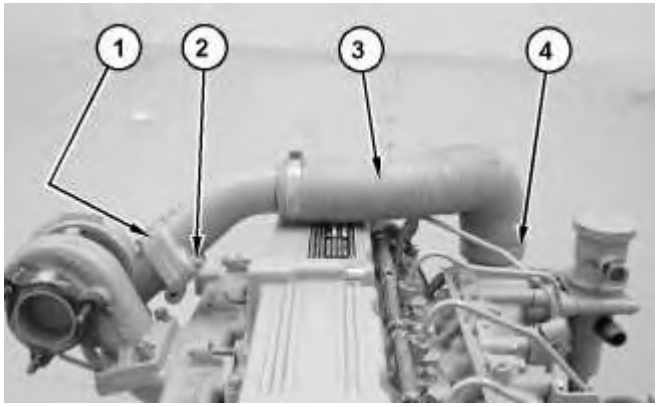


Illustration 4 g01036032

2. Install gasket (1) and position the tube and hose (3). Install bolts (2) and tighten clamp (4) .

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i02000449

Rocker Shaft and Pushrod - Remove

SMCS - 1102-011; 1208-011

Removal Procedure

Start By:

A. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

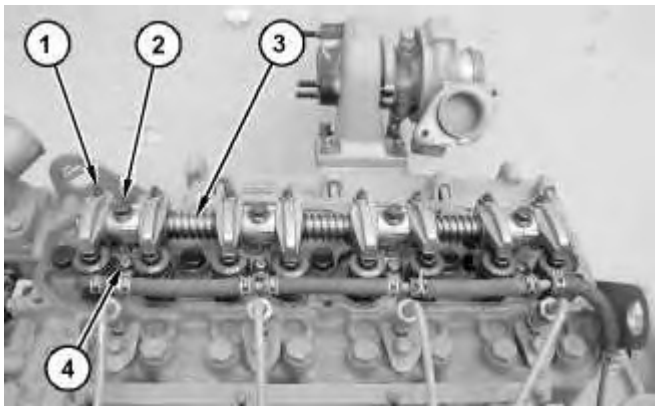


Illustration 1 g01035049

1. Loosen each nut and adjustment screw (1) by one rotation.

2. Remove bolts (4) .
3. Remove bolts (2) .
4. Remove rocker shaft assembly (3) .



Illustration 2 g01035051

5. Remove pushrods (5) .

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i02000461

Rocker Shaft - Disassemble

SMCS - 1102-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

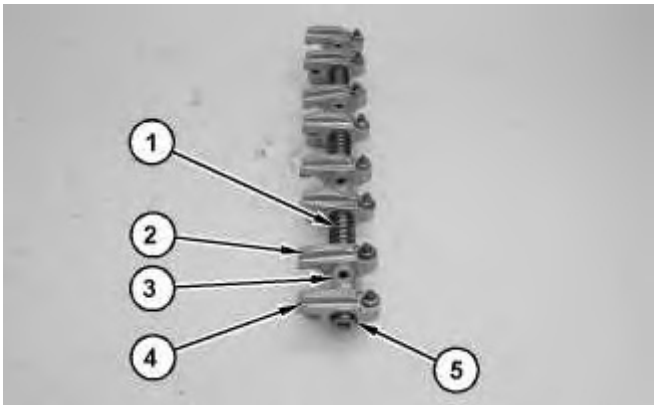


Illustration 1 g01035060

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Use Tooling (A) to remove retaining rings (5) .
2. Place an identification mark on each of the components for installation purposes.
3. Remove rocker arm assembly (4) .
4. Remove bracket (3) .
5. Remove rocker arm assembly (2) .
6. Remove spring (1) .
7. Repeat Steps 3 through 6 in order to completely disassemble the rocker shaft assembly.

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i02000483

Rocker Shaft - Assemble

SMCS - 1102-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

Note: Ensure that all of the oil holes in the rocker shaft and in the rocker arms are not plugged before you begin the assembly procedure.

1. Lubricate all of the components with clean engine oil before assembly.

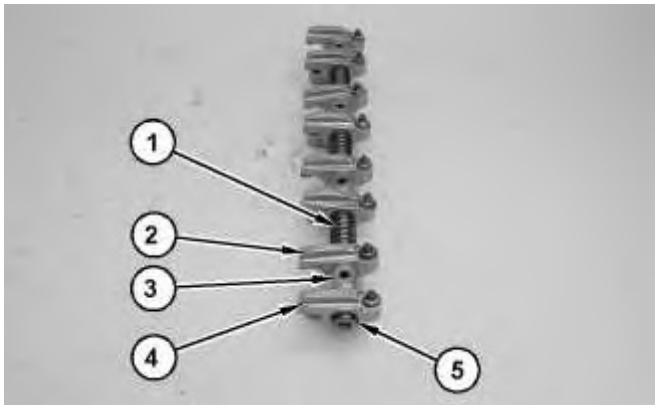


Illustration 1 g01035060

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

2. Install spring (1) .
3. Install rocker arm assembly (2) .
4. Install bracket (3) .
5. Install rocker arm assembly (4) .
6. Repeat Steps 2 through 5 in order to assemble the rocker shaft assembly.
7. Use Tooling (A) to install retaining rings (5) .

End By: Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i04520110

Rocker Shaft and Pushrod - Install

SMCS - 1102-012; 1208-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01035051

1. Install pushrods (5) .

   Note: Ensure that the pushrods are installed in the original location and that the pushrods are seated in the valve lifters correctly.

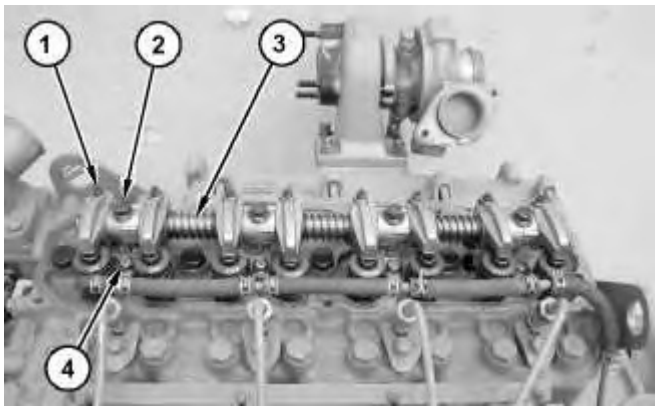


Illustration 2 g01035049

2. Loosen the nut and adjustment screw (1) on each rocker arm to prevent bending a valve or a pushrod during the installation.
3. Position rocker shaft assembly (3) .
4. Install bolts (2) and tighten to a torque of 10 to 20 N·m (89 to 177 lb in).
5. Install bolts (4) and tighten to a torque of 10 to 20 N·m (89 to 177 lb in).
6. Final torque for the nut on adjustment screw (1) is 20 N·m (177 lb in)
7. Adjust the inlet valve lash and the exhaust valve lash to 0.250 mm (0.0098 inch). Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".

End By: Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

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i01998877

Lifter Group - Remove and Install

SMCS - 1209-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

Start By:

A. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

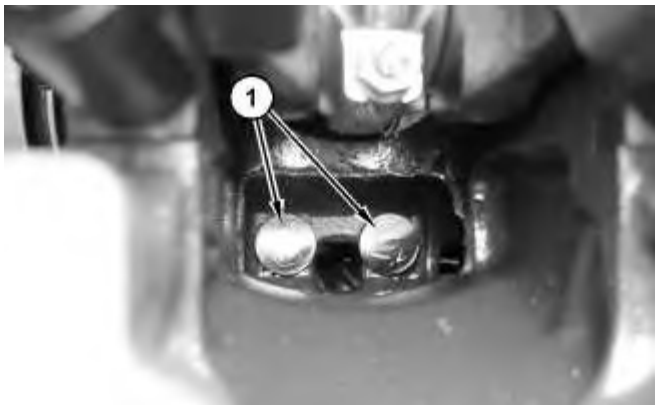


Illustration 1 g01034177

1. Use Tooling (A) to remove lifters (1) .

   Note: Place an identification mark on the lifters for installation purposes.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Lubricate the lifters with clean engine oil before installing the lifters in the cylinder block.

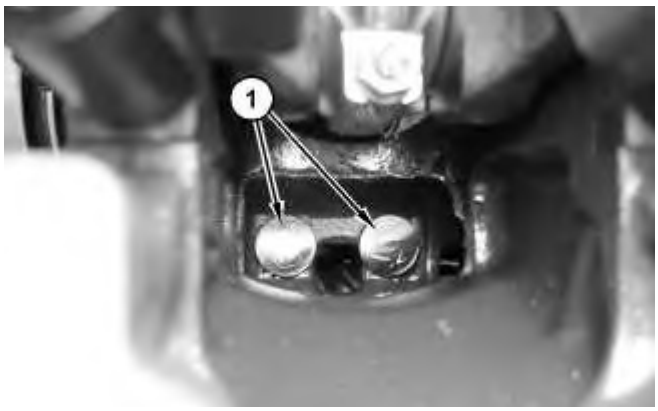


Illustration 2 g01034177

2. Use Tooling (A) to install lifters (1) .

   Note: Ensure that the lifters are installed in the original location and that the lifters are seated correctly.

End By: Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639285

Valve Mechanism Cover - Remove and Install

SMCS - 1107-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

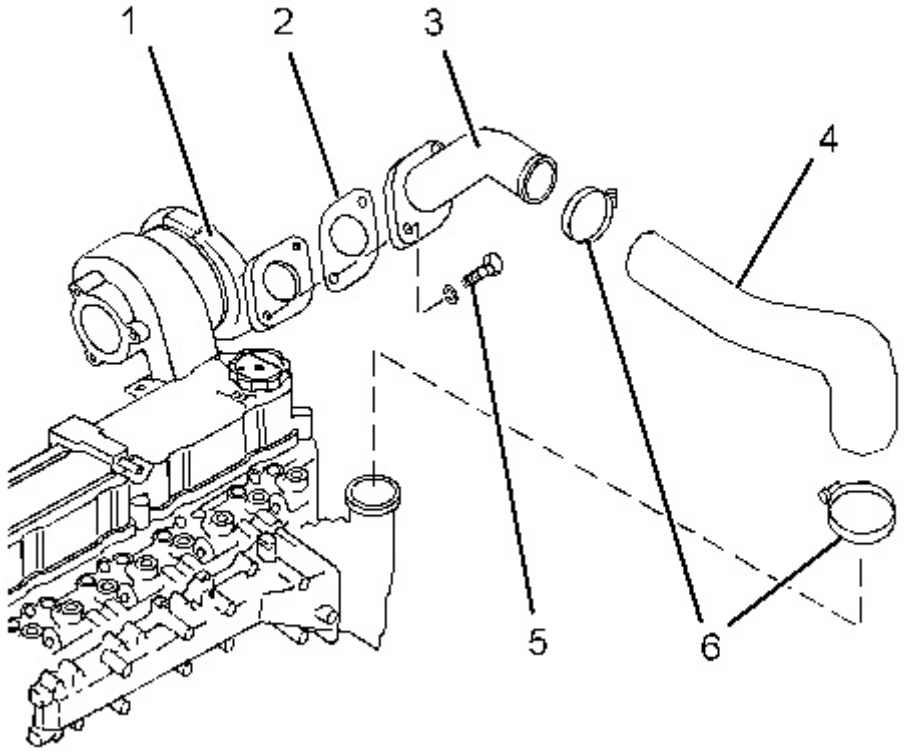


Illustration 1 g01336694

Typical example

1. If the engine is equipped with a turbocharger, follow Steps 1.a through 1.c in order to remove the air pipe.
    a. Loosen hose clamps (6) and remove hose (4) .
    b. Remove bolts (5) and remove air pipe (3) from turbocharger (1). Remove gasket (2) .
    c. Plug the opening in the inlet manifold and the opening in the turbocharger with suitable plugs.

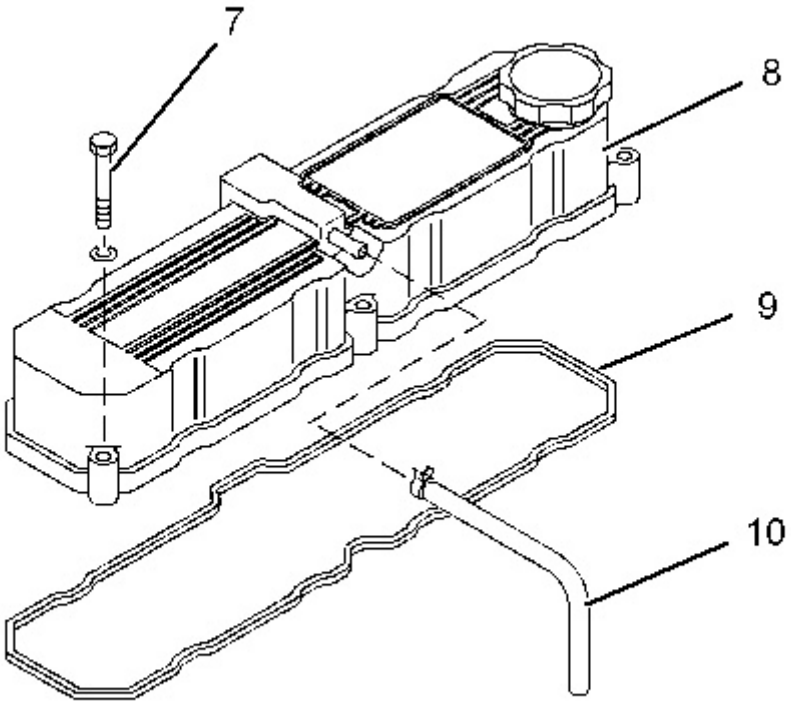


Illustration 2 g01345049

2. Loosen the hose clamp and disconnect hose (10) from valve mechanism cover (8) .
3. Remove bolts (7). Remove valve mechanism cover (8) from the cylinder head.
4. Remove seal (9) from valve mechanism cover (8) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Thoroughly clean the valve mechanism cover. Clean the mating surfaces of the cylinder head.

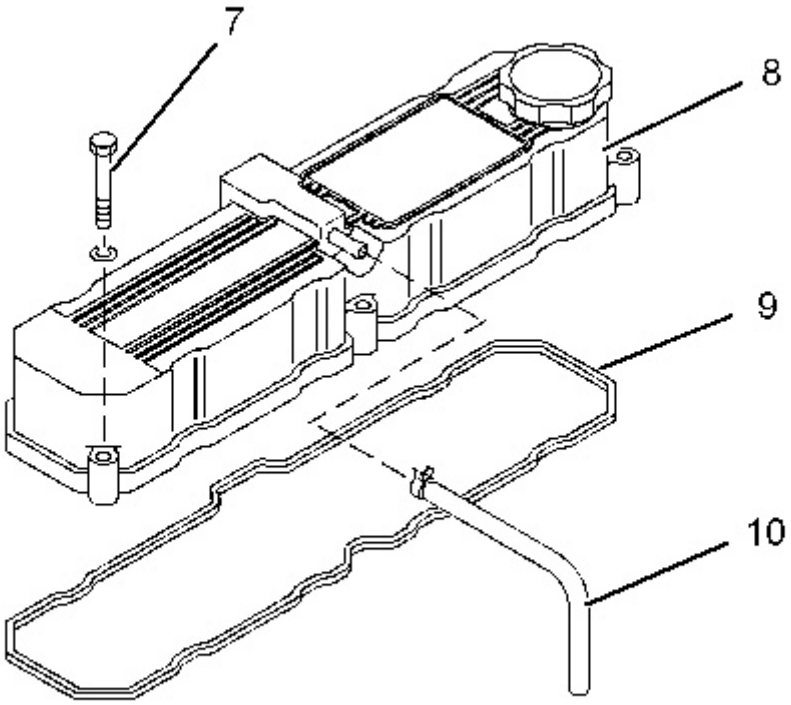


Illustration 3 g01345049

2. Install a new seal (9) to valve mechanism cover (8) .

   Note: Ensure that the joint is fully seated into the groove of the valve mechanism cover.

3. Place valve mechanism cover (8) in position on the cylinder head.
4. Install bolts (7). Tighten the bolts to a torque of 12 N·m (106 lb in).
5. Connect hose (10) to valve mechanism cover (8) and tighten the hose clamp.

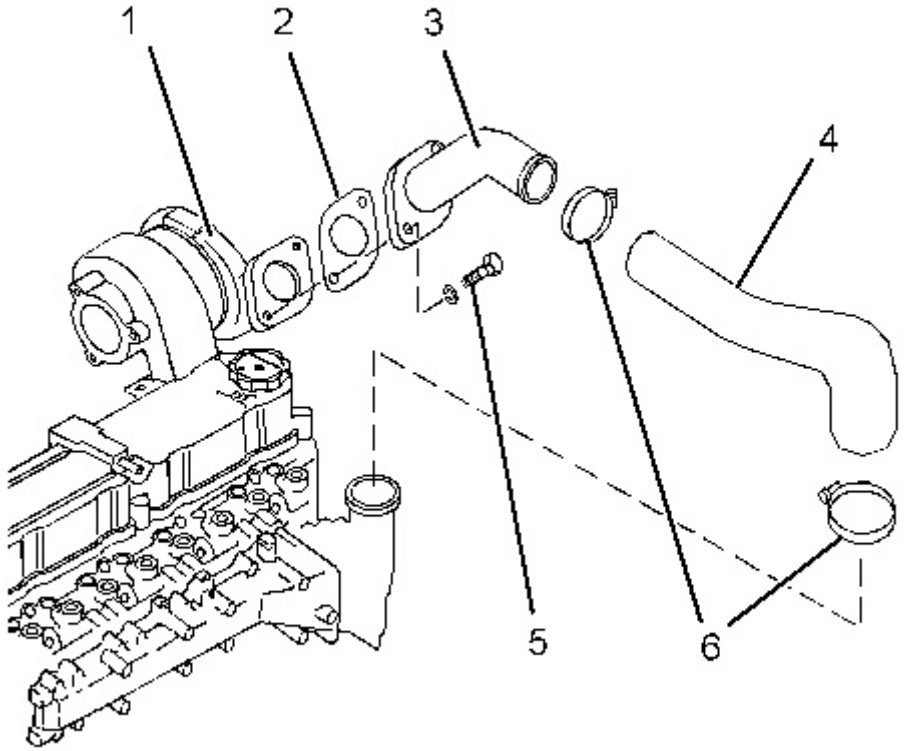


Illustration 4 g01336694

Typical example

6. If the engine is equipped with a turbocharger, follow Steps 6.a through 6.c in order to install the air pipe.

   a. Remove the plugs from the inlet manifold and from the turbocharger.

   b. Position a new joint (2) and air pipe (3) onto turbocharger (1). Install bolts (5). Tighten the bolts to a torque of 18 N·m (13 lb ft).

   c. Install hose (4) and tighten hose clamps (6) securely.

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i02639290

Rocker Shaft and Pushrod - Remove

SMCS - 1102-011; 1208-011

Removal Procedure

Start By:

A. Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

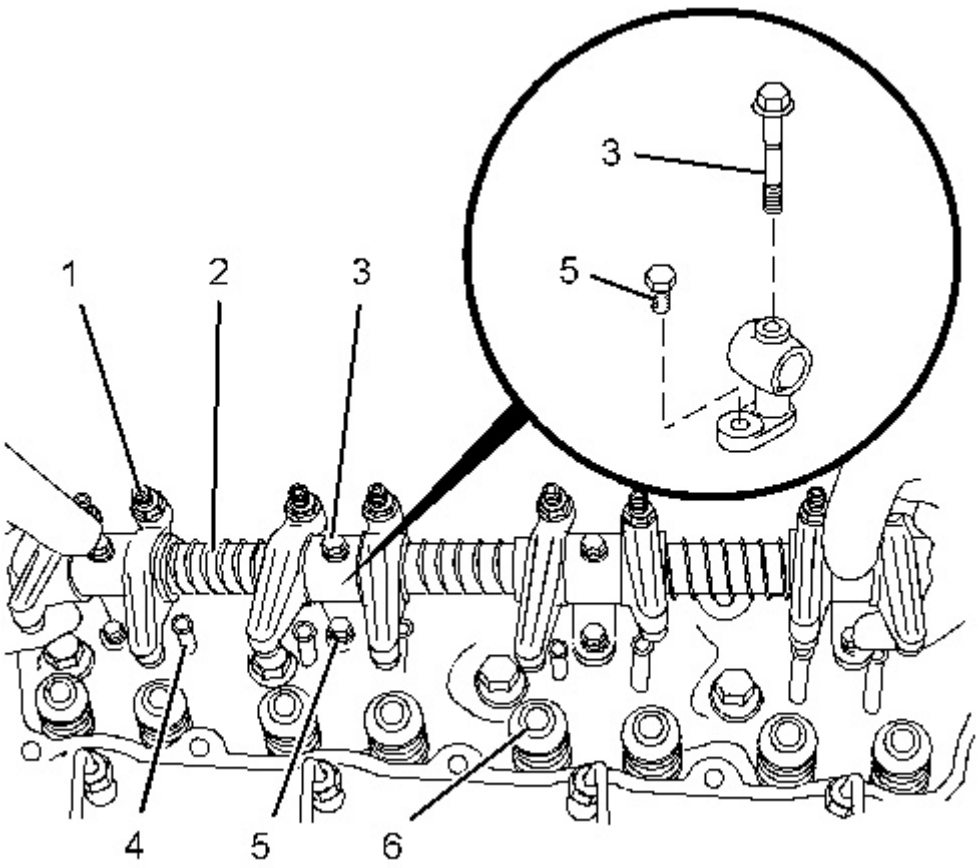


Illustration 1 g01345395

Typical example

1. Loosen the nuts and adjustment screws (1) on all rocker arms.
2. Remove bolts (5) .
3. Progressively loosen bolts (3). Begin at the ends of the rocker shaft assembly and work toward the center.

   Note: Damage to the rocker shaft may occur if the long bolts are loosened first. To avoid distortion of the rocker shaft assembly, each bolt should be loosened by a quarter of a turn at one time. Repeat the procedure until all bolts are loosened.
4. Remove bolts (3) .
5. Remove rocker shaft assembly (2) from the cylinder head.
6. Place temporary identification marks on pushrods (4) and pads (6) .

   Note: Identification will ensure that the pushrods and pads can be reinstalled in the correct position. Do not interchange the positions of used pushrods or pads.
7. Remove pushrods (4) from the cylinder head. Remove pads (6) from the valve stems.

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i02639287

Rocker Shaft - Disassemble

SMCS - 1102-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

Start By:

A. Remove the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Remove".

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

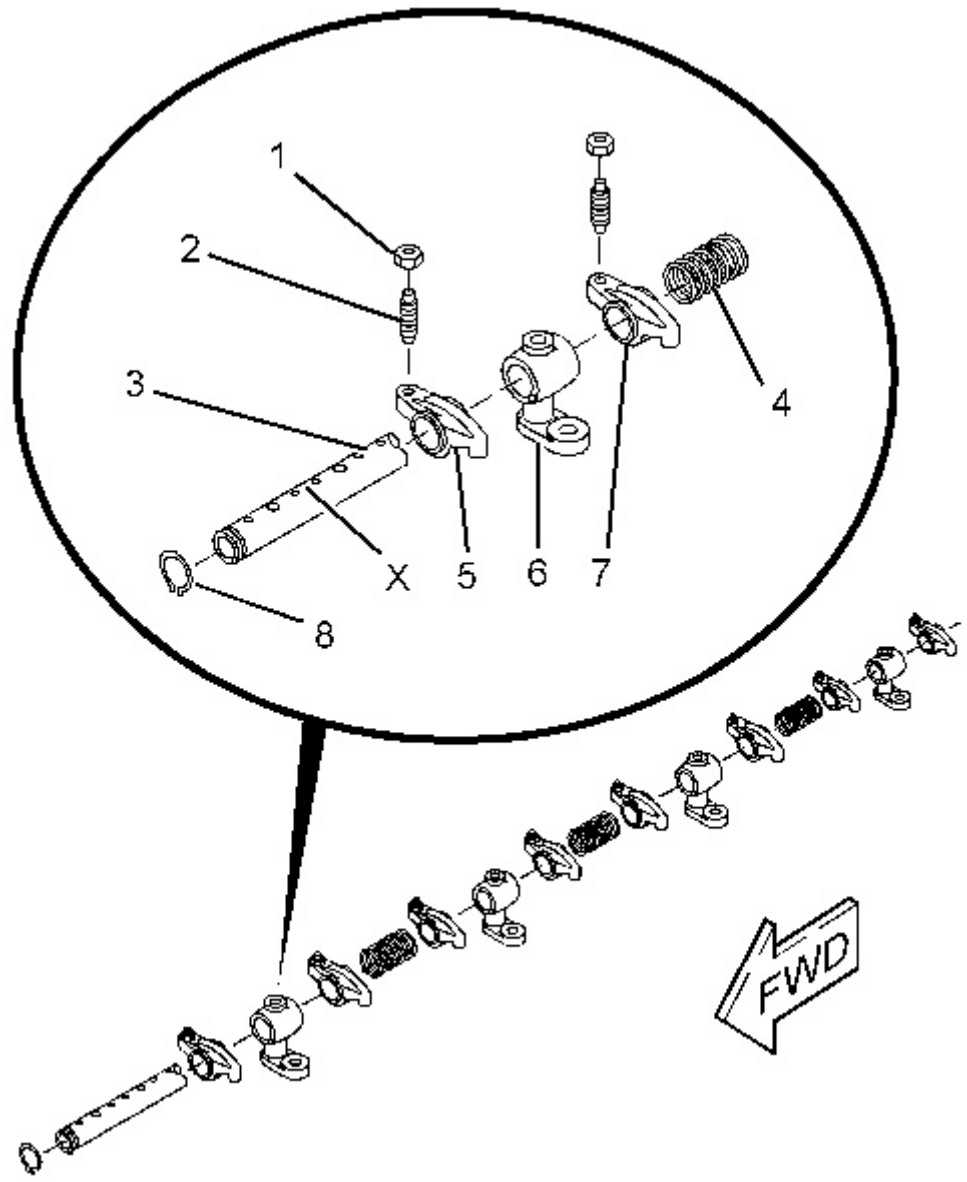


Illustration 1 g01345402

1. Make an identification mark on each rocker arm assembly in order to show the location. Note the mark at position (X) for installation purposes.

   Note: The components must be reinstalled in the original location. Do not interchange components.

2. Use Tooling (A) to remove retaining rings (8) .

3. Remove rocker arm assembly (5) .

4. Remove pedestal (6) from rocker shaft (3) .

5. Remove rocker arm assembly (7) .
6. Remove spring (4) .
7. Repeat Steps 3 through 6 in order to remove the remaining rocker arm assemblies from rocker shaft (3) .
8. If necessary, remove nuts (1) and adjusters (2) from the rocker arms. Make a temporary identification mark on each adjuster in order to show the location.

   Note: The components must be reinstalled in the original location. Do not interchange components.

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i02639289

Rocker Shaft - Assemble

SMCS - 1102-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1855	Retaining Ring Pliers	1

1. Ensure that all components are clean and free from wear or damage. Refer to Specifications, "Rocker Shaft" for more information. If necessary, replace any components that are worn or damaged.

   Note: Ensure that all oil holes are free from blockages.

2. Lubricate all of the components with clean engine oil before assembly.

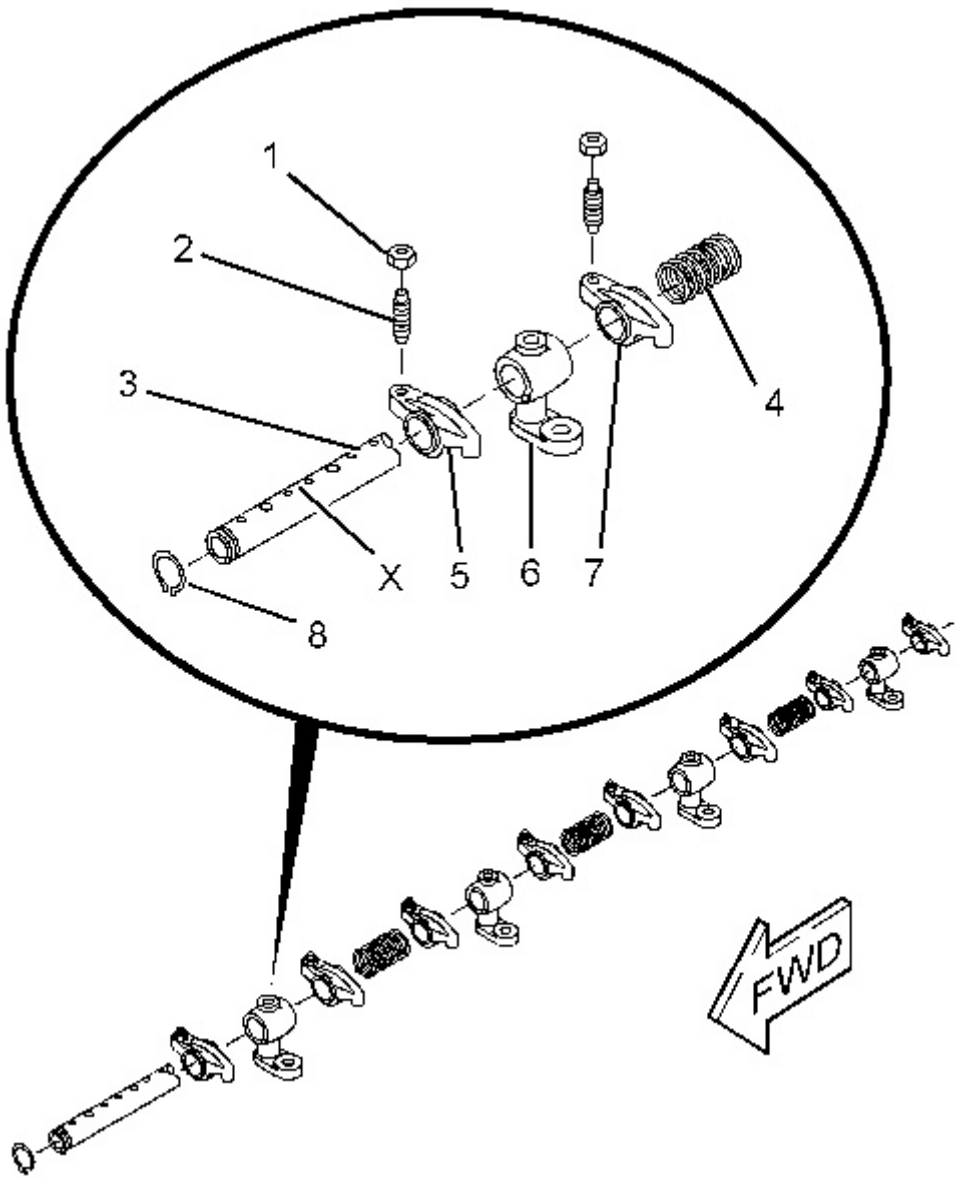


Illustration 1 g01345402

3. If necessary, install nuts (1) and adjusters (2) to rocker arm assemblies (5) and (7). If the original adjusters are reused, ensure that the adjusters are installed in the original positions.

4. Use Tooling (A) to install retaining ring (8) to the front end of rocker shaft (3). The front end of the rockershaft is identified by the mark at Position (X). Ensure that the mark at position (X) is upward.

5. Install rocker arm assembly (5) to rocker shaft (3) .

6. Install bracket (6) to rocker shaft (3) .

   Note: Ensure correct orientation of the bracket. Refer to Illustration 1.

7. Install rocker arm assembly (7) to rocker shaft (3) .

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

8. Install spring (4) to rocker shaft (3) .
9. Repeat Steps 5 through 8 in order to assemble the remaining components of the rocker shaft assembly.
10. Use Tooling (A) to install retaining ring (8) to the rear end of rocker shaft (3) .

End By: Install the rocker shaft and pushrods. Refer to Disassembly and Assembly, "Rocker Shaft and Pushrod - Install".

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i02639286

Rocker Shaft and Pushrod - Install

SMCS - 1102-012; 1208-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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1. Ensure that all components are clean and free from wear or damage. Refer to Specifications, "Rocker Shaft" for more information. Replace any components that are worn or damaged.

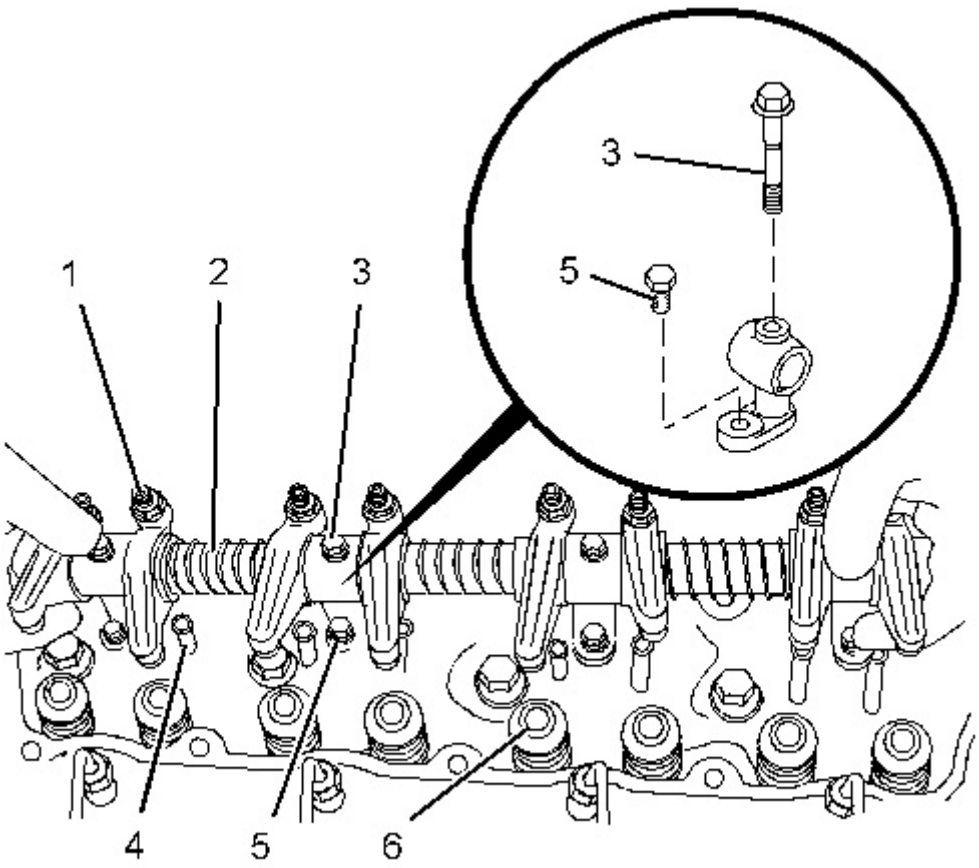


Illustration 1 g01345395

Typical example

2. Apply clean engine lubricating oil to both ends of pushrods (4). Install the pushrods to the engine with the cup upward. Ensure that the pushrods are installed correctly in the socket of the valve lifters.

   Note: If the pushrods have been used, ensure that the pushrods are installed in original positions.

3. Lubricate the top of the valve stems with clean engine oil. Install caps (6) to the valve stems.

   Note: If the caps have been used, ensure that the caps are installed in original positions.

4. Install rocker shaft (2) to the cylinder head.

   Note: Ensure that the ends of adjustment screws (1) are correctly seated in ends of pushrods (4). Also ensure that valve caps (6) are in position under the rocker arms.

5. Install bolts (3) to the rocker shaft. Tighten the bolts to a torque of 15 N·m (11 lb ft). Begin at the center of the rocker shaft assembly and work outward.

   Note: Damage to the rockershaft may occur if the short bolts are tightened first.

6. Install bolts (5) to the rocker shaft. Tighten the bolts to a torque of 15 N·m (11 lb ft).

7. Adjust the valve lash. Refer to Systems Operation, Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust" for the correct procedure.

End By: Install the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install".

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i02639293

Lifter Group - Remove and Install

SMCS - 1209-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

Start By:

A. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove". If the engine is not equipped with a balancer, remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

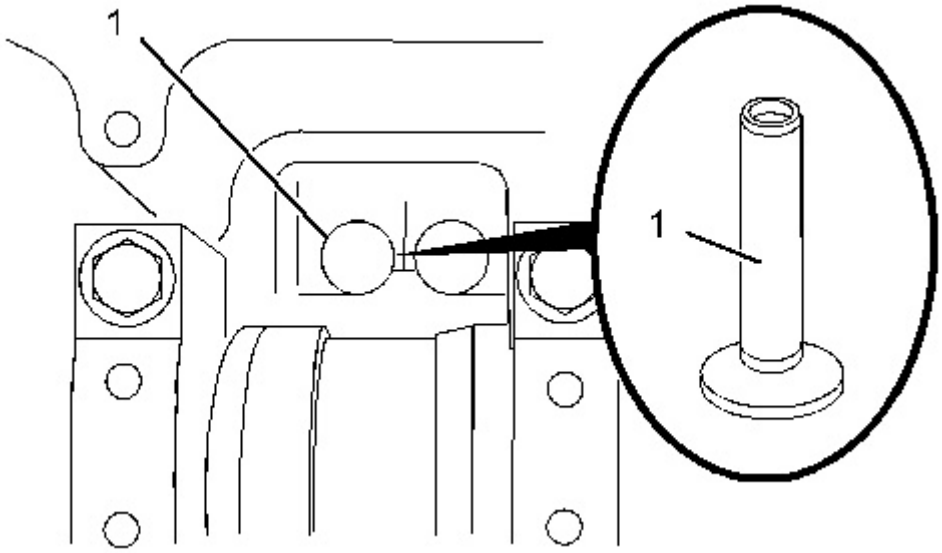


Illustration 1 g01343537

Typical example

1. If the crankshaft is installed, rotate the crankshaft in order to gain access to lifters (1) .
2. Use Tooling (A) to remove lifters (1) .

   Note: Make a temporary identification mark on each lifter in order to identify the correct location.
3. Repeat Steps 1 and 2 in order to remove the remaining lifters.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

It is strongly recommended that all lifters should be replaced when a new camshaft is installed.

1. Clean the lifters. Follow Steps 1.a through 1.c in order to inspect the lifters. Replace lifters that are worn or damaged.
   a. Inspect the seat of the pushrod in the lifter for visual wear or damage.
   b. Inspect the shank of the lifter for wear or damage. Refer to Specifications, "Lifter Group" for more information.
   c. Inspect the face of the lifter that runs on the camshaft for visual wear or damage.
2. If the crankshaft is installed, rotate the crankshaft to access to the cylinder block in order to install lifters (1) .
3. Lubricate lifters (1) with clean engine oil.

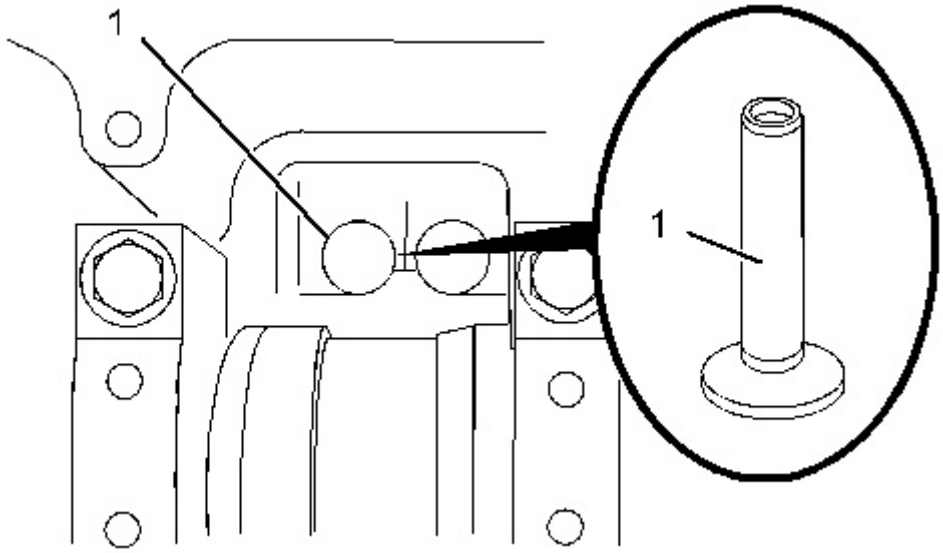


Illustration 2 g01343537

Typical example

4. Use Tooling (A) to install lifters (1) to the cylinder block. Ensure that used lifters are installed in the correct location.

   Note: The lifters should be free to rotate.
5. Repeat Steps 2 through 4 in order to install the remaining lifters.

End By:

a. Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".
b. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install". If the engine is not equipped with a balancer, install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02639293

Lifter Group - Remove and Install

SMCS - 1209-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

Start By:

A. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove". If the engine is not equipped with a balancer, remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".
B. Remove the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

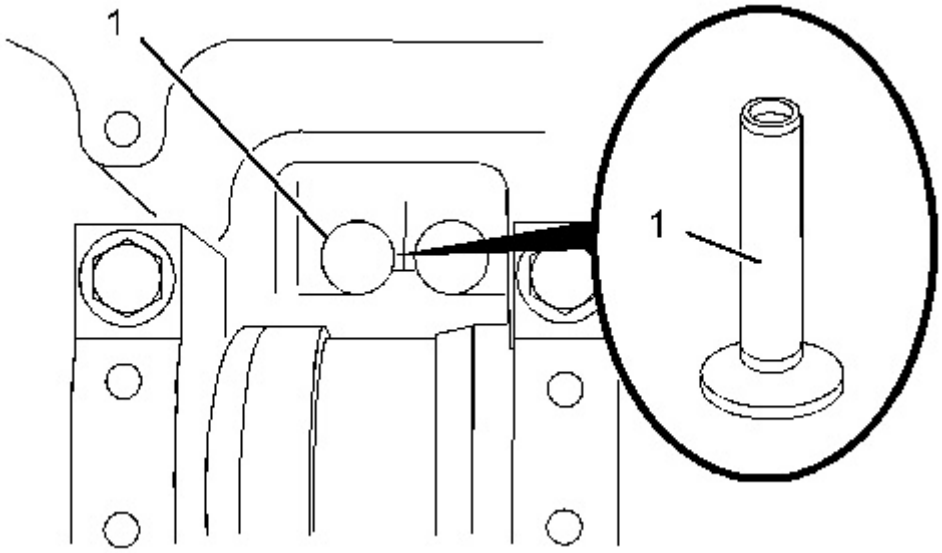


Illustration 1 g01343537

Typical example

1. If the crankshaft is installed, rotate the crankshaft in order to gain access to lifters (1) .
2. Use Tooling (A) to remove lifters (1) .

   Note: Make a temporary identification mark on each lifter in order to identify the correct location.
3. Repeat Steps 1 and 2 in order to remove the remaining lifters.

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1U-7262	Telescoping Magnet	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

It is strongly recommended that all lifters should be replaced when a new camshaft is installed.

1. Clean the lifters. Follow Steps 1.a through 1.c in order to inspect the lifters. Replace lifters that are worn or damaged.
   a. Inspect the seat of the pushrod in the lifter for visual wear or damage.
   b. Inspect the shank of the lifter for wear or damage. Refer to Specifications, "Lifter Group" for more information.
   c. Inspect the face of the lifter that runs on the camshaft for visual wear or damage.
2. If the crankshaft is installed, rotate the crankshaft to access to the cylinder block in order to install lifters (1) .
3. Lubricate lifters (1) with clean engine oil.

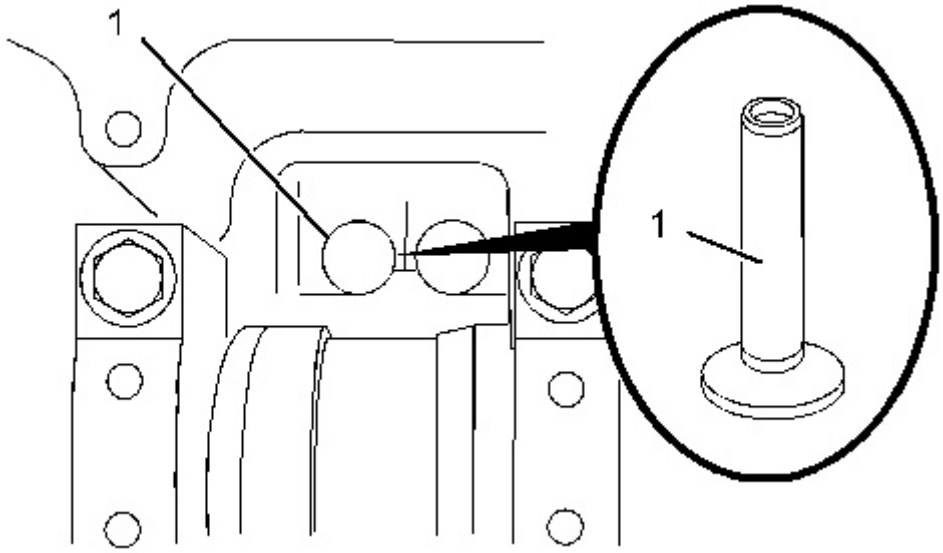


Illustration 2 g01343537

Typical example

4. Use Tooling (A) to install lifters (1) to the cylinder block. Ensure that used lifters are installed in the correct location.

   Note: The lifters should be free to rotate.
5. Repeat Steps 2 through 4 in order to install the remaining lifters.

End By:

a. Install the camshaft. Refer to Disassembly and Assembly, "Camshaft - Remove and Install".
b. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install". If the engine is not equipped with a balancer, install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i01964002

Cooling System

SMCS - 1350

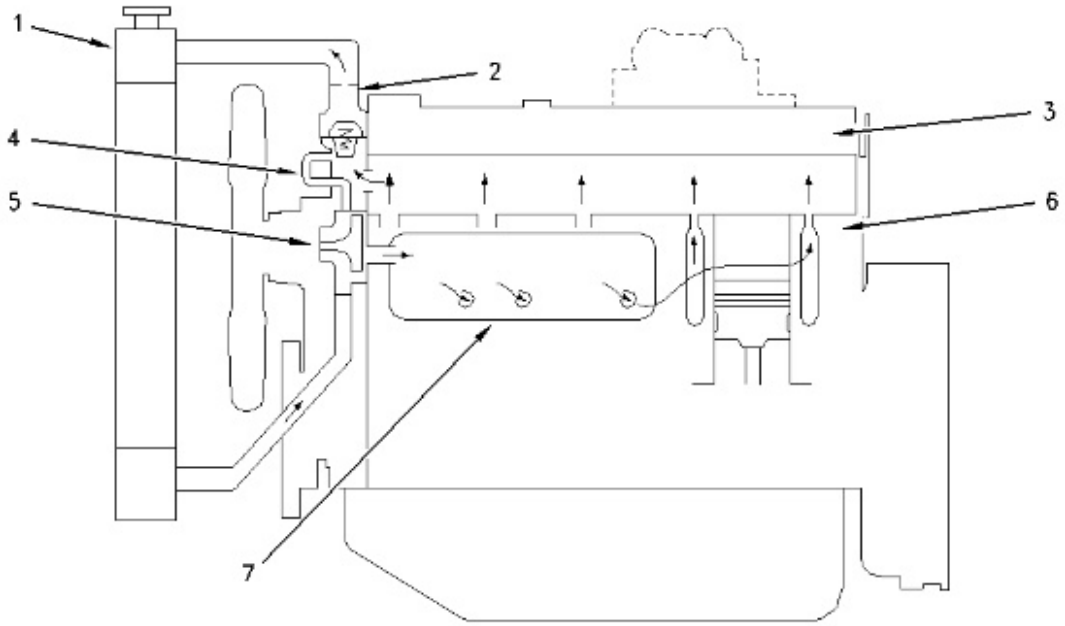


Illustration 1 g00987289

Flow diagram of the cooling system

(1) Radiator

(2) Water temperature regulator housing

(3) Cylinder head

(4) Bypass tube

(5) Water pump

(6) Water jacket in the cylinder block

(7) Engine oil cooler

The coolant flows from the bottom of radiator (1) to a centrifugal water pump (5). The water pump assists in the flow of the coolant through the system. The water pump is installed on the front of the timing case and the pump is driven by a belt from the crankshaft pulley.

The water pump forces the coolant through a passage in the front of the water jacket in the cylinder block (6) .

Some of the coolant passes into the engine oil cooler (7). The coolant flows around the element of the oil cooler back into the cylinder block.

The coolant then passes from the entire length of the cylinder block through passages and into the cylinder head (3) .

The coolant flows forward through the cylinder head and into the water temperature regulator housing (2). If the water temperature regulator is closed, the coolant goes directly through the bypass tube (4) to the inlet side of the water pump. If the water temperature regulator is open, the bypass is closed and the coolant flows to the top of the radiator.

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i01964002

Cooling System

SMCS - 1350

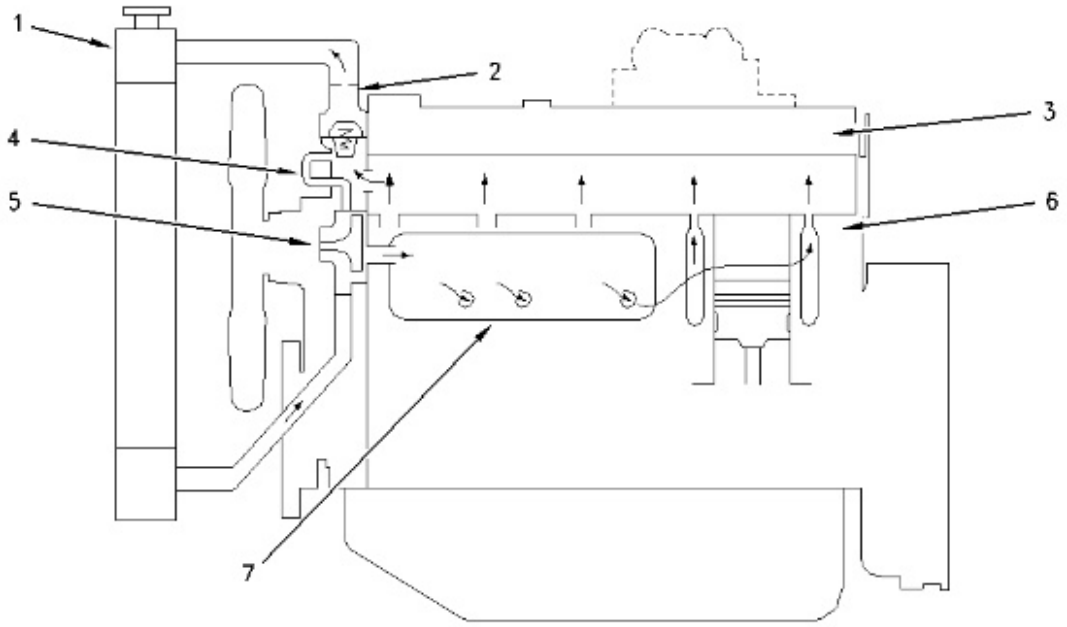


Illustration 1 g00987289

Flow diagram of the cooling system

(1) Radiator

(2) Water temperature regulator housing

(3) Cylinder head

(4) Bypass tube

(5) Water pump

(6) Water jacket in the cylinder block

(7) Engine oil cooler

The coolant flows from the bottom of radiator (1) to a centrifugal water pump (5). The water pump assists in the flow of the coolant through the system. The water pump is installed on the front of the timing case and the pump is driven by a belt from the crankshaft pulley.

The water pump forces the coolant through a passage in the front of the water jacket in the cylinder block (6) .

Some of the coolant passes into the engine oil cooler (7). The coolant flows around the element of the oil cooler back into the cylinder block.

The coolant then passes from the entire length of the cylinder block through passages and into the cylinder head (3) .

The coolant flows forward through the cylinder head and into the water temperature regulator housing (2). If the water temperature regulator is closed, the coolant goes directly through the bypass tube (4) to the inlet side of the water pump. If the water temperature regulator is open, the bypass is closed and the coolant flows to the top of the radiator.

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i02707222

Cooling System - Check - Overheating

SMCS - 1350-535

Above normal coolant temperatures can be caused by many conditions. Use the following procedure to determine the cause of above normal coolant temperatures:

1. Check the coolant level in the cooling system. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow and bubbles in the coolant. Air bubbles will keep coolant away from the engine parts, which will prevent the transfer of heat to the coolant. Low coolant level is caused by leaks or incorrectly filling the expansion tank.

2. Check the mixture of antifreeze and water. The mixture should be approximately 50 percent water and 50 percent antifreeze with 3 to 6 percent coolant conditioner. If the coolant mixture is incorrect, drain the system. Put the correct mixture of water, antifreeze and coolant conditioner in the cooling system.

3. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are not filling the cooling system correctly and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket. Air in the cooling system causes a reduction in coolant flow and bubbles in the coolant. Air bubbles keep coolant away from the engine parts, which prevents the transfer of heat to the coolant.

4. Check the sending unit. In some conditions, the temperature sensor in the engine sends signals to a sending unit. The sending unit converts these signals to an electrical impulse which is used by a mounted gauge. If the sending unit malfunctions, the gauge can show an incorrect reading. Also if the electric wire breaks or if the electric wire shorts out, the gauge can show an incorrect reading.

5. Check the radiator for a restriction to coolant flow. Check the radiator for debris, dirt, or deposits on the inside of the core. Debris, dirt, or deposits will restrict the flow of coolant through the radiator.

6. Check the filler cap. A pressure drop in the cooling system can cause the boiling point to be lower. This can cause the cooling system to boil. Refer to Testing and Adjusting, "Cooling System - Test".

7. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can cause a restriction in the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can cause a restriction of the coolant flow.

8. Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures require higher than normal temperatures in the cooling system.

9. Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

    a. Make a visual inspection of the exhaust system.

    b. Check for damage to exhaust piping. Check for damage to the exhaust elbow. If no damage is found, check the exhaust system for a restriction.

10. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating. Refer to Testing and Adjusting, "Water Temperature Regulator - Test".

11. Check the jacket water pump. A jacket water pump with a damaged impeller does not pump enough coolant for correct engine cooling. Remove the water pump and check for damage to the impeller.

12. Check the air flow through the engine compartment. Not enough air flow over the engine can affect the engine operating temperature.

13. Consider high outside temperatures. When outside temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the outside air and coolant temperatures. The maximum temperature of the ambient air that enters the engine should not exceed 50 °C (120 °F).

14. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system. This combination of less air and less coolant flow during high input of fuel will cause above normal heating.

15. Timing of the engine which is incorrect may also cause overheating of the engine. Late timing creates more heat in the engine. Early timing creates less heat in the engine.

    Note: If the timing of the engine is incorrect, the exhaust valves may be burned and damage to the exhaust manifold may occur.

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
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i05182965

Cooling System - Inspect

SMCS - 1350-040

Introduction

This engine has a pressure type cooling system. A pressure type cooling system gives two advantages:

- The pressure type cooling system can operate safely at a higher temperature than the boiling point of water at a range of atmospheric pressures.
- The pressure type cooling system prevents cavitation in the water pump.

Cavitation is the sudden generation of low-pressure bubbles in liquids by mechanical forces. The generation of an air or steam pocket is much more difficult in a pressure type cooling system.

Regular inspections of the cooling system should be made in order to identify problems before damage can occur. Visually inspect the cooling system before tests are made with the test equipment.

Inspection Procedure

Visual Inspection Of The Cooling System

1. Check the coolant level in the cooling system.
2. Look for leaks in the system.

   Note: A small amount of coolant leakage across the surface of the water pump seals is normal. This leakage is required in order to provide lubrication for this type of seal. A hole is provided in the water pump housing in order to allow this coolant/seal lubricant to drain from the pump housing. Intermittent leakage of small amounts of coolant from this hole is not an indication of water pump seal failure.
3. Inspect the radiator for bent fins and other restriction to the flow of air through the radiator.
4. Inspect the drive belt for the fan.

5. Inspect the blades of the fan for damage.
6. Look for air or combustion gas in the cooling system.
7. Inspect the radiator cap for damage. The sealing surface must be clean.
8. Look for large amounts of dirt in the radiator core. Look for large amounts of dirt on the engine.
9. Shrouds that are loose or missing cause poor air flow for cooling.

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i05183281

Cooling System - Test

SMCS - 1350-040; 1350-081

Introduction

Remember that temperature and pressure work together. When a diagnosis is made of a cooling system problem, temperature and pressure must be checked. Cooling system pressure will have an effect on the cooling system temperature. For an example, refer to Illustration 1. This will show the effect of pressure on the boiling point (steam) of water. This will also show the effect of height above sea level.

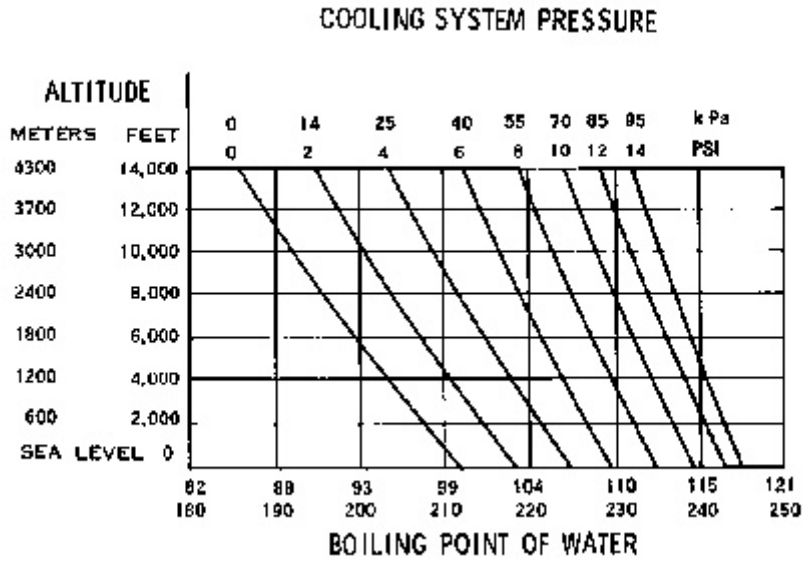


Illustration 1 g00286266

Cooling system pressure at specific altitudes and boiling points of water

The coolant level must be to the correct level in order to check the coolant system. The engine must be cold and the engine must not be running.

After the engine is cool, loosen the pressure cap in order to relieve the pressure out of the cooling system. Then remove the pressure cap.

The level of the coolant should not be more than 13 mm (0.5 inch) from the bottom of the filler pipe. If the cooling system is equipped with a sight glass, the coolant should be to the proper level in the sight glass.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
4C-6500	Digital Thermometer	1
8T-2700	Blowby/Air Flow Indicator	1
9U-7400	Multitach Tool Group	1
9S-8140	Pressurizing Pump	1
1U-7297	Coolant/Battery Tester	1
1U-7298	Coolant/Battery Tester	1

WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

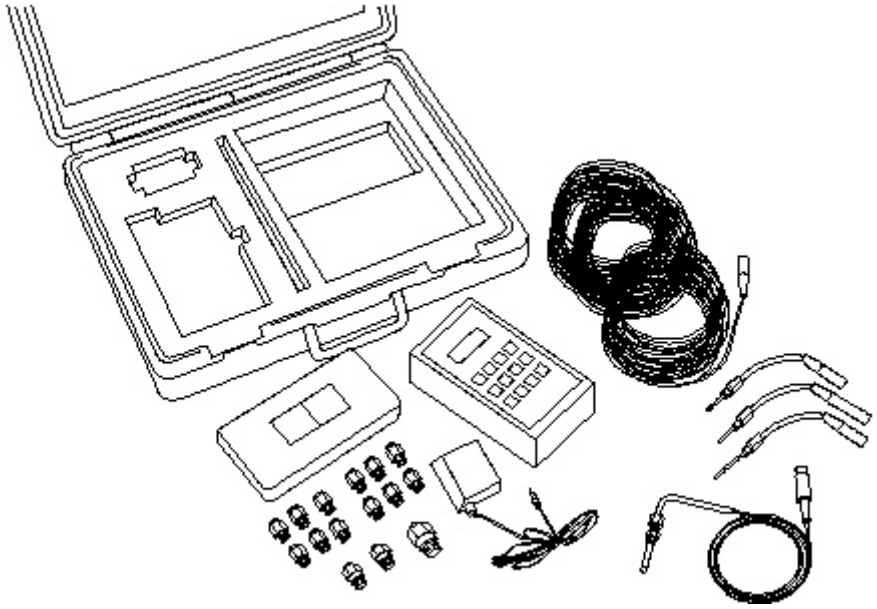


Illustration 2 g00876179

4C-6500 Digital Thermometer

The **4C-6500** Digital Thermometer is used in the diagnosis of problems that cause overheating or overcooling in the engine. This tool can be used to check the temperature in several areas of the cooling system. The testing procedure is in Tool Operating Manual, NEHS0554.

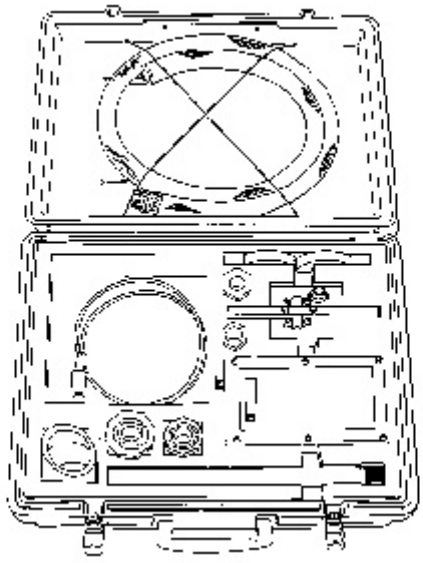


Illustration 3 g00313263

8T-2700 Blowby/Air Flow Indicator

The **8T-2700** Blowby/Air Flow Indicator is used to check the air flow through the radiator core. Refer to Special Instruction, SEHS8712, "Using the **8T-2700** Blowby/Air Flow Indicator " for the test procedure for checking blowby and air flow.

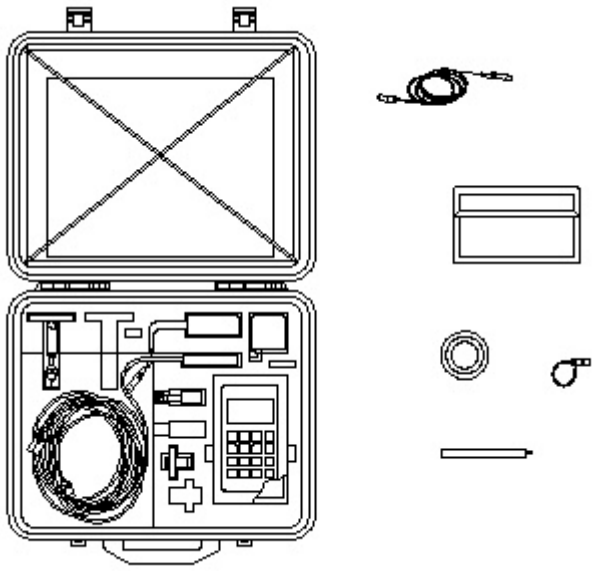


Illustration 4 g00286276

9U-7400 Multitach Tool Group

The **9U-7400** Multitach Tool Group is used to measure the fan speed. Refer to Operating Manual, NEHS0605, " **9U-7400** Multitach Tool Group " for the testing procedure.

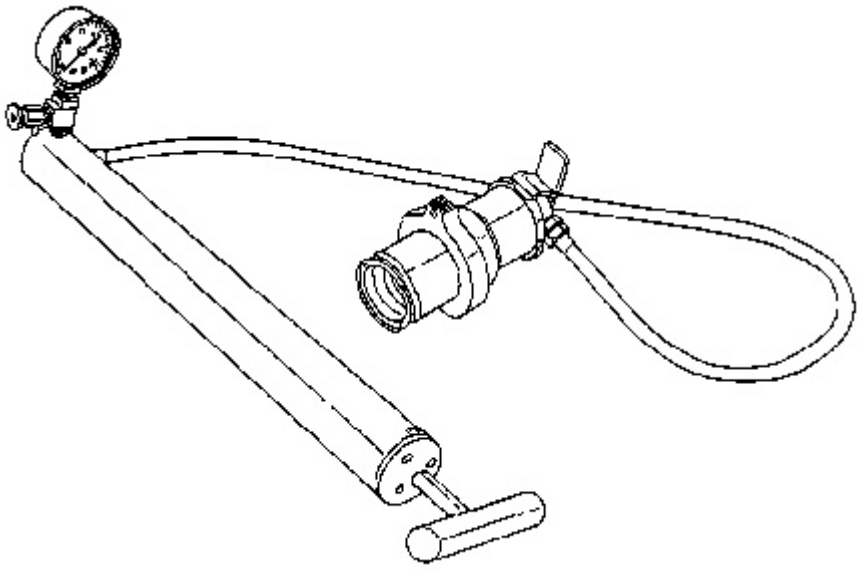


Illustration 5 g00286369

9S-8140 Pressurizing Pump

The **9S-8140** Pressurizing Pump is used to test the filler caps. This pressurizing pump is also used to pressure test the cooling system for leaks.

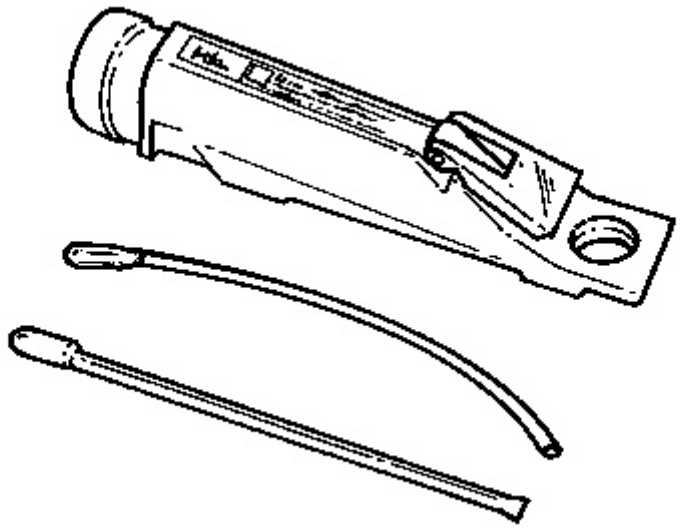


Illustration 6 g00439083

1U-7297 Coolant/Battery Tester or 1U-7298 Coolant/Battery Tester

Check the coolant frequently in cold weather for the proper glycol concentration. Use either the **1U-7297** Coolant/Battery Tester or the **1U-7298** Coolant/Battery Tester in order to ensure adequate freeze protection. The testers are identical except for the temperature scale. The testers give immediate, accurate readings. The testers can be used for antifreeze/coolants that contain ethylene or propylene glycol.

Test Procedure

Making the Correct Antifreeze Mixtures

Do not add pure antifreeze to the cooling system in order to adjust the concentration of antifreeze. The pure antifreeze increases the concentration of antifreeze in the cooling system. The increased concentration increases the concentration of dissolved solids and undissolved chemical inhibitors in the cooling system.

Add an antifreeze and water mixture in the concentration which provides the desired freeze protection. Use the following chart in order to determine the correct concentration of antifreeze in water to use.

Table 2

Antifreeze Concentrations For Freeze Protection	
Temperature	**Concentration**
Protection to -15°C (5°F)	30% antifreeze and 70% water
Protection to -23°C (-9°F)	40% antifreeze and 60% water
Protection to -37°C (-35°F)	50% antifreeze and 50% water
Protection to -51°C (-60°F)	60% antifreeze and 40% water

Checking the Filler Cap

Table 3

Required Tools		
Part Number	**Part Name**	**Qty**
9S-8140	Pressurizing Pump	1

One cause for a pressure loss in the cooling system can be a faulty seal on the radiator pressure cap.

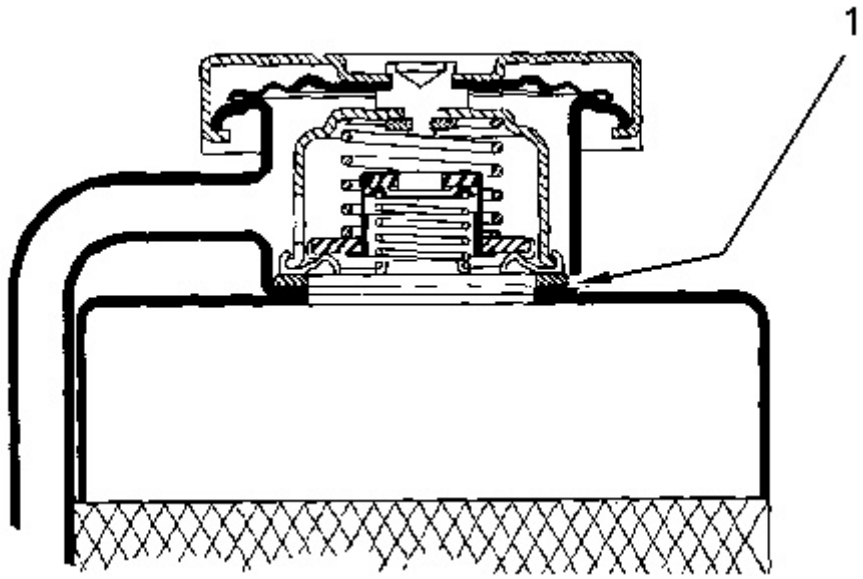


Illustration 7 g00296067

Typical schematic of filler cap

(1) Sealing surface between the pressure cap and the radiator

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

To check for the amount of pressure that opens the filler cap, use the following procedure:

1. After the engine cools, carefully loosen the filler cap. Slowly release the pressure from the cooling system. Then, remove the filler cap.
2. Inspect the pressure cap carefully. Look for damage to the seal. Look for damage to the surface that seals. Remove any debris on the cap, the seal, or the sealing surface.

   Carefully inspect the filler cap. Look for any damage to the seals and to the sealing surface. Inspect the following components for any foreign substances:

   - Filler cap
   - Seal
   - Surface for seal

   Remove any deposits that are found on these items, and remove any material that is found on these items.
3. Install the pressure cap on the **9S-8140** Pressurizing Pump .
4. Observe the exact pressure that opens the filler cap.
5. Compare the pressure to the pressure rating that is found on the top of the filler cap.
6. If the filler cap is damaged, replace the filler cap.

Testing The Radiator And Cooling System For Leaks

Table 4

Required Tools		
Part Number	**Part Name**	**Qty**
9S-8140	Pressurizing Pump	1

Use the following procedure to test the radiator and the cooling system for leaks.

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

1. When the engine has cooled, loosen the filler cap to the first stop. Allow the pressure to release from the cooling system. Then remove the filler cap.
2. Make sure that the coolant covers the top of the radiator core.
3. Put the **9S-8140** Pressurizing Pump onto the radiator.
4. Use the pressurizing pump to increase the pressure to an amount of 20 kPa (3 psi) more than the operating pressure of the filler cap.
5. Check the radiator for leakage on the outside.
6. Check all connections and hoses of the cooling system for leaks

   The radiator and the cooling system do not have leakage if all of the following conditions exist:

   The inside of the cooling system has leakage only if the following conditions exist:

   - The reading on the gauge goes down.
   - You do NOT observe any outside leakage.

   Make any repairs, as required.

Cooling System Conditioner

WARNING

Supplemental cooling system additive contains alkali. To prevent personal injury, do not drink, avoid contact with the skin and eyes.

NOTICE

All water is corrosive at engine operating temperature. The cooling system should be protected with a 3% to 6% concentration of cooling system conditioner at all times.

Caterpillar does not recommend the use of cooling system solutions that are intended to stop leaks.

Use of these products may result in excessive internal deposits that could reduce the engine's heat transfer characteristics.

Caterpillar Cooling System Conditioner can be used with an antifreeze or without an antifreeze of ethylene glycol base in the coolant.

When the conditioner is added to the coolant, the cooling system must be flushed and the cooling system must be cleaned.

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Engine Oil Cooler - Inspect

SMCS - 1378-040

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

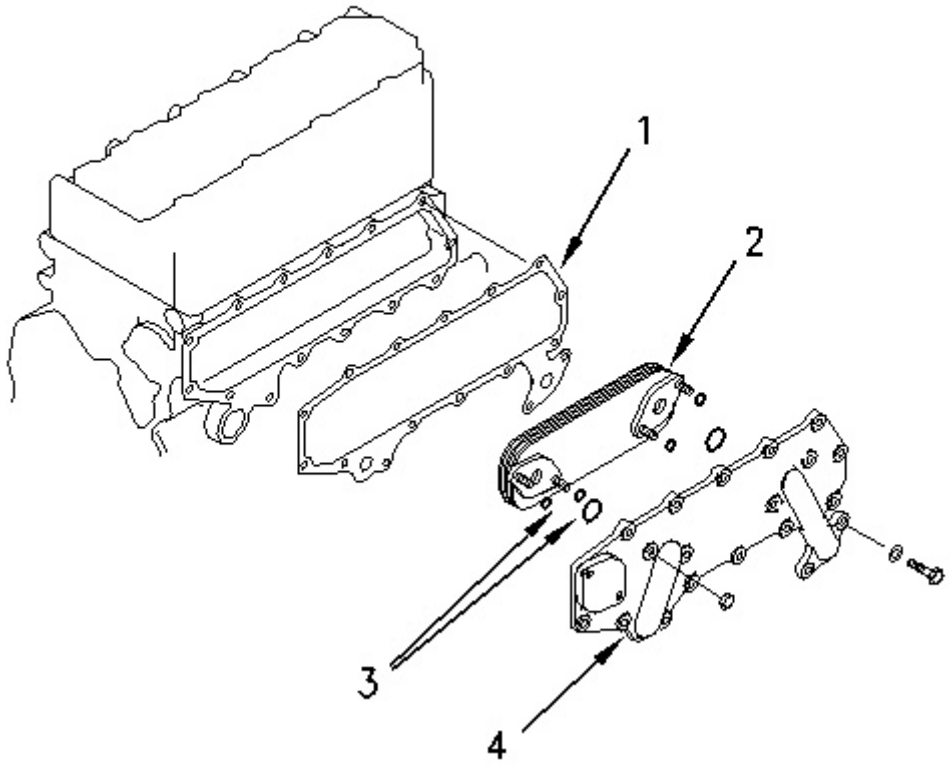


Illustration 1 g00987668

Exploded view of the engine oil cooler

(1) Gasket

(2) Cooling plates

(3) O-rings

(4) Cover

Perform the following procedure in order to inspect the engine oil cooler:

1. Place a container under the oil cooler in order to collect any engine oil or coolant that drains from the oil cooler.
2. Remove the cover (4). Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove" for removal of the engine oil cooler.
3. Thoroughly clean the flange face of the cover and the cylinder block.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

4. Inspect the cooling plates (2) for cracks and dents. Replace the cooling plates if cracks or dents exist.

   If necessary, clean the outside and clean the inside of the cooling plates. Use a solvent that is not corrosive on copper. Ensure that no restrictions for the flow of lubricating oil exist in the cooling plates.

   Dry the cooling plates with low pressure air. Flush the inside of the cooling plates with clean lubricating oil.

5. Replace the O-rings (3) and the gasket (1). Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install" for installation of the engine oil cooler.

6. Ensure that the cooling system of the engine is filled to the correct level. Operate the engine. Check for oil or coolant leakage.

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i05183360

Water Temperature Regulator - Test

SMCS - 1355-081; 1355-081-ON

Introduction

This procedure is intended to give information on testing the water temperature regulator.

Test Procedure

WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

1. Remove the water temperature regulator from the engine.
2. Heat water in a pan until the temperature of the water is equal to the fully open temperature of the water temperature regulator. Refer to Specifications, "Water Temperature Regulator" for the fully open temperature of the water temperature regulator. Stir the water in the pan. This will distribute the temperature throughout the pan.
3. Hang the water temperature regulator in the pan of water. The water temperature regulator must be below the surface of the water. The water temperature regulator must be away from the sides and the bottom of the pan.
4. Keep the water at the correct temperature for ten minutes.
5. After ten minutes, remove the water temperature regulator. Immediately measure the opening of the water temperature regulator. Refer to Specifications, "Water Temperature Regulator" for the minimum opening distance of the water temperature regulator at the fully open temperature.

If the distance is less than the amount listed in the manual, replace the water temperature regulator.

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i02707222

Cooling System - Check - Overheating

SMCS - 1350-535

Above normal coolant temperatures can be caused by many conditions. Use the following procedure to determine the cause of above normal coolant temperatures:

1. Check the coolant level in the cooling system. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow and bubbles in the coolant. Air bubbles will keep coolant away from the engine parts, which will prevent the transfer of heat to the coolant. Low coolant level is caused by leaks or incorrectly filling the expansion tank.

2. Check the mixture of antifreeze and water. The mixture should be approximately 50 percent water and 50 percent antifreeze with 3 to 6 percent coolant conditioner. If the coolant mixture is incorrect, drain the system. Put the correct mixture of water, antifreeze and coolant conditioner in the cooling system.

3. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are not filling the cooling system correctly and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket. Air in the cooling system causes a reduction in coolant flow and bubbles in the coolant. Air bubbles keep coolant away from the engine parts, which prevents the transfer of heat to the coolant.

4. Check the sending unit. In some conditions, the temperature sensor in the engine sends signals to a sending unit. The sending unit converts these signals to an electrical impulse which is used by a mounted gauge. If the sending unit malfunctions, the gauge can show an incorrect reading. Also if the electric wire breaks or if the electric wire shorts out, the gauge can show an incorrect reading.

5. Check the radiator for a restriction to coolant flow. Check the radiator for debris, dirt, or deposits on the inside of the core. Debris, dirt, or deposits will restrict the flow of coolant through the radiator.

6. Check the filler cap. A pressure drop in the cooling system can cause the boiling point to be lower. This can cause the cooling system to boil. Refer to Testing and Adjusting, "Cooling System - Test".

7. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can cause a restriction in the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can cause a restriction of the coolant flow.

8. Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures require higher than normal temperatures in the cooling system.

9. Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

    a. Make a visual inspection of the exhaust system.

    b. Check for damage to exhaust piping. Check for damage to the exhaust elbow. If no damage is found, check the exhaust system for a restriction.

10. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating. Refer to Testing and Adjusting, "Water Temperature Regulator - Test".

11. Check the jacket water pump. A jacket water pump with a damaged impeller does not pump enough coolant for correct engine cooling. Remove the water pump and check for damage to the impeller.

12. Check the air flow through the engine compartment. Not enough air flow over the engine can affect the engine operating temperature.

13. Consider high outside temperatures. When outside temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the outside air and coolant temperatures. The maximum temperature of the ambient air that enters the engine should not exceed 50 °C (120 °F).

14. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system. This combination of less air and less coolant flow during high input of fuel will cause above normal heating.

15. Timing of the engine which is incorrect may also cause overheating of the engine. Late timing creates more heat in the engine. Early timing creates less heat in the engine.

    Note: If the timing of the engine is incorrect, the exhaust valves may be burned and damage to the exhaust manifold may occur.

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C3.4 Engines for Caterpillar Built Machines
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i05182965

Cooling System - Inspect

SMCS - 1350-040

Introduction

This engine has a pressure type cooling system. A pressure type cooling system gives two advantages:

- The pressure type cooling system can operate safely at a higher temperature than the boiling point of water at a range of atmospheric pressures.
- The pressure type cooling system prevents cavitation in the water pump.

Cavitation is the sudden generation of low-pressure bubbles in liquids by mechanical forces. The generation of an air or steam pocket is much more difficult in a pressure type cooling system.

Regular inspections of the cooling system should be made in order to identify problems before damage can occur. Visually inspect the cooling system before tests are made with the test equipment.

Inspection Procedure

Visual Inspection Of The Cooling System

1. Check the coolant level in the cooling system.
2. Look for leaks in the system.

   Note: A small amount of coolant leakage across the surface of the water pump seals is normal. This leakage is required in order to provide lubrication for this type of seal. A hole is provided in the water pump housing in order to allow this coolant/seal lubricant to drain from the pump housing. Intermittent leakage of small amounts of coolant from this hole is not an indication of water pump seal failure.
3. Inspect the radiator for bent fins and other restriction to the flow of air through the radiator.
4. Inspect the drive belt for the fan.

5. Inspect the blades of the fan for damage.
6. Look for air or combustion gas in the cooling system.
7. Inspect the radiator cap for damage. The sealing surface must be clean.
8. Look for large amounts of dirt in the radiator core. Look for large amounts of dirt on the engine.
9. Shrouds that are loose or missing cause poor air flow for cooling.

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i05183281

Cooling System - Test

SMCS - 1350-081; 1350-040

Introduction

Remember that temperature and pressure work together. When a diagnosis is made of a cooling system problem, temperature and pressure must be checked. Cooling system pressure will have an effect on the cooling system temperature. For an example, refer to Illustration 1. This will show the effect of pressure on the boiling point (steam) of water. This will also show the effect of height above sea level.

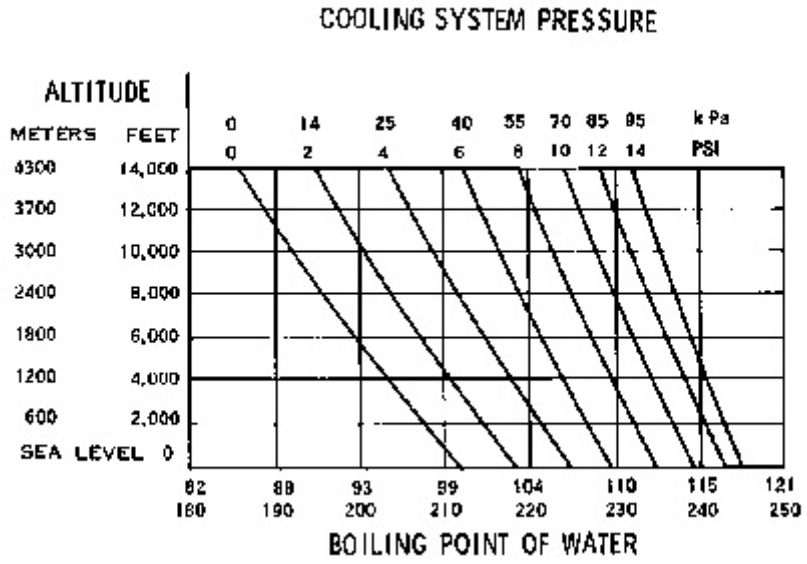


Illustration 1 g00286266

Cooling system pressure at specific altitudes and boiling points of water

The coolant level must be to the correct level in order to check the coolant system. The engine must be cold and the engine must not be running.

After the engine is cool, loosen the pressure cap in order to relieve the pressure out of the cooling system. Then remove the pressure cap.

The level of the coolant should not be more than 13 mm (0.5 inch) from the bottom of the filler pipe. If the cooling system is equipped with a sight glass, the coolant should be to the proper level in the sight glass.

Required Tools

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
4C-6500	Digital Thermometer	1
8T-2700	Blowby/Air Flow Indicator	1
9U-7400	Multitach Tool Group	1
9S-8140	Pressurizing Pump	1
1U-7297	Coolant/Battery Tester	1
1U-7298	Coolant/Battery Tester	1

WARNING

Making contact with a running engine can cause burns from hot parts and can cause injury from rotating parts.

When working on an engine that is running, avoid contact with hot parts and rotating parts.

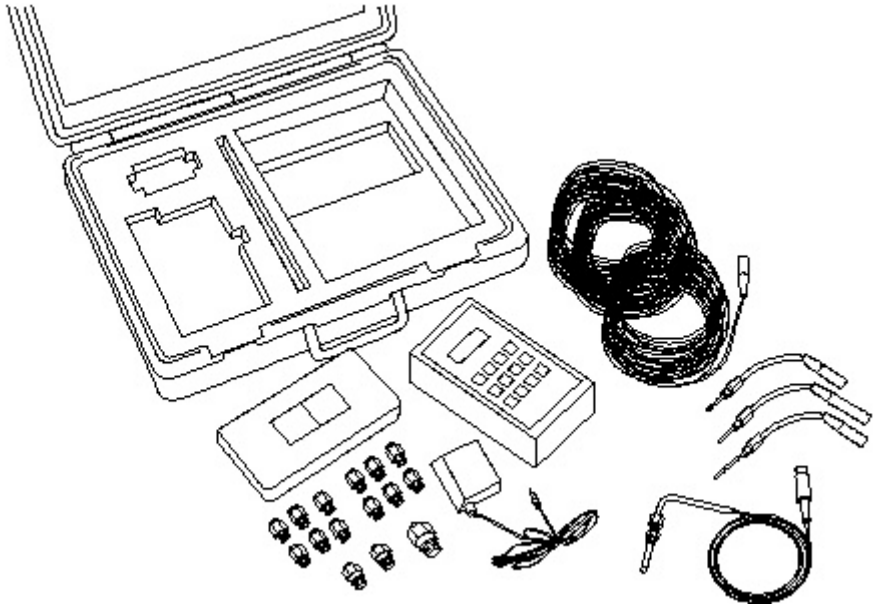


Illustration 2 g00876179

4C-6500 Digital Thermometer

The **4C-6500** Digital Thermometer is used in the diagnosis of problems that cause overheating or overcooling in the engine. This tool can be used to check the temperature in several areas of the cooling system. The testing procedure is in Tool Operating Manual, NEHS0554.

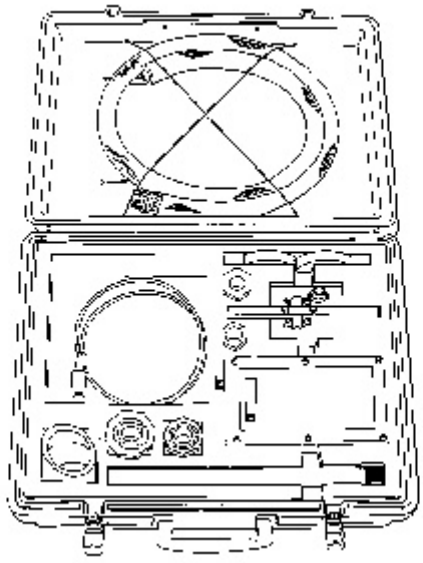


Illustration 3 g00313263

8T-2700 Blowby/Air Flow Indicator

The **8T-2700** Blowby/Air Flow Indicator is used to check the air flow through the radiator core. Refer to Special Instruction, SEHS8712, "Using the **8T-2700** Blowby/Air Flow Indicator " for the test procedure for checking blowby and air flow.

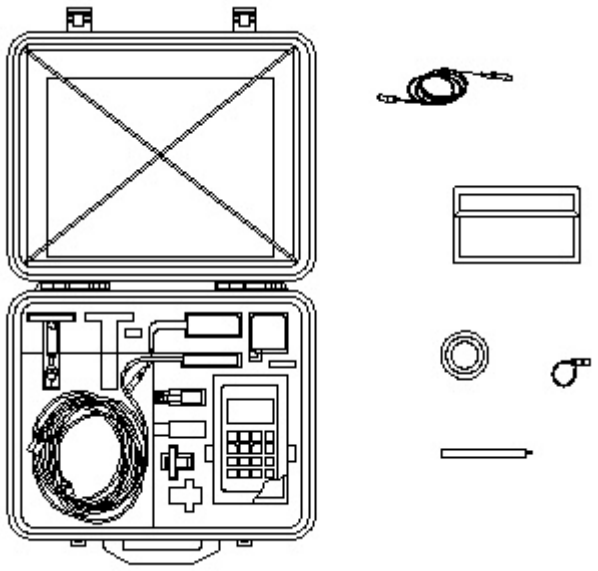


Illustration 4 g00286276

9U-7400 Multitach Tool Group

The **9U-7400** Multitach Tool Group is used to measure the fan speed. Refer to Operating Manual, NEHS0605, " **9U-7400** Multitach Tool Group " for the testing procedure.

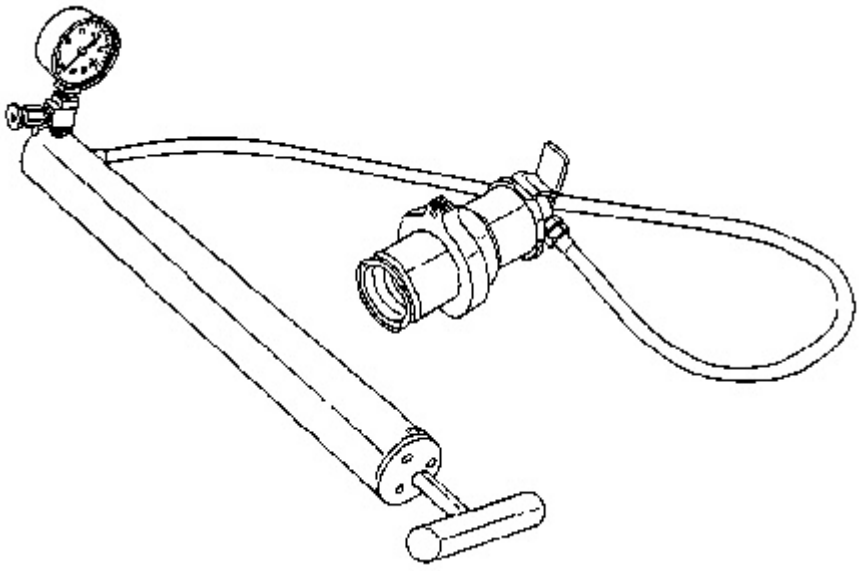


Illustration 5 g00286369

9S-8140 Pressurizing Pump

The **9S-8140** Pressurizing Pump is used to test the filler caps. This pressurizing pump is also used to pressure test the cooling system for leaks.

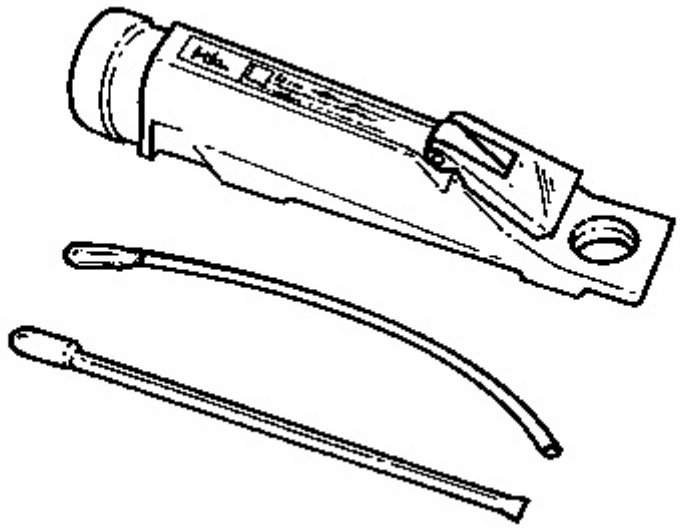


Illustration 6 g00439083

1U-7297 Coolant/Battery Tester or 1U-7298 Coolant/Battery Tester

Check the coolant frequently in cold weather for the proper glycol concentration. Use either the **1U-7297** Coolant/Battery Tester or the **1U-7298** Coolant/Battery Tester in order to ensure adequate freeze protection. The testers are identical except for the temperature scale. The testers give immediate, accurate readings. The testers can be used for antifreeze/coolants that contain ethylene or propylene glycol.

Test Procedure

Making the Correct Antifreeze Mixtures

Do not add pure antifreeze to the cooling system in order to adjust the concentration of antifreeze. The pure antifreeze increases the concentration of antifreeze in the cooling system. The increased concentration increases the concentration of dissolved solids and undissolved chemical inhibitors in the cooling system.

Add an antifreeze and water mixture in the concentration which provides the desired freeze protection. Use the following chart in order to determine the correct concentration of antifreeze in water to use.

Table 2

Antifreeze Concentrations For Freeze Protection	
Temperature	**Concentration**
Protection to -15°C (5°F)	30% antifreeze and 70% water
Protection to -23°C (-9°F)	40% antifreeze and 60% water
Protection to -37°C (-35°F)	50% antifreeze and 50% water
Protection to -51°C (-60°F)	60% antifreeze and 40% water

Checking the Filler Cap

Table 3

Required Tools		
Part Number	**Part Name**	**Qty**
9S-8140	Pressurizing Pump	1

One cause for a pressure loss in the cooling system can be a faulty seal on the radiator pressure cap.

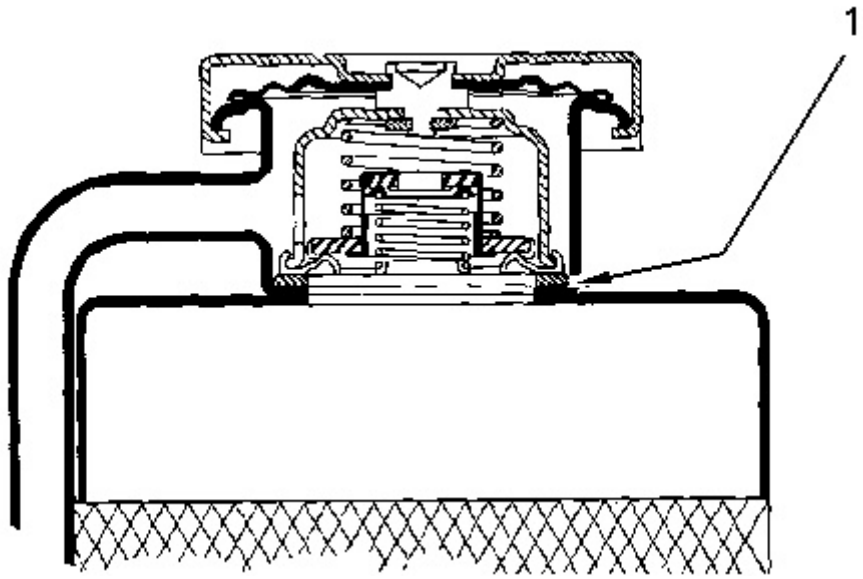


Illustration 7 g00296067

Typical schematic of filler cap

(1) Sealing surface between the pressure cap and the radiator

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

To check for the amount of pressure that opens the filler cap, use the following procedure:

1. After the engine cools, carefully loosen the filler cap. Slowly release the pressure from the cooling system. Then, remove the filler cap.
2. Inspect the pressure cap carefully. Look for damage to the seal. Look for damage to the surface that seals. Remove any debris on the cap, the seal, or the sealing surface.

   Carefully inspect the filler cap. Look for any damage to the seals and to the sealing surface. Inspect the following components for any foreign substances:

   - Filler cap
   - Seal
   - Surface for seal

   Remove any deposits that are found on these items, and remove any material that is found on these items.
3. Install the pressure cap on the **9S-8140** Pressurizing Pump .
4. Observe the exact pressure that opens the filler cap.
5. Compare the pressure to the pressure rating that is found on the top of the filler cap.
6. If the filler cap is damaged, replace the filler cap.

Testing The Radiator And Cooling System For Leaks

Table 4

Required Tools		
Part Number	**Part Name**	**Qty**
9S-8140	Pressurizing Pump	1

Use the following procedure to test the radiator and the cooling system for leaks.

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

1. When the engine has cooled, loosen the filler cap to the first stop. Allow the pressure to release from the cooling system. Then remove the filler cap.
2. Make sure that the coolant covers the top of the radiator core.
3. Put the **9S-8140** Pressurizing Pump onto the radiator.
4. Use the pressurizing pump to increase the pressure to an amount of 20 kPa (3 psi) more than the operating pressure of the filler cap.
5. Check the radiator for leakage on the outside.
6. Check all connections and hoses of the cooling system for leaks

   The radiator and the cooling system do not have leakage if all of the following conditions exist:

   The inside of the cooling system has leakage only if the following conditions exist:

   - The reading on the gauge goes down.
   - You do NOT observe any outside leakage.

   Make any repairs, as required.

Cooling System Conditioner

WARNING

Supplemental cooling system additive contains alkali. To prevent personal injury, do not drink, avoid contact with the skin and eyes.

NOTICE

All water is corrosive at engine operating temperature. The cooling system should be protected with a 3% to 6% concentration of cooling system conditioner at all times.

Caterpillar does not recommend the use of cooling system solutions that are intended to stop leaks.

Use of these products may result in excessive internal deposits that could reduce the engine's heat transfer characteristics.

Caterpillar Cooling System Conditioner can be used with an antifreeze or without an antifreeze of ethylene glycol base in the coolant.

When the conditioner is added to the coolant, the cooling system must be flushed and the cooling system must be cleaned.

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i01959183

Engine Oil Cooler - Inspect

SMCS - 1378-040

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

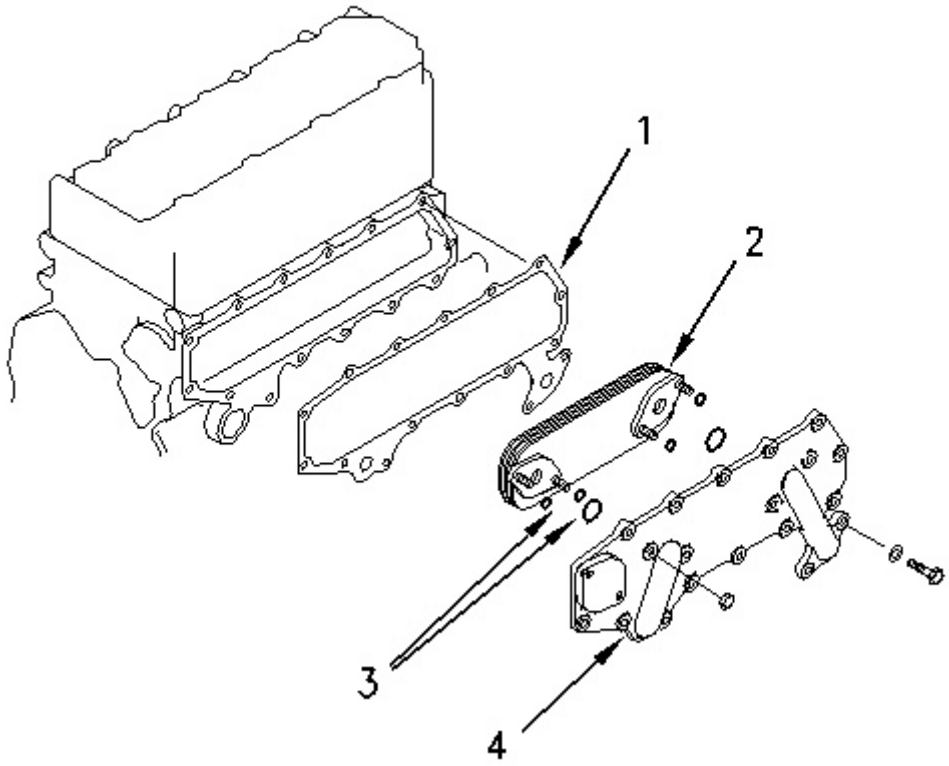


Illustration 1 g00987668

Exploded view of the engine oil cooler

(1) Gasket

(2) Cooling plates

(3) O-rings

(4) Cover

Perform the following procedure in order to inspect the engine oil cooler:

1. Place a container under the oil cooler in order to collect any engine oil or coolant that drains from the oil cooler.
2. Remove the cover (4). Refer to Disassembly and Assembly, "Engine Oil Cooler - Remove" for removal of the engine oil cooler.
3. Thoroughly clean the flange face of the cover and the cylinder block.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

4. Inspect the cooling plates (2) for cracks and dents. Replace the cooling plates if cracks or dents exist.

   If necessary, clean the outside and clean the inside of the cooling plates. Use a solvent that is not corrosive on copper. Ensure that no restrictions for the flow of lubricating oil exist in the cooling plates.

   Dry the cooling plates with low pressure air. Flush the inside of the cooling plates with clean lubricating oil.

5. Replace the O-rings (3) and the gasket (1). Install the engine oil cooler. Refer to Disassembly and Assembly, "Engine Oil Cooler - Install" for installation of the engine oil cooler.

6. Ensure that the cooling system of the engine is filled to the correct level. Operate the engine. Check for oil or coolant leakage.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05183360

Water Temperature Regulator - Test

SMCS - 1355-081; 1355-081-ON

Introduction

This procedure is intended to give information on testing the water temperature regulator.

Test Procedure

WARNING

Personal injury can result from escaping fluid under pressure.

If a pressure indication is shown on the indicator, push the release valve in order to relieve pressure before removing any hose from the radiator.

1. Remove the water temperature regulator from the engine.
2. Heat water in a pan until the temperature of the water is equal to the fully open temperature of the water temperature regulator. Refer to Specifications, "Water Temperature Regulator" for the fully open temperature of the water temperature regulator. Stir the water in the pan. This will distribute the temperature throughout the pan.
3. Hang the water temperature regulator in the pan of water. The water temperature regulator must be below the surface of the water. The water temperature regulator must be away from the sides and the bottom of the pan.
4. Keep the water at the correct temperature for ten minutes.
5. After ten minutes, remove the water temperature regulator. Immediately measure the opening of the water temperature regulator. Refer to Specifications, "Water Temperature Regulator" for the minimum opening distance of the water temperature regulator at the fully open temperature.

If the distance is less than the amount listed in the manual, replace the water temperature regulator.

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i03898085

Disconnecting Snap To Connect Fittings

SMCS - 7554-X6

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disconnection Procedure

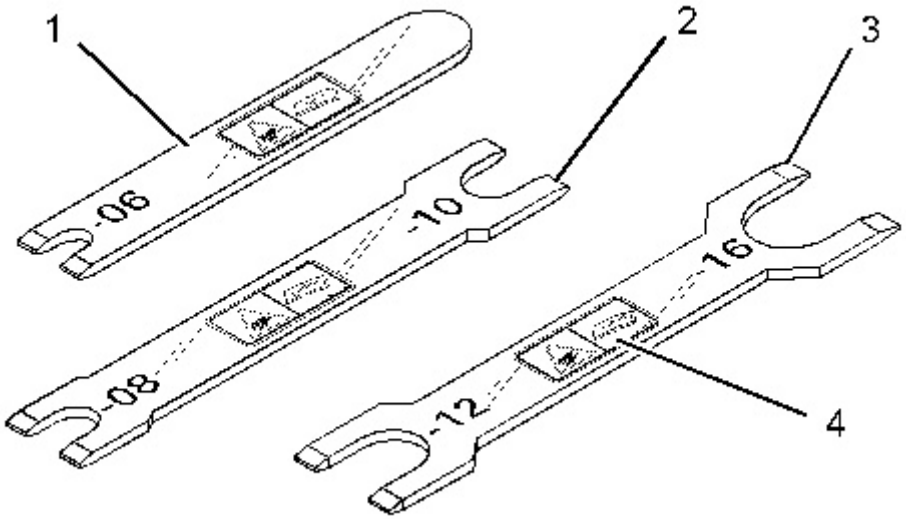


Illustration 1 g02145423

Table 1

304-1165 Tool Kit			
Item	**Part No.**	**description**	**Fitting Size**
1	304-1166	STC Wrench	-06
2	304-1167	STC Wrench	-08 and -10
3	304-1168	STC Wrench	-12 and -16
4	341-2603	Warning Film	-
-	304-2721	Tool Pouch	-

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

NOTICE

Using the incorrect size snap to connect (STC) wrench can cause slippage, resulting in personal injury. Always verify that the STC wrench size matches the size fitting to be disconnected.

1. Lower all work tools and attachments to the ground.
2. Release the system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".
3. Clean the connection that is to be disassembled. Clean the surrounding area in order to ensure that the connection is free of all dirt, dust, and grit.
4. Pressure can be trapped in circuits after the engine has stopped. Personal injury or death can result if all pressures are not released. Ensure that the pressure is zero in the line that is being disconnected.

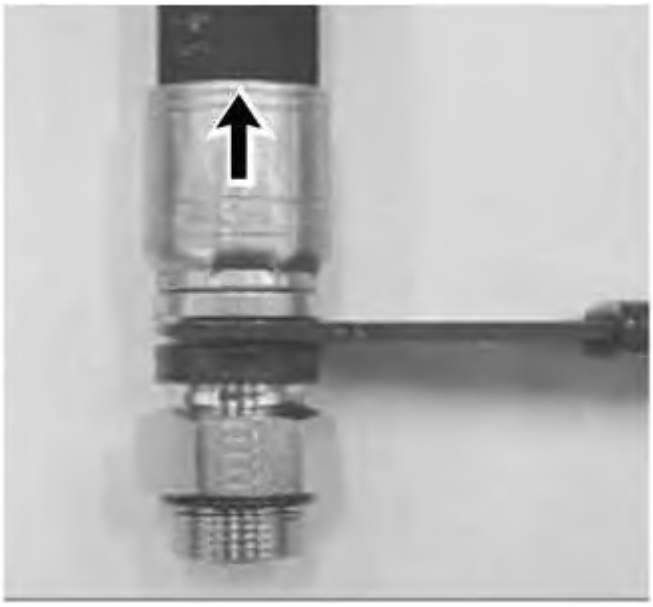


Illustration 2 g02141795

5. Select the designated release tool for the size of the connection. Using the wrong tool may result in damage to the coupling, or cause slippage, resulting in unsafe conditions.

   Note: Prying on the connection may result in damage to the release sleeve, requiring hose replacement.

6. Insert the release tool behind the release sleeve, so that the release tool is perpendicular to the connection. Fully insert the release tool in order to cause the release sleeve to move and separate the retaining ring. The coupling may now be separated.

7. Pull on the hose in the direction parallel to the axis of connection while keeping the release tool engaged. Pulling the hose at an angle may result in extra force required to disconnect the connection.

8. Cover both ends of the connection with recommended plugs or caps in order to avoid contamination.

Connection Procedure

1. Clean the connection that is to be assembled. Ensure that the connection is free of all dirt, dust, and grit.



Illustration 3 g02141956

Note: If the release sleeve is damaged during the connection or disconnection of the STC connection, the male portion must be replaced with new parts.

Note: Do not use the rubber sleeve as leverage to push the male half into the female half of the STC connection.

2. Align the STC fitting on the hose assembly with the STC connector. Push the hose fitting into the mating connector until you feel a definite snap and a solid stop.
3. Pull straight back on the connection. An improperly made connection will disconnect.

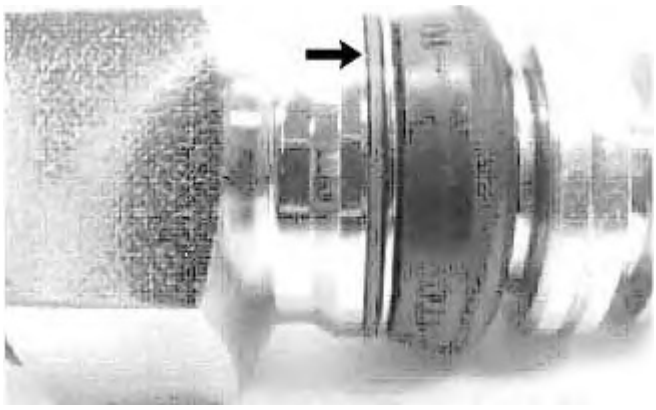


Illustration 4 g02141958

Red ring, on an improper connection.

4. Check for a visible red ring. An improper assembly shows the red ring.

Note: For more information on the operation and the maintenance of Snap to Connect wrenches, refer to Tool Operating Manual, NEHS1083.

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001025

Engine Oil Cooler - Remove

SMCS - 1378-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the engine coolant and the engine oil from the engine oil cooler into a suitable container. Refer to Operation and Maintenance Manual for the procedure on draining the engine coolant and the engine oil.

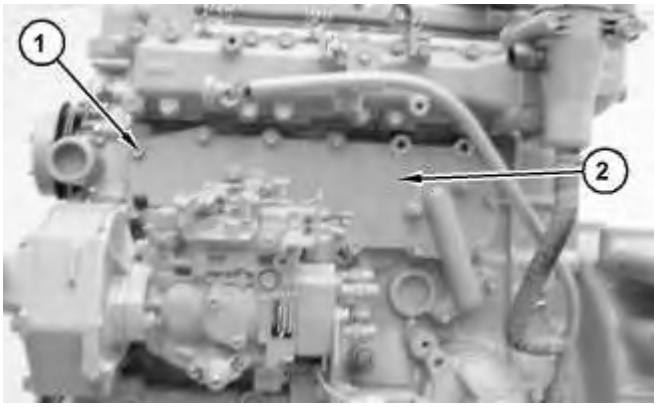


Illustration 1 g01035409

2. Remove bolts (1). Remove engine oil cooler (2) .

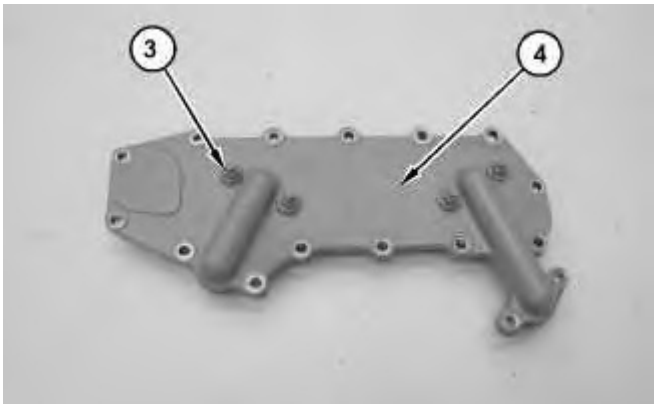


Illustration 2 g01035412

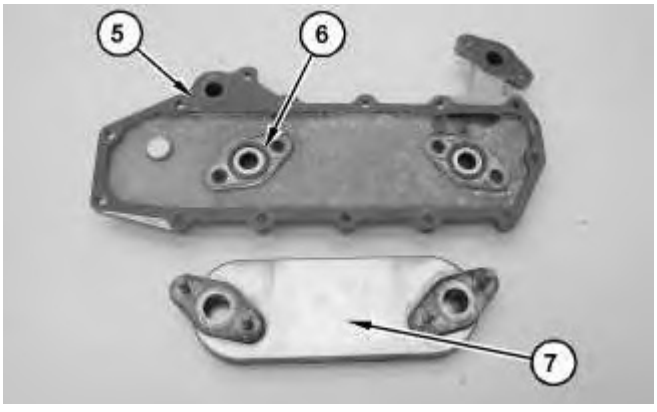


Illustration 3 g01035413

3. Remove nuts (3). Remove cover (4) from oil cooler assembly (7). Remove gaskets (5) and O-ring seals (6) .

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i02001052

Engine Oil Cooler - Install

SMCS - 1378-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

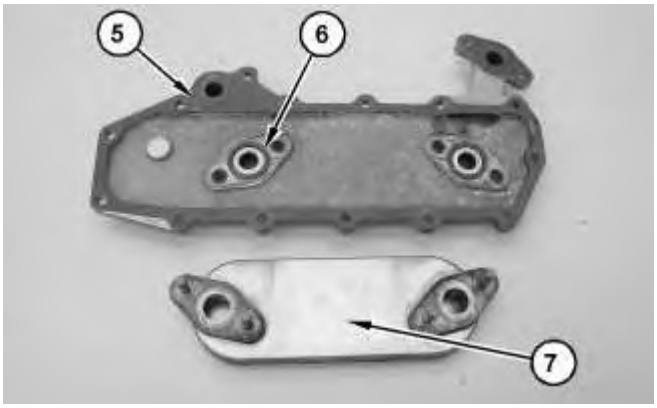


Illustration 1 g01035413

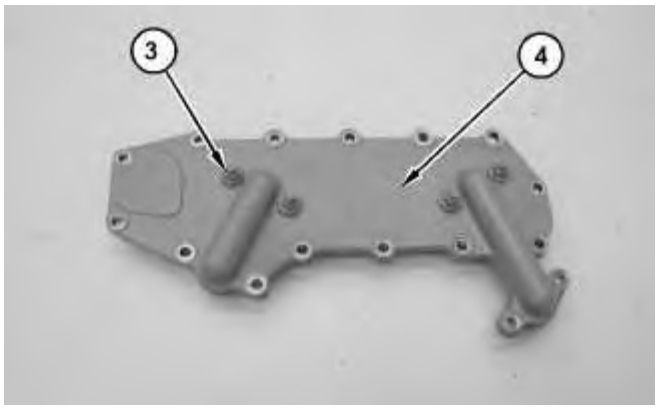


Illustration 2 g01035412

1. Install gaskets (5) and O-ring seals (6). Position cover (4) on oil cooler assembly (7). Install nuts (3) .

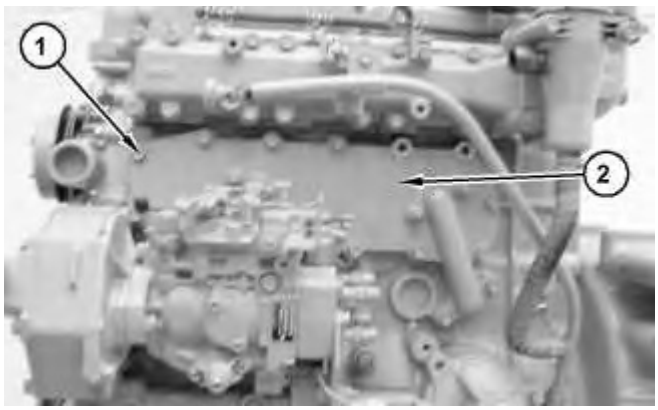


Illustration 3 g01035409

2. Position engine oil cooler (2) and install bolts (1) .
3. Fill the cooling system with coolant. Fill the lubrication system with engine oil. Refer to Operation and Maintenance Manual, "Refill Capacities" for the cooling system and the lubrication system capacities.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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i02001025

Engine Oil Cooler - Remove

SMCS - 1378-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the engine coolant and the engine oil from the engine oil cooler into a suitable container. Refer to Operation and Maintenance Manual for the procedure on draining the engine coolant and the engine oil.

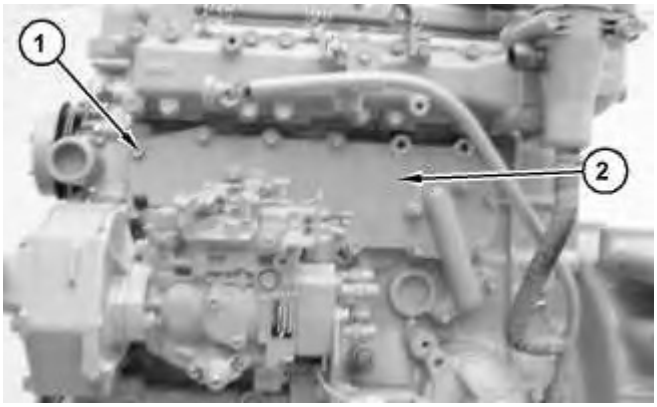


Illustration 1 g01035409

2. Remove bolts (1). Remove engine oil cooler (2) .

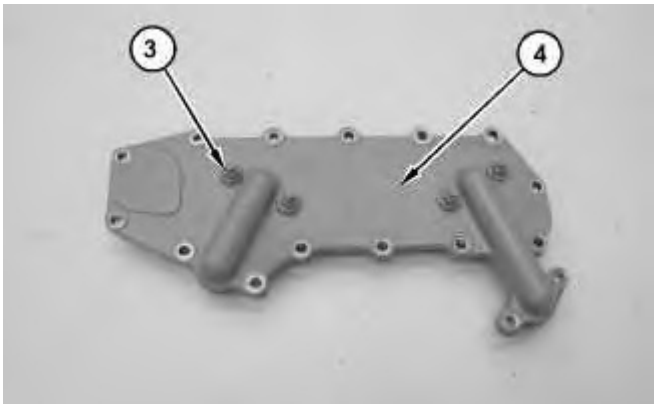


Illustration 2 g01035412

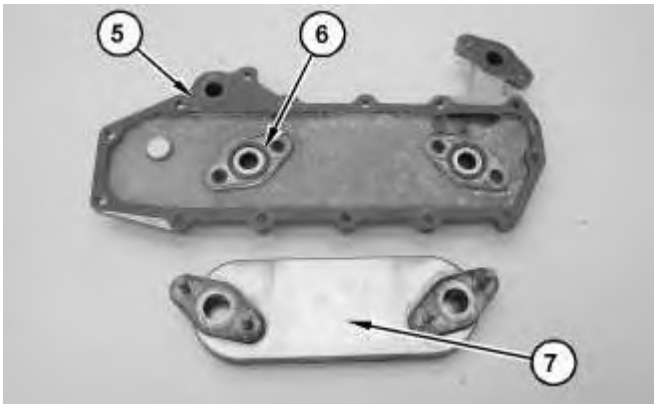


Illustration 3 g01035413

3. Remove nuts (3). Remove cover (4) from oil cooler assembly (7). Remove gaskets (5) and O-ring seals (6) .

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i02001052

Engine Oil Cooler - Install

SMCS - 1378-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

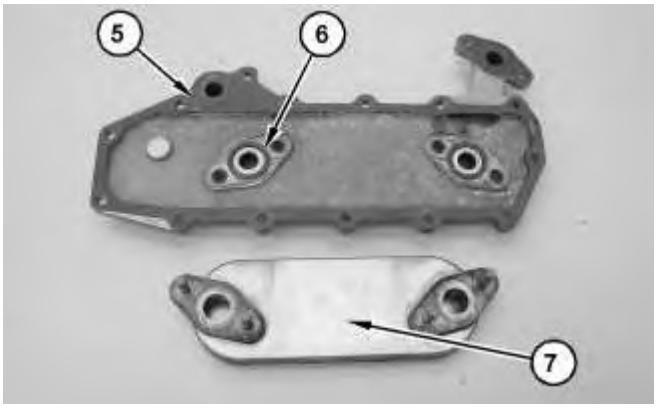


Illustration 1 g01035413

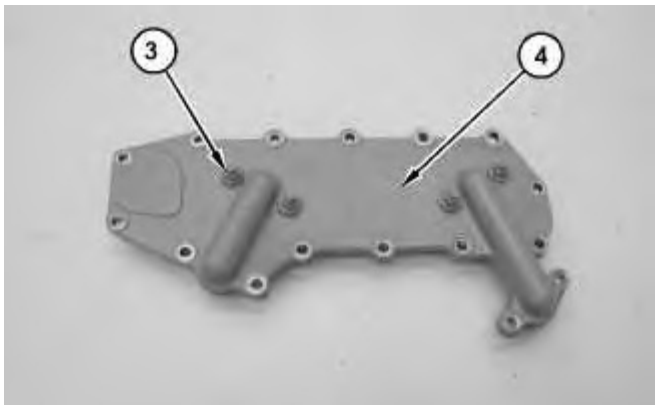


Illustration 2 g01035412

1. Install gaskets (5) and O-ring seals (6). Position cover (4) on oil cooler assembly (7). Install nuts (3) .

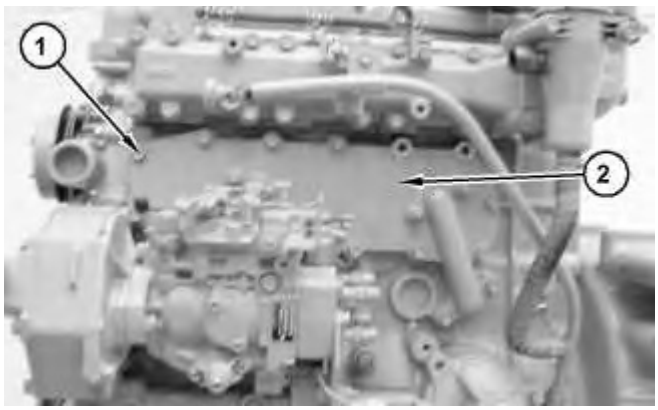


Illustration 3 g01035409

2. Position engine oil cooler (2) and install bolts (1) .
3. Fill the cooling system with coolant. Fill the lubrication system with engine oil. Refer to Operation and Maintenance Manual, "Refill Capacities" for the cooling system and the lubrication system capacities.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638800

Engine Oil Cooler - Remove

SMCS - 1378-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

2. Drain the engine lubricating oil into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the procedure.

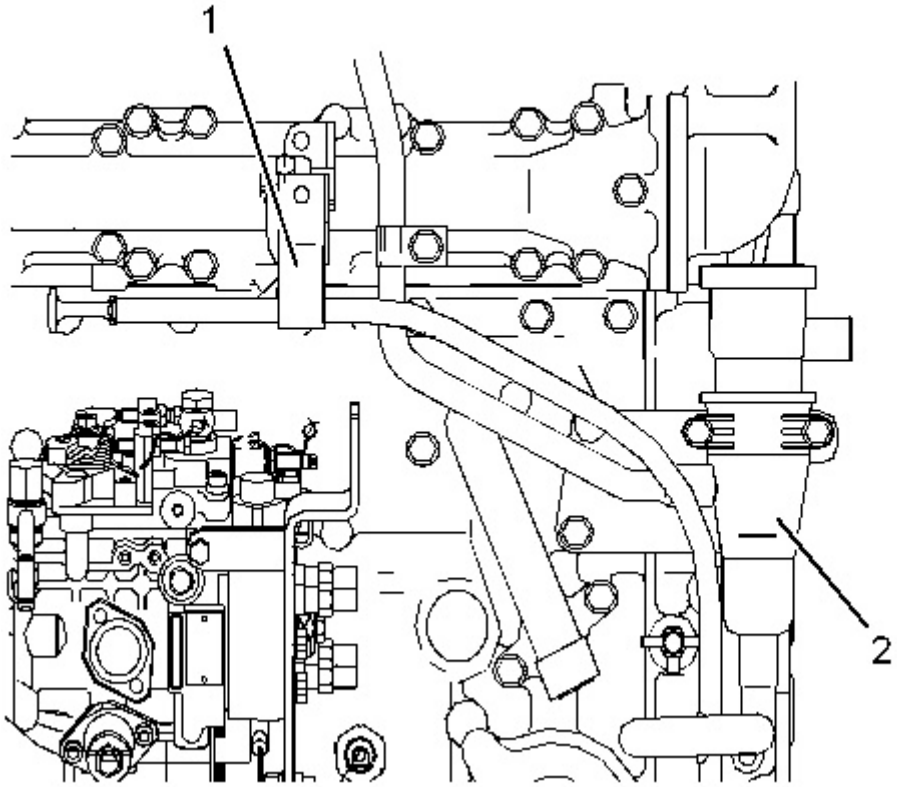


Illustration 1 g01361343

Typical example

3. For turbocharged engines, remove crankcase breather (2). Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".

4. Remove dipstick tube (1) .

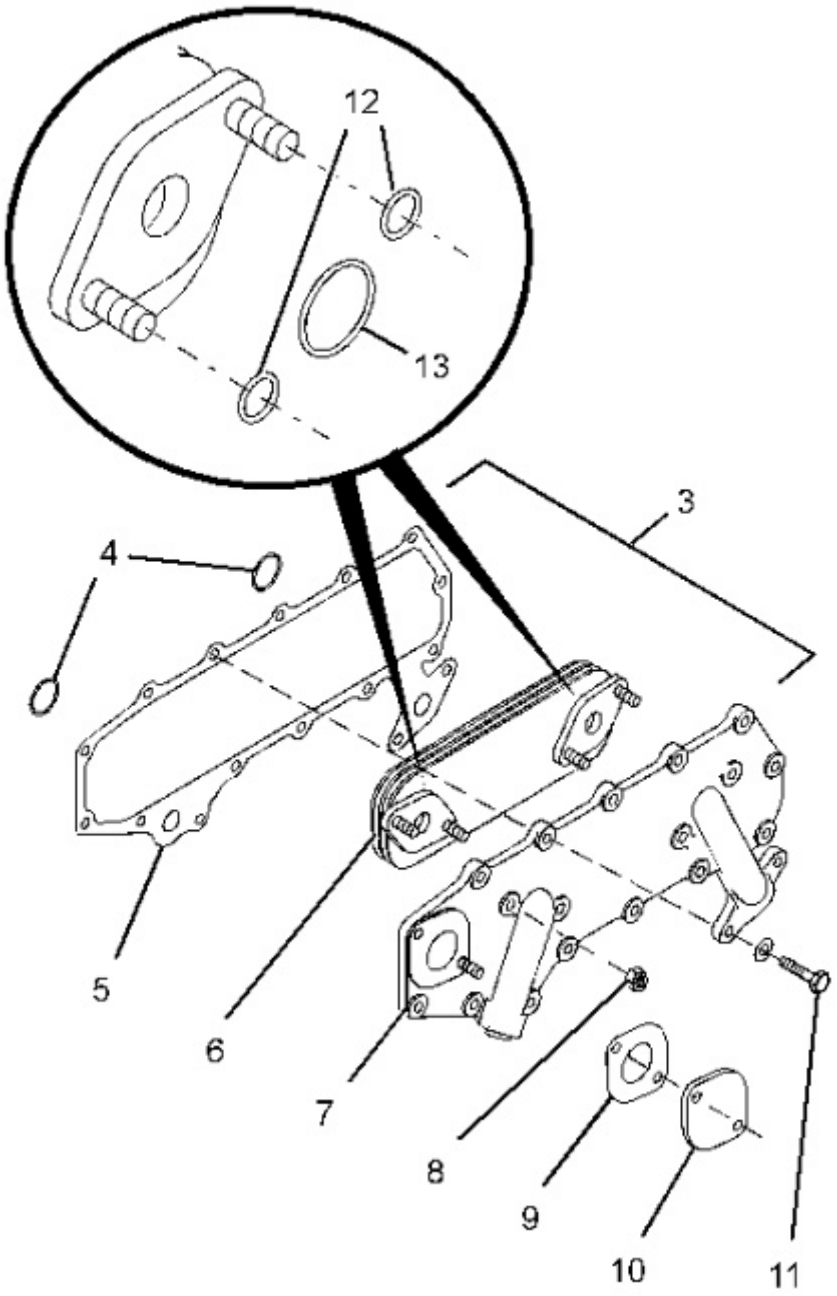


Illustration 2 g01333881

Typical example

5. Gradually loosen bolts (11). Note the position of any brackets that are secured by the bolts.
6. Support the assembly of engine oil cooler (3). Remove bolts (11) and remove the assembly of engine oil cooler (3) from the cylinder block.
7. Remove joint (5) .
8. Remove O-ring seals (4) from the recesses in the cylinder block.
9. If necessary, follow Steps 9.a through 9.d in order to disassemble the engine oil cooler.

a. Remove nuts (8) .

b. Remove cooler matrix (6) from cover (7) .

c. Remove O-ring seals (12) and (13) .

d. Remove plate (10) and joint (9) from cover (7) .

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i02638789

Engine Oil Cooler - Install

SMCS - 1378-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

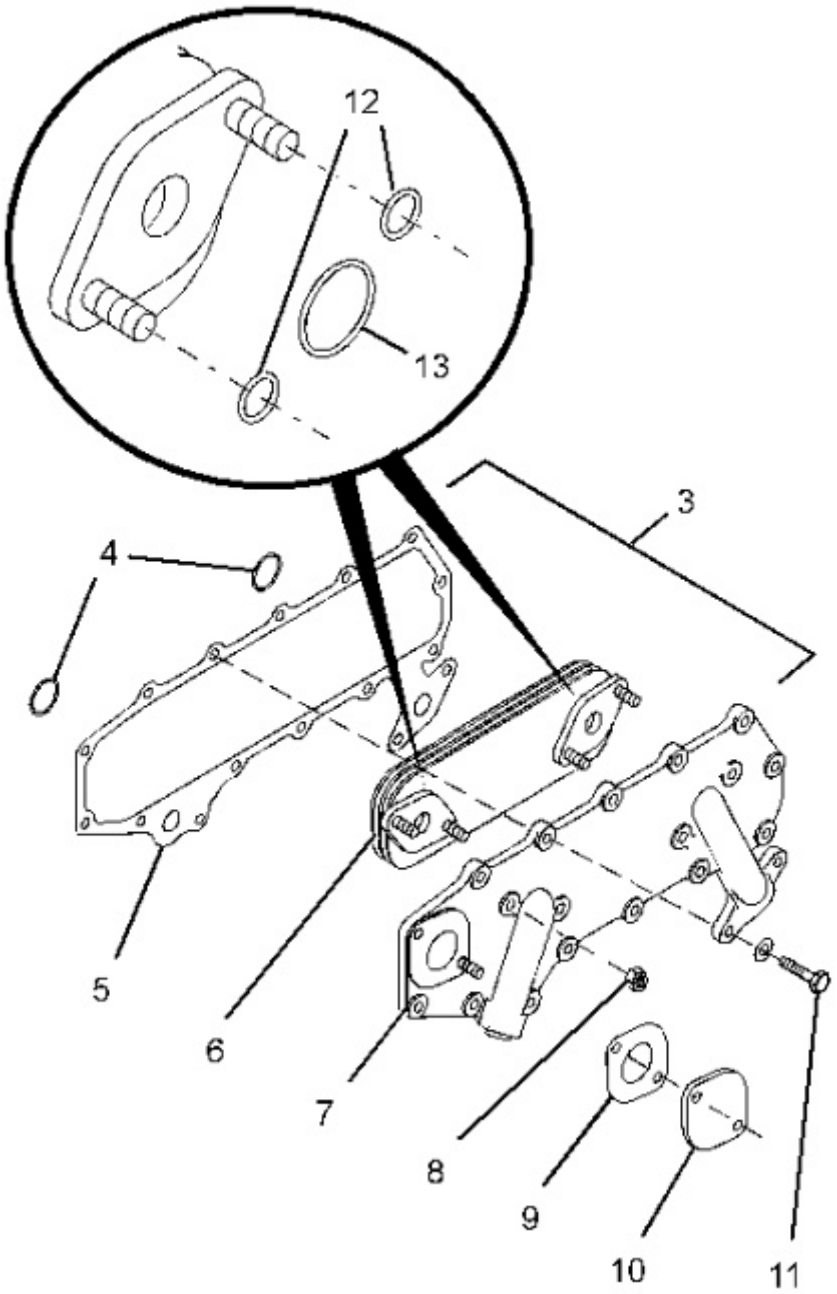


Illustration 1 g01333881

Typical example

1. If necessary, follow Steps 1.a through 1.e in order to assemble the engine oil cooler.
    a. Ensure that cooler matrix (6) is clean and free from damage. Ensure that cover (7) is clean and free from damage.
    b. Position new O-ring seals (12) and (13) onto cover (7) .
    c. Install cooler matrix (6) to cover (7) .
    d. Install nuts (8). Tighten the nuts to a torque of 18 N·m (13 lb ft).

e. Install joint (9) and plate (10) .

2. Clean the mating surface of the cylinder block.
3. Install new O-ring seals (4) to the recesses in the cylinder block.
4. Install two bolts (11) to the upper corners of the assembly of engine oil cooler (3). Install a new joint (5) to the assembly of engine oil cooler (3) .
5. Install the assembly of engine oil cooler (3) to the cylinder block. Install the remaining bolts (11) .

   Note: Ensure that any brackets that are secured by the bolts are installed in the correct location.

6. Tighten bolts (11) evenly to a torque of 18 N·m (13 lb ft).

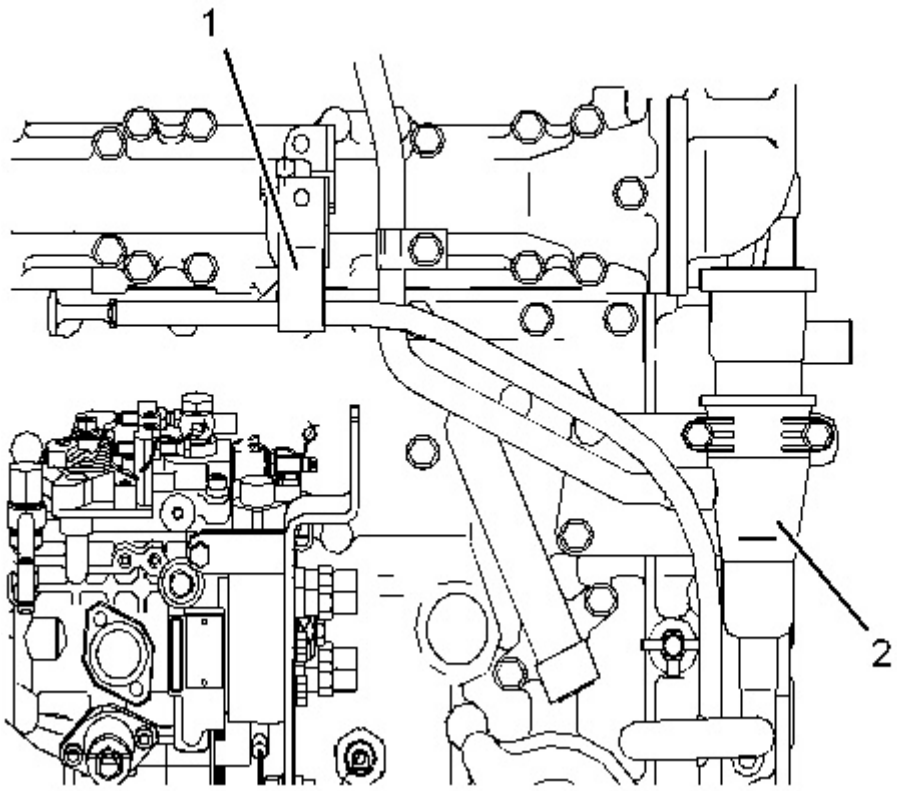


Illustration 2 g01361343

Typical example

7. Install dipstick tube (1) .
8. For turbocharged engines, install crankcase breather (2). Refer to Disassembly and Assembly, "Crankcase Breather - Remove and Install".

9. Fill the cooling system to the correct level. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

10. Fill the engine oil pan to the correct level. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the correct procedure.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Install".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

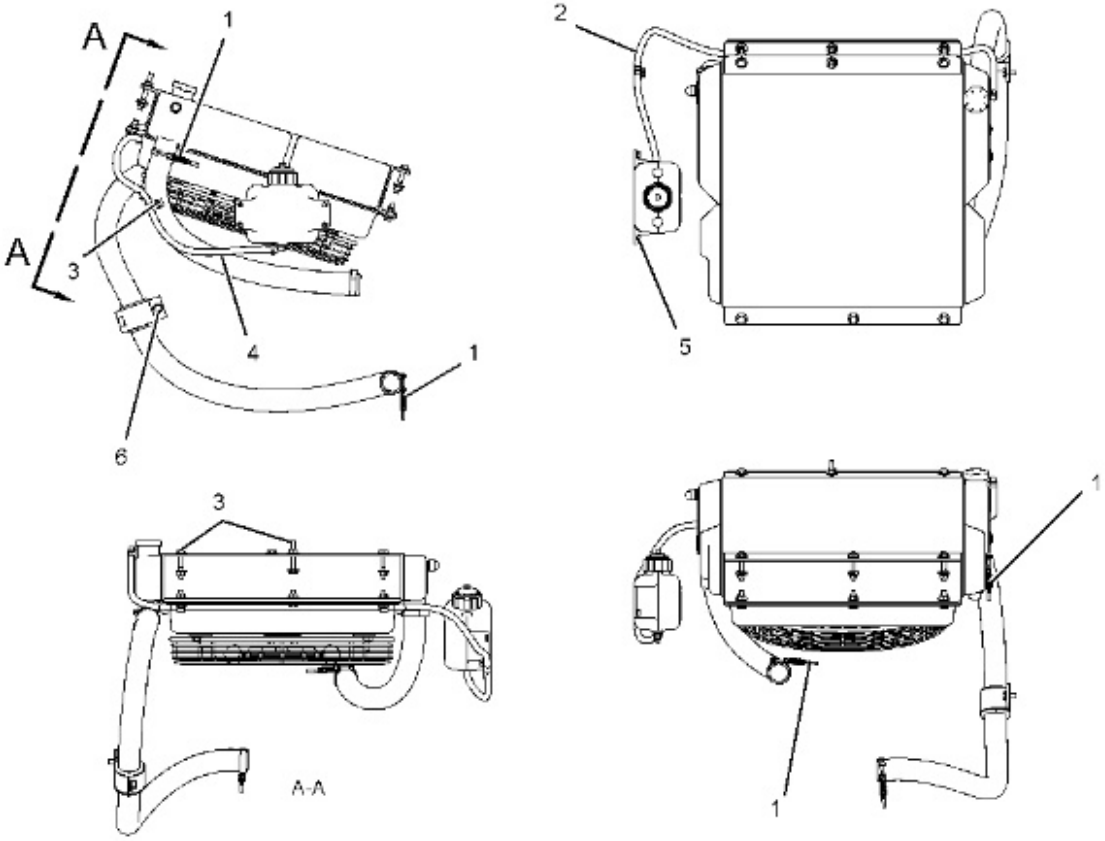


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

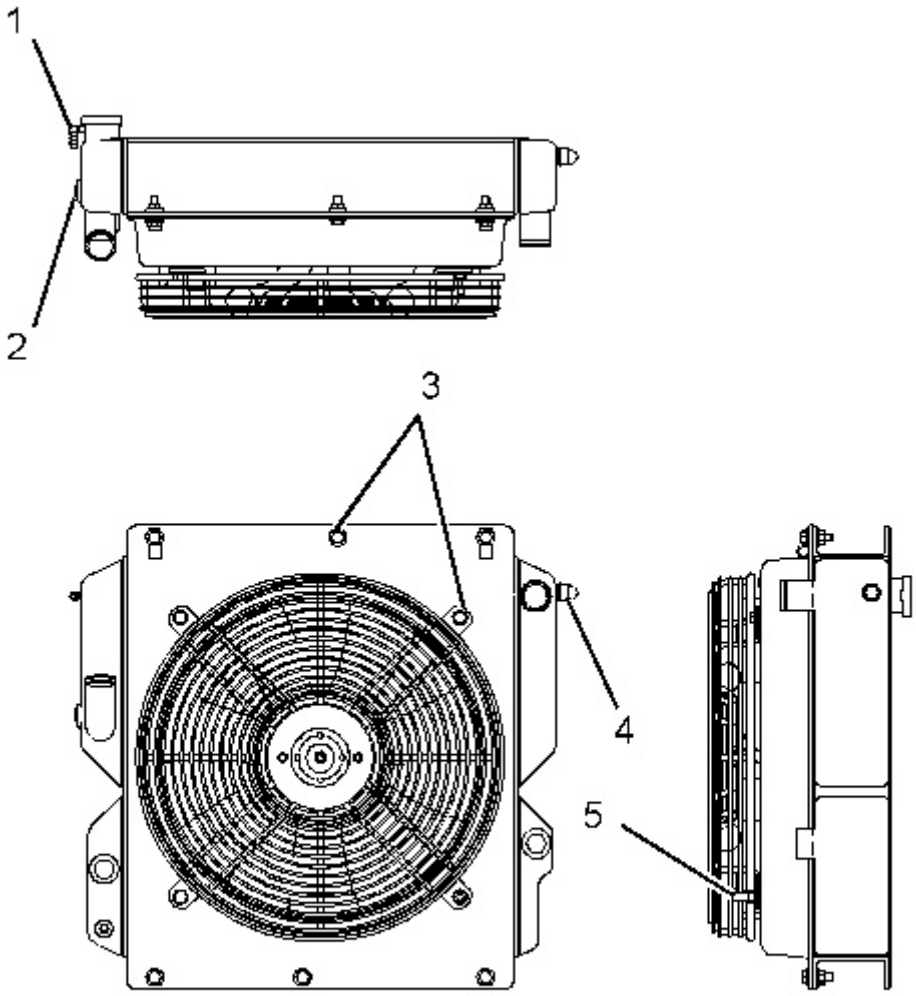


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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i02854767

Gear Motor (Fan)

SMCS - 1386-GT

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

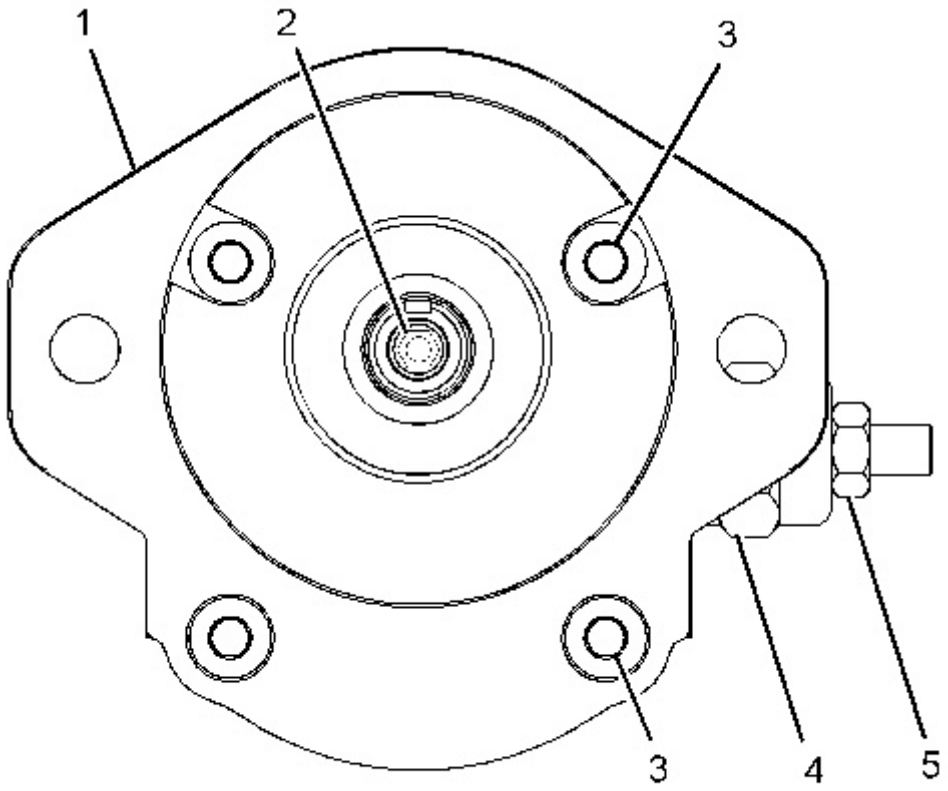


Illustration 1 g01421849

(1) **289-6384** Gear Motor Gp

Rotation ... Clockwise
Displacement per revolution ... 13.34 cc (0.814 in^3)
Maximum continuous pressure ... 15000 kPa (2176 psi)
Intermittent pressure ... 18000 kPa (2611 psi)
Peak pressure ... 20000 kPa (2901 psi)
Minimum rotation at a pressure of 15000 kPa (2176 psi) ... 500 rpm
Maximum rotation at a pressure of 15000 kPa (2176 psi) ... 3500 rpm
Minimum operating temperature ... -40 °C (-40 °F)
Maximum temperature for continuous operation ... 93 °C (199.4 °F)
Maximum temperature for intermittent operation ... 105 °C (224.6 °F)
Setting for the relief valve at a flow rate of 35 L/min (9.2 US gpm) and a temperature of 50 °C (122 °F) ... 21000 kPa (3050 psi)

(2) Torque for the bolt ... 30 ± 7 N·m (22 ± 5 lb ft)

(3) Torque for the four bolts ... 45 ± 3 N·m (33 ± 2 lb ft)

(4) Torque for the nut ... 7 N·m (60 lb in)

(5) Torque for the relief valve group ... 30 N·m (22 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

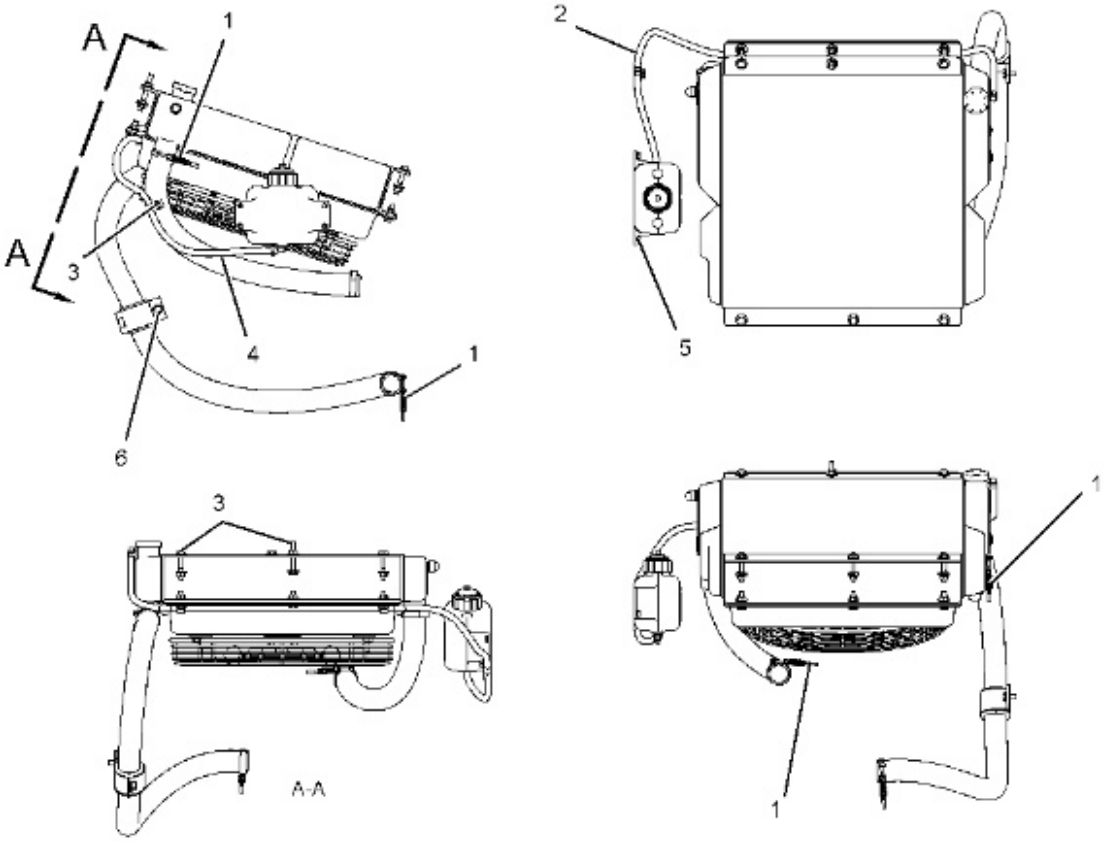


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

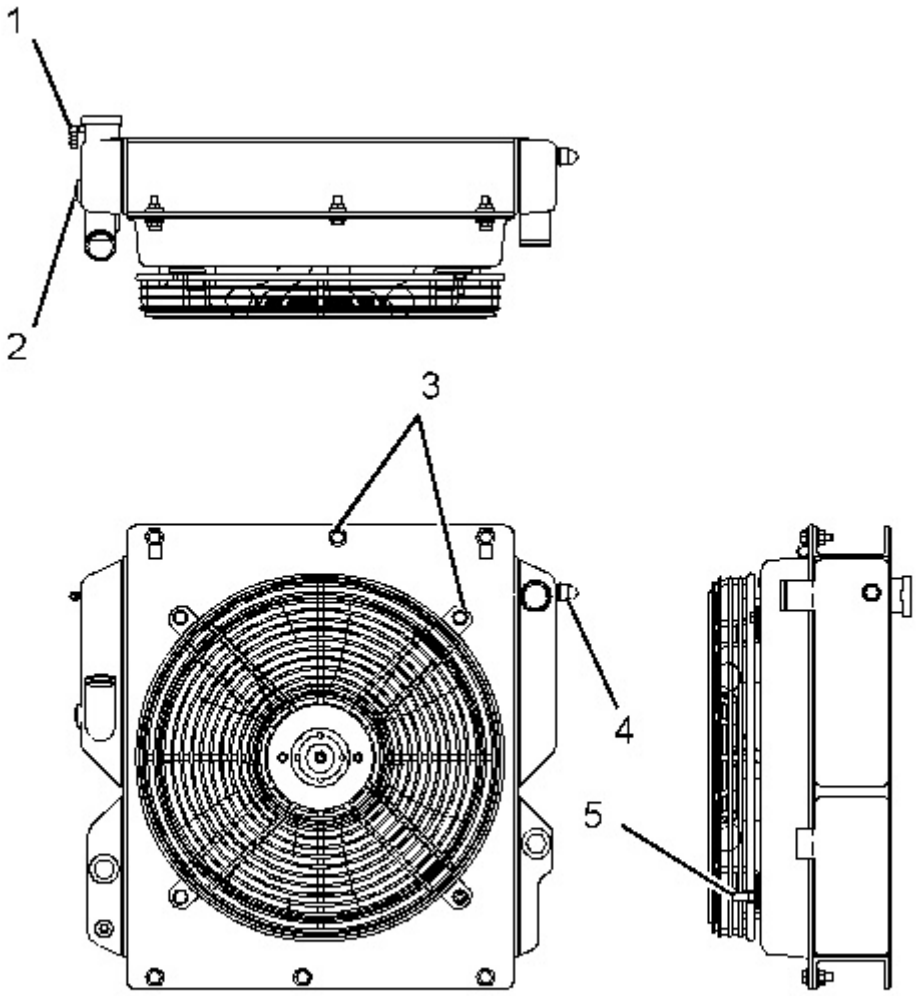


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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i02854767

Gear Motor (Fan)

SMCS - 1386-GT

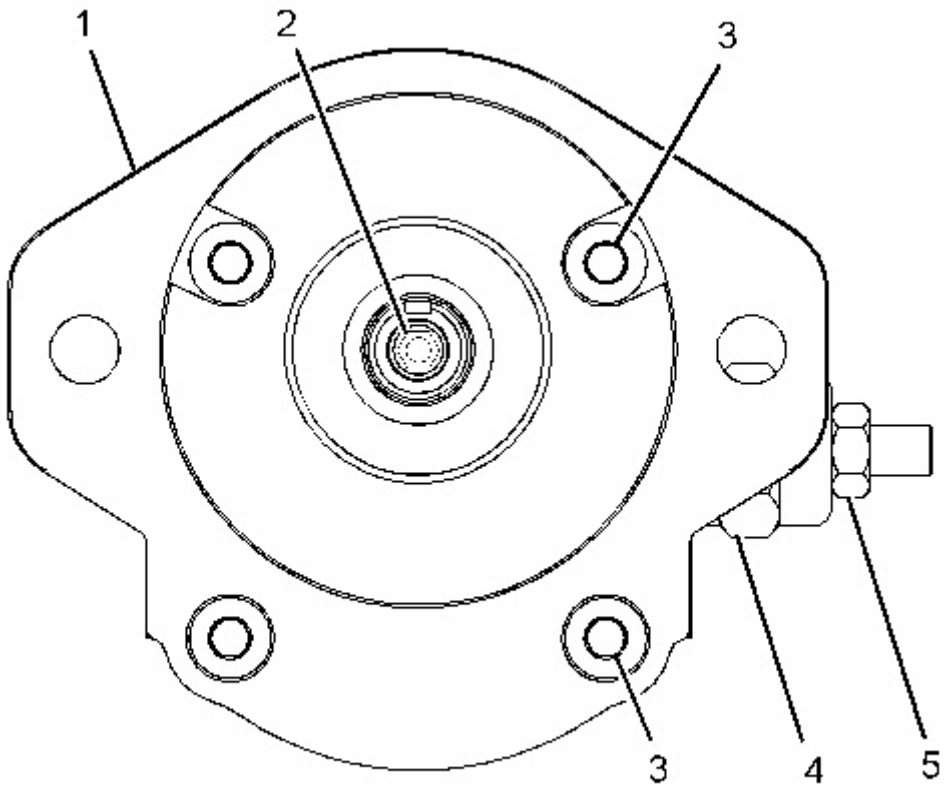


Illustration 1 g01421849

(1) **289-6384** Gear Motor Gp

Rotation ... Clockwise
Displacement per revolution ... 13.34 cc (0.814 in^3)
Maximum continuous pressure ... 15000 kPa (2176 psi)

Intermittent pressure ... 18000 kPa (2611 psi)
Peak pressure ... 20000 kPa (2901 psi)
Minimum rotation at a pressure of 15000 kPa (2176 psi) ... 500 rpm
Maximum rotation at a pressure of 15000 kPa (2176 psi) ... 3500 rpm
Minimum operating temperature ... -40 °C (-40 °F)
Maximum temperature for continuous operation ... 93 °C (199.4 °F)
Maximum temperature for intermittent operation ... 105 °C (224.6 °F)
Setting for the relief valve at a flow rate of 35 L/min (9.2 US gpm) and a temperature of 50 °C (122 °F) ... 21000 kPa (3050 psi)

(2) Torque for the bolt ... 30 ± 7 N·m (22 ± 5 lb ft)

(3) Torque for the four bolts ... 45 ± 3 N·m (33 ± 2 lb ft)

(4) Torque for the nut ... 7 N·m (60 lb in)

(5) Torque for the relief valve group ... 30 N·m (22 lb ft)

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i02639316

Fan - Remove and Install

SMCS - 1356-010

Removal Procedure

Start By:

A. Remove the V-Belt. Refer to Disassembly and Assembly, "V-Belts - Remove and Install".

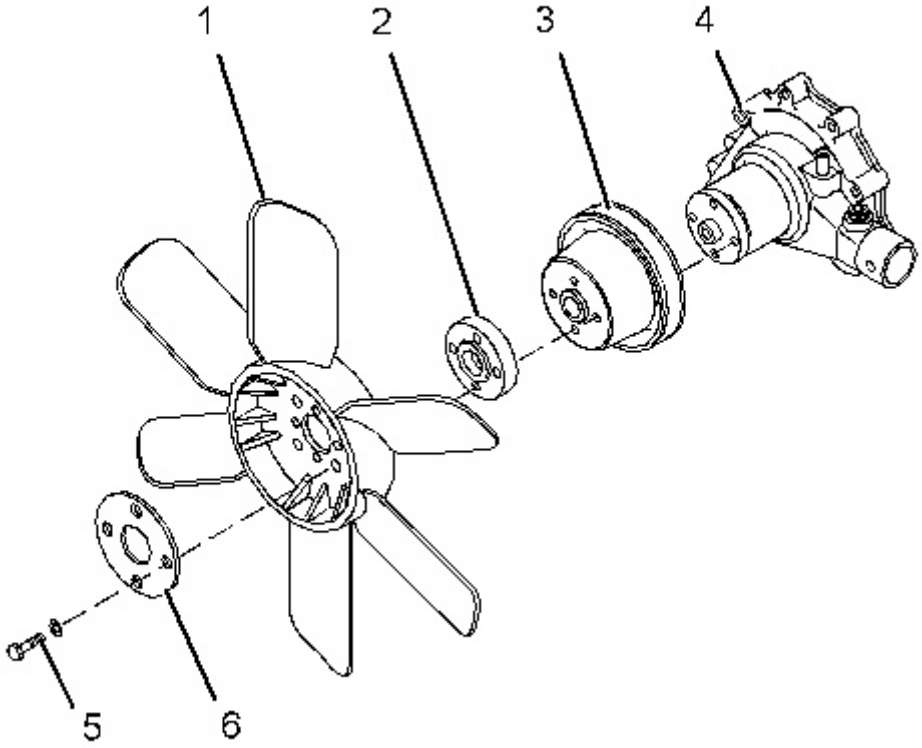


Illustration 1 g01343637

Typical example

1. Remove bolts (5) and plate (6) .
2. Remove fan (1). Note the orientation of the fan for installation.
3. If the engine is equipped with a spacer, remove spacer (2) .
4. Remove pulley (3) from water pump (4) .

Installation Procedure

1. Ensure that all components are free from wear or damage. If necessary, replace any components that are worn or damaged.

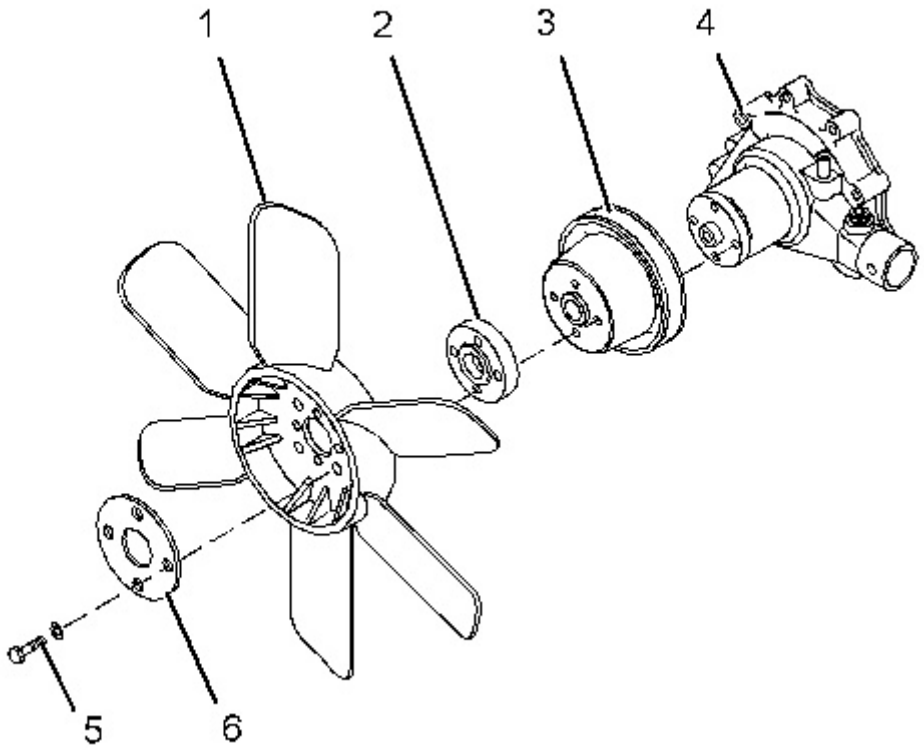


Illustration 2 g01343637

Typical example

2. Position fan pulley (3) onto water pump (4) .

3. If the engine is equipped with a spacer, position spacer (2) onto pulley (3) .
4. Install fan (1), plate (6), and bolts (5) .

   Note: Ensure that the fan is correctly oriented.
5. Tighten bolts (5) to a torque of 18 N·m (13 lb ft).

End By: Install the V-Belt. Refer to Disassembly and Assembly, "V-Belts - Remove and Install".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01893737

Water Temperature Regulator

SMCS - 1355

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

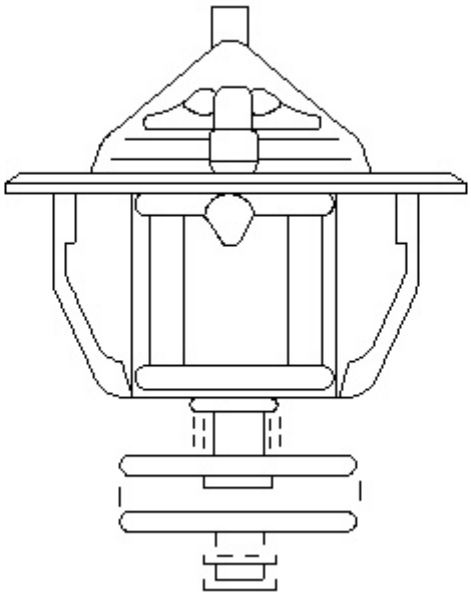


Illustration 1 g00877006

The water temperature regulator starts to open at the following temperature. ... 82° ± 1.5°C (180° ± 2.7°F)

The water temperature regulator has a lift of more than 8 mm (0.3 inch) at the following temperature. ... 95 °C (203 °F)

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i01893737

Water Temperature Regulator

SMCS - 1355

S/N - -

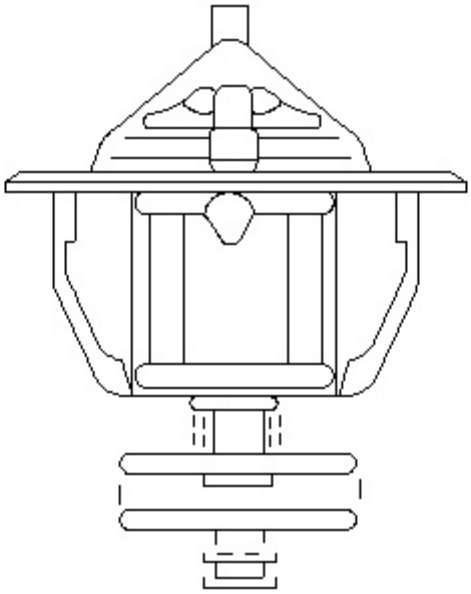


Illustration 1 g00877006

The water temperature regulator starts to open at the following temperature. ... 82° ± 1.5°C (180° ± 2.7°F)

The water temperature regulator has a lift of more than 8 mm (0.3 inch) at the following temperature. ... 95 °C (203 °F)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02002193

Water Temperature Regulator Housing - Remove and Install

SMCS - 1393-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

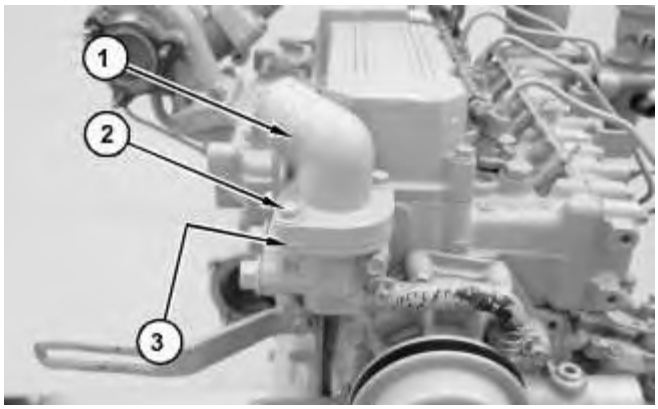


Illustration 1 g01035909

2. Remove bolts (2). Remove elbow assembly (1) and gasket (3) .

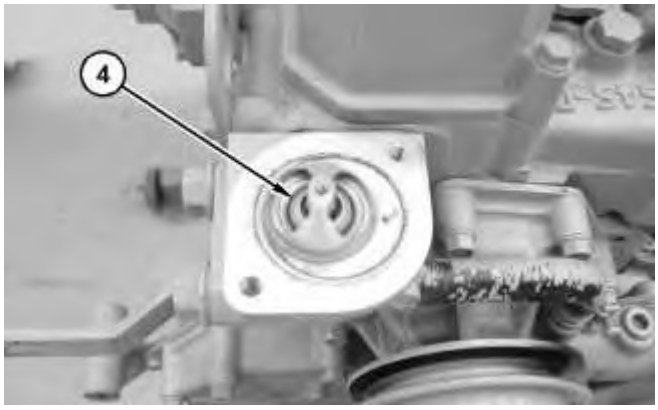


Illustration 2 g01035910

3. Remove water temperature regulator (4). Note the orientation of the water temperature regulator for installation purposes.

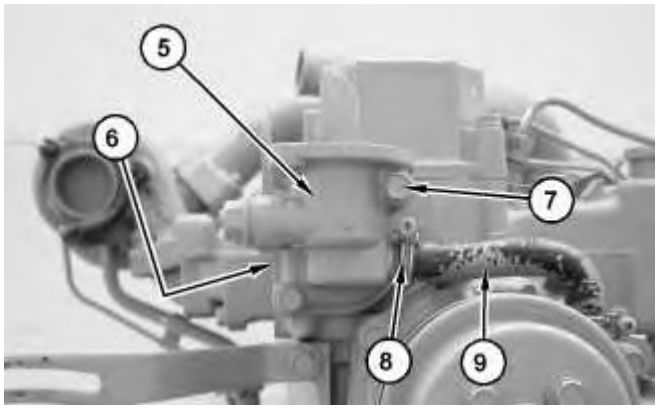


Illustration 3 g01035912

4. Loosen clamp (8) and disconnect hose (9). Remove bolts (7). Remove water temperature regulator housing (5) and gasket (6) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

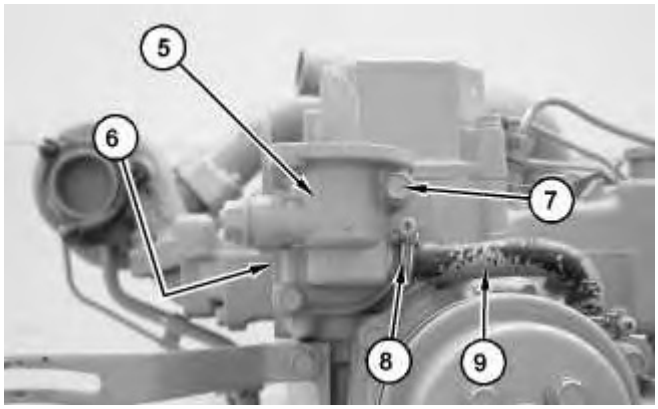


Illustration 4 g01035912

1. Install gasket (6) and position water temperature regulator housing (5). Install bolts (7). Connect hose (9) and tighten clamp (8) .

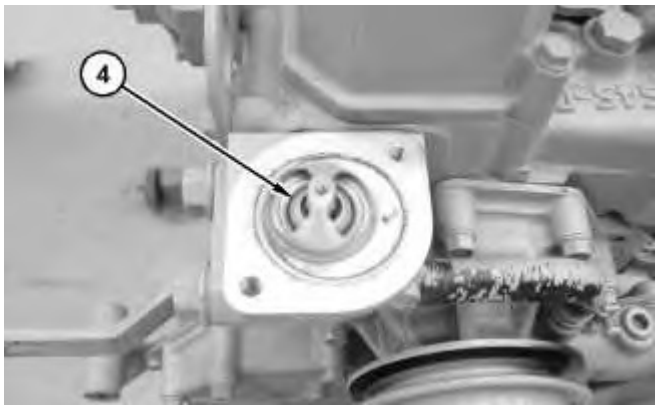


Illustration 5 g01035910

2. Note the orientation of water temperature regulator (4). Install water temperature regulator (4) .

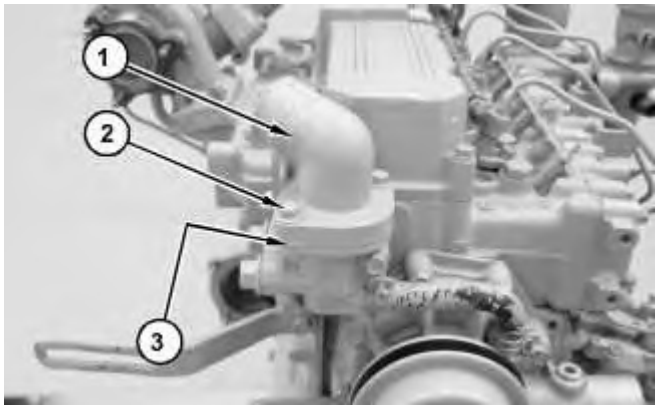


Illustration 6 g01035909

3. Install gasket (3) and elbow assembly (1). Install bolts (2) .

4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i02002193

Water Temperature Regulator Housing - Remove and Install

SMCS - 1393-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

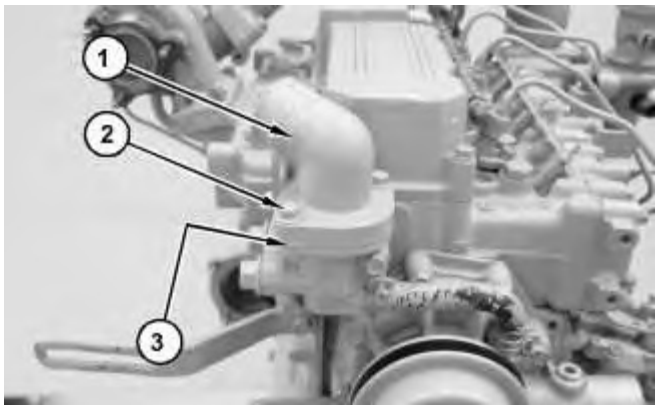


Illustration 1 g01035909

2. Remove bolts (2). Remove elbow assembly (1) and gasket (3) .

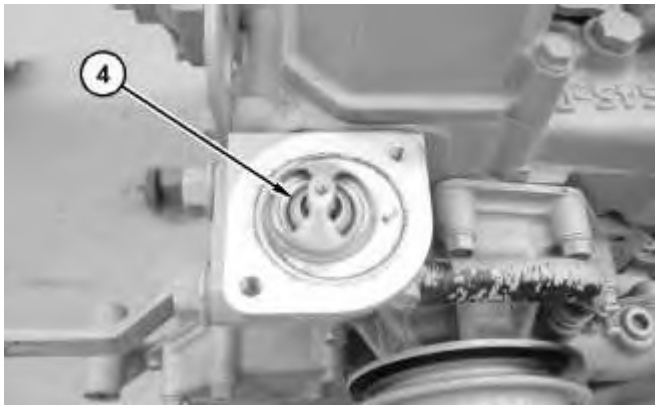


Illustration 2 g01035910

3. Remove water temperature regulator (4). Note the orientation of the water temperature regulator for installation purposes.

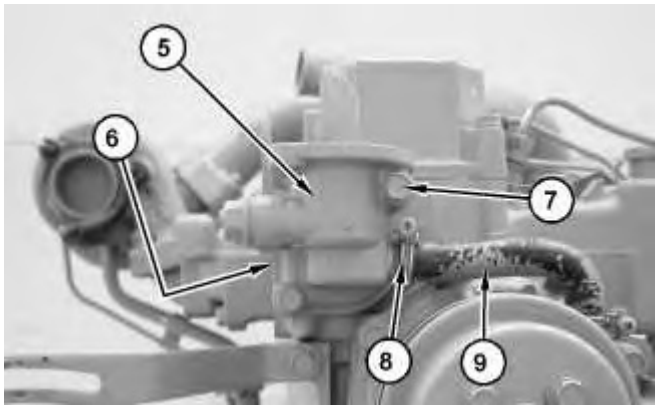


Illustration 3 g01035912

4. Loosen clamp (8) and disconnect hose (9). Remove bolts (7). Remove water temperature regulator housing (5) and gasket (6) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

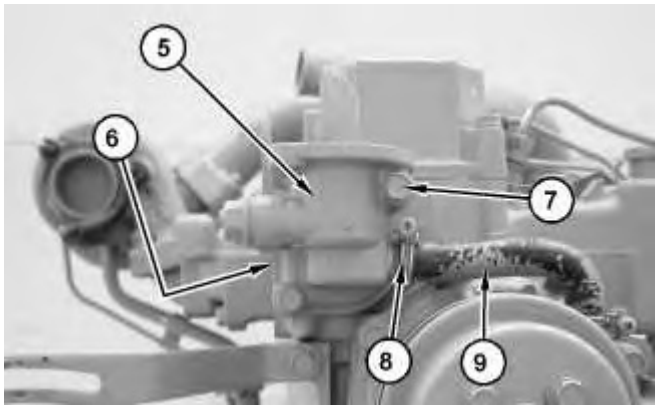


Illustration 4 g01035912

1. Install gasket (6) and position water temperature regulator housing (5). Install bolts (7). Connect hose (9) and tighten clamp (8) .

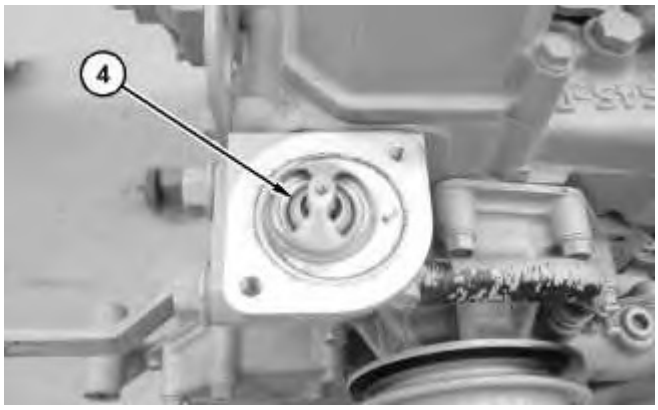


Illustration 5 g01035910

2. Note the orientation of water temperature regulator (4). Install water temperature regulator (4) .

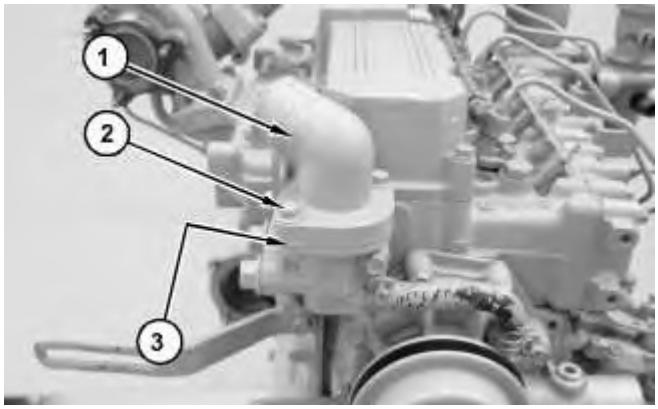


Illustration 6 g01035909

3. Install gasket (3) and elbow assembly (1). Install bolts (2) .

4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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i02638861

Water Temperature Regulator Housing - Remove and Install

SMCS - 1393-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

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1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

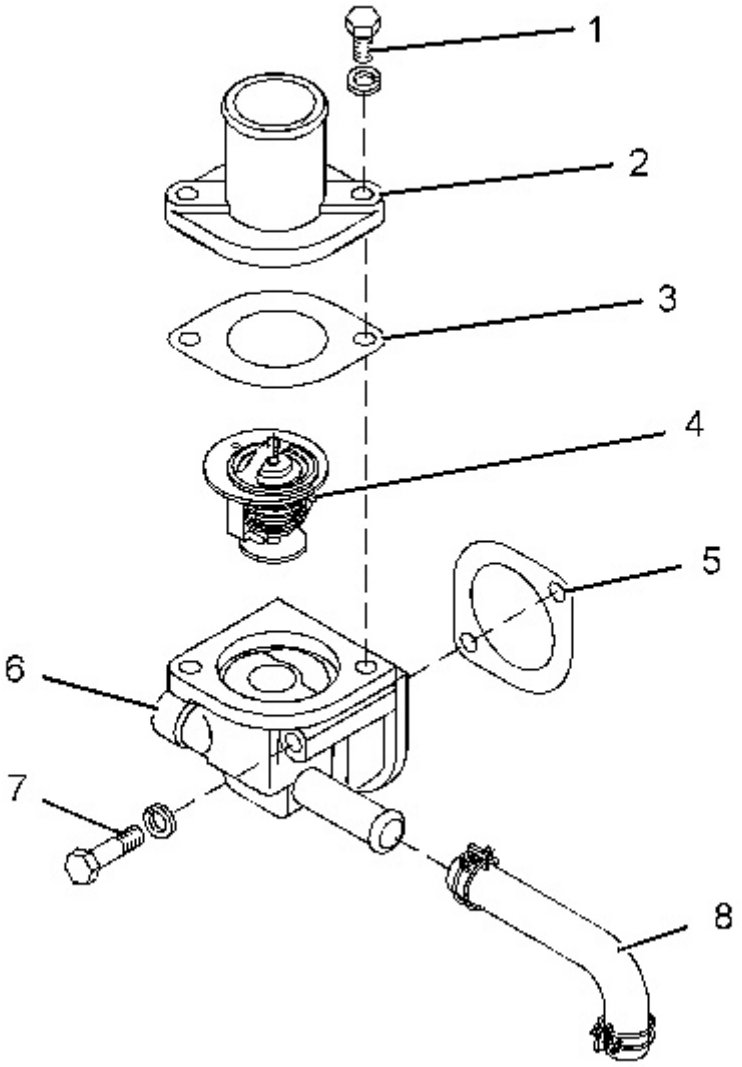


Illustration 1 g01335249

Typical example

2. Remove bolts (1) and remove outlet connection (2) .
3. Remove joint (3) and remove water temperature regulator (4). Note the orientation of the water temperature regulator for installation.
4. Loosen the hose clamp and disconnect hose (8) from water temperature regulator housing (6) .
5. Remove bolts (7) and remove water temperature regulator housing (6) from the cylinder head.
6. Remove joint (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the water temperature regulator for wear, damage and correct operation. Refer to Systems Operation,Testing and Adjusting, "Water Temperature Regulator - Test" for more information. If necessary, replace the water temperature regulator.
2. Ensure that the mating surfaces of the outlet connection, the water temperature regulator housing and the cylinder head are clean and free from damage.

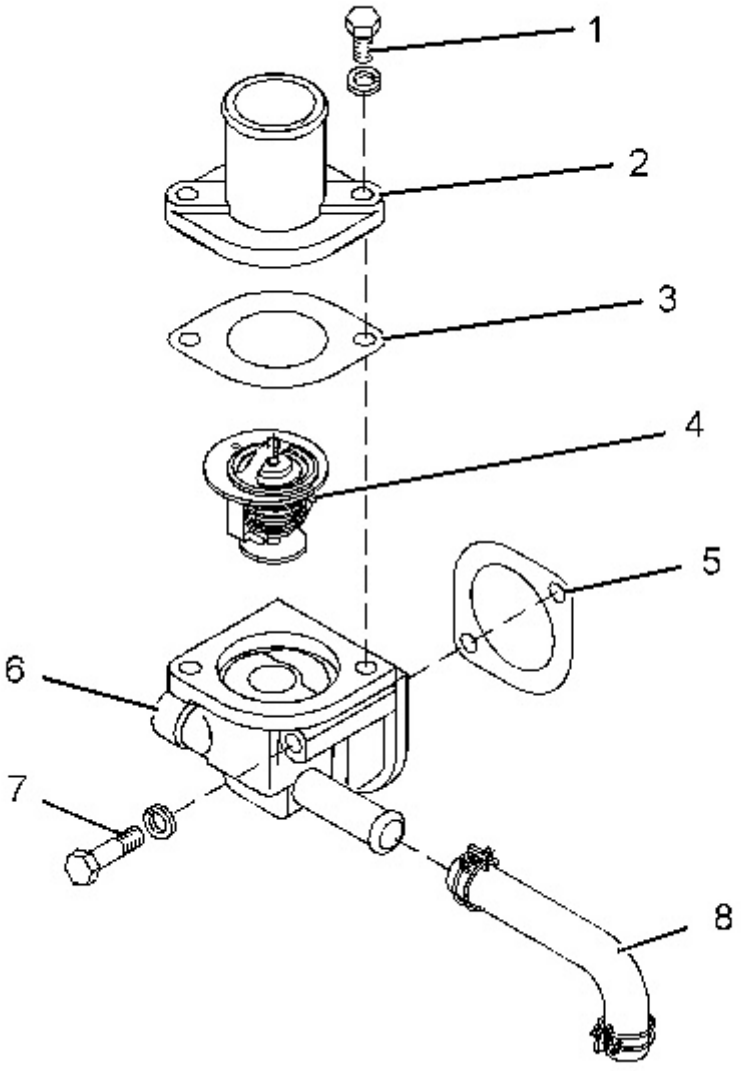


Illustration 2 g01335249

Typical example

3. Position bolts (7) and a new joint (5) onto water temperature regulator housing (6) .
4. Position water temperature regulator housing (6) onto the cylinder head. Tighten bolts (7) to a torque of 18 N·m (13 lb ft).

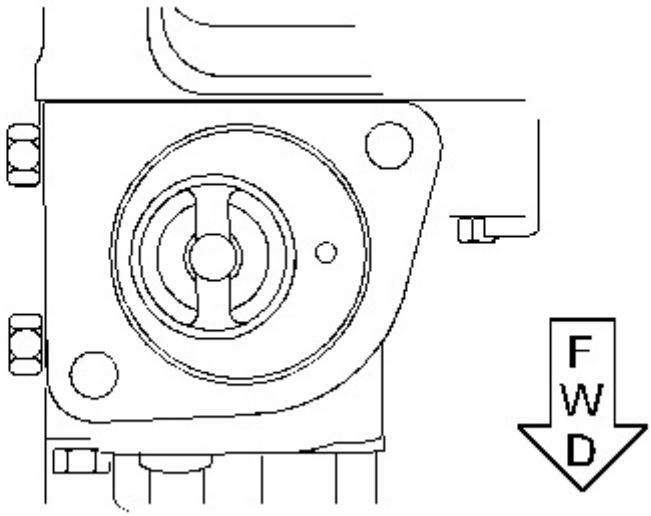


Illustration 3 g01335282

Orientation of the water temperature regulator

5. Install water temperature regulator (4) to water temperature regulator housing (6). Ensure the correct orientation of the water temperature regulator.
6. Position a new joint (3) and outlet connection (2) onto water temperature regulator housing (6) .
7. Install bolts (1). Tighten the bolts to 18 N·m (13 lb ft).
8. Connect hose (8) to water temperature regulator housing (6). Tighten the hose clamps securely.
9. Fill the cooling system with coolant to the correct level. Refer to Operation and Maintenance Manual, "Cooling System Coolant -Change" for the correct procedure.

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02006771

Water Temperature Regulator - Remove and Install

SMCS - 1355-010

Removal Procedure

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

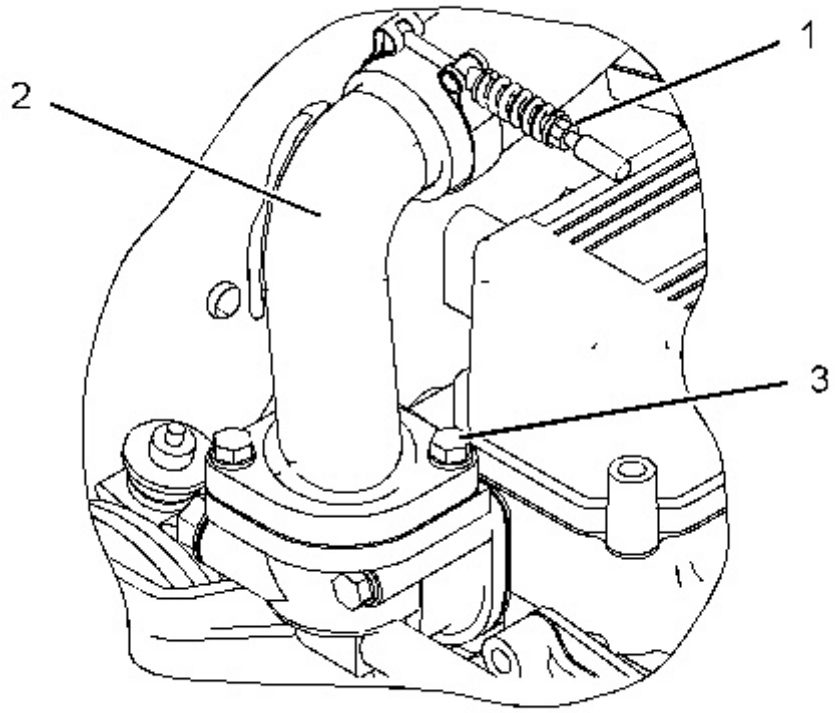


Illustration 1 g01038133

2. Remove bolts (3). Loosen clamp (1) and remove tube assembly (2) .

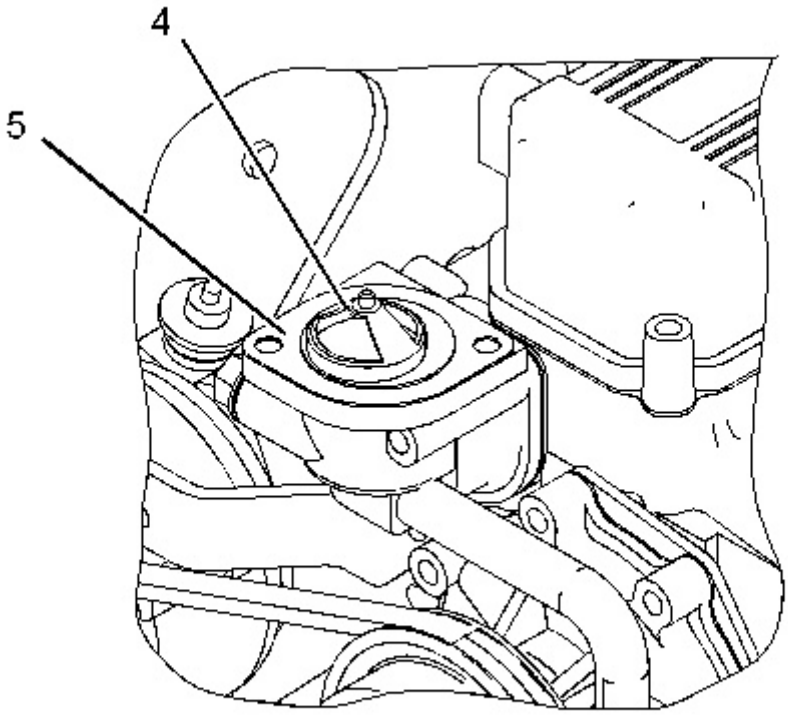


Illustration 2 g01038135

3. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. Remove gasket (5) and remove water temperature regulator (4) .

Installation Procedure

1. Clean all mating surfaces.

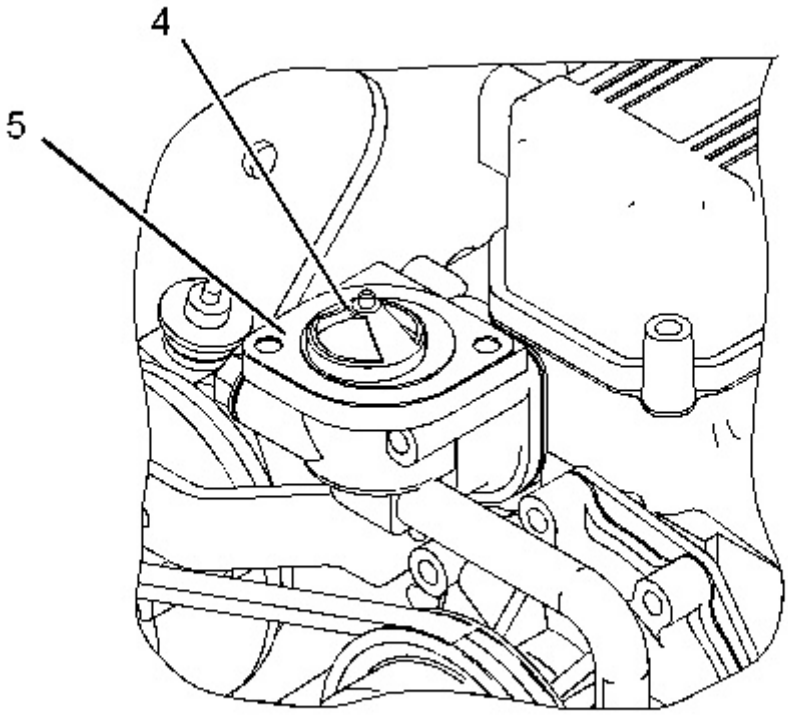


Illustration 3 g01038135

2. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. The pin should be oriented toward the right side of the machine. Install gasket (5) and install water temperature regulator (4) .

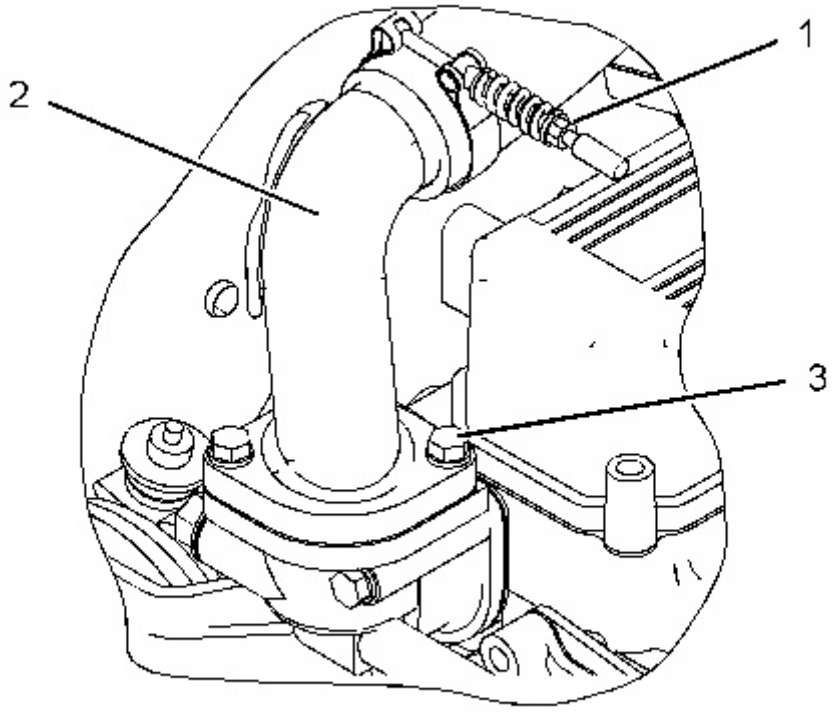


Illustration 4 g01038133

3. Install tube assembly (2). Install bolts (3). Tighten clamp (1) .
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i03037529

Water Pump - Remove and Install

SMCS - 1361-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

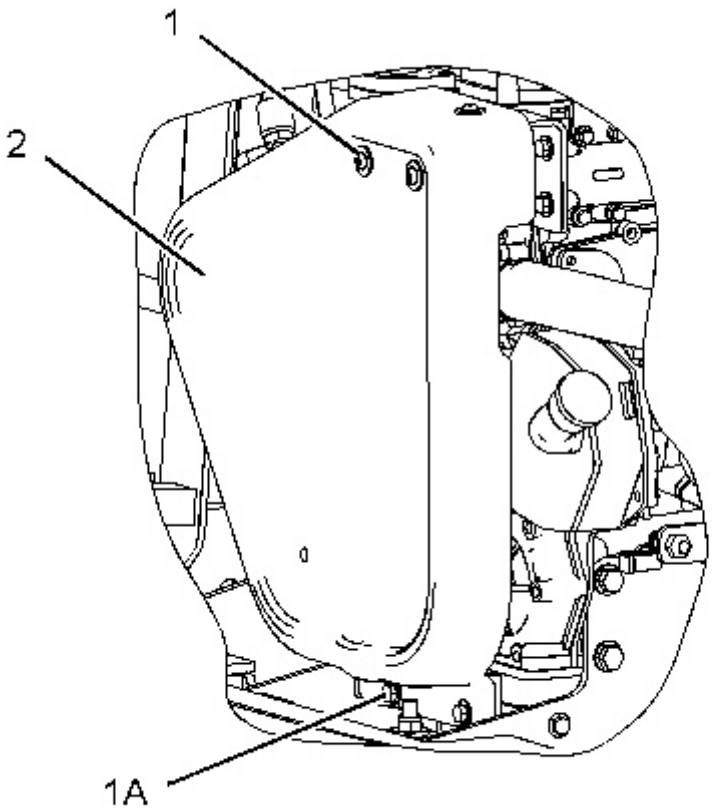


Illustration 1 g01541413

2. Remove bolts (1A) and screws (1) . Remove cover (2) .

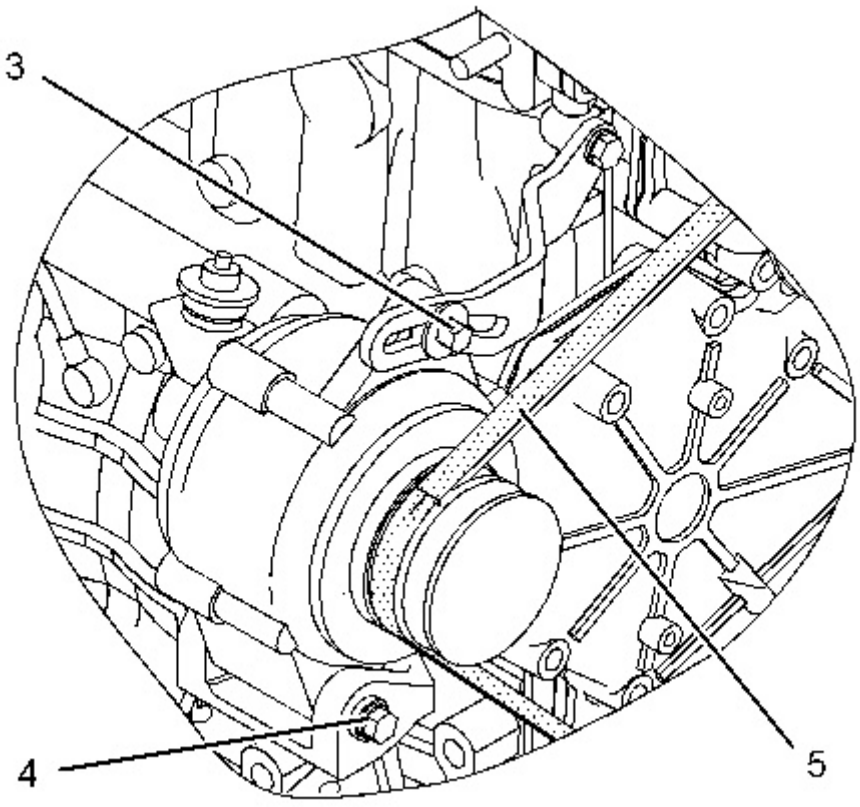


Illustration 2 g01037886

3. Loosen bolts (3) and (4) . Rotate the alternator in order to loosen belt (5) .

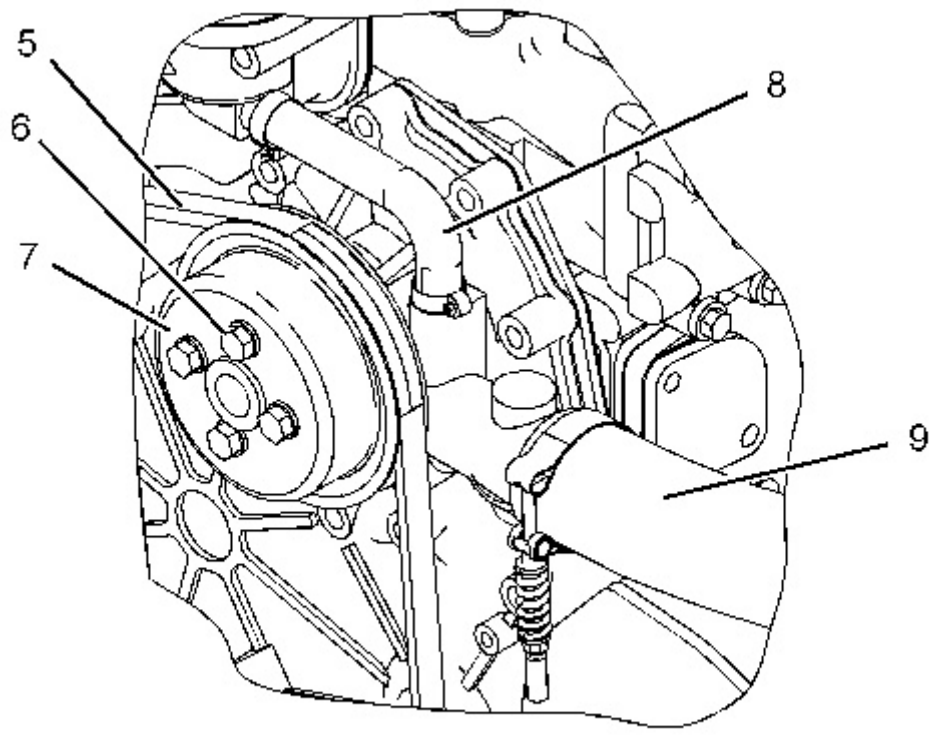


Illustration 3 g01037901

4. Remove belt (5) . Remove bolts (6) and remove pulley (7) . Disconnect hoses (8) and (9) .

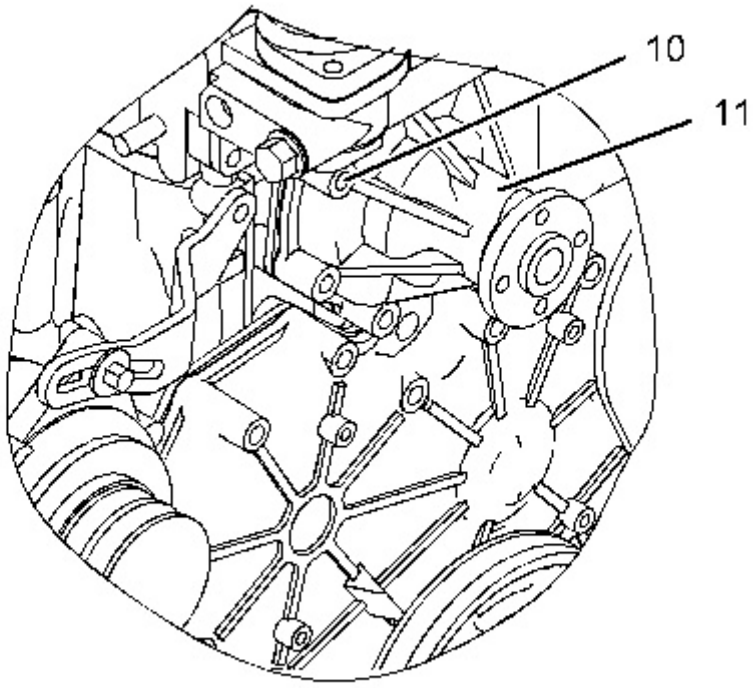


Illustration 4 g01037941

5. Remove bolts (10) and remove water pump (11) .

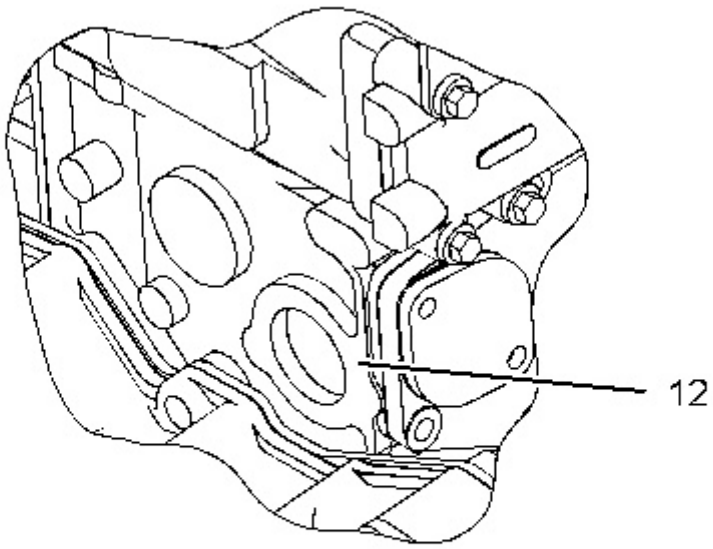


Illustration 5 g01037949

6. Remove gasket (12) .

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

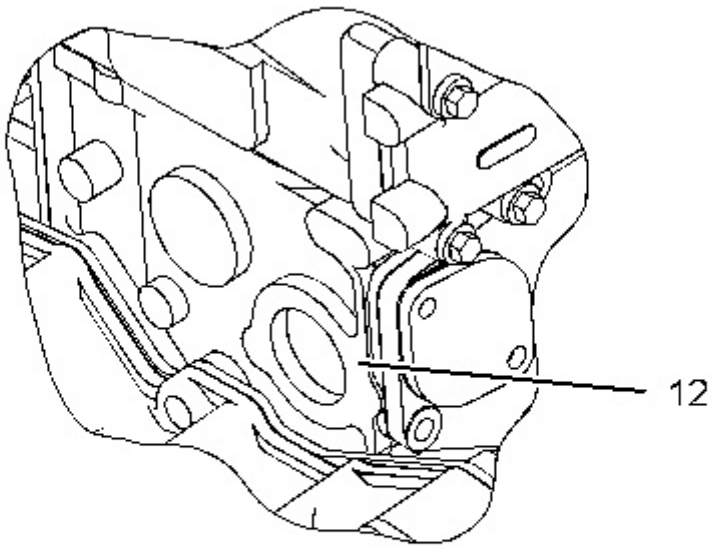


Illustration 6 g01037949

1. Install new gasket (12) .

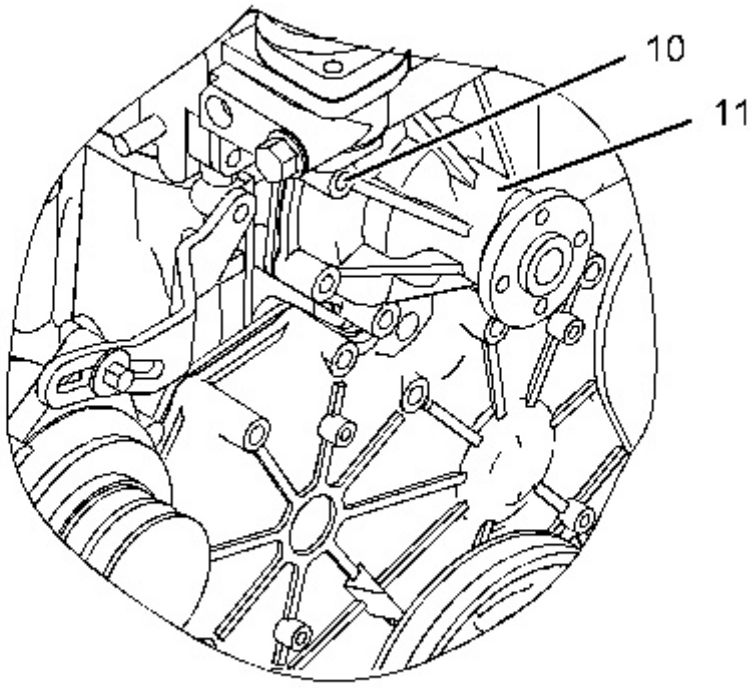


Illustration 7 g01037941

2. Install water pump (11) and install bolts (10) .

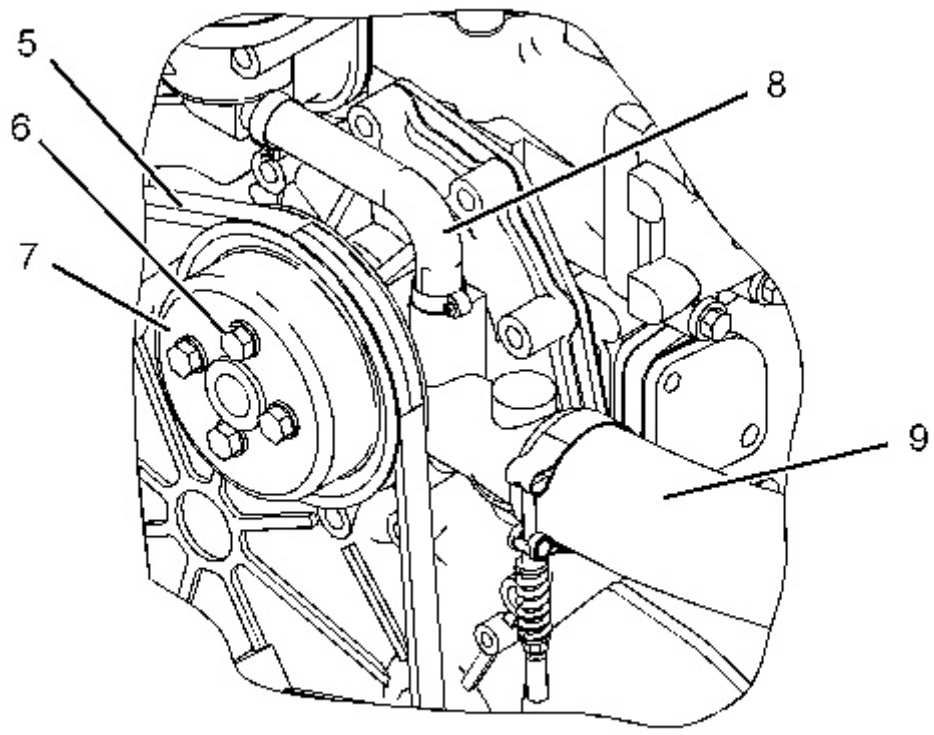


Illustration 8 g01037901

3. Install pulley (7) and bolts (6) . Install belt (5) . Install hoses (8) and (9) .

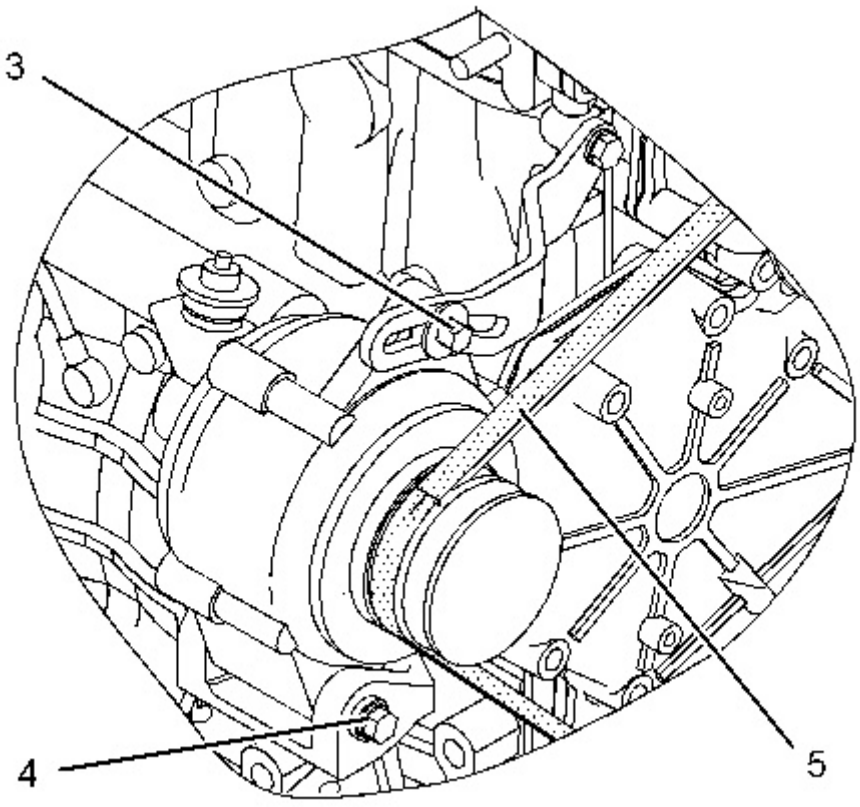


Illustration 9 g01037886

4. Rotate the alternator in order to tighten belt (5) . Tighten bolts (3) and (4) . Refer to Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace" for additional information.

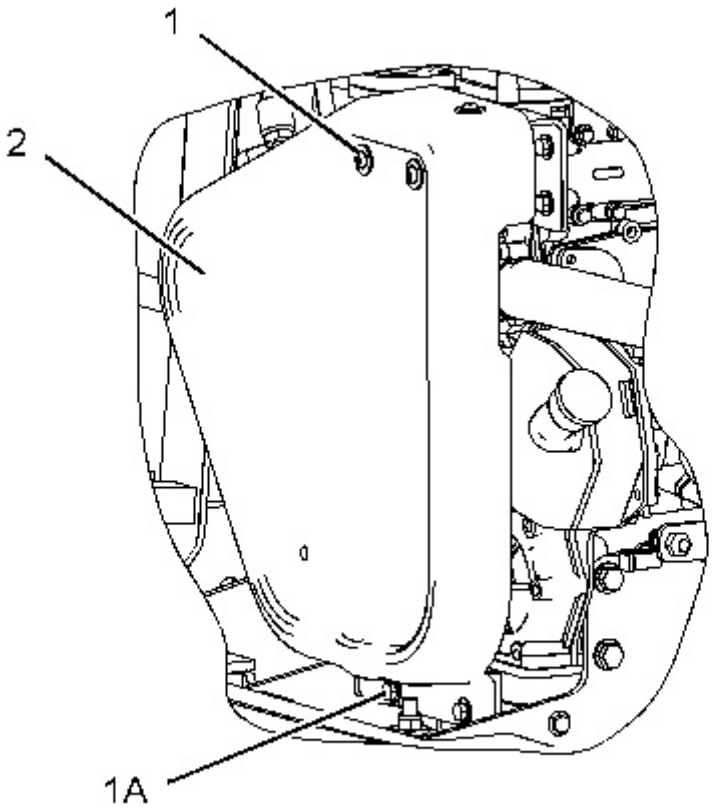


Illustration 10 g01541413

5. Install cover (2) and install screws (1) . Tighten screws (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).
6. Install bolts (1A) . Tighten bolts (1A) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).
7. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02006771

Water Temperature Regulator - Remove and Install

SMCS - 1355-010

Removal Procedure

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

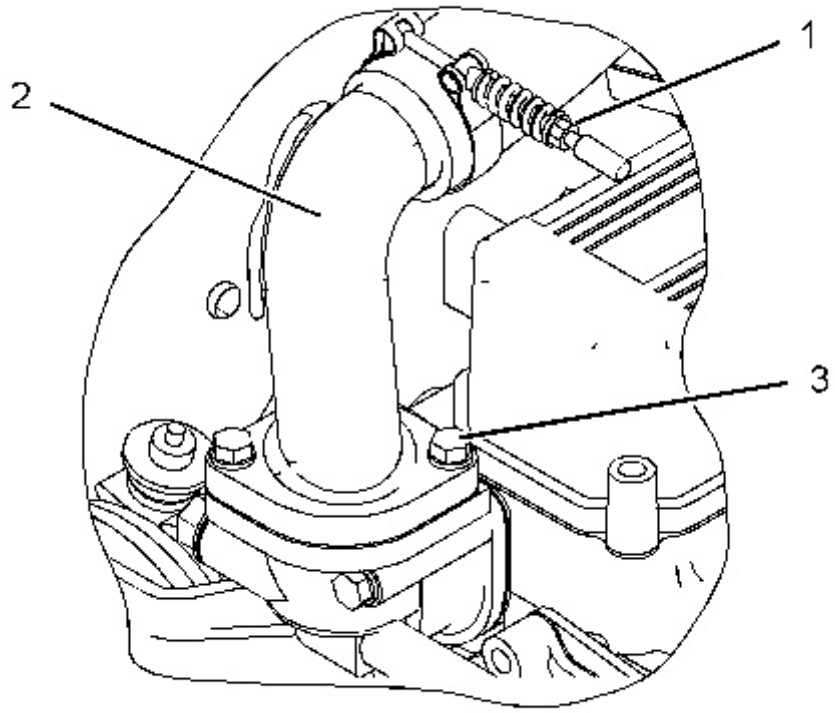


Illustration 1 g01038133

2. Remove bolts (3). Loosen clamp (1) and remove tube assembly (2) .

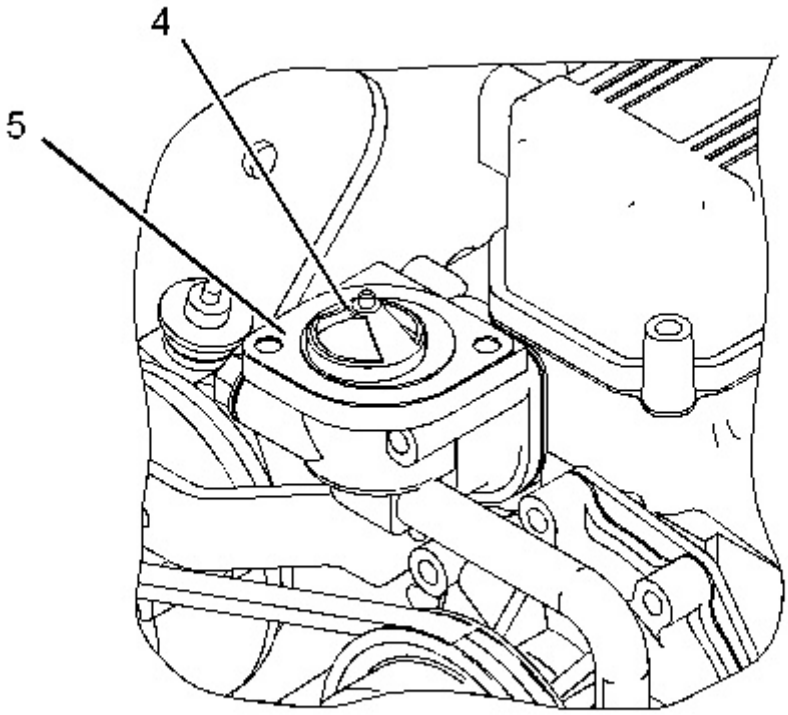


Illustration 2 g01038135

3. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. Remove gasket (5) and remove water temperature regulator (4) .

Installation Procedure

1. Clean all mating surfaces.

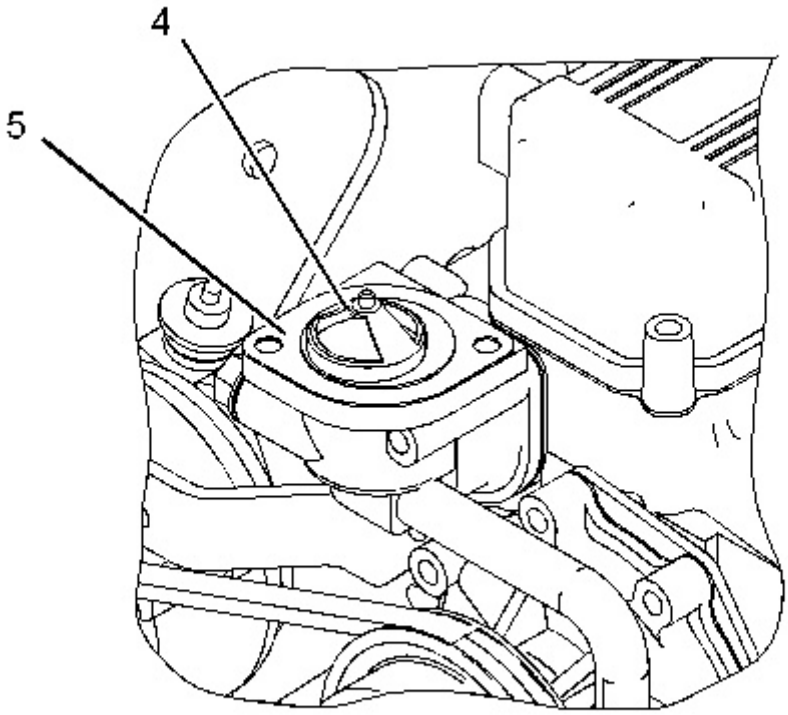


Illustration 3 g01038135

2. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. The pin should be oriented toward the right side of the machine. Install gasket (5) and install water temperature regulator (4) .

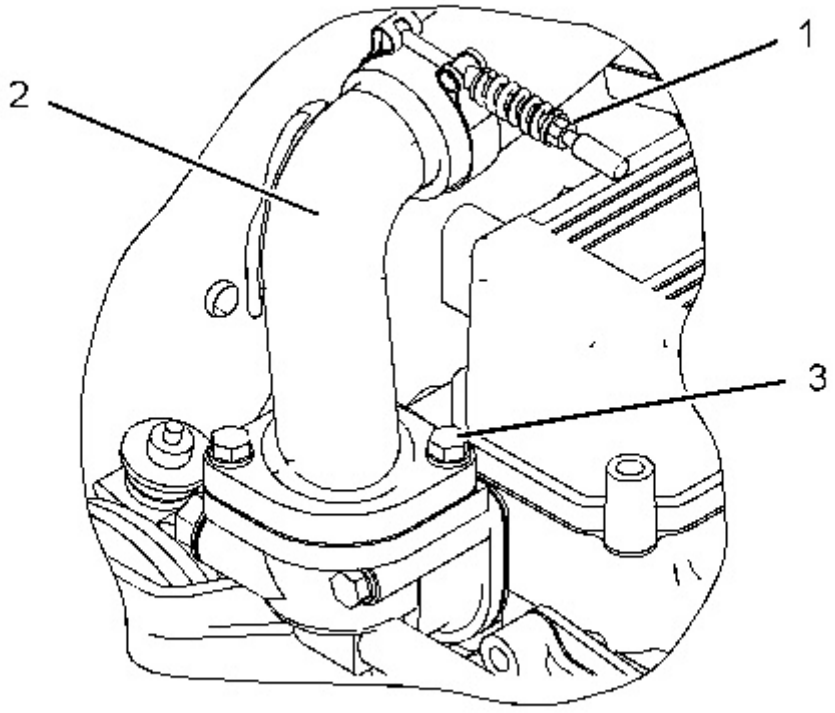


Illustration 4 g01038133

3. Install tube assembly (2). Install bolts (3). Tighten clamp (1) .
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i03037529

Water Pump - Remove and Install

SMCS - 1361-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

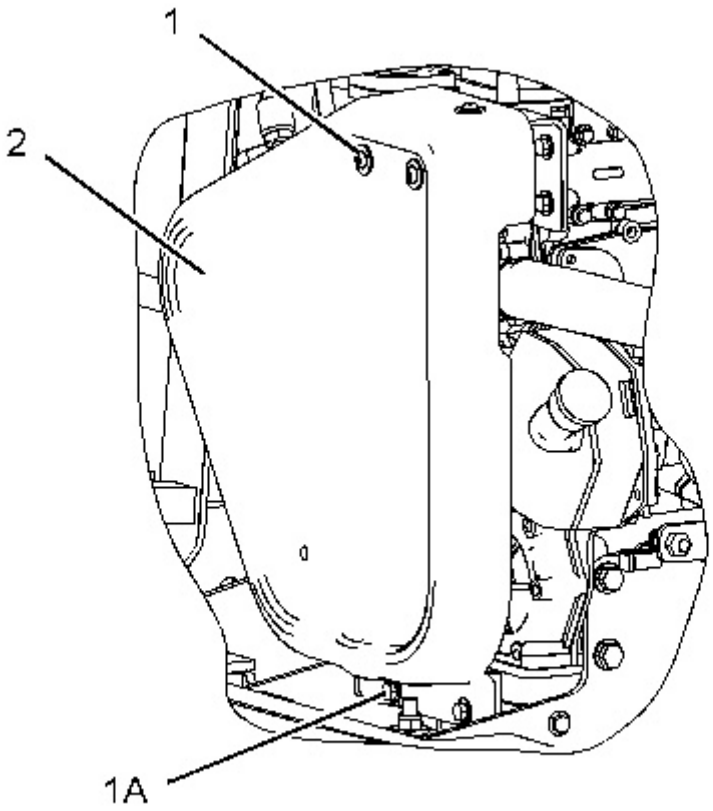


Illustration 1 g01541413

2. Remove bolts (1A) and screws (1) . Remove cover (2) .

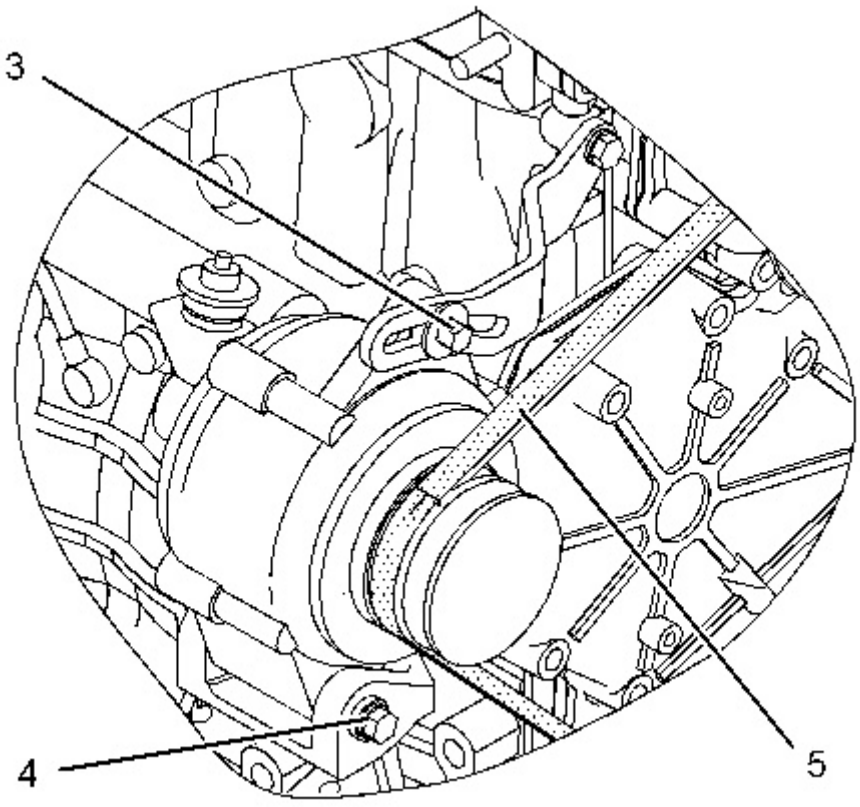


Illustration 2 g01037886

3. Loosen bolts (3) and (4) . Rotate the alternator in order to loosen belt (5) .

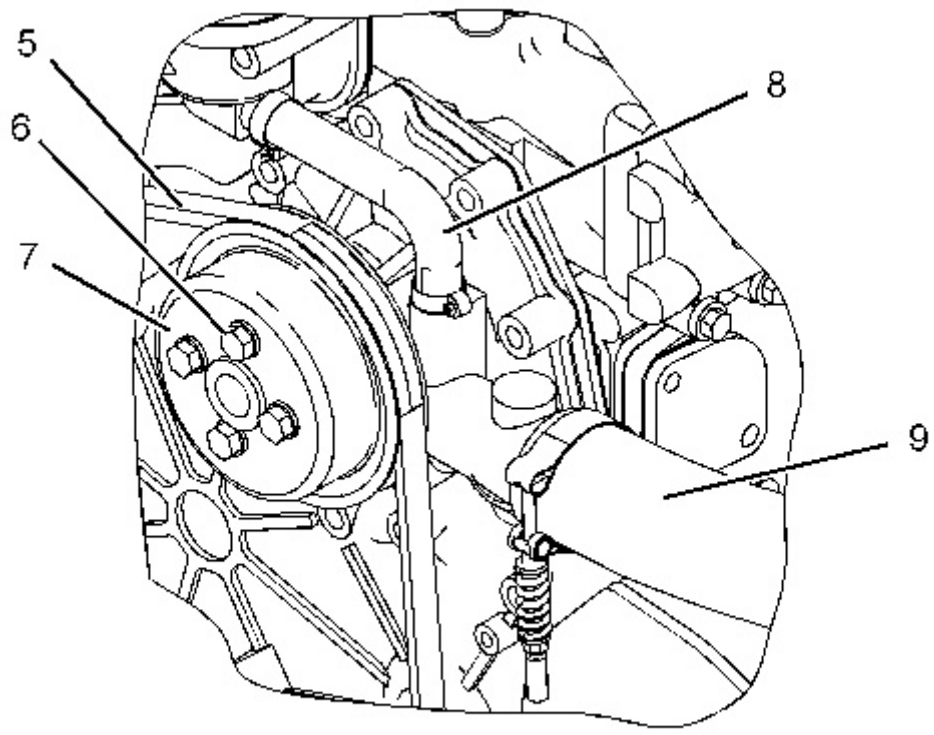


Illustration 3 g01037901

4. Remove belt (5) . Remove bolts (6) and remove pulley (7) . Disconnect hoses (8) and (9) .

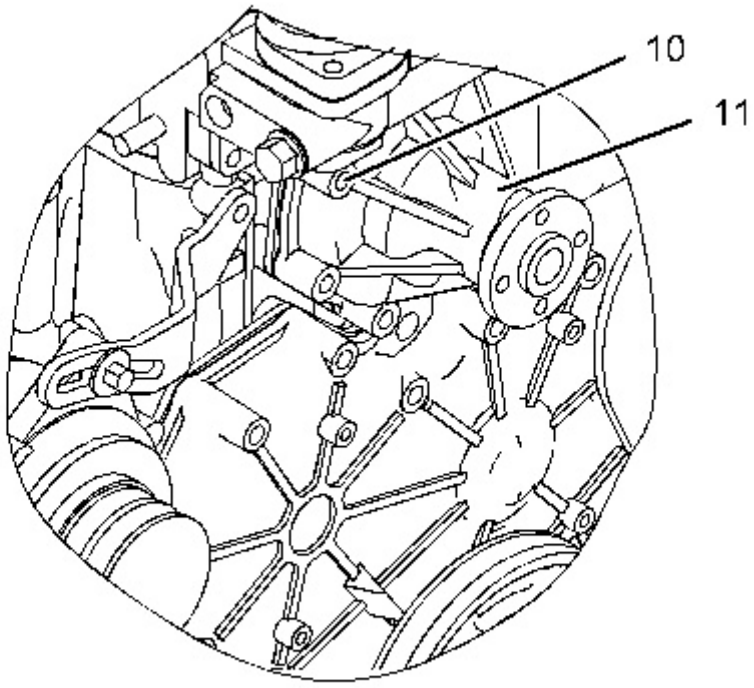


Illustration 4 g01037941

5. Remove bolts (10) and remove water pump (11) .

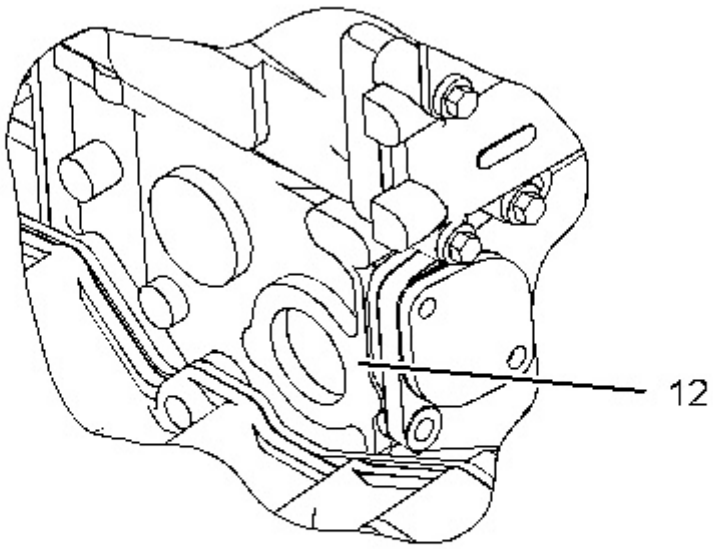


Illustration 5 g01037949

6. Remove gasket (12) .

Installation Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

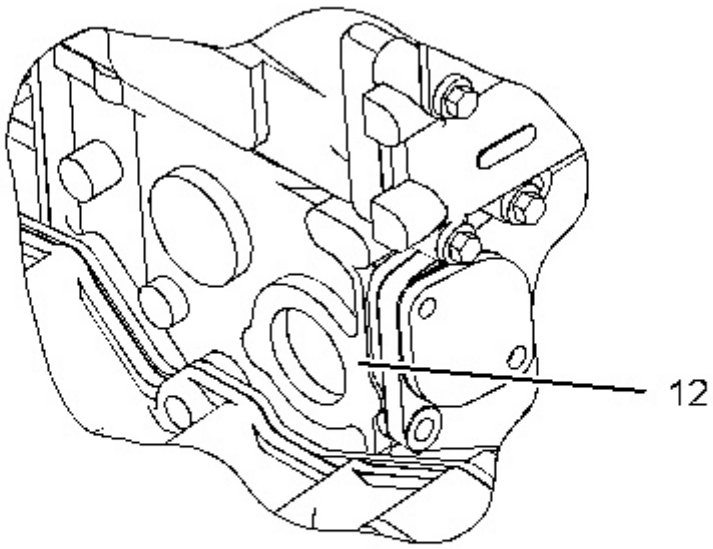


Illustration 6 g01037949

1. Install new gasket (12) .

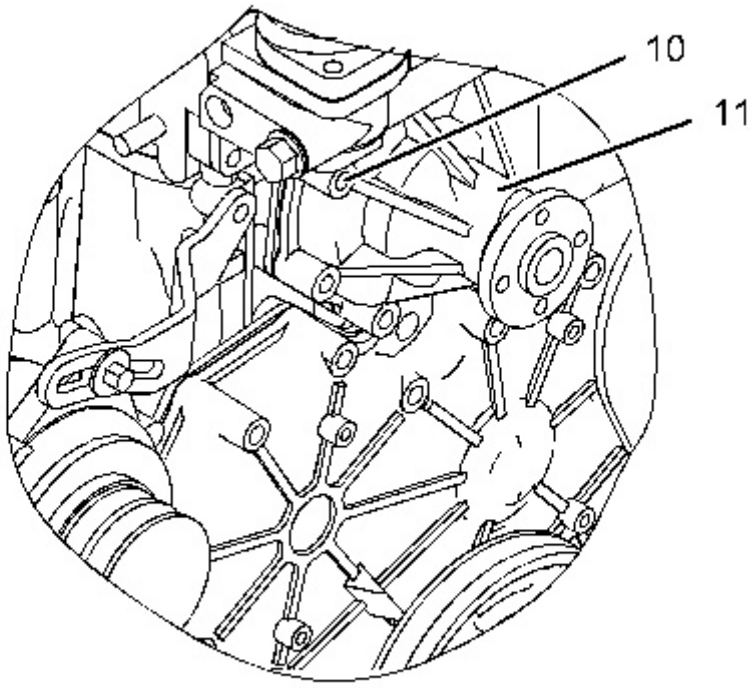


Illustration 7 g01037941

2. Install water pump (11) and install bolts (10) .

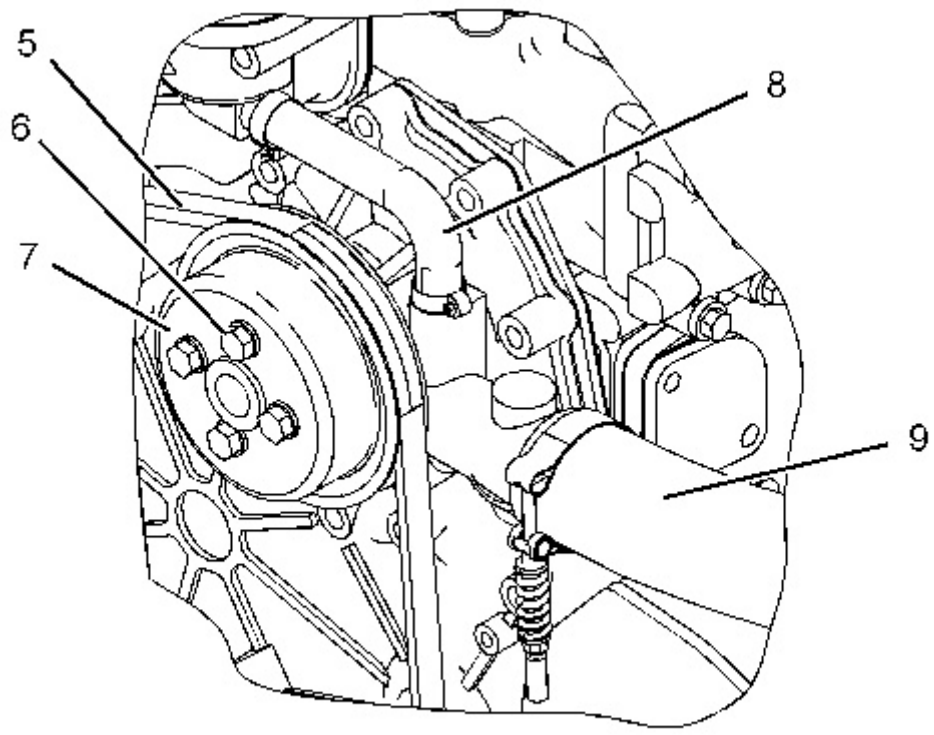


Illustration 8 g01037901

3. Install pulley (7) and bolts (6) . Install belt (5) . Install hoses (8) and (9) .

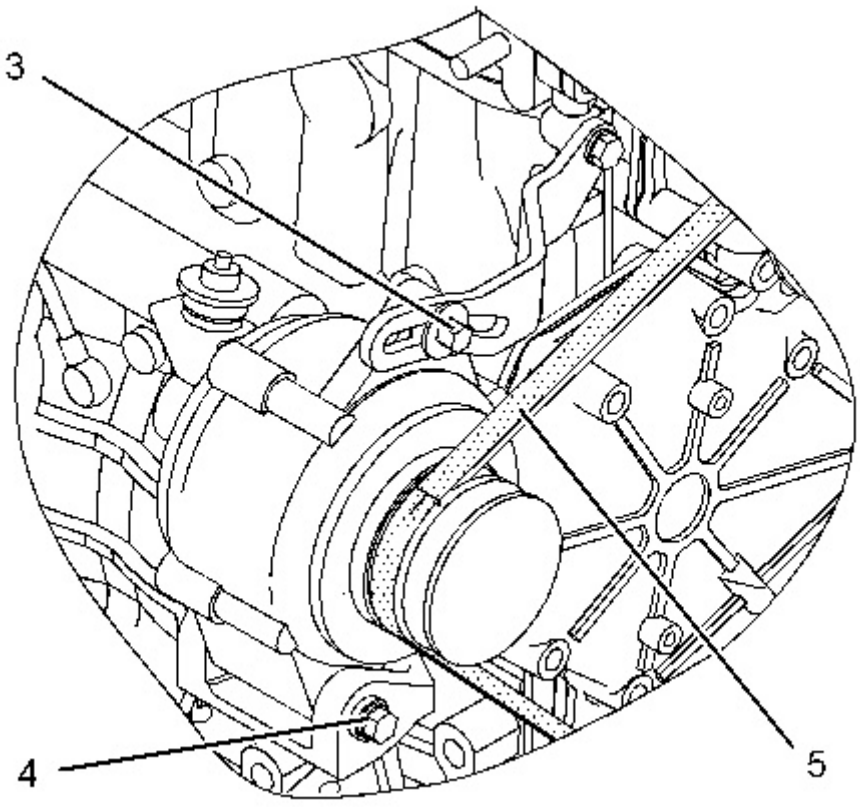


Illustration 9 g01037886

4. Rotate the alternator in order to tighten belt (5) . Tighten bolts (3) and (4) . Refer to Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace" for additional information.

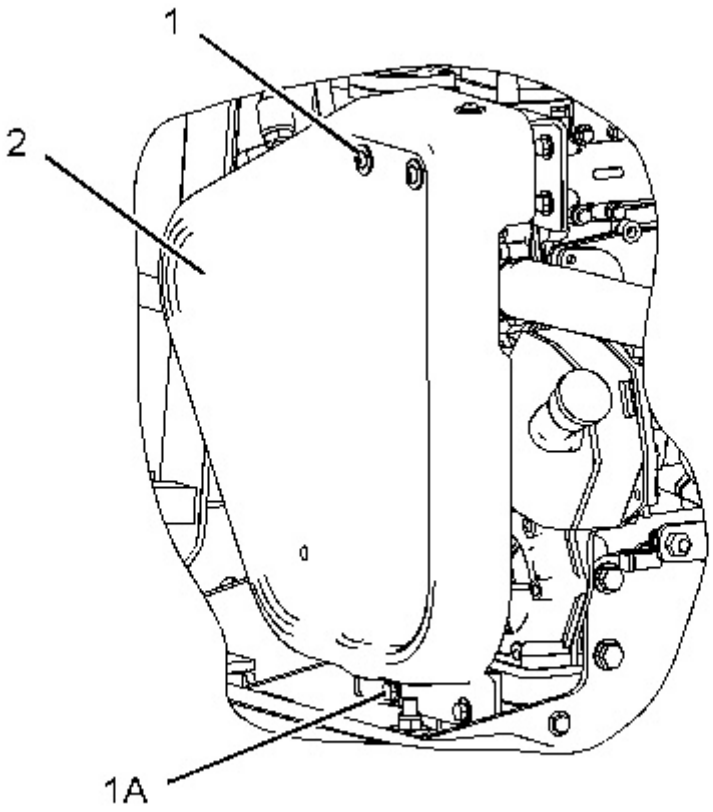


Illustration 10 g01541413

5. Install cover (2) and install screws (1) . Tighten screws (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).
6. Install bolts (1A) . Tighten bolts (1A) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).
7. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02002832

Water Pump - Remove and Install

SMCS - 1361-012; 1361-011

Removal Procedure

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

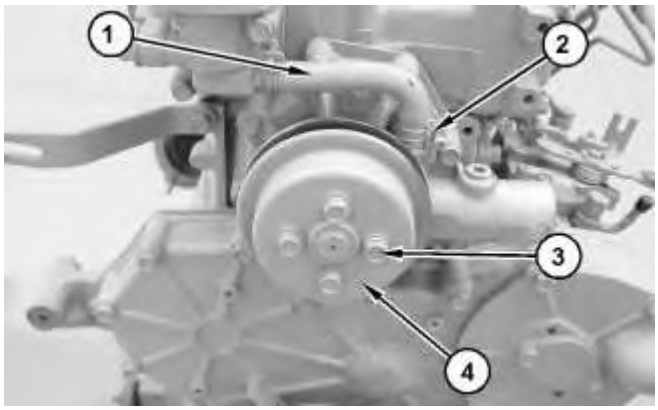


Illustration 1 g01035994

2. Loosen clamp (2) and disconnect hose (1). Remove bolts (3) and pulley (4) .

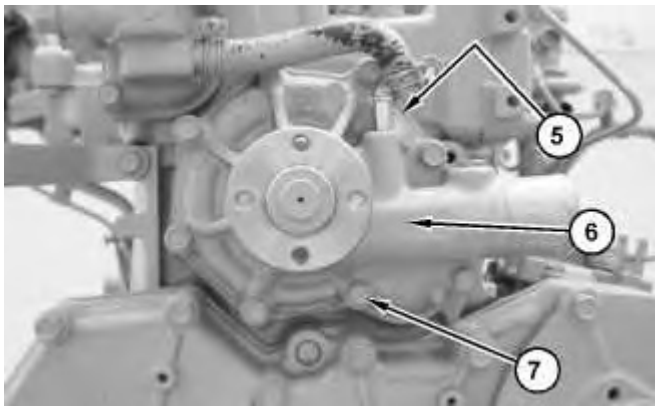


Illustration 2 g01036000

3. Remove bolts (7). Remove water pump (6) and gasket (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

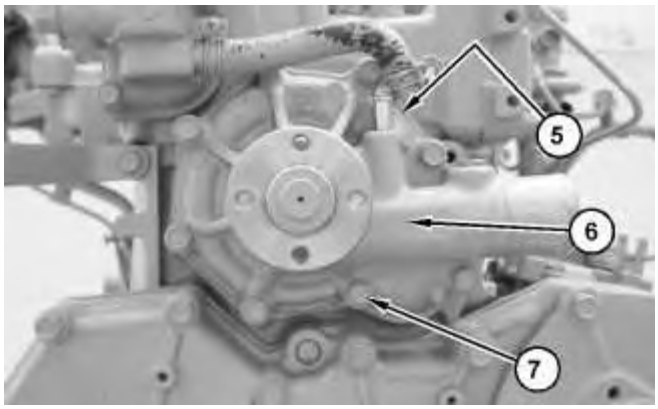


Illustration 3 g01036000

1. Install gasket (5) and position water pump (6). Install bolts (7) .

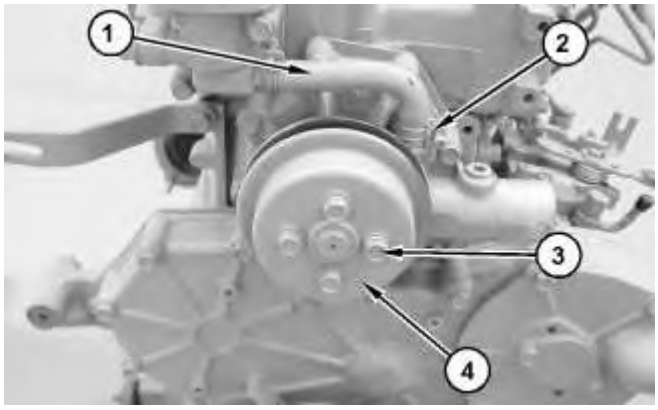


Illustration 4 g01035994

2. Connect hose (1) and tighten clamp (2). Position pulley (4) and install bolts (3) .
3. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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i02002832

Water Pump - Remove and Install

SMCS - 1361-012; 1361-011

Removal Procedure

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

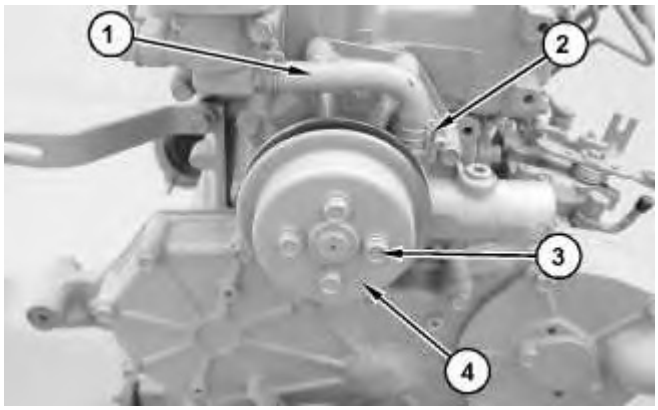


Illustration 1 g01035994

2. Loosen clamp (2) and disconnect hose (1). Remove bolts (3) and pulley (4) .

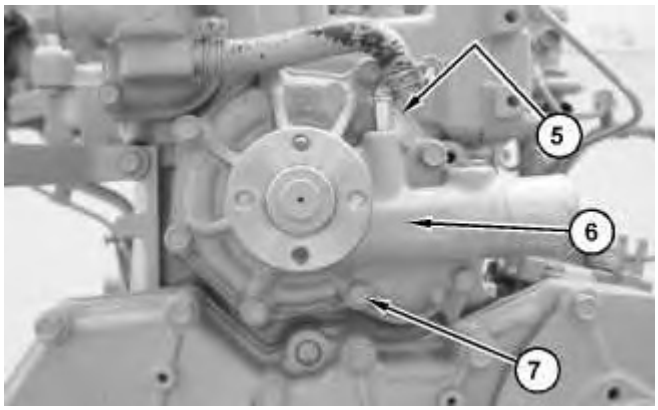


Illustration 2 g01036000

3. Remove bolts (7). Remove water pump (6) and gasket (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

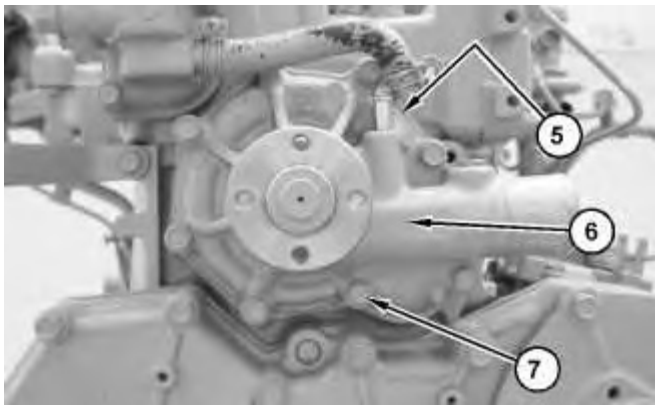


Illustration 3 g01036000

1. Install gasket (5) and position water pump (6). Install bolts (7) .

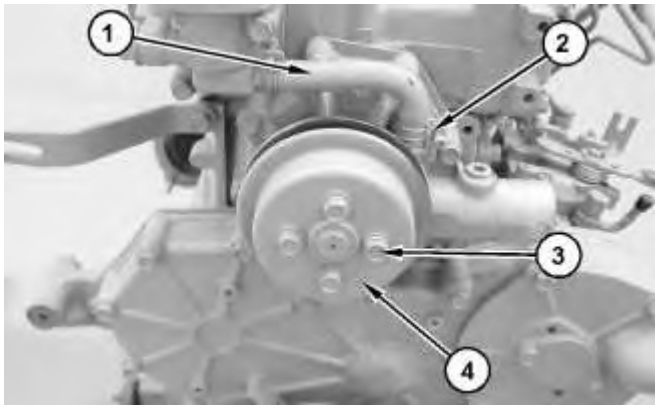


Illustration 4 g01035994

2. Connect hose (1) and tighten clamp (2). Position pulley (4) and install bolts (3) .
3. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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i02638853

Water Pump - Remove and Install

SMCS - 1361-012; 1361-011

Removal Procedure

Start By:

A. If the engine is equipped with a fan, remove the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install". If the engine is not equipped with a fan, remove the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for more information.

2. Loosen the hose clamp and disconnect the hose (not shown) from the water pump inlet.

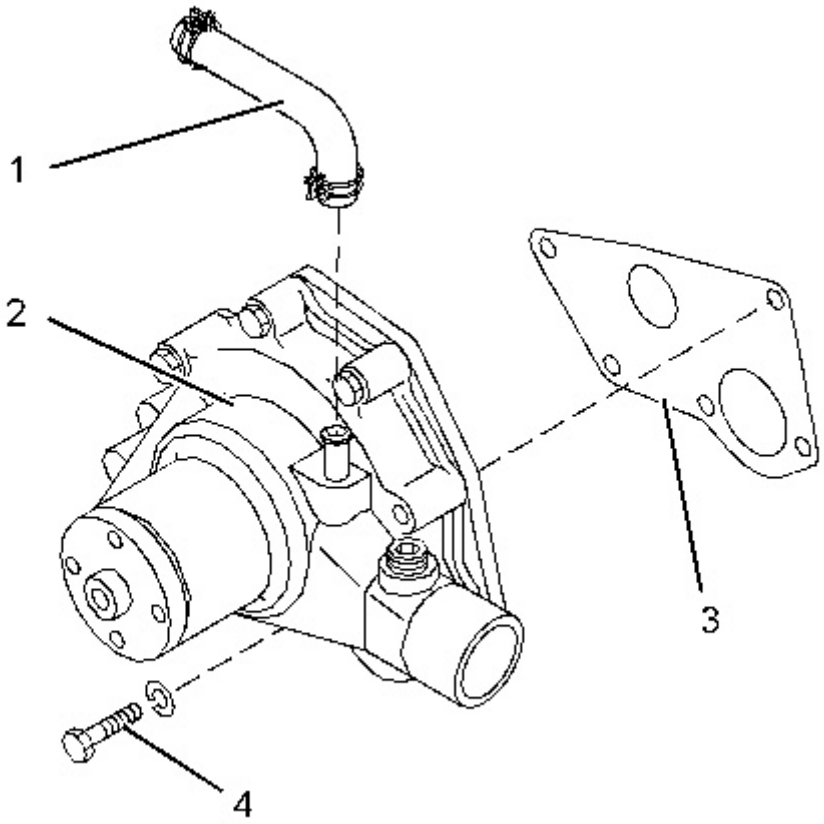


Illustration 1 g01335213

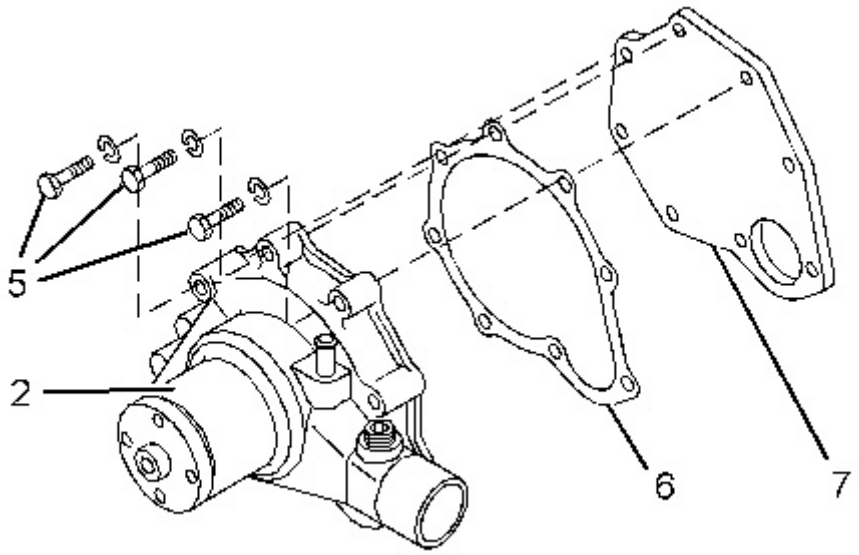


Illustration 2 g01335205

3. Loosen the hose clamp and disconnect hose (1) from water pump (2) .
4. Remove bolts (4) and remove water pump (2). Do not remove bolts (5) at this time.

   Note: If necessary, gently tap the water pump with a soft faced hammer in order to loosen the water pump.
5. Remove joint (3) .
6. If necessary, remove bolts (5), and remove cover (7). Remove joint (6) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the mating surfaces of the water pump and the cylinder block are clean and free from damage. If the cover was removed, ensure that the mating surfaces of the cover are clean and free from damage.

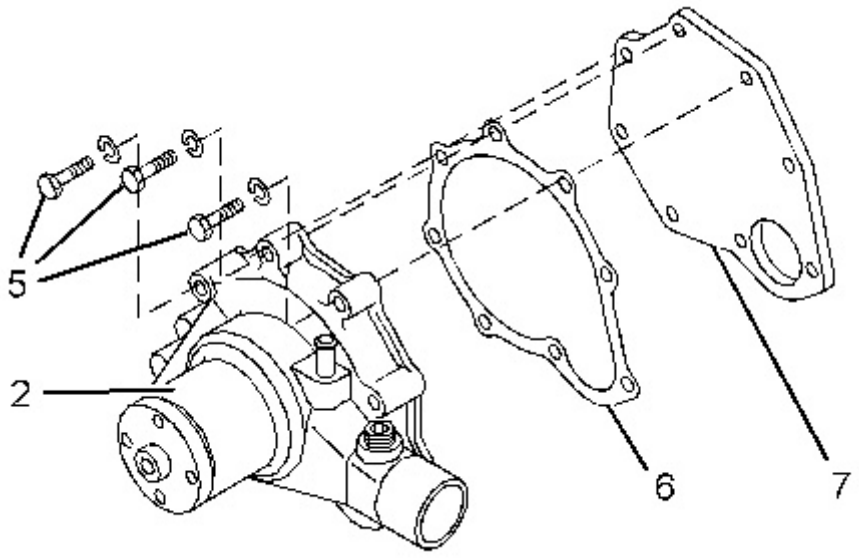


Illustration 3 g01335205

2. If necessary, align a new joint (6) and cover (7) with the holes in water pump (2). Install bolts (5). Tighten the bolts to a torque of 10 N·m (89 lb in).

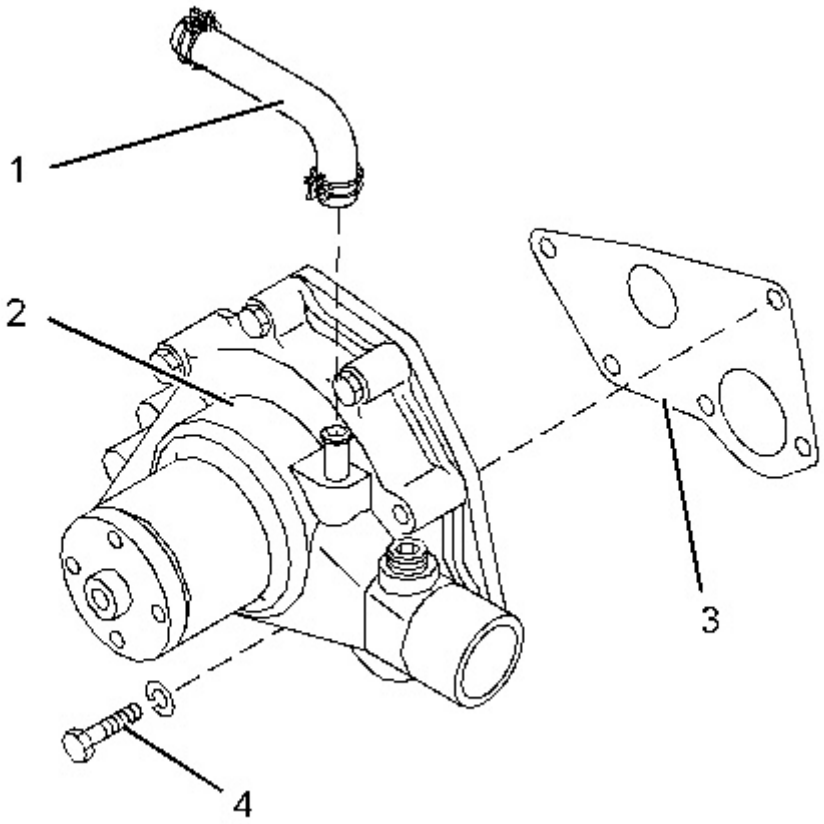


Illustration 4 g01335213

3. Place water pump (2) in position and install bolts (4). Ensure that bolts of different lengths are installed in the correct positions. Tighten bolts (4) to a torque of 18 N·m (160 lb in).
4. Connect hose (1) and tighten the hose clamp.
5. Connect the hose (not shown) to the water pump inlet and tighten the hose clamp.
6. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

End By: If the engine is equipped with a fan, install the fan. Refer to Disassembly and Assembly, "Fan - Remove and Install". If the engine is not equipped with a fan, install the V-belt. Refer to Disassembly and Assembly, "V-belts - Remove and Install".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

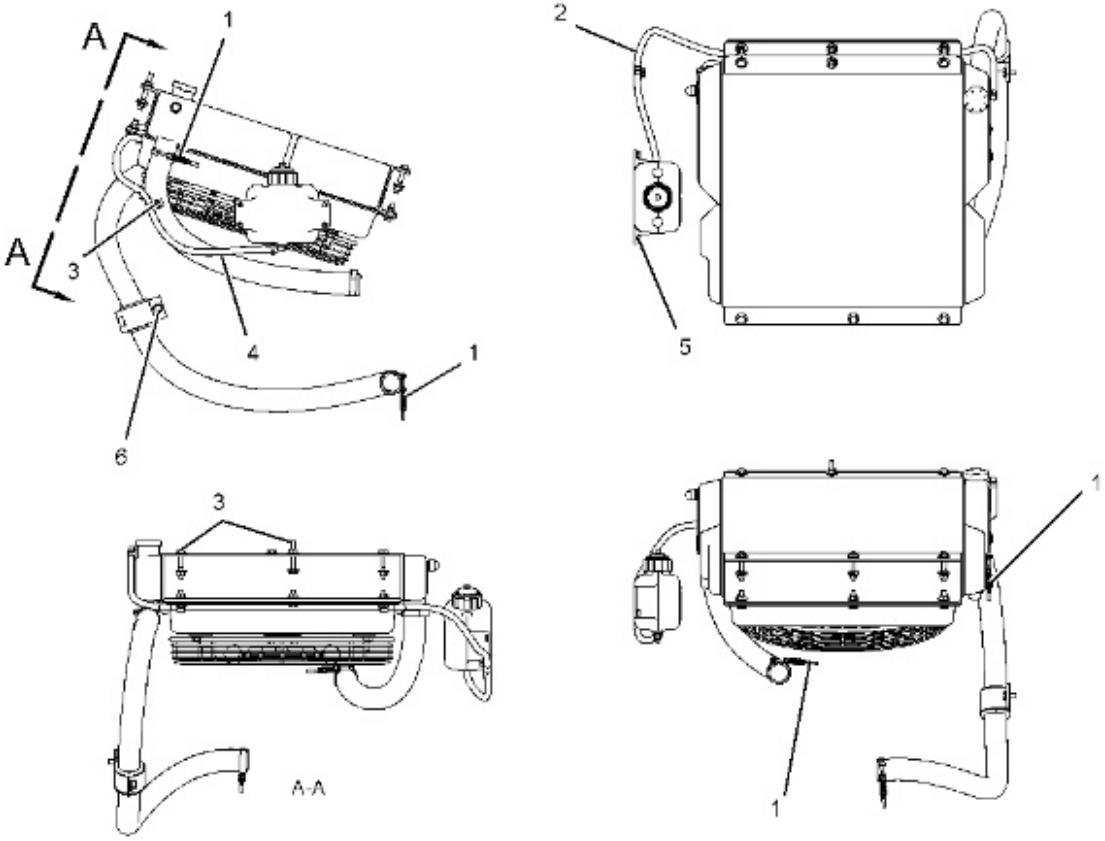


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

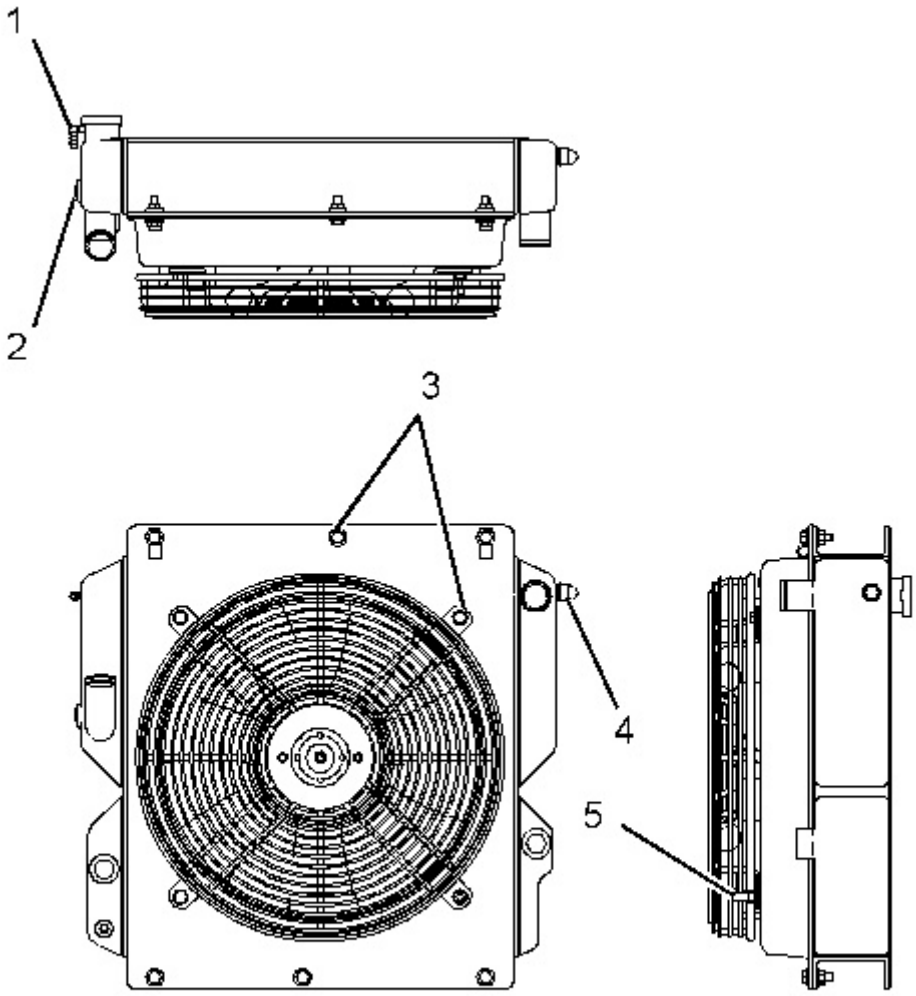


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

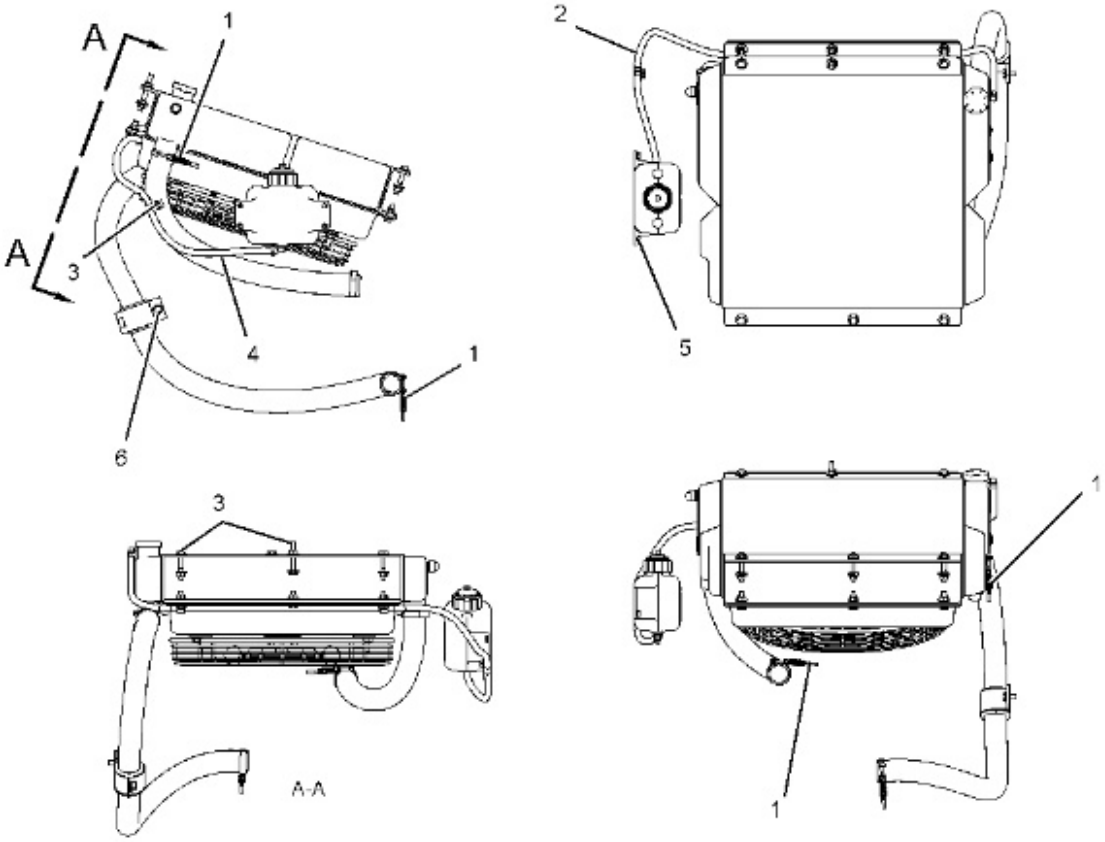


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

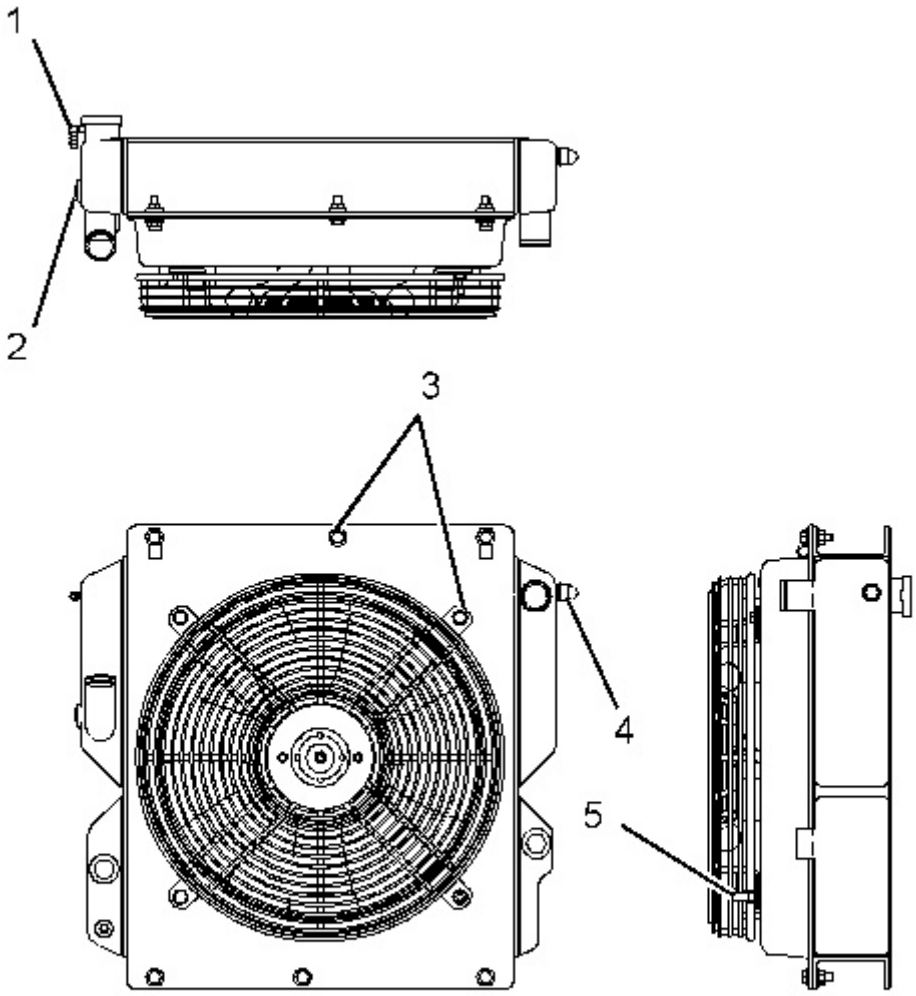


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02783657

Radiator and Hydraulic Oil Cooler - Install

SMCS - 1353-012; 1374-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3

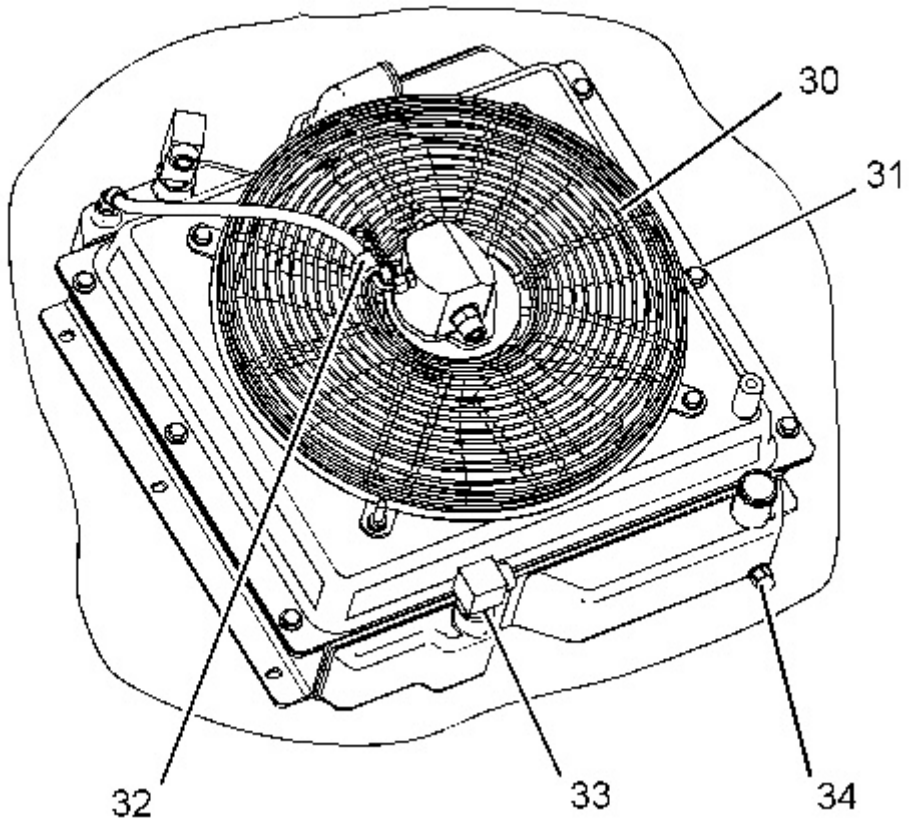


Illustration 1 g01092599

1. Position the radiator shroud and fan assembly (30) . Install six bolts (31) . Tighten bolts (31) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install sight glass (34) . Tighten sight glass (34) to a torque of 15 ± 2 N·m (11 ± 1 lb ft). Install fitting (33) and connect hose assembly (32) .

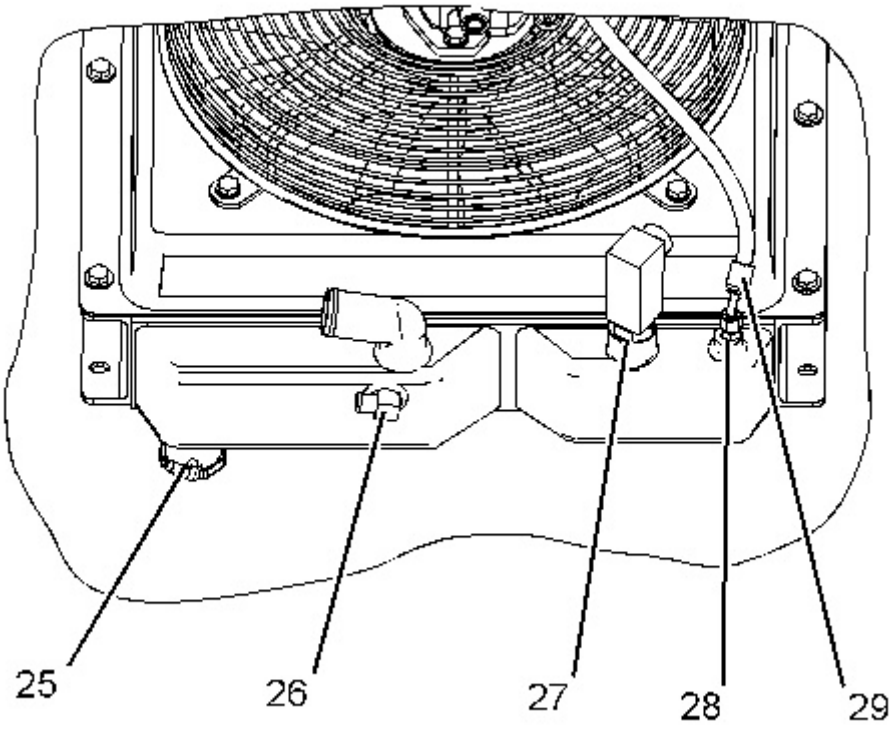


Illustration 2 g01043891

2. Install fittings (25) , (26) , (27) and (28) . Connect hose assembly (29) .

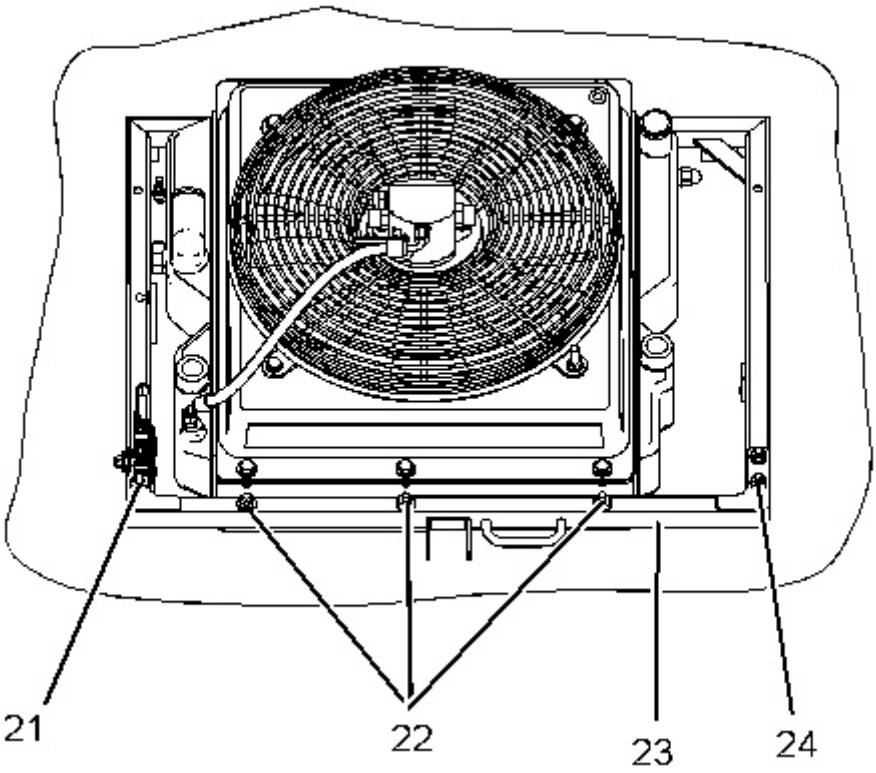


Illustration 3 g01092595

3. Install radiator support (23) and bolts (21) , (22) and (24) . Tighten bolts (21) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

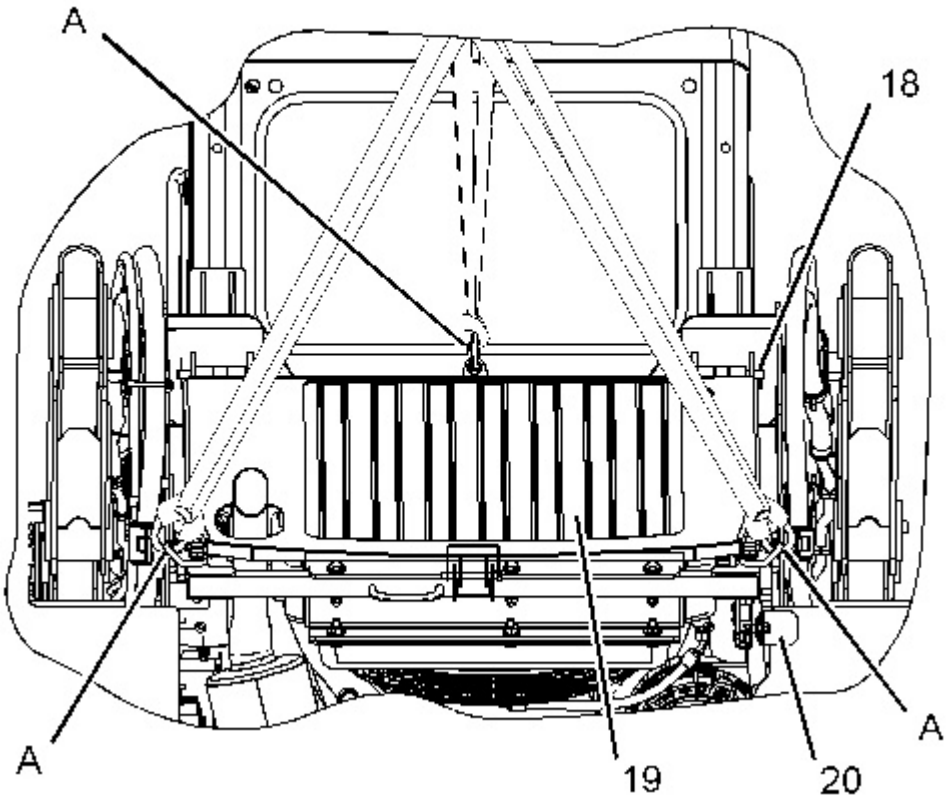


Illustration 4 g01043746

4. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Install radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb). Install pins (18) to each side of the machine and install the cotter pins. Engage latch (20) .



Illustration 5 g01390286

Typical Example

5. Attach a suitable lifting device to the radiator assembly, as shown. The weight of the radiator assembly is approximately 60 kg (130 lb). Use the suitable lifting device in order to raise the radiator, as shown. This will hold the radiator assembly in position until the struts are installed.

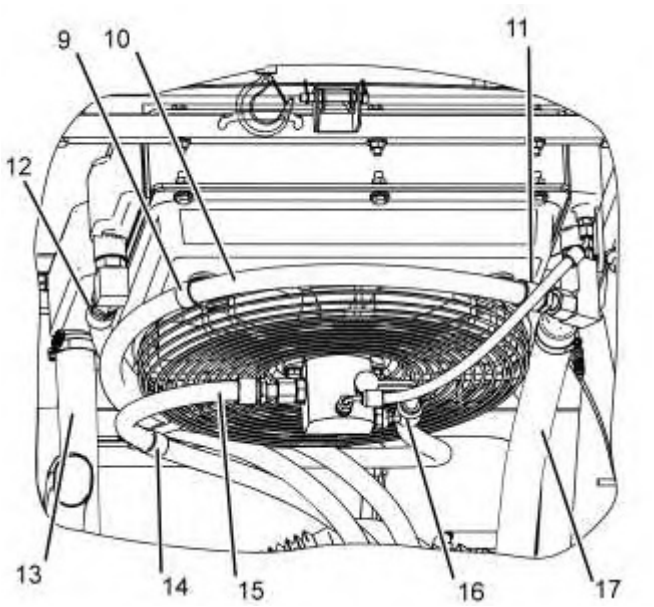


Illustration 6 g01390300

6. Connect hose assemblies (10) and (12) and hoses (13) and (17) . Connect hose assembly (15) . Install clips (9) , (11) , and (14) . Connect hose assembly (16) .

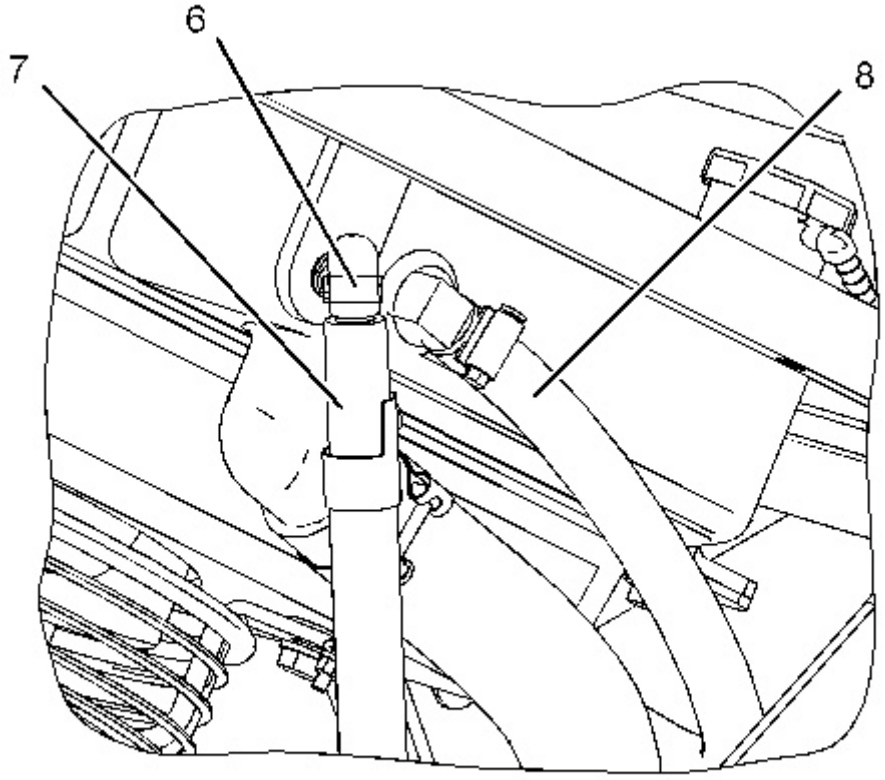


Illustration 7 g01096079

7. Install strut (7) and clip (6) . Connect hose (8) . Remove Tooling (A) .

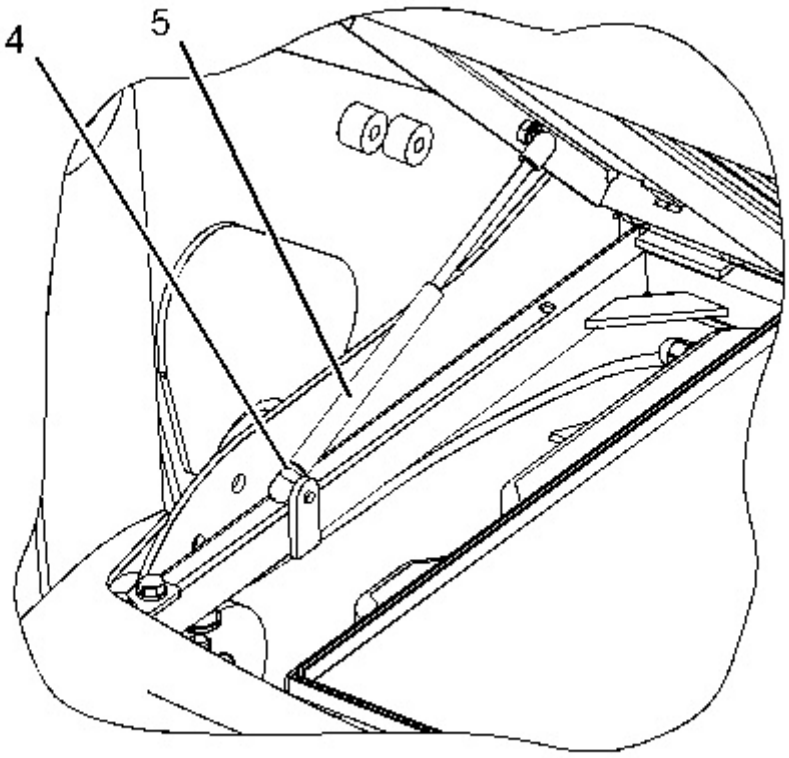


Illustration 8 g01096078

8. Connect struts (5) and install clips (4) .

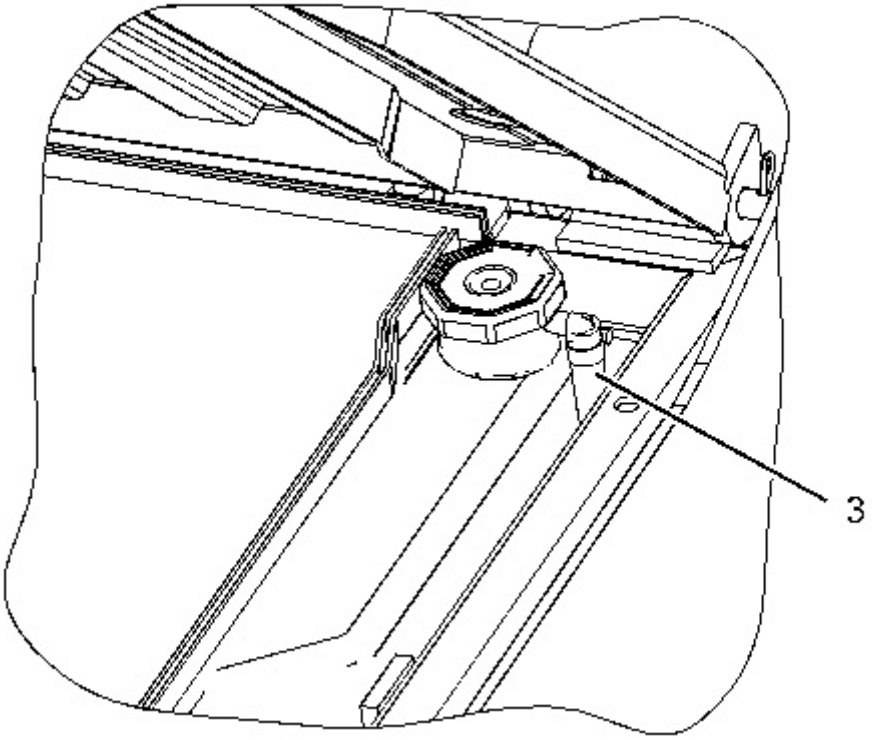


Illustration 9 g01042099

9. Connect hose (3) .

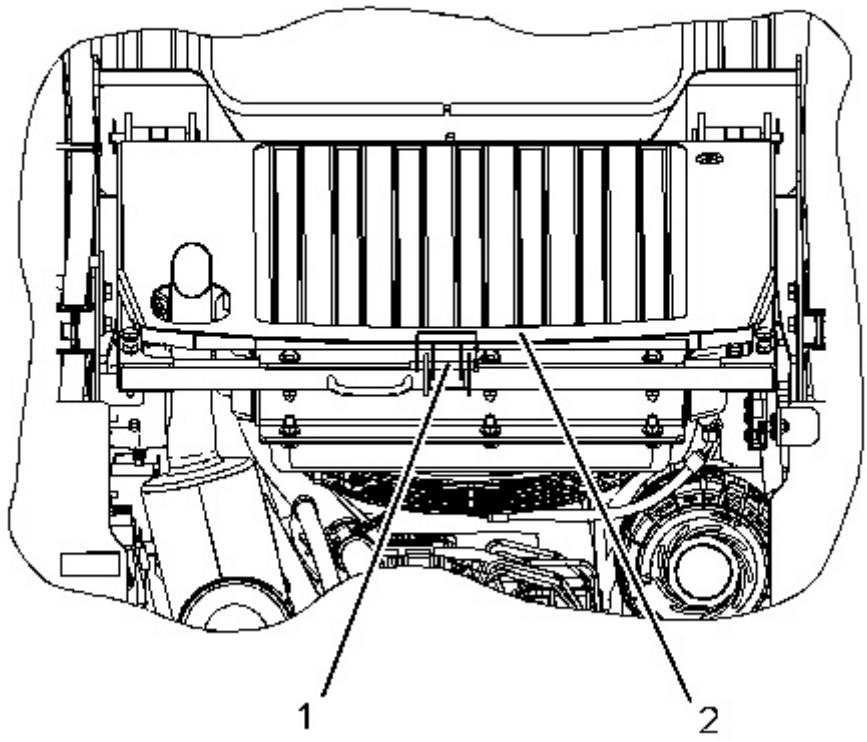


Illustration 10 g01042083

10. Lower radiator guard (2) and install pin (1) .

11. Fill the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

12. Check the level of the hydraulic oil system. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02783363

Radiator and Hydraulic Oil Cooler - Remove

SMCS - 1353-011; 1374-011

Removal Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3
B	8T-4133	Nut	1
C	8T-4121	Hard Washer	1

Start By:

A. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

1. Drain the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

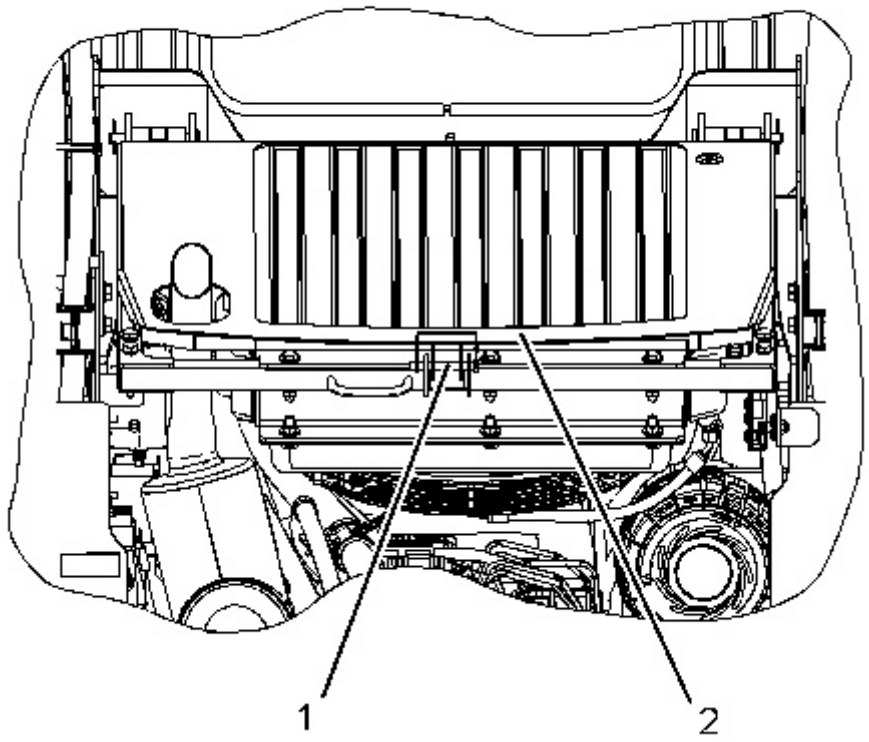


Illustration 1 g01042083

2. Remove pin (1) . Raise radiator guard (2) .

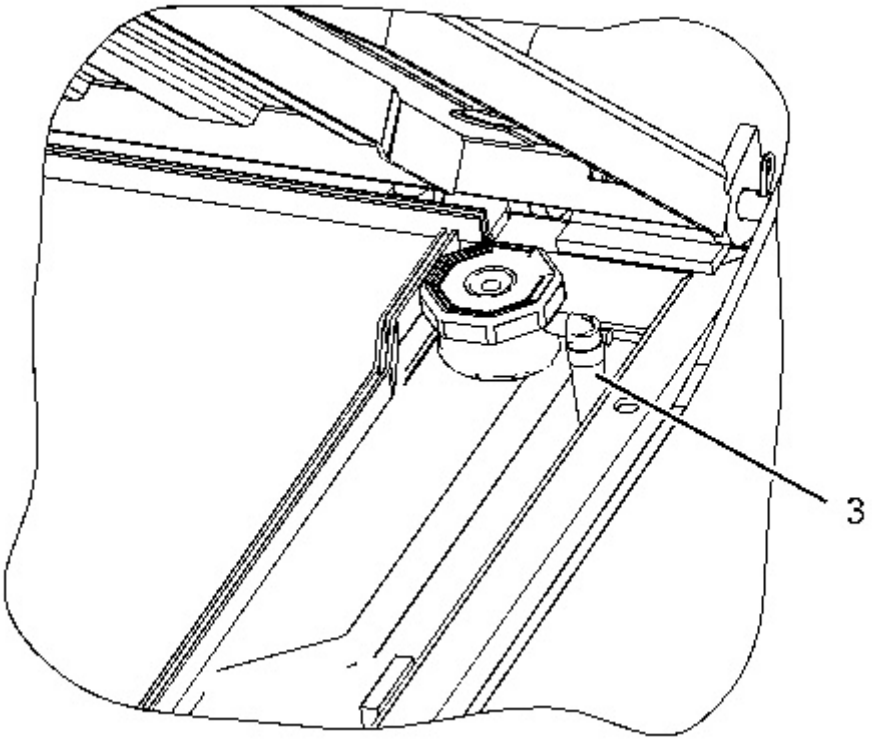


Illustration 2 g01042099

3. Disconnect hose (3) .



Illustration 3 g01390286

Typical Example

4. Attach a suitable lifting device to the radiator assembly, as shown. This will support the radiator assembly when the struts are removed. The weight of the radiator assembly is approximately 60 kg (130 lb).

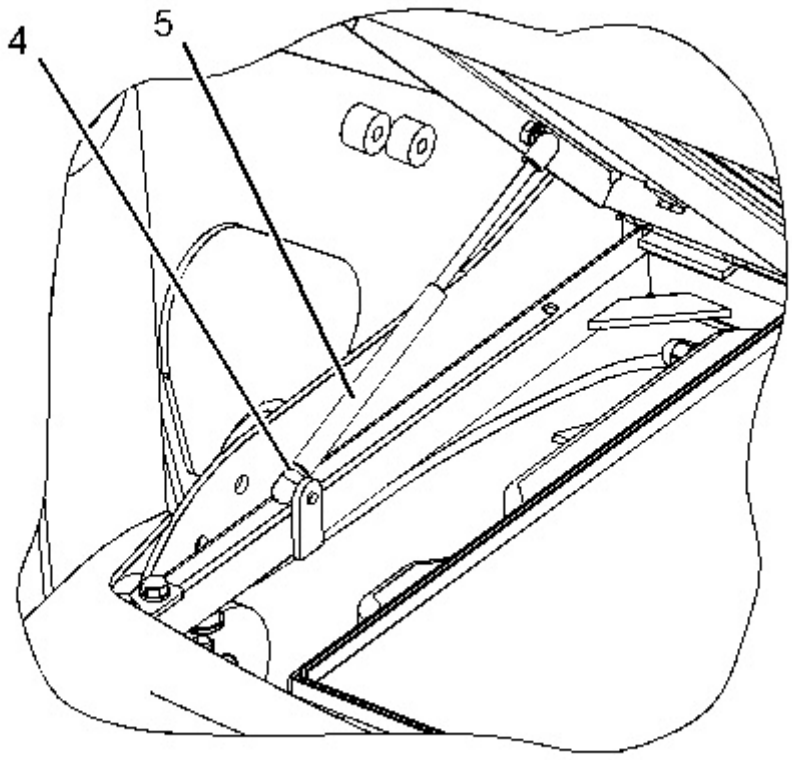


Illustration 4 g01096078

5. Remove clips (4) and disconnect strut (5) .

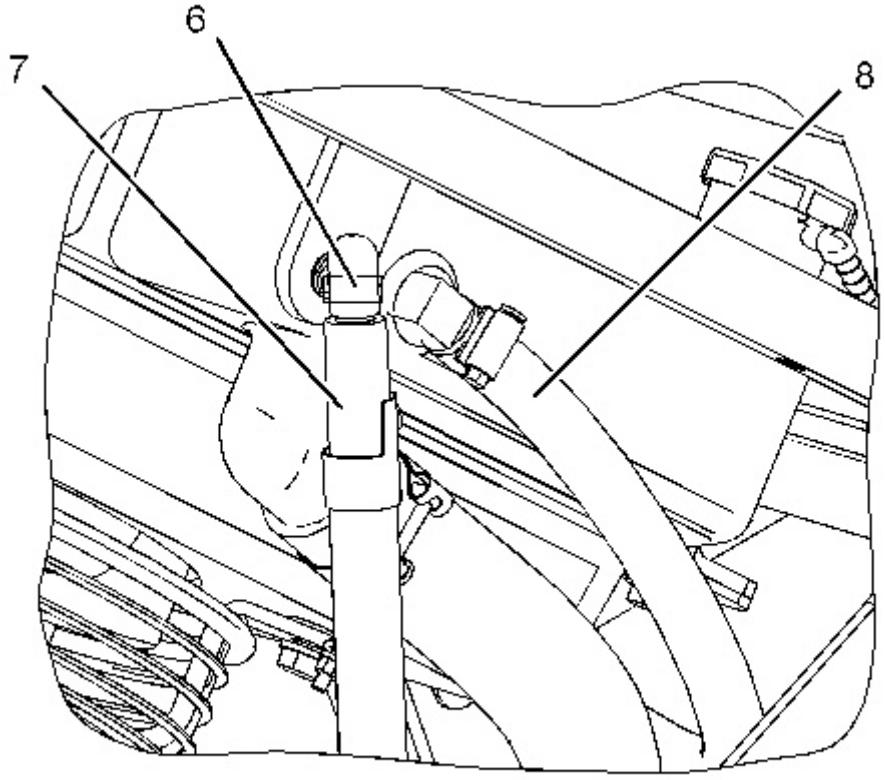


Illustration 5 g01096079

6. Remove clip (6) and remove strut (7) . Disconnect hose (8) .

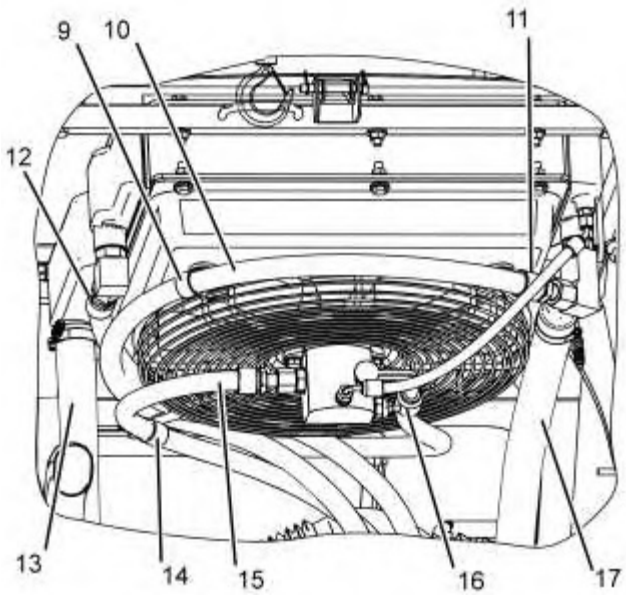


Illustration 6 g01390300

7. Remove clips (9) , (11) and (14) . Disconnect hose assemblies (10) and (12) , and hoses (13) and (17) . Disconnect hose assembly (15) . Use the suitable lifting device that was attached in Step 4 in order to lower the radiator assembly.

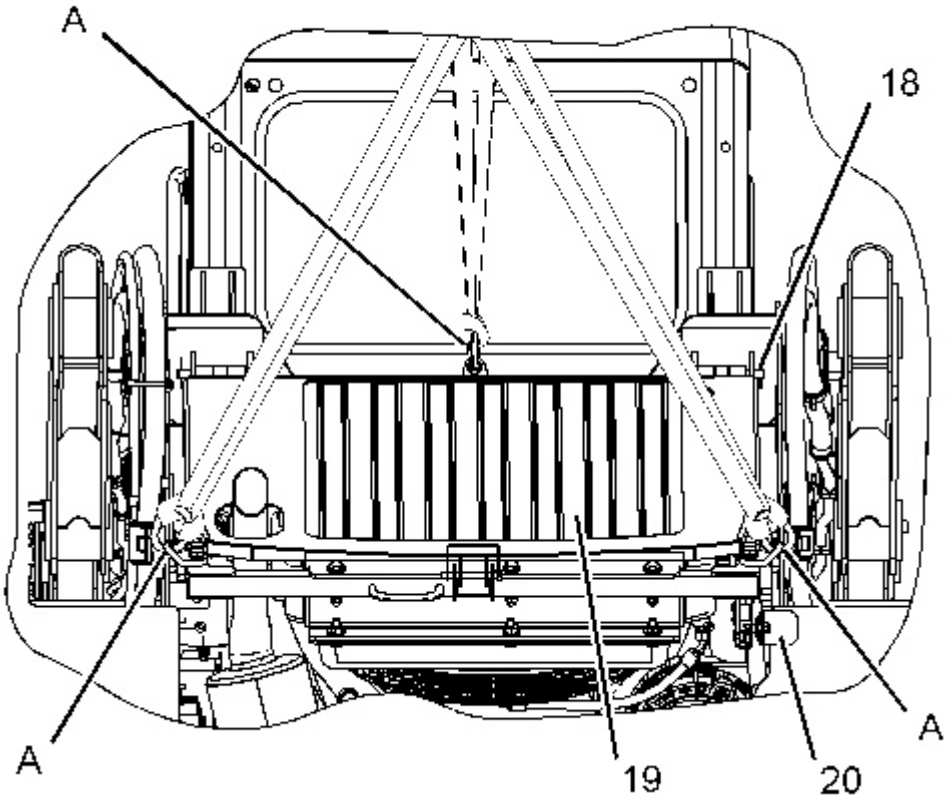


Illustration 7 g01043746

8. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Remove the cotter pins and remove pins (18) from each side of the machine.

9. Release latch (20) and remove radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb).

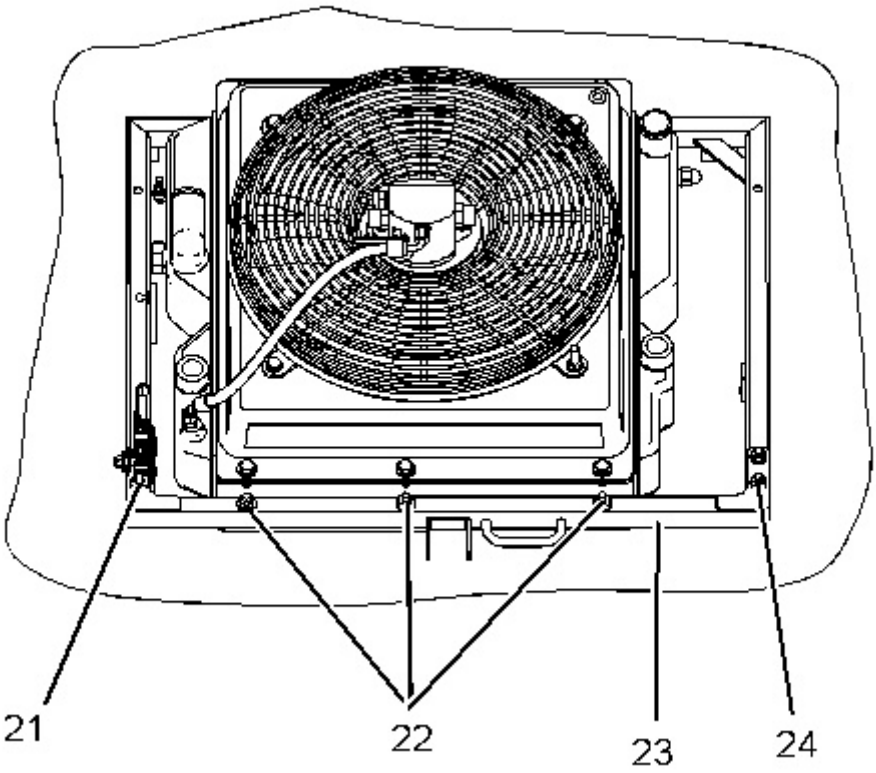


Illustration 8 g01092595

10. Remove bolts (21) , (22) and (24) . Remove the radiator support (23) .

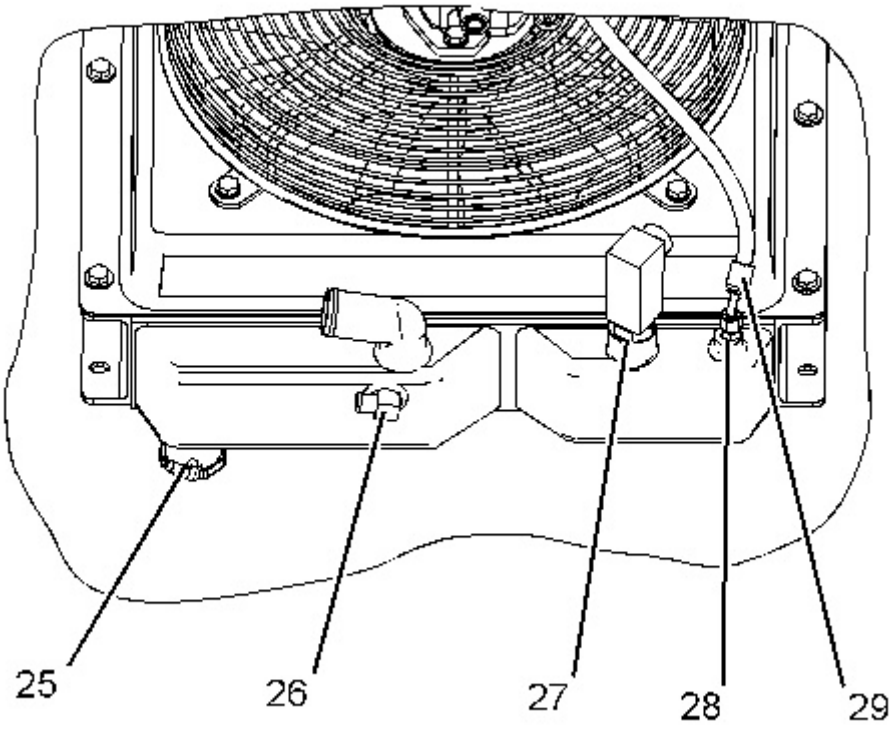


Illustration 9 g01043891

11. Disconnect hose assembly (29) . Remove fittings (25) , (26) , (27) and (28) .

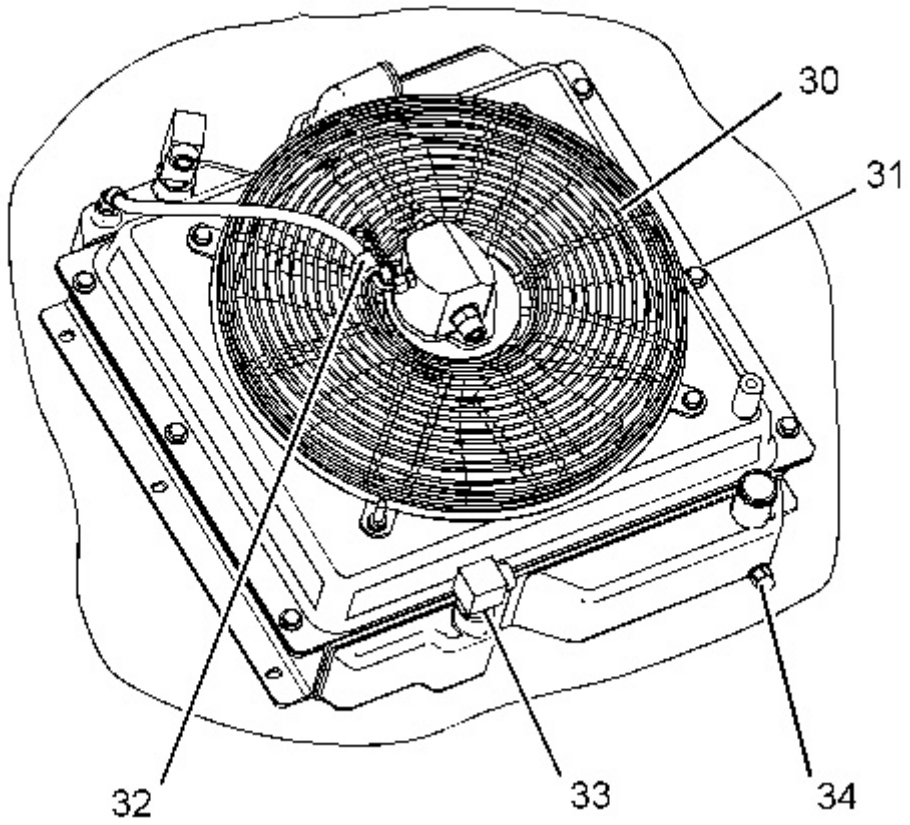


Illustration 10 g01092599

12. Disconnect hose assembly (32) , fitting (33) , sight glass (34) , six bolts (31) , the radiator shroud, and fan assembly (30) .

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Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02783657

Radiator and Hydraulic Oil Cooler - Install

SMCS - 1353-012; 1374-012

Installation Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3

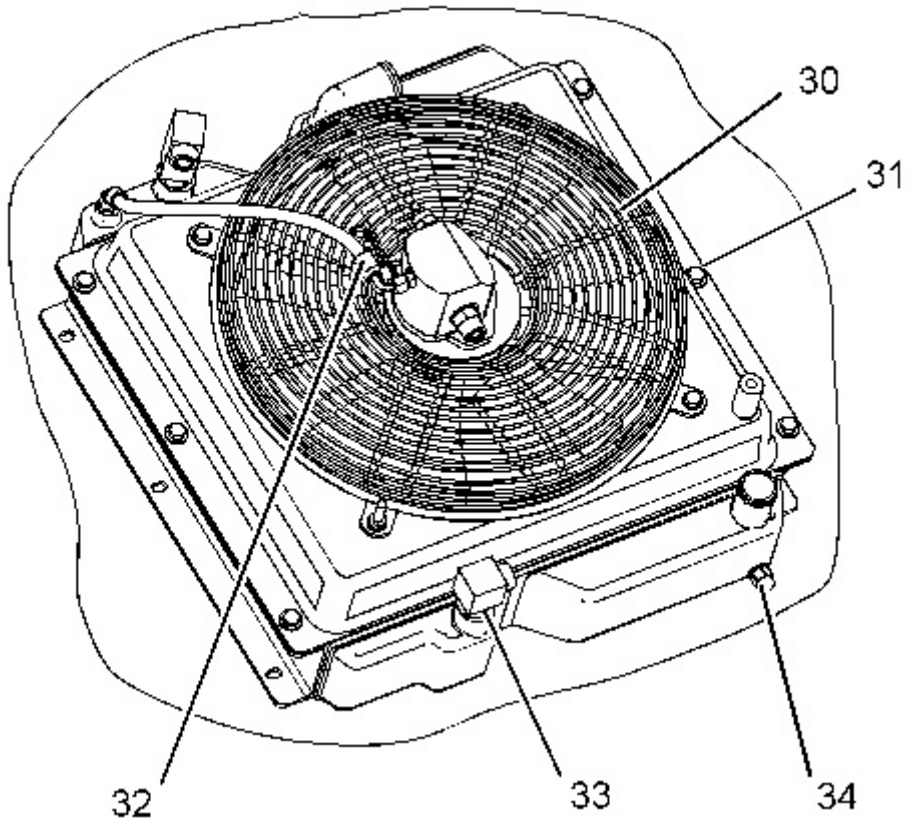


Illustration 1 g01092599

1. Position the radiator shroud and fan assembly (30) . Install six bolts (31) . Tighten bolts (31) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install sight glass (34) . Tighten sight glass (34) to a torque of 15 ± 2 N·m (11 ± 1 lb ft). Install fitting (33) and connect hose assembly (32) .

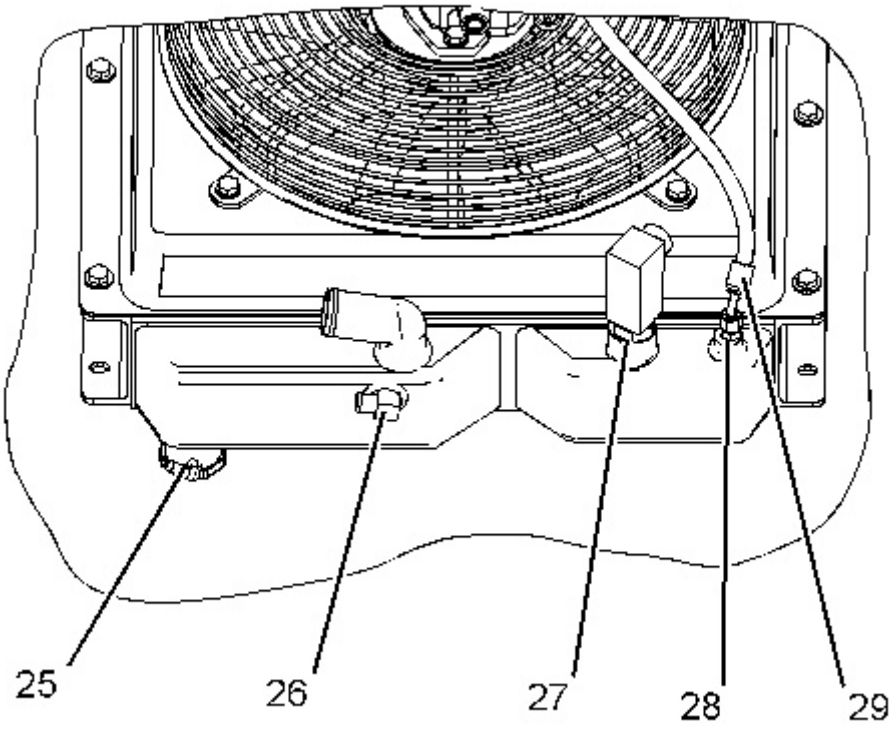


Illustration 2 g01043891

2. Install fittings (25) , (26) , (27) and (28) . Connect hose assembly (29) .

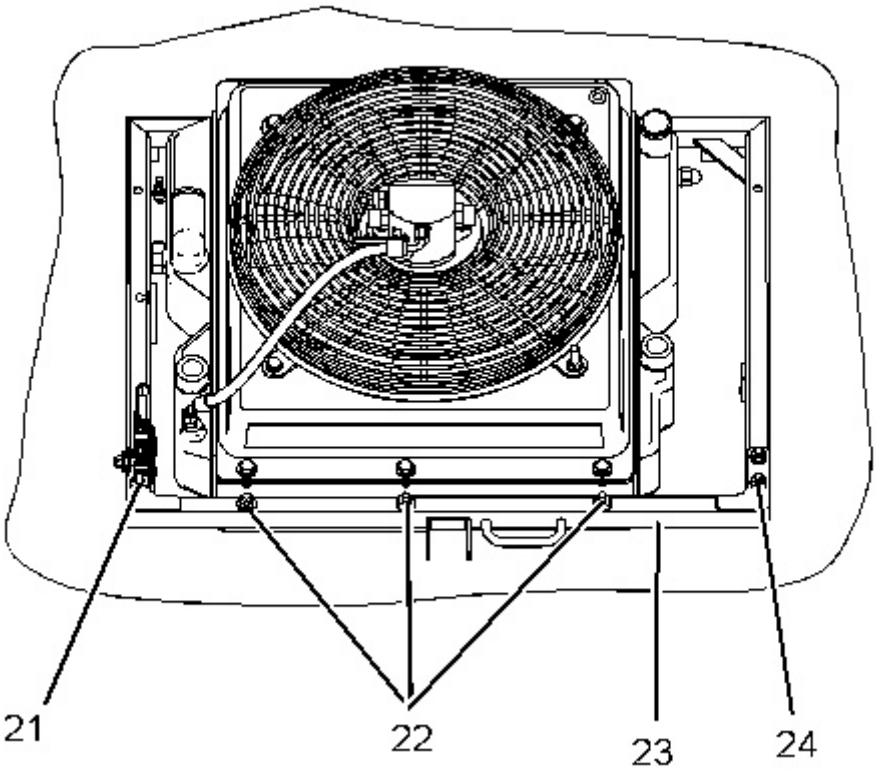


Illustration 3 g01092595

3. Install radiator support (23) and bolts (21) , (22) and (24) . Tighten bolts (21) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

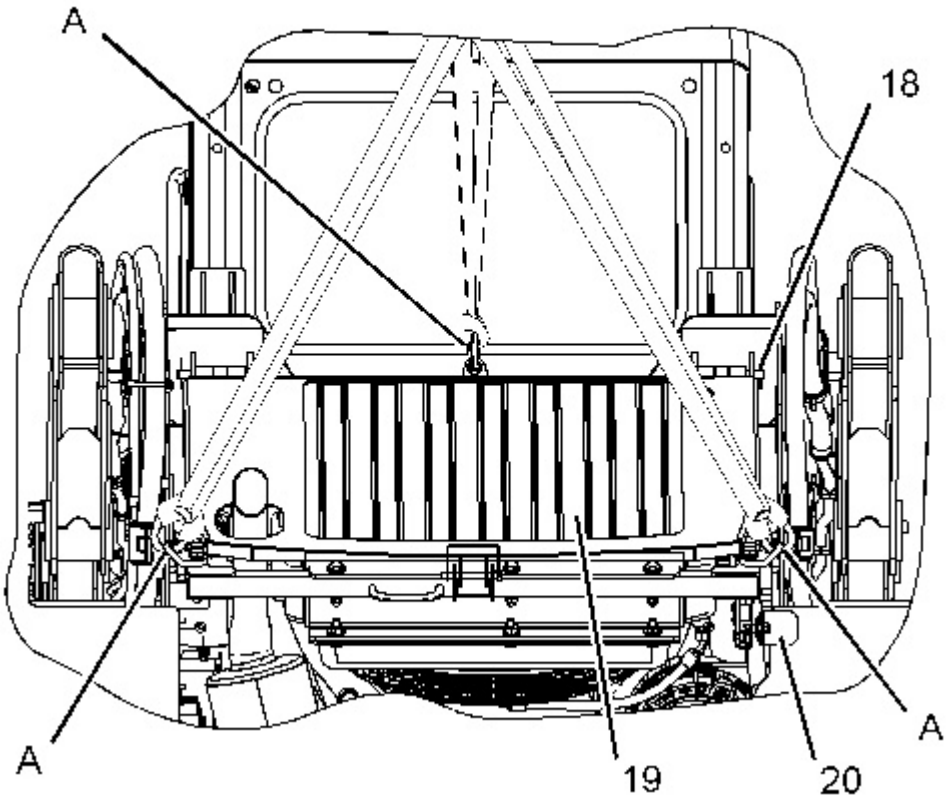


Illustration 4 g01043746

4. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Install radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb). Install pins (18) to each side of the machine and install the cotter pins. Engage latch (20) .



Illustration 5 g01390286

Typical Example

5. Attach a suitable lifting device to the radiator assembly, as shown. The weight of the radiator assembly is approximately 60 kg (130 lb). Use the suitable lifting device in order to raise the radiator, as shown. This will hold the radiator assembly in position until the struts are installed.

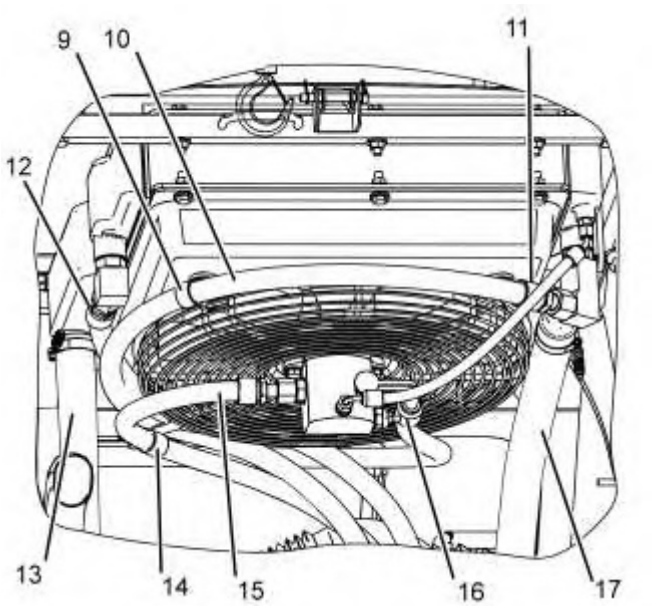


Illustration 6 g01390300

6. Connect hose assemblies (10) and (12) and hoses (13) and (17) . Connect hose assembly (15) . Install clips (9) , (11) , and (14) . Connect hose assembly (16) .

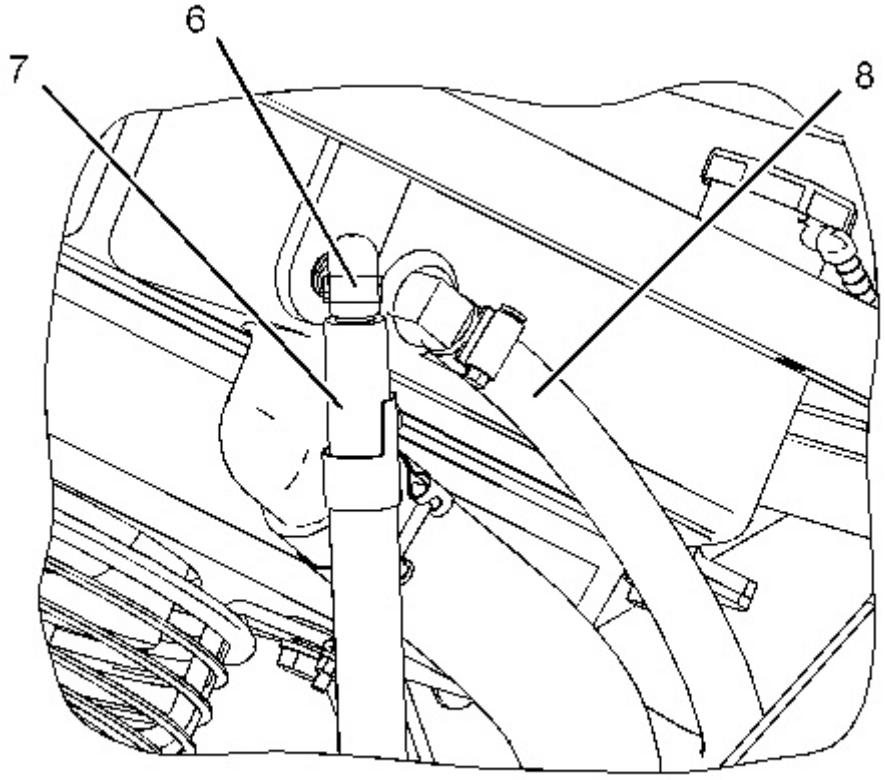


Illustration 7 g01096079

7. Install strut (7) and clip (6) . Connect hose (8) . Remove Tooling (A) .

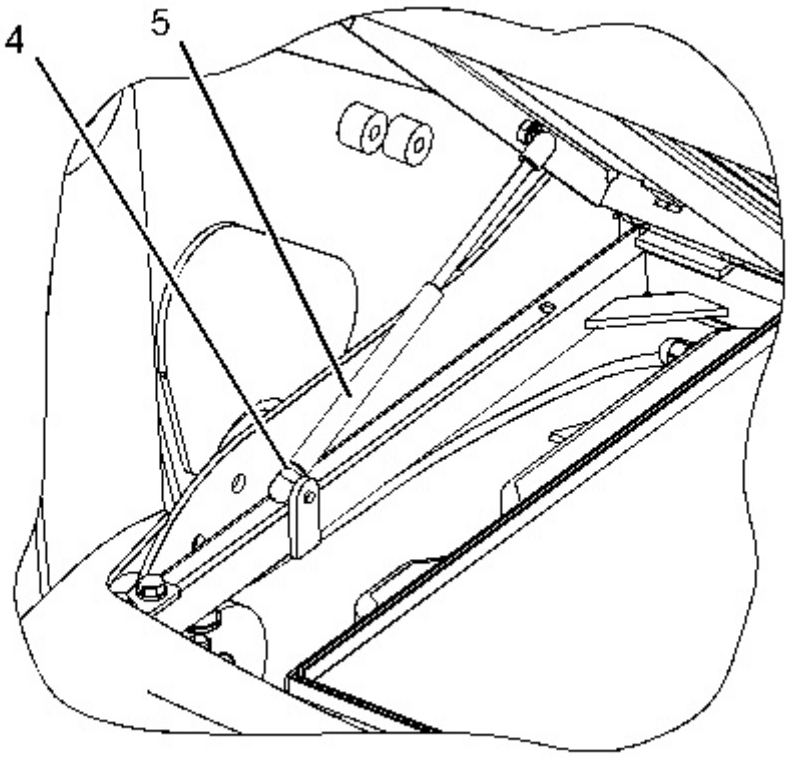


Illustration 8 g01096078

8. Connect struts (5) and install clips (4) .

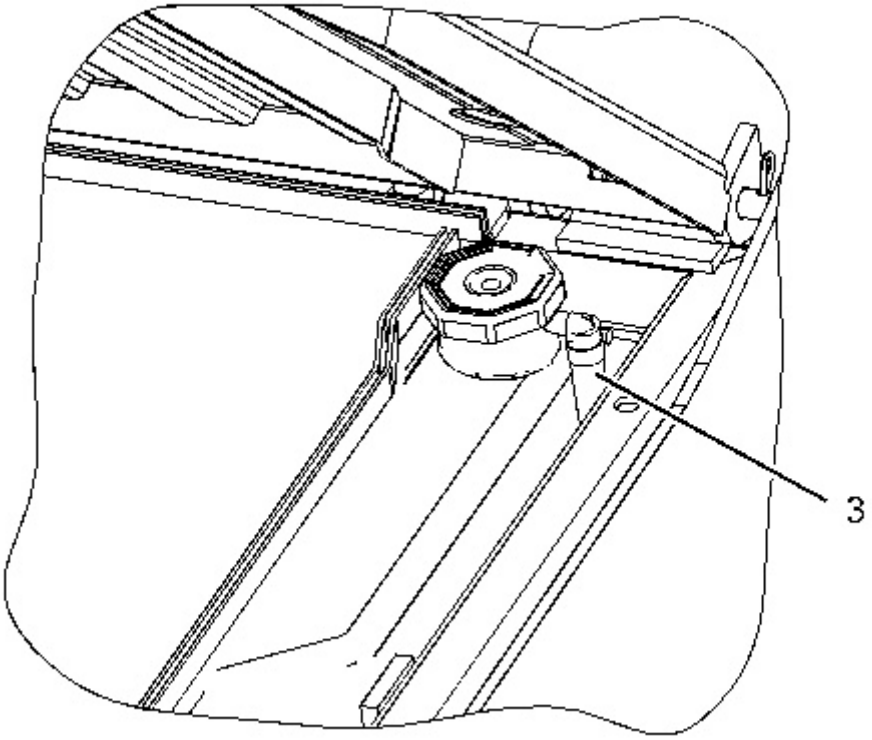


Illustration 9 g01042099

9. Connect hose (3) .

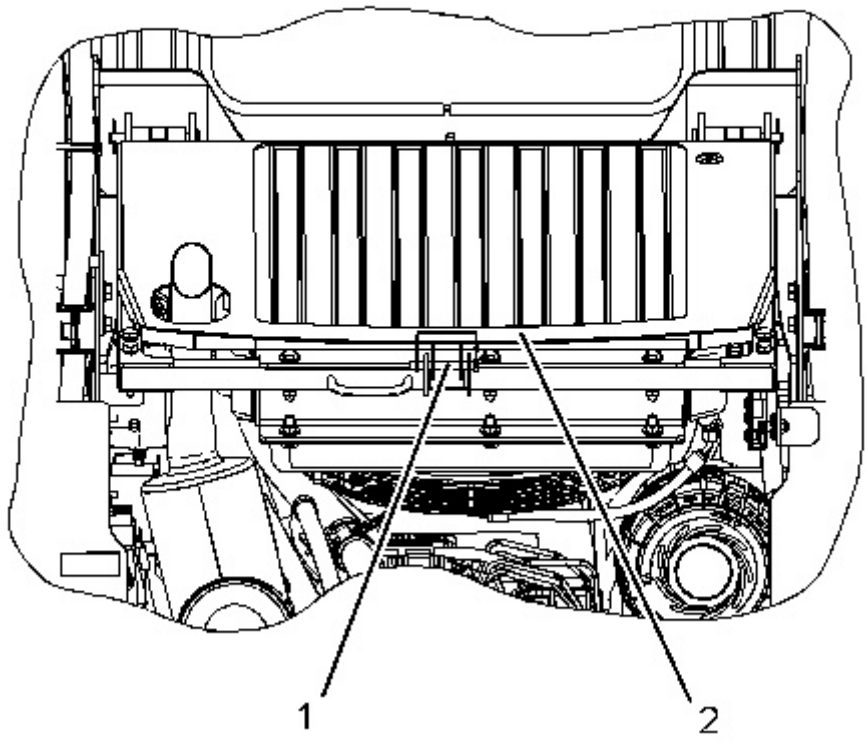


Illustration 10 g01042083

10. Lower radiator guard (2) and install pin (1) .

11. Fill the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

12. Check the level of the hydraulic oil system. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01893737

Water Temperature Regulator

SMCS - 1355

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

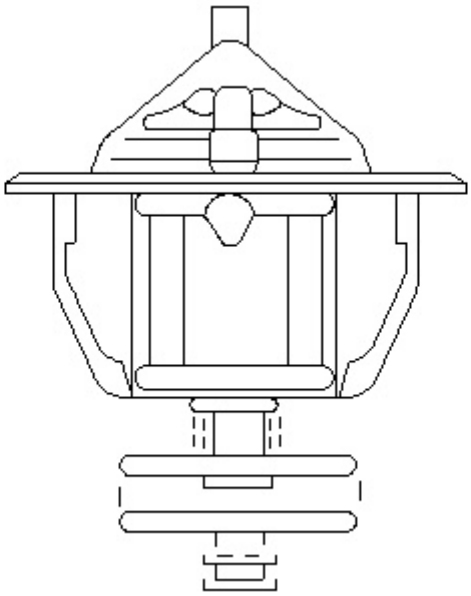


Illustration 1 g00877006

The water temperature regulator starts to open at the following temperature. ... 82° ± 1.5°C (180° ± 2.7°F)

The water temperature regulator has a lift of more than 8 mm (0.3 inch) at the following temperature. ... 95 °C (203 °F)

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i01893737

Water Temperature Regulator

SMCS - 1355

S/N - -

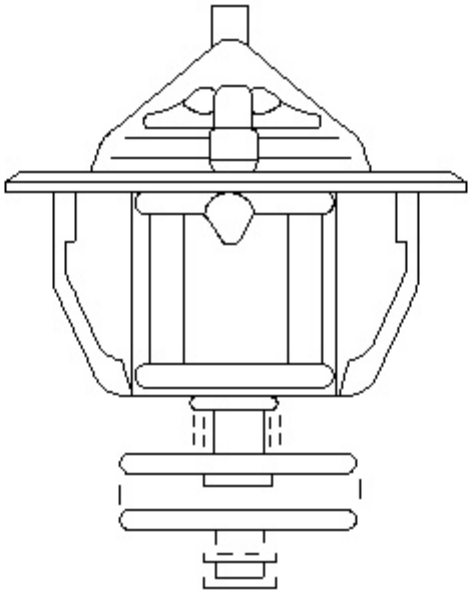


Illustration 1 g00877006

The water temperature regulator starts to open at the following temperature. ... 82° ± 1.5°C (180° ± 2.7°F)

The water temperature regulator has a lift of more than 8 mm (0.3 inch) at the following temperature. ... 95 °C (203 °F)

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02006771

Water Temperature Regulator - Remove and Install

SMCS - 1355-010

Removal Procedure

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

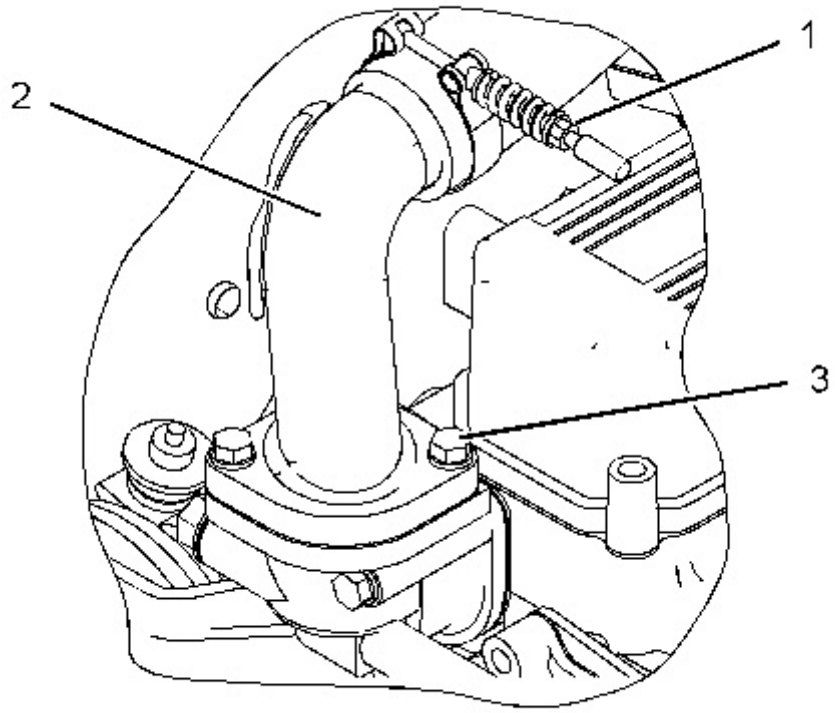


Illustration 1 g01038133

2. Remove bolts (3). Loosen clamp (1) and remove tube assembly (2) .

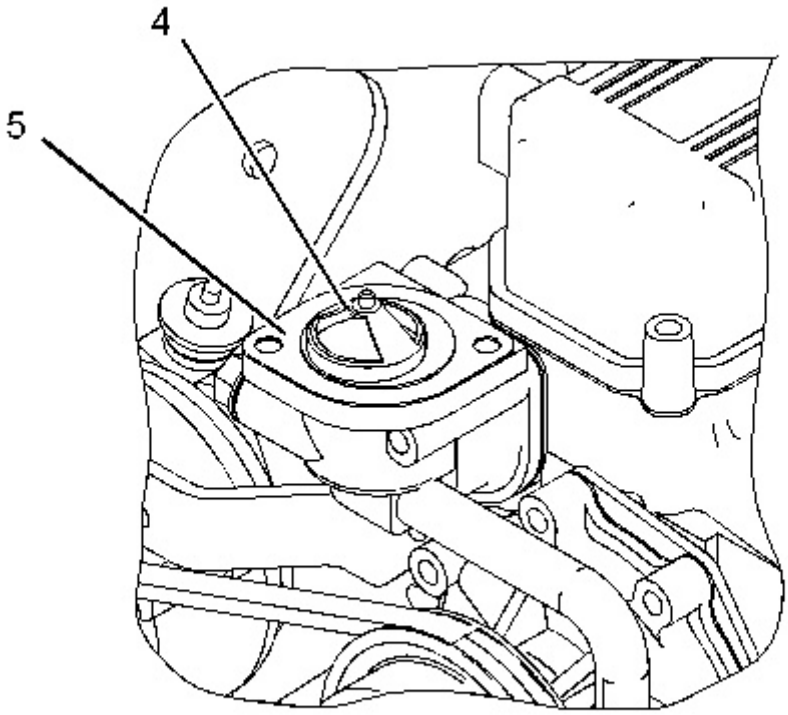


Illustration 2 g01038135

3. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. Remove gasket (5) and remove water temperature regulator (4) .

Installation Procedure

1. Clean all mating surfaces.

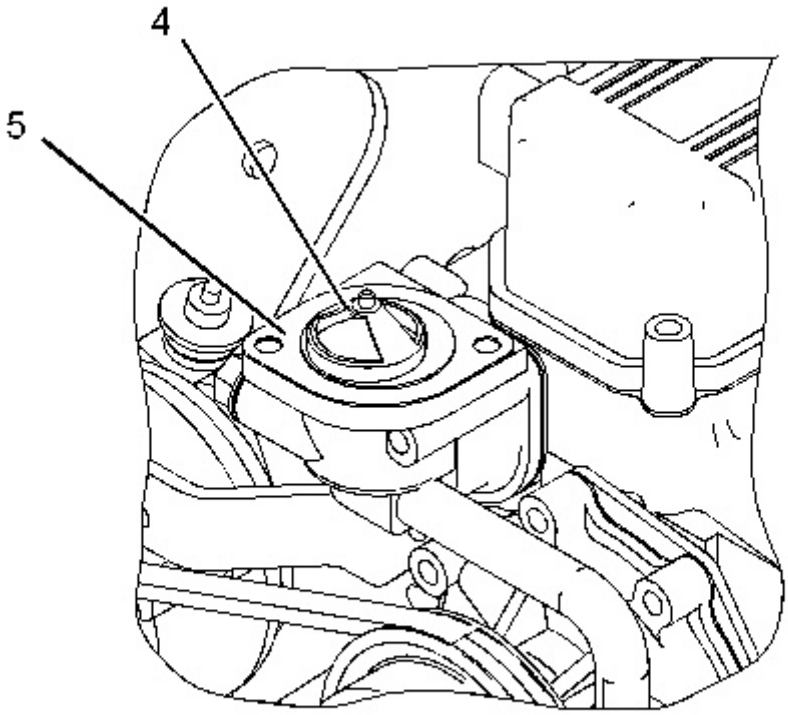


Illustration 3 g01038135

2. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. The pin should be oriented toward the right side of the machine. Install gasket (5) and install water temperature regulator (4) .

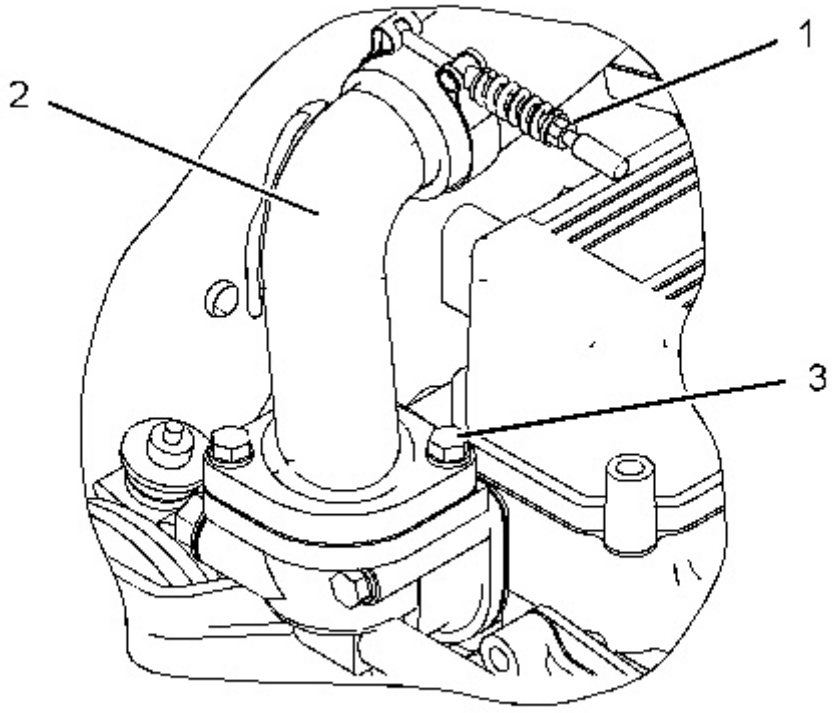


Illustration 4 g01038133

3. Install tube assembly (2). Install bolts (3). Tighten clamp (1) .
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02006771

Water Temperature Regulator - Remove and Install

SMCS - 1355-010

Removal Procedure

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

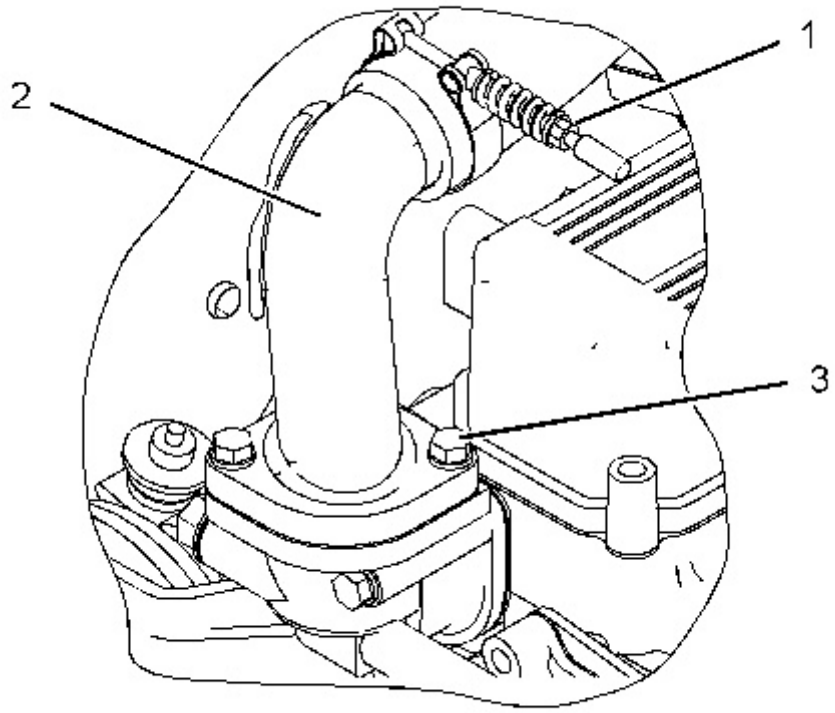


Illustration 1 g01038133

2. Remove bolts (3). Loosen clamp (1) and remove tube assembly (2) .

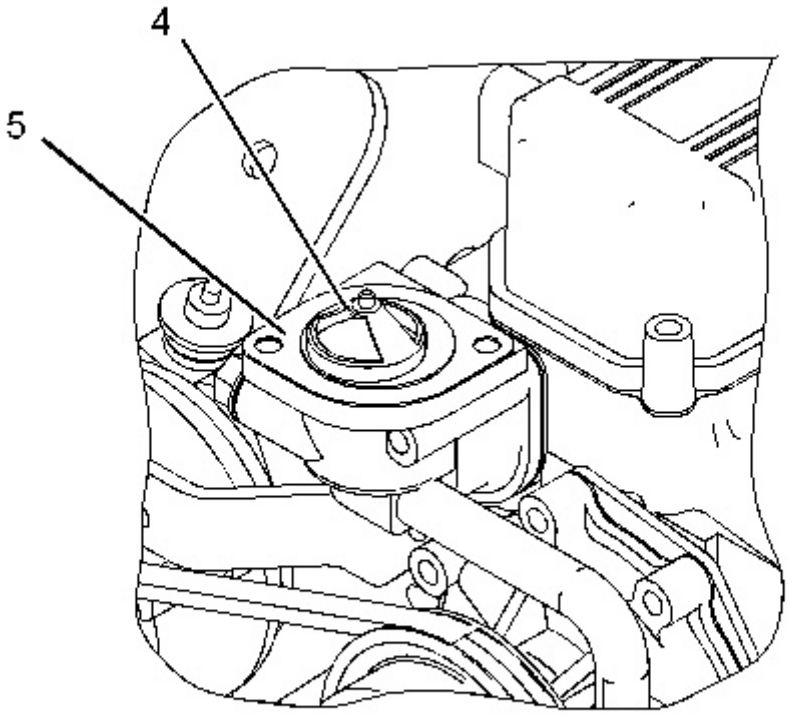


Illustration 2 g01038135

3. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. Remove gasket (5) and remove water temperature regulator (4) .

Installation Procedure

1. Clean all mating surfaces.

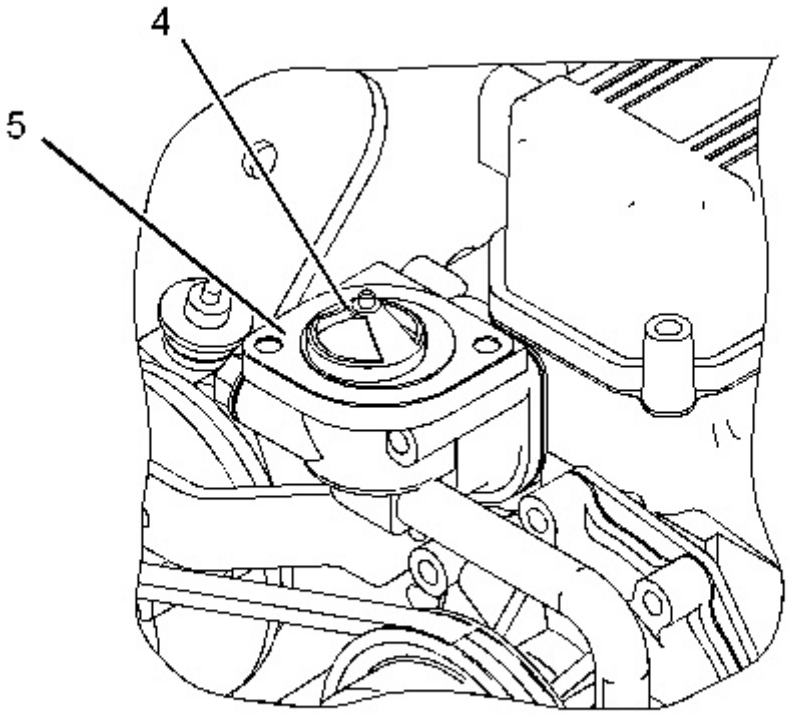


Illustration 3 g01038135

2. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. The pin should be oriented toward the right side of the machine. Install gasket (5) and install water temperature regulator (4) .

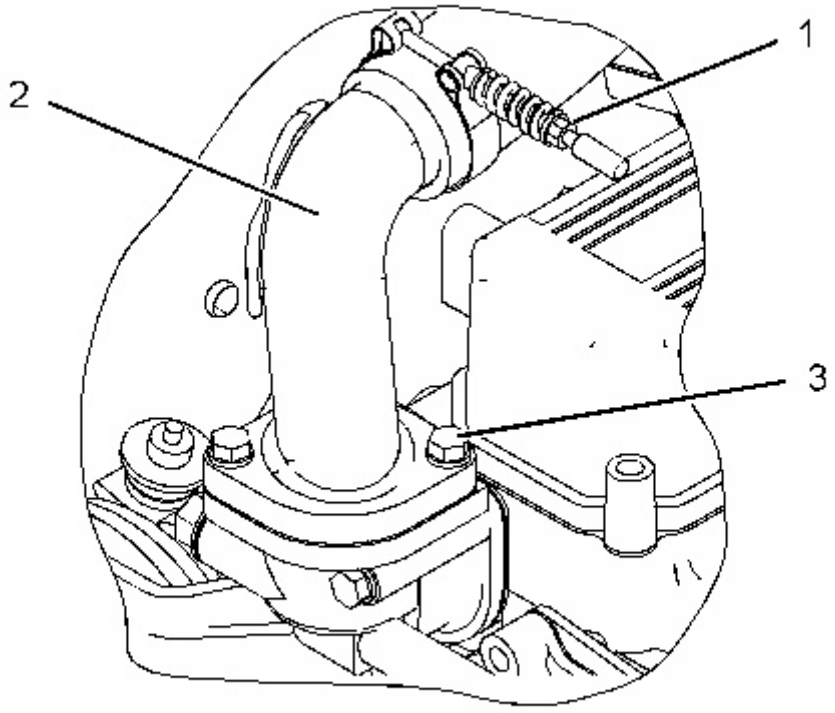


Illustration 4 g01038133

3. Install tube assembly (2). Install bolts (3). Tighten clamp (1) .
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02006771

Water Temperature Regulator - Remove and Install

SMCS - 1355-010

Removal Procedure

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

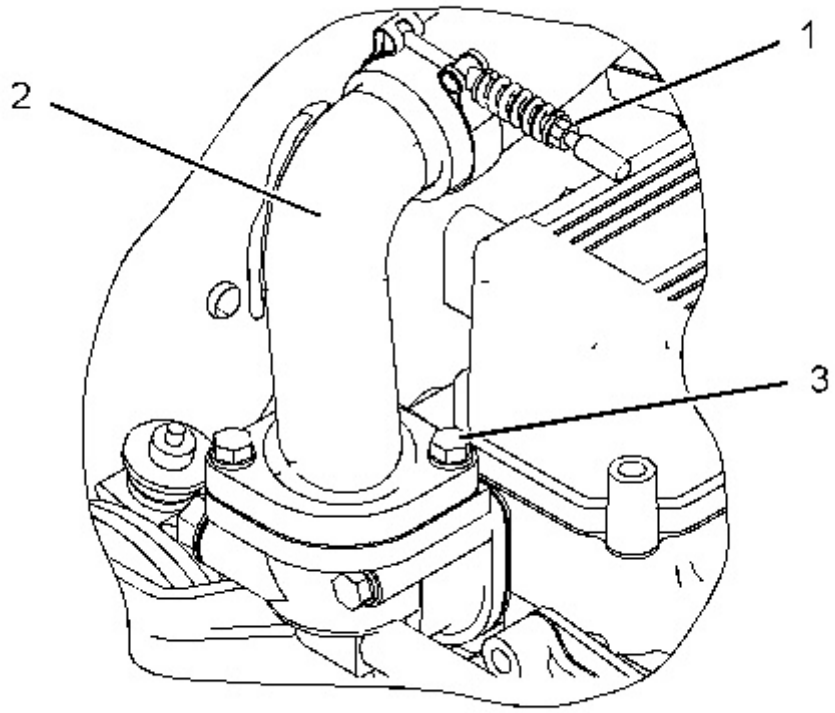


Illustration 1 g01038133

2. Remove bolts (3). Loosen clamp (1) and remove tube assembly (2) .

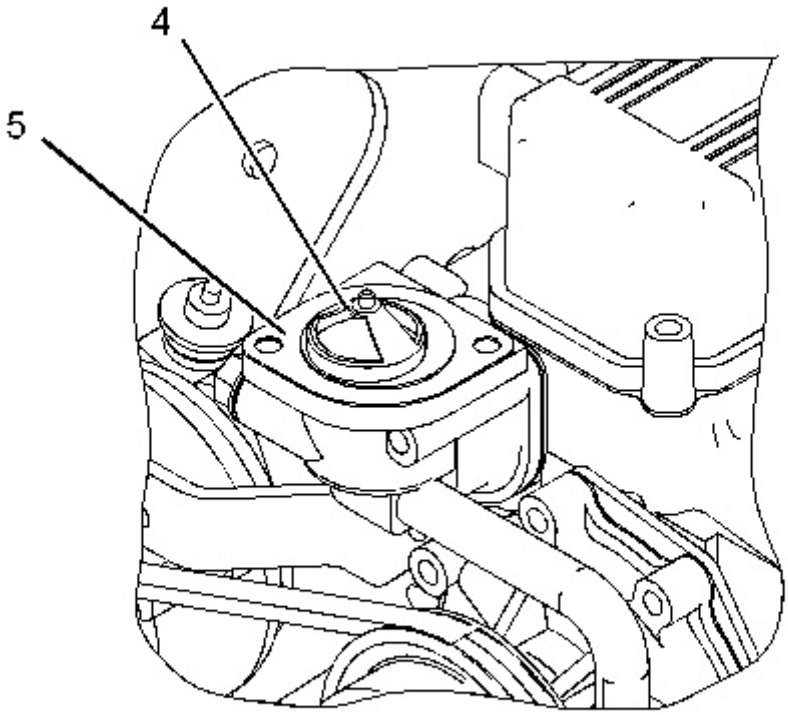


Illustration 2 g01038135

3. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. Remove gasket (5) and remove water temperature regulator (4) .

Installation Procedure

1. Clean all mating surfaces.

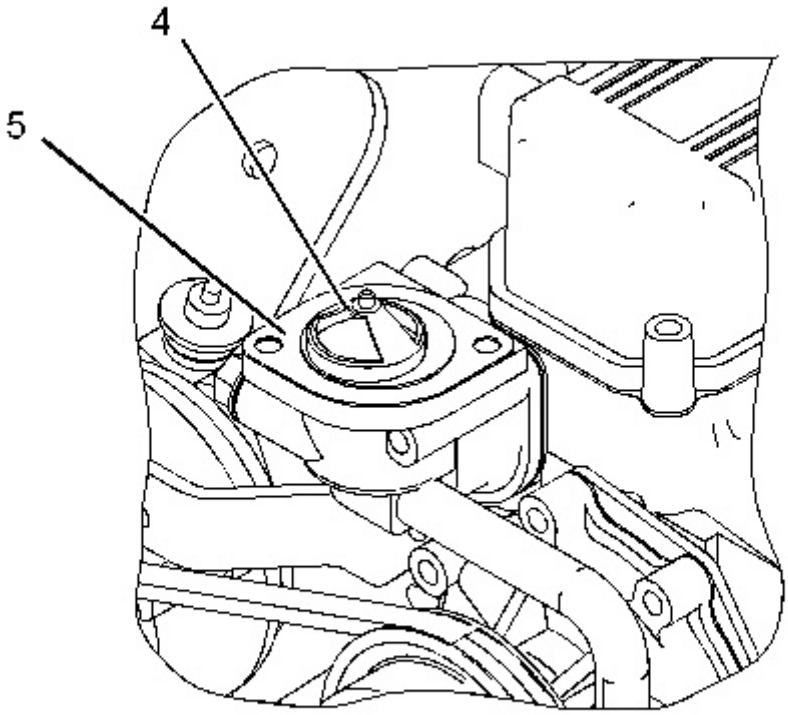


Illustration 3 g01038135

2. Observe the orientation of the pin on the water temperature regulator (4) for reassembly. The pin should be oriented toward the right side of the machine. Install gasket (5) and install water temperature regulator (4) .

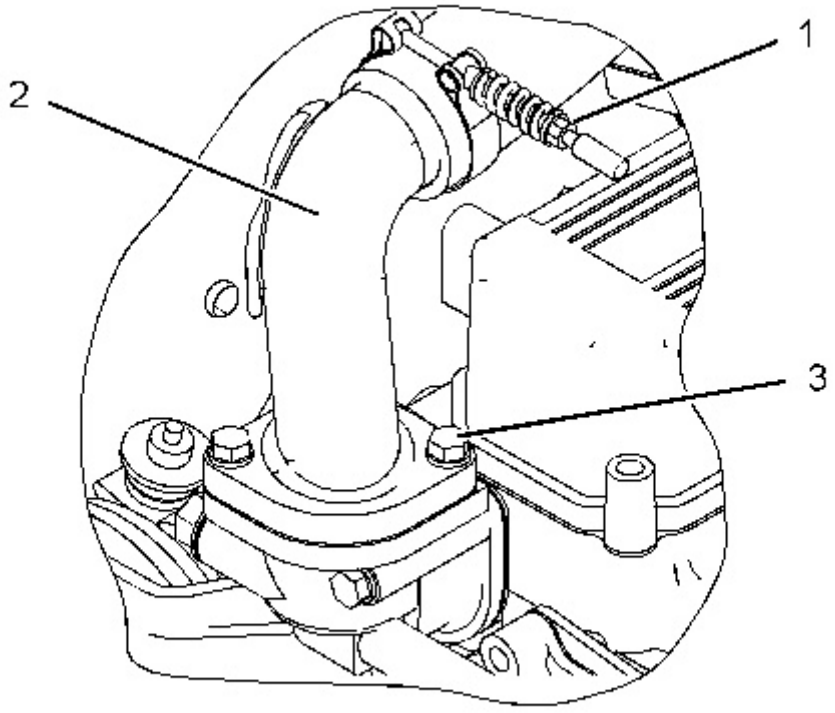


Illustration 4 g01038133

3. Install tube assembly (2). Install bolts (3). Tighten clamp (1) .
4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02002193

Water Temperature Regulator Housing - Remove and Install

SMCS - 1393-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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1. Drain the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

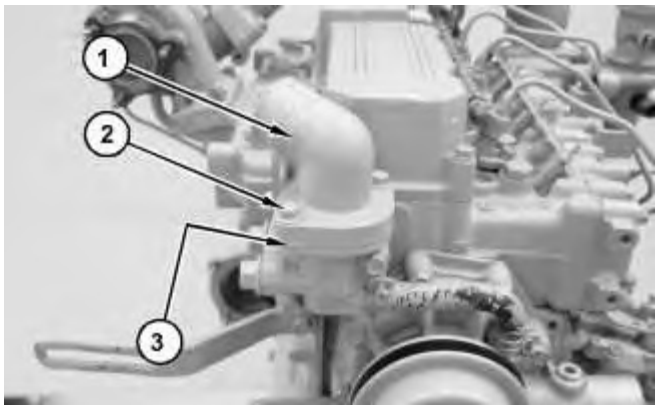


Illustration 1 g01035909

2. Remove bolts (2). Remove elbow assembly (1) and gasket (3) .

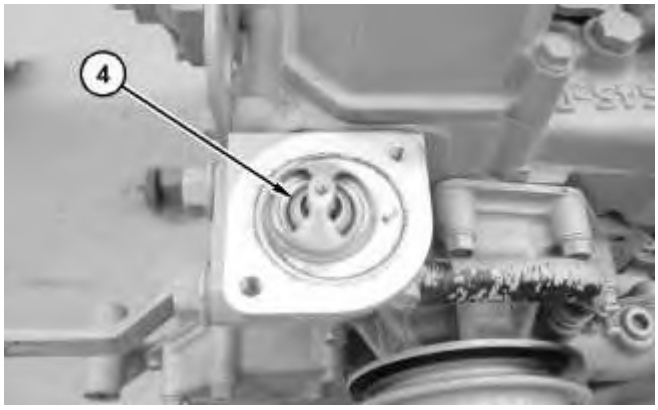


Illustration 2 g01035910

3. Remove water temperature regulator (4). Note the orientation of the water temperature regulator for installation purposes.

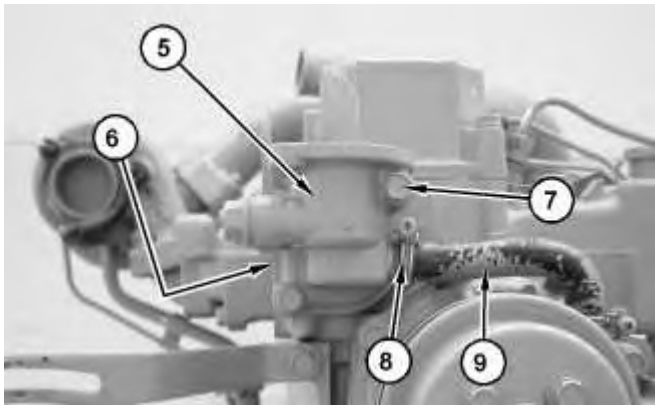


Illustration 3 g01035912

4. Loosen clamp (8) and disconnect hose (9). Remove bolts (7). Remove water temperature regulator housing (5) and gasket (6) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

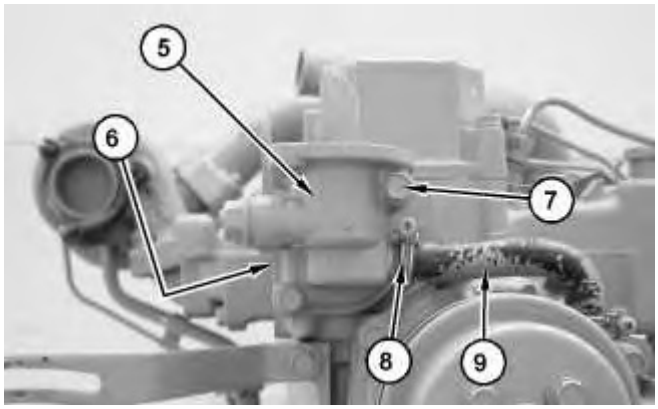


Illustration 4 g01035912

1. Install gasket (6) and position water temperature regulator housing (5). Install bolts (7). Connect hose (9) and tighten clamp (8) .

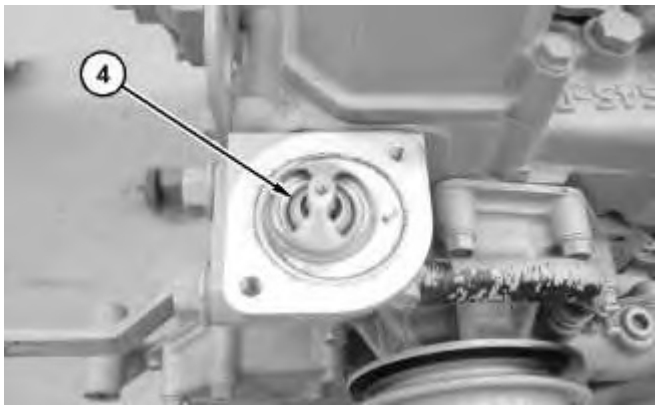


Illustration 5 g01035910

2. Note the orientation of water temperature regulator (4). Install water temperature regulator (4) .

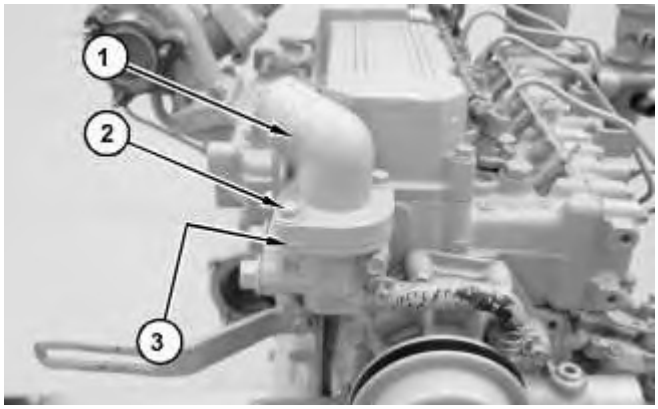


Illustration 6 g01035909

3. Install gasket (3) and elbow assembly (1). Install bolts (2) .

4. Fill the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

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i02638861

Water Temperature Regulator Housing - Remove and Install

SMCS - 1393-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.

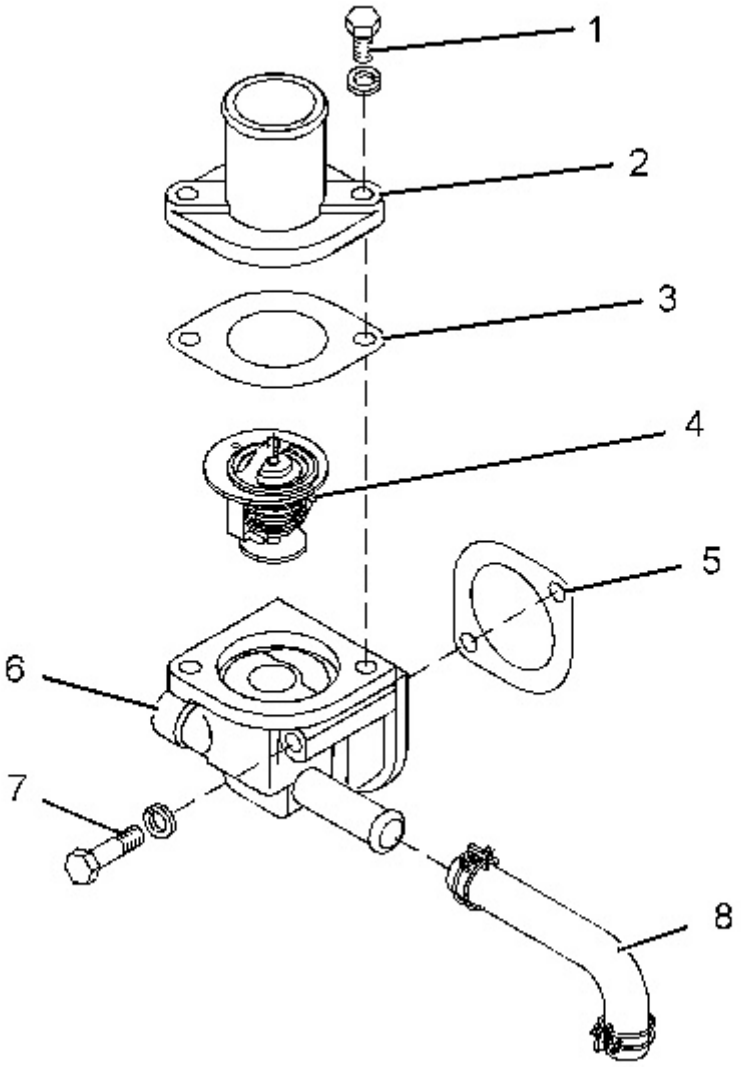


Illustration 1 g01335249

Typical example

2. Remove bolts (1) and remove outlet connection (2) .
3. Remove joint (3) and remove water temperature regulator (4). Note the orientation of the water temperature regulator for installation.
4. Loosen the hose clamp and disconnect hose (8) from water temperature regulator housing (6) .
5. Remove bolts (7) and remove water temperature regulator housing (6) from the cylinder head.
6. Remove joint (5) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the water temperature regulator for wear, damage and correct operation. Refer to Systems Operation,Testing and Adjusting, "Water Temperature Regulator - Test" for more information. If necessary, replace the water temperature regulator.
2. Ensure that the mating surfaces of the outlet connection, the water temperature regulator housing and the cylinder head are clean and free from damage.

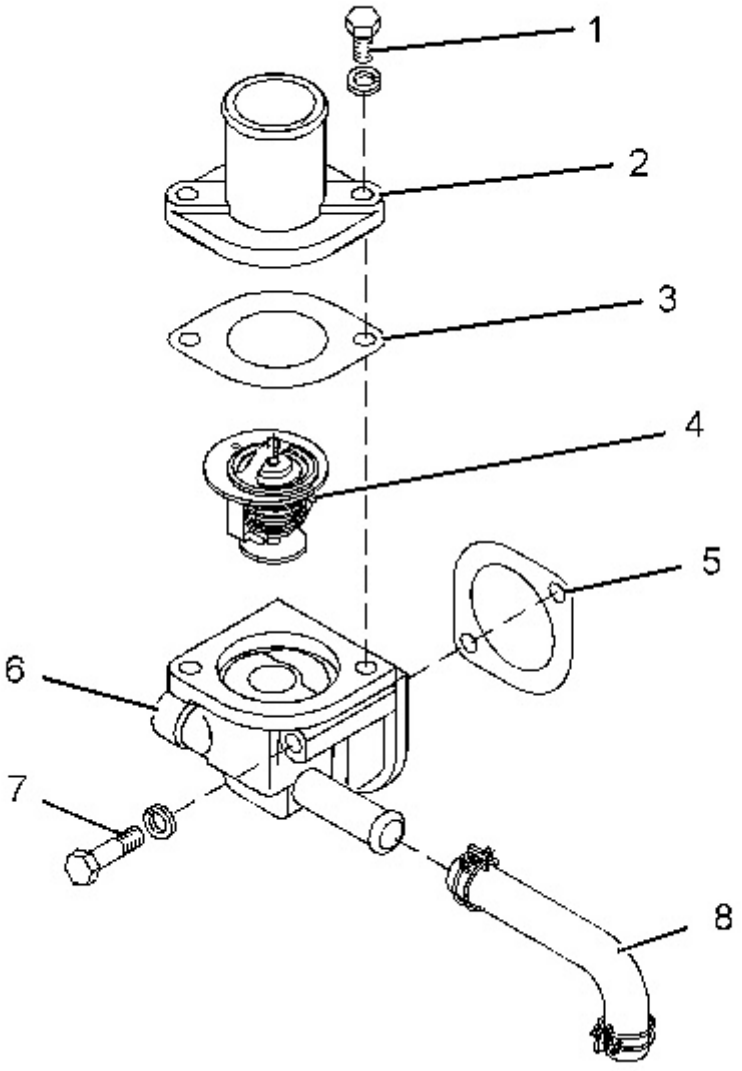


Illustration 2 g01335249

Typical example

3. Position bolts (7) and a new joint (5) onto water temperature regulator housing (6) .
4. Position water temperature regulator housing (6) onto the cylinder head. Tighten bolts (7) to a torque of 18 N·m (13 lb ft).

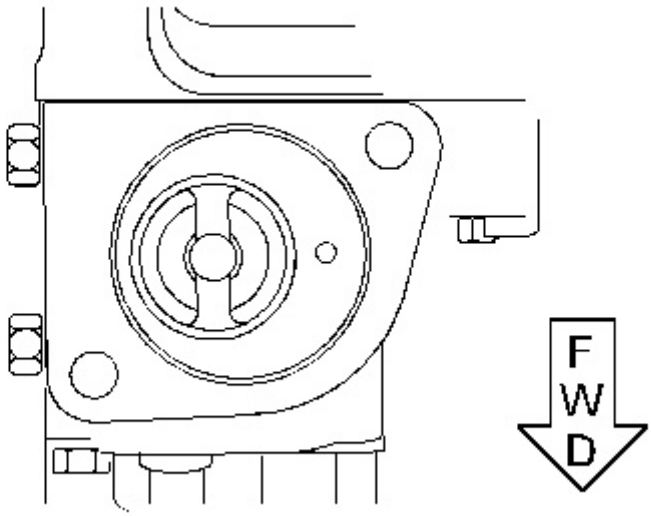


Illustration 3 g01335282

Orientation of the water temperature regulator

5. Install water temperature regulator (4) to water temperature regulator housing (6). Ensure the correct orientation of the water temperature regulator.
6. Position a new joint (3) and outlet connection (2) onto water temperature regulator housing (6) .
7. Install bolts (1). Tighten the bolts to 18 N·m (13 lb ft).
8. Connect hose (8) to water temperature regulator housing (6). Tighten the hose clamps securely.
9. Fill the cooling system with coolant to the correct level. Refer to Operation and Maintenance Manual, "Cooling System Coolant -Change" for the correct procedure.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01994469

General Information

SMCS - 6700-EK2

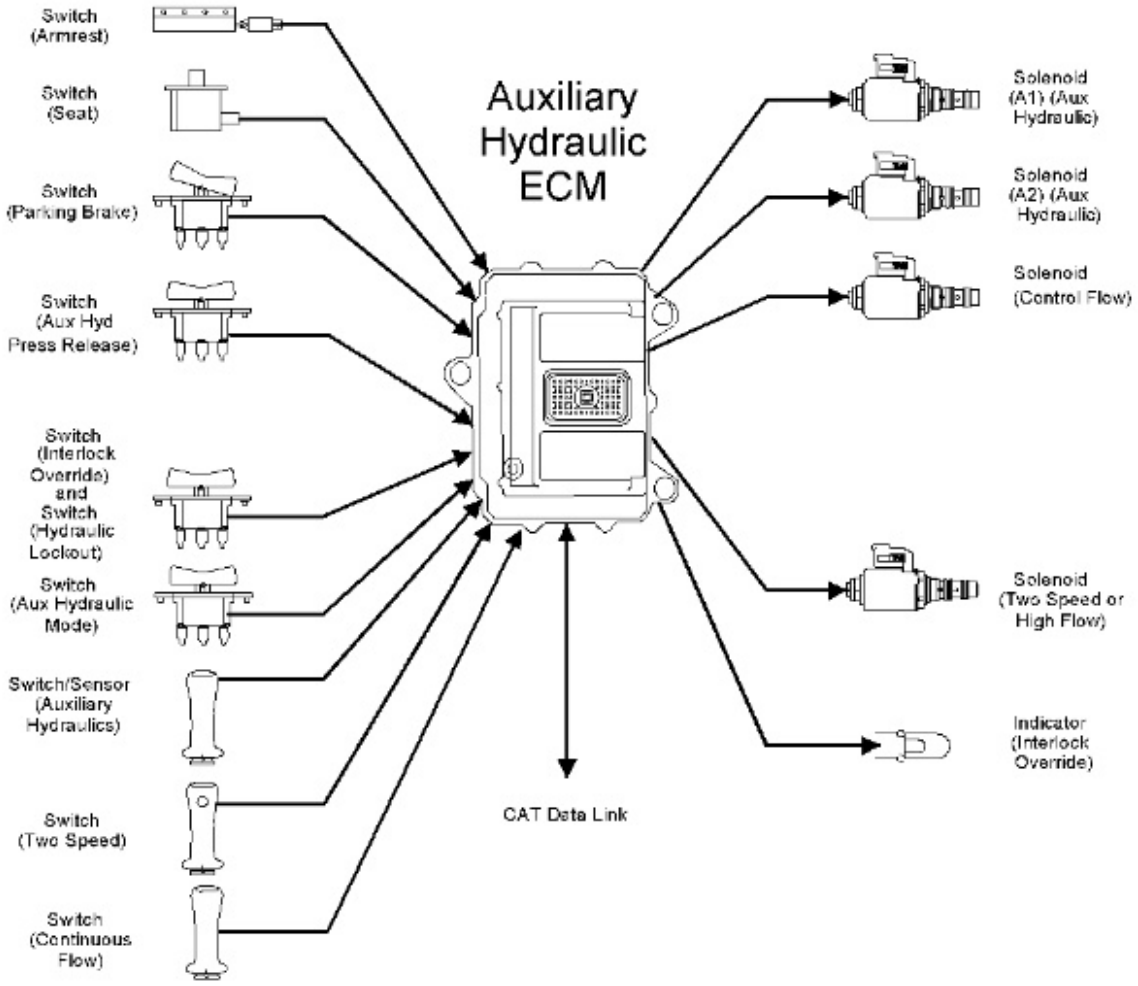


Illustration 1 g01032184

Block diagram for the electronic control system for the auxiliary hydraulics

The auxiliary hydraulic system consists of switches, an ECM, indicators, and actuators.

The auxiliary hydraulic ECM gathers information from the switches. The information is processed by the software. The ECM will then activate the indicators and solenoids.

The auxiliary hydraulic ECM will communicate with the Caterpillar Electronic Technician (ET) over the Cat Data Link.

The auxiliary hydraulic ECM utilizes the following components for the input signals:

- Switch (armrest)
- Switch (seat)
- Switch (parking brake)
- Switch (hydraulic lockout)
- Switch (continuous flow)
- Switch (interlock override)
- Switch (auxiliary hydraulics) (A1)
- Switch (auxiliary hydraulics) (A2)
- Position sensor (auxiliary control)
- Switch (two speed)
- Switch (auxiliary hydraulic pressure release)
- Switch (auxiliary hydraulic mode)

Note: The position sensor (if equipped) is used in place of the switches for the auxiliary hydraulics (A1 and A2).

Note: All of the switch inputs must be in the neutral state when power is applied to the machine.

The auxiliary hydraulic ECM controls the following components:

- Modulating valve (auxiliary hydraulics) (A1)
- Modulating valve (auxiliary hydraulics) (A2)
- Solenoid valve (flow control)
- Solenoid valve (high flow)
- Solenoid valve (two speed)
- Indicator (interlock override)
- Indicator (two speed)

The auxiliary hydraulic ECM and the interlock ECM share the inputs of the following switches:

- Switch (armrest)
- Switch (seat)
- Switch (parking brake)
- Switch (hydraulic lockout)

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Systems Operation
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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995769

Normal Operation

SMCS - 6700-EK2

The following sequence of switch inputs must occur in order to enable the auxiliary hydraulic ECM:

- The operator must sit in the seat.
- The operator must pull down the armrest.
- The operator must start the machine.
- The operator must press the parking brake switch.

The auxiliary hydraulics will now be enabled. The following inputs can now be activated:

- Switch (auxiliary hydraulics) (A1)
- Switch (auxiliary hydraulics) (A2)
- Switch (hydraulic lockout)
- Switch (continuous flow)
- Switch (interlock override)
- Position sensor (auxiliary control)
- Switch (two speed)
- Switch (auxiliary hydraulics mode)

Note: The position sensor (if equipped) is used in place of the switches for the auxiliary hydraulics (A1 and A2).

Auxiliary Control

Switches (Auxiliary)

Pressing the A1 switch will energize the A1 solenoid for the auxiliary hydraulics.

Pressing the A2 switch will energize the A2 solenoid for the auxiliary hydraulics.

Position Sensor (Auxiliary Control)

Moving the auxiliary control forward will energize the A1 solenoid for the auxiliary hydraulics.

Moving the auxiliary control backward will energize the A2 solenoid for the auxiliary hydraulics.

Continuous Flow

`

The continuous flow function allows the flow of hydraulic oil to the auxiliary hydraulics without the need of continuously actuating the auxiliary control. Once either the A1 solenoid or the A2 solenoid is energized, pressing the continuous flow switch and releasing the A1 switch or A2 switch will allow the solenoid to remain energized. The A1 switch or A2 switch must be released within one second of pressing the continuous flow switch.

Interlock Override

The interlock override function will allow the operator to raise the armrest in order to exit the machine while the A1 solenoid or the A2 solenoid remains energized. When the continuous flow function is enabled, depress the interlock override switch in order to enable the interlock override function.

Note: Raising the armrest and/or exiting the seat without enabling the interlock override function will reset the ECM.

XPS High Flow

The XPS high flow function is available on the High Flow models only.

The system uses a proportional control on the work tool lever. When the proportional control is moved to the A1 position and the mode select switch is in the high flow mode, the auxiliary solenoid A1 and the control flow solenoid will energize. When the proportional control is moved to the A2 position, the auxiliary solenoid A2 and the control flow solenoid will energize.

High Flow

The high flow option is available on some machines.

When the mode switch is in the high flow position, the ECM will energize the control flow solenoid. When the proportional control is moved to the A1 position, the auxiliary solenoid A2 and the high flow solenoid will energize. When the proportional control is moved to the A2 position, the auxiliary A2 solenoid will only energize.

Secondary Auxiliary (C+/C-)

The secondary auxiliary is only available on machines equipped with either high flow option.

The secondary auxiliary (hydraulic flow) utilizes another set of lines that run down the lift arm for worktool positioning.

Pressing the C+ switch on the right joystick in order to provide hydraulic oil flow to the hydraulic connector on the loader arm.

Pressing the C- switch on the right joystick in order to provide hydraulic oil flow to the hydraulic connector on the loader arm.

On machines with XPS high flow, the control flow solenoid will be disabled reducing system pressure. On high flow machines with the mode switch in auxiliary hydraulic mode, the control flow solenoid will energize.

Two Speed

The two speed function is an optional attachment on certain models.

The auxiliary hydraulic ECM controls the two speed function. The two speed function activates a solenoid valve which blocks the flow of hydrostatic oil to half of the pistons in the drive motors. This process allows the motor to spin faster. The two speed function is activated by depressing the two speed switch.

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Systems Operation
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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995772

Electronic Control Module (ECM)

SMCS - 6700-EK2; 7610-WTL

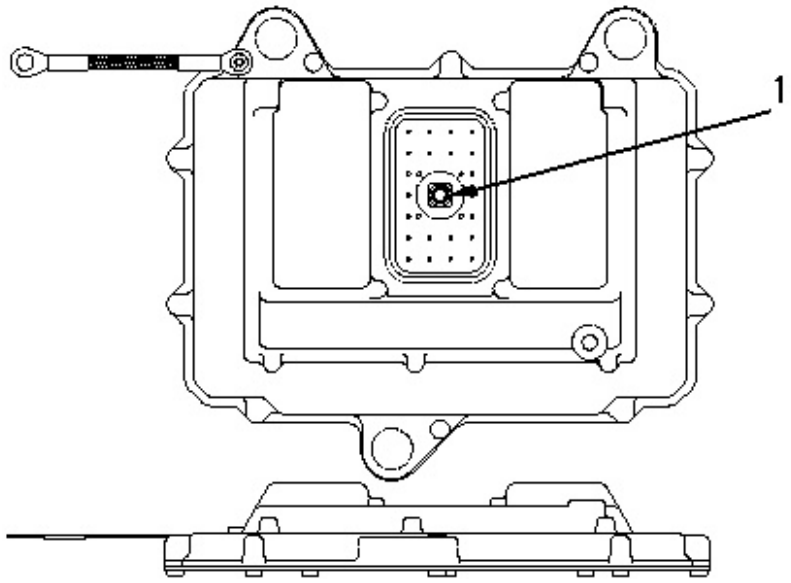


Illustration 1 g00532313

Auxiliary hydraulic ECM

(1) J1 connector



Illustration 2 g00777829

Location of the auxiliary hydraulic ECM

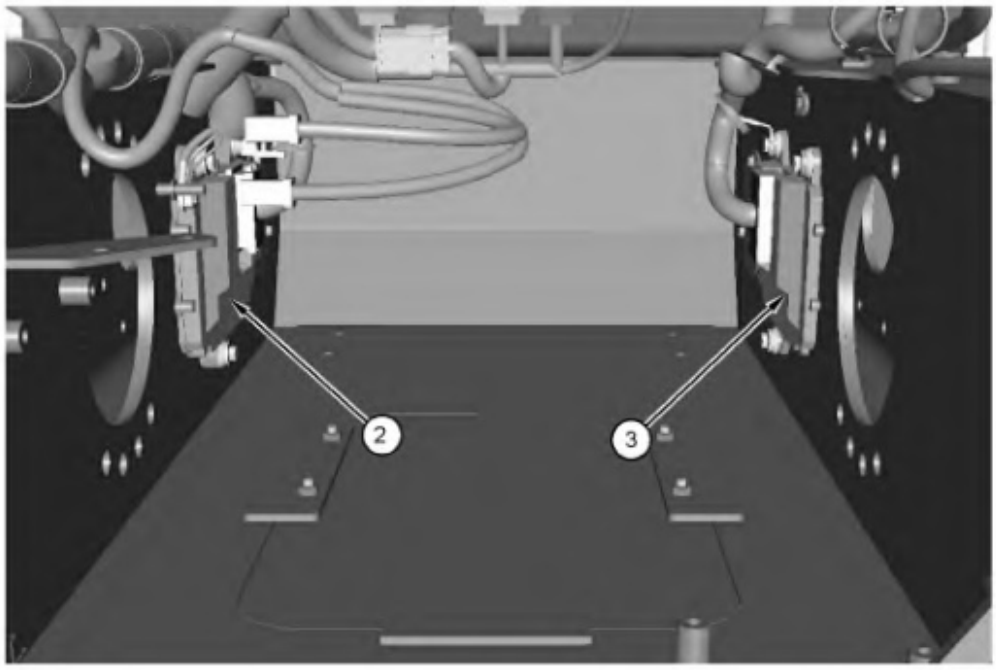


Illustration 3 g01032468

(2) The Interlock ECM is located on the left side of the machine.

(3) The Auxiliary Hydraulic ECM is located on the right side of the machine.

The auxiliary hydraulic ECM is located on the right side of the machine beneath the floorplate on Skid Steer Loaders.

On Multi Terrain Loaders, the auxiliary hydraulic ECM is located on the front side of the machine beneath the floorplate.

Decisions are made by the circuits in the auxiliary hydraulic ECM. Software in the ECM activates the electronic circuits in the appropriate way to correctly operate the machine. Connectors join the harness wiring to the inputs and outputs of the ECM.

There is one connector (J1) with 70 contacts. Refer to the table below for contact descriptions.

Table 1

Contact Description		
No.	**Function**	**Type**
1	+ Battery	Power
3	- Battery	Ground
5 (1)	Solenoid Valve (High flow) (H2)	Driver Output
5 (2)	Solenoid (Two Speed)	Driver Output
7	Switch (Continuous Flow)	Switch Input
9	Switch (Auxiliary Hydraulic Mode)	Switch Input
11	CAT Data Link -	Input/Output
13	CAT Data Link +	Input/Output
18	Indicator (Interlock Override)	Driver Output
19	Switch (Auxiliary Pressure Release)	Switch Input
24	Solenoid Valve (Control flow)	Driver Output
26	Solenoid Valve (Source)	Sourcing Drive Output
29	Switch (Two Speed)	Switch Input
31	Switch (Auxiliary Hydraulic Mode)	Switch Input
40	Solenoid (Auxiliary Hydraulics) (A1)	Driver Output
42	Solenoid (Auxiliary Hydraulics) (A1 and A2)	Sourcing Drive Output
45	Switch (Parking Brake)	Switch Input
47	Switch (Hydraulic Lockout)	Switch Input
52	Auxiliary Control	Return
53	Switch (Auxiliary) (A2) or Position Sensor (auxiliary)	Switch Input
58	Solenoid (Auxiliary Hydraulics) (A2)	Driver Output
60	+ 8 Volt	Supply
62	Switch (Auxiliary Hydraulics) (A1) (Hydraulic Pressure)	Switch Input
64	Switch (Interlock Override)	Switch Input
66	Switch (C+,C- Relay)	Switch Input
68	Switch (Seat)	Switch Input

70	Switch (Armrest)	Switch Input

(1) The contact is used on machines that are equipped with high flow.

(2) The contact is used on machines that are equipped with the two speed function.

The ECM monitors the condition of the machine for proper system operation. Components sense the condition of the machine. Components then send electrical signals to the inputs of the ECM. The ECM compares the information from the inputs to the stored information. The ECM then decides if outputs should be activated. The activation is performed by sending electrical signals through the outputs to an electronic circuit.

Inputs

The switch inputs provide information about operator requests to the control. The inputs receive information from the switches concerning operation of the solenoid outputs. The inputs receive information from the switches concerning the status of the operator. The ECM reads the inputs as an open circuit or a grounded circuit.

Outputs

The indicators allow the operator to know the state of certain functions of the interlock ECM.

The ECM supplies a current to the appropriate outputs that energize relays and solenoids.

Communication

The CAT® Data Link is used to communicate with the Caterpillar Electronic Technician (ET).

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Systems Operation
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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995783

Solenoid Valves

SMCS - 3139; 5479

Modulating Valve (Auxiliary Hydraulics)

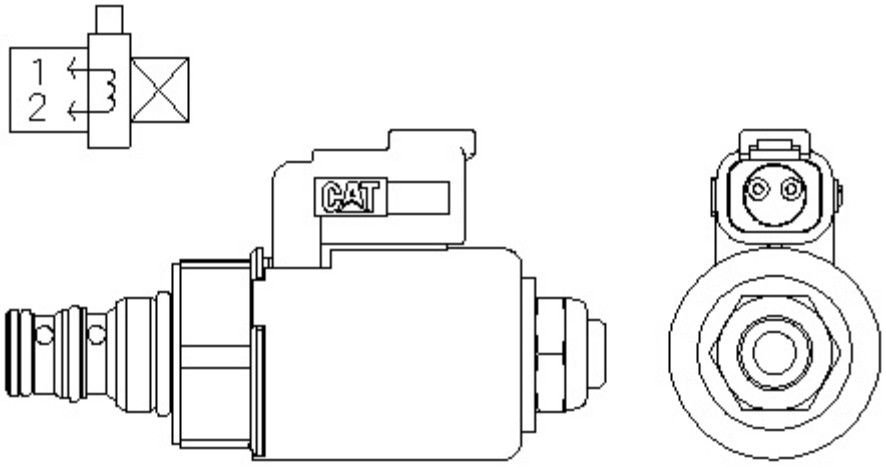


Illustration 1 g00778150

Modulating valve (auxiliary hydraulics)

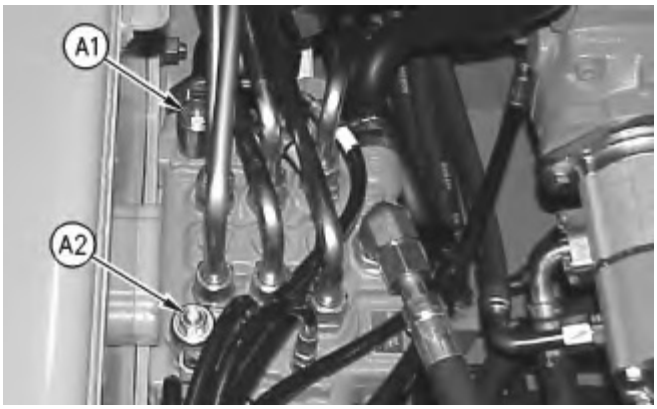


Illustration 2 g00778141

Location of the modulating valves for the auxiliary hydraulics

The modulating valves are located behind the work tool control.

The auxiliary hydraulic ECM activates the auxiliary hydraulic solenoids. There are two auxiliary hydraulic solenoids. The solenoids are referred to as A1 and A2. The solenoids control the pilot pressure for the auxiliary hydraulics. The solenoids are proportional. These solenoids receive a proportional current from the ECM that is from 0 Amperes to 1.8 Amperes on the standard machine and 0 Amperes to 2.0 Amperes on the XPS high flow machines.

Solenoid Valve (Two Speed)

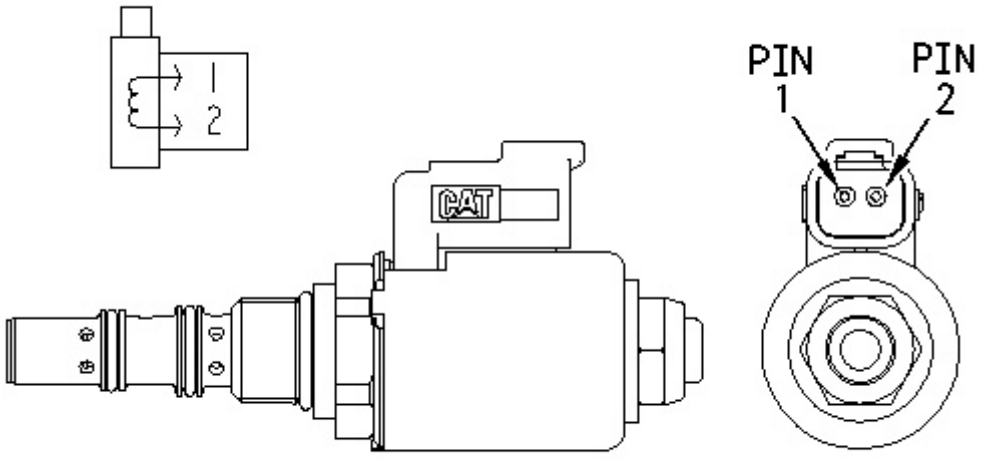


Illustration 3 g00876549

Solenoid valve (two speed)

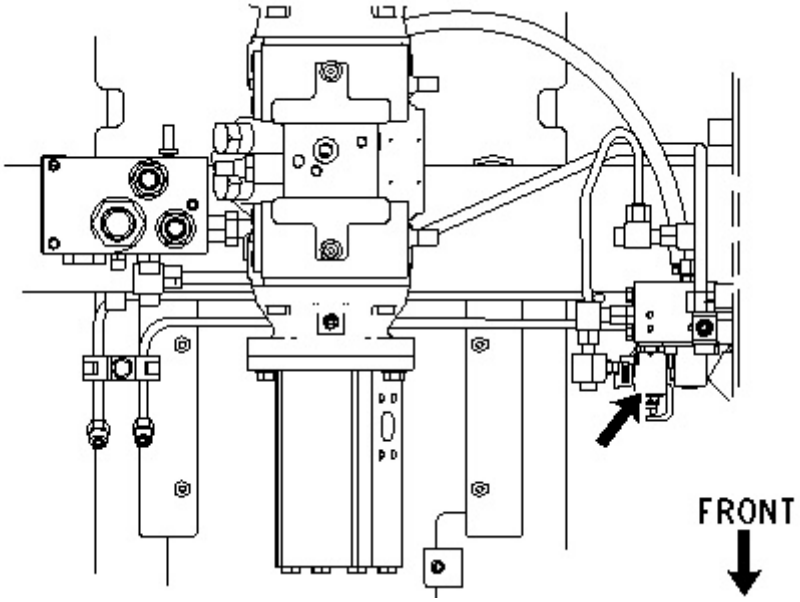


Illustration 4 g00876550

Location of the solenoid valve (two speed)

The solenoid valve for the two speed is located beneath the cab next to the parking brake solenoid.

The auxiliary hydraulic ECM will activate the solenoid valve for the two speed. The valve will block the flow of hydraulic oil to half of the pistons in the hydraulic motors.

High Flow Valve

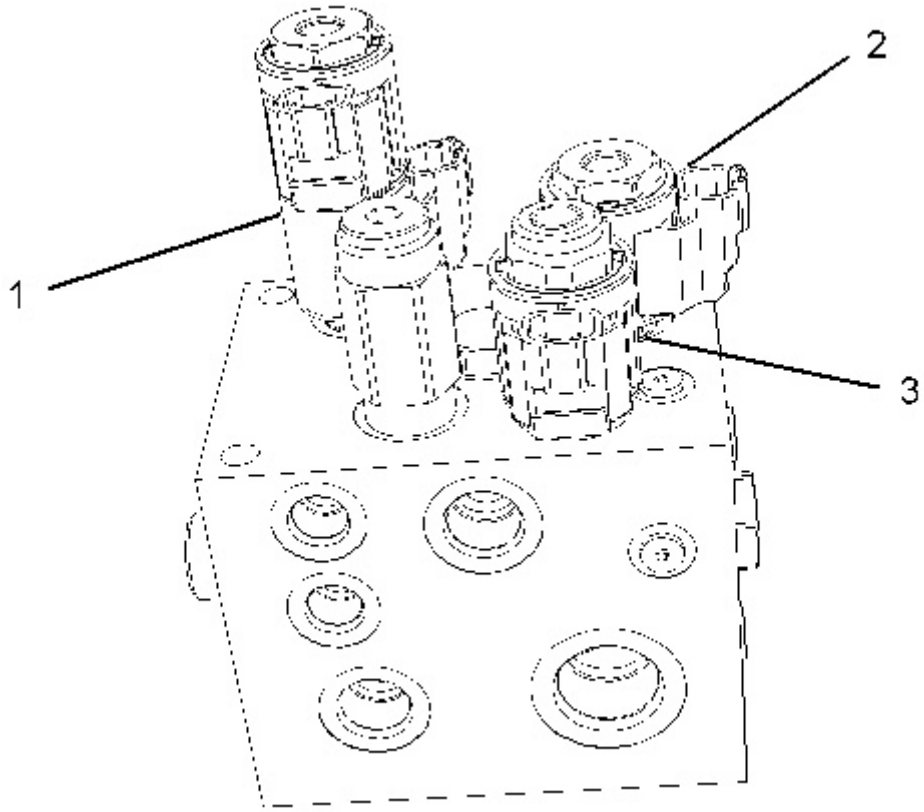


Illustration 5 g01045992

High Flow Valve

(1) C+/C- Solenoids

(2) Control flow solenoid

(3) High flow solenoid

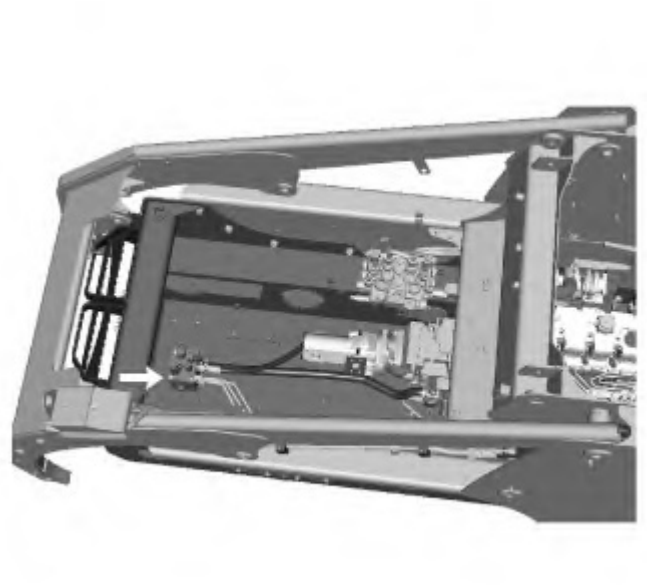


Illustration 6 g01045990

Location of the high flow valve

The high flow valve is located under the floor plate at the front of the machine. The high flow valve contains the circuits for the high flow and worktool control circuits.

Solenoid Valve (High Flow)

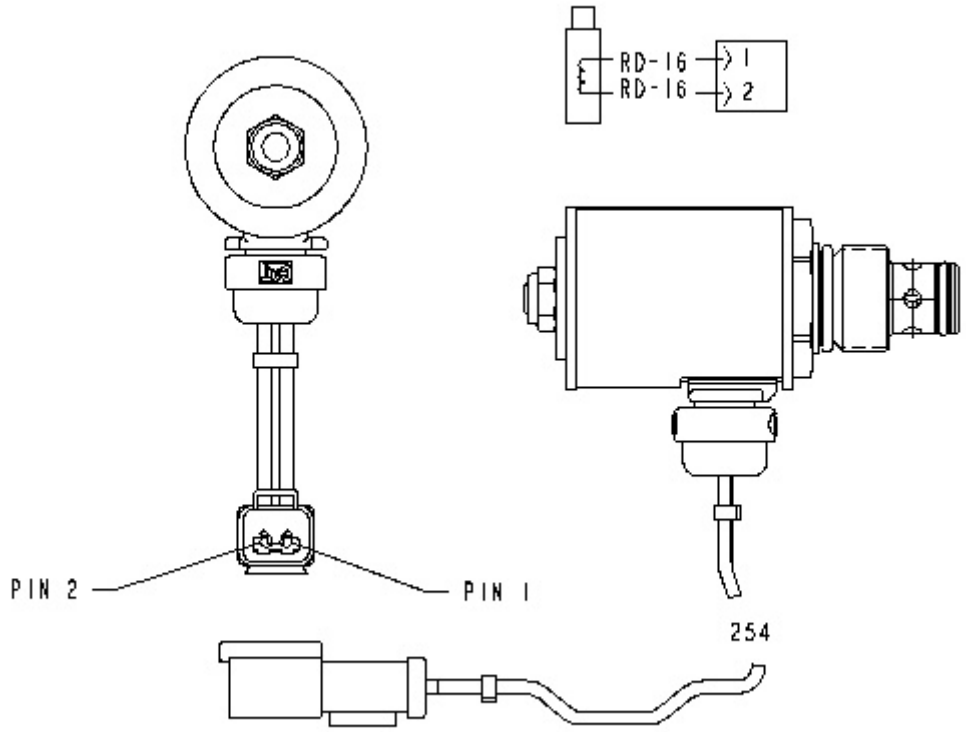


Illustration 7 g01046191

The ECM controls the high flow solenoid in order to provide a higher amount of hydraulic flow. When the high flow solenoid is energized, flow from the high flow gear pump is blocked to the tank, causing pressure to build.

Modulating Valve (Control Flow) for High Flow Machines

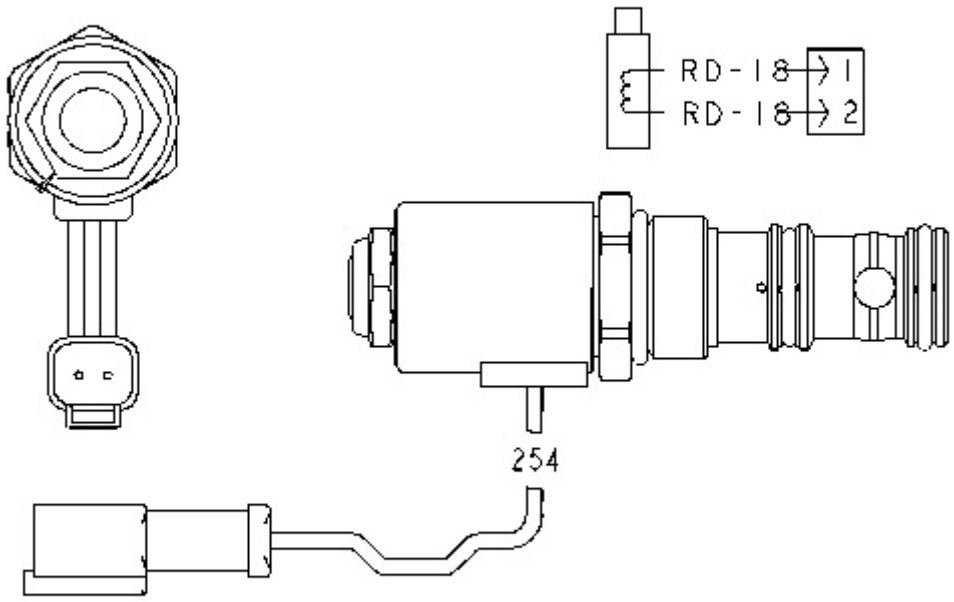


Illustration 8 g01046289

The control flow solenoid directs the pump supply oil to either the worktool control or the high flow system. When the control flow solenoid is energized, some of the flow from the high flow pump is directed to open the check valve in the circuit to the auxiliary worktool.

Modulating Valve (Control Flow) for (XPS) High Flow Machines

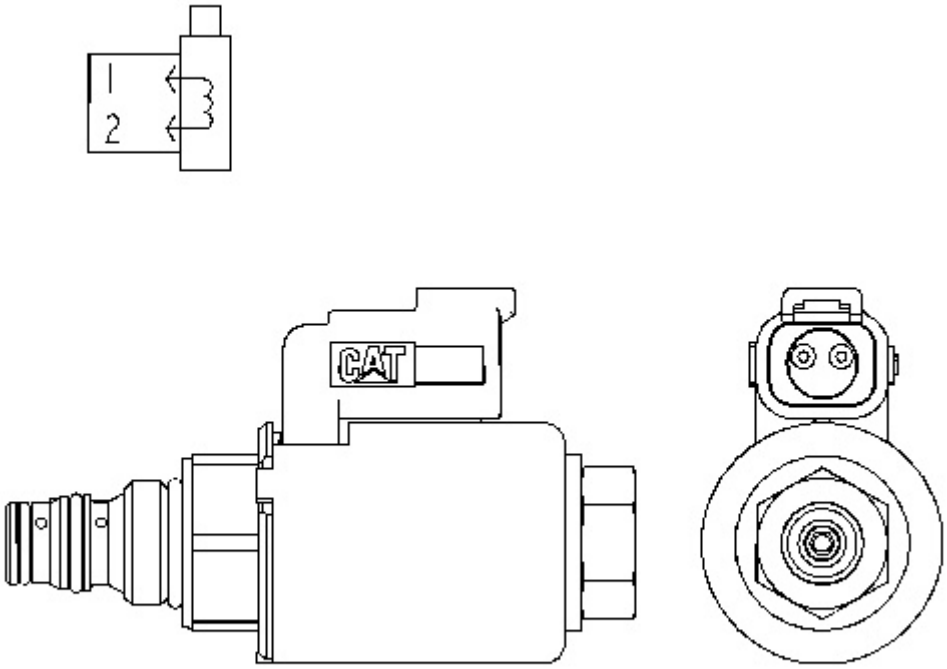


Illustration 9 g01046296



Illustration 10 g01046343

The solenoid valve for the control flow is located beneath the cab.

If a high flow worktool is detected and the C+/C- functions or the worktool pressure switch are not activated, the auxiliary hydraulic ECM will activate the control flow solenoid.

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Systems Operation
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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233290

Cat Data Link

SMCS - 1408; 6700-EK2

The auxiliary hydraulic ECM uses the Cat Data Link. The Cat Data Link is an input/output of the ECM at contacts J1-11 and J1-13. The Cat Data Link communicates with Caterpillar Electronic Technician (ET). The Cat Data Link consists of internal control circuits and a wiring harness.

The auxiliary hydraulic ECM sends information via the Cat Data Link to the Cat ET. The Cat ET can monitor the inputs of the ECM. The ET will also retrieve any diagnostic codes that are set by the ECM.

All electronic control modules that use the Cat Data Link have a module identifier (MID). The MID for the auxiliary hydraulic ECM is the number 106.

See Troubleshooting Section, "Using Caterpillar Electronic Technician to Determine Diagnostic Codes" for additional information for using the Cat ET.

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Systems Operation
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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995790

Related Components

SMCS - 1408; 6700-EK2

Interlock Electronic Control Modules (ECM)

The interlock ECM is used on all of the skid steer loaders and multi terrain loaders.

The interlock ECM is used in order to control the following functions:

- Engine start interlock
- Parking brake interlock
- Hydraulic interlock
- Hydrostatic system

The interlock ECM uses the parking brake indicator and the armrest indicator in order to show active faults.

Reference: See System Operations, RENR6417 for information on the interlock ECM.

Common Switches

The following switches are used on both of the electronic control modules for the skid steer loaders and multi terrain loaders.

- Switch (Parking Brake)
- Switch (Hydraulic Lockout)
- Switch (Armrest)
- Switch (Seat)

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Systems Operation

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01994607

General Information

SMCS - 7630

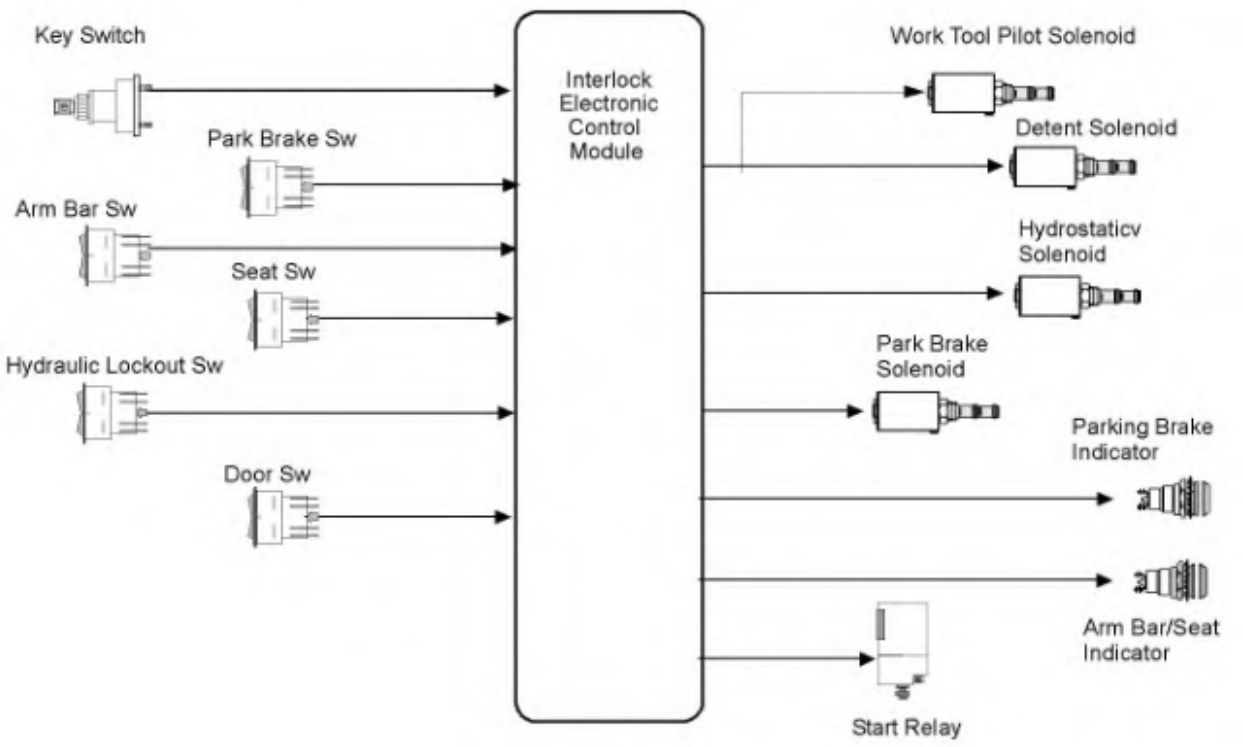


Illustration 1 g01032263

Block diagram for the interlock ECM

The interlock system is standard equipment. The interlock system consists of switches, an ECM, indicators, and actuators. The ECM gathers information from the switches. The information is processed by the software. The ECM will then activate the relays and solenoids.

The Interlock ECM utilizes the following components for the input signals:

- Switch (start)
- Switch (armrest)
- Switch (seat)
- Switch (parking brake)
- Switch (hydraulic lockout)
- Switch (door)

The interlock ECM controls the following components:

- Solenoid valve (hydrostatic pilot)
- Solenoid valve (work tool pilot)
- Solenoid valve (parking brake)
- Coil (work tool detent)
- Relay (start)
- Relay (fuel shutoff)
- Indicator (parking brake)
- Indicator (armrest)

Specific functions of the interlock system are shown below:

- Engine start interlock
- Hydrostatic system
- Parking brake interlock
- Work tool interlock

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i01994640

Normal Operation

SMCS - 7630

These switch inputs must be in valid states in order for the ECM to enable the starting of the machine.

- switch (seat)
- switch (armrest)

The machine may be started once these conditions are met. The operator must remain in the seat with the armrest in the down position in order to enable the machine.

The operator should then press the parking brake switch. Releasing the parking brake enables the hydrostatic system and the hydraulic interlock.

Note: Raising the armrest and/or exiting the seat will cause the following conditions: a disabled hydrostatic system, a disabled hydraulic interlock and an engaged parking brake.

The hydraulic lockout feature is enabled once the engine is started. If the hydraulic lockout switch is in the locked position, then the work tools will be locked out.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01502891

Engine Start Interlock

SMCS - 7630

The engine start interlock uses the following components:

- Switch (key start)
- Switch (armrest)
- Switch (seat)
- Relay (start)
- Indicator (armrest)

When power is applied to the ECM, the output for the start relay will be off. The output will remain off until the ECM receives valid inputs from the armrest switch, the seat switch, and the key start switch.

When the ECM receives signals that indicate that the seat is occupied and the armrest is lowered, the ECM will turn off the armrest indicator. When the ECM receives a signal from the key start switch, the ECM will turn on the output for the start relay. The start relay supplies current to the starting motor in order to crank the engine.

Note: On machines that are equipped with the machine security system (MSS), the output for the start relay goes to the MSS. The MSS will then send an output to the start relay.

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Systems Operation
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Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01502893

Hydrostatic System Interlock and Parking Brake Interlock

SMCS - 7630

The interlock system for the hydrostatic system and the parking brake uses the following components:

- Switch (armrest)
- Switch (seat)
- Switch (parking brake)
- Solenoid valve (hydrostatic pilot)
- Solenoid valve (parking brake)
- Indicator (armrest)
- Indicator (parking brake)

When power is applied to the ECM, the outputs for the hydrostatic pilot solenoid and the parking brake solenoid will be off. The outputs will remain off until the ECM receives valid inputs from the armrest switch, the seat switch and the parking brake switch.

When the ECM receives signals that indicate that the seat is occupied and the armrest is lowered, the ECM will turn off the armrest indicator. When the ECM sees the parking brake switch close, the ECM will then turn on the outputs for the hydrostatic pilot solenoid and the parking brake solenoid. Energizing these solenoids allows the machine to move.

Pressing the parking brake switch again will turn off the hydrostatic pilot solenoid and the parking brake solenoid. When the parking brake solenoid is turned off, the parking brake will become engaged and the parking brake indicator will illuminate.

Note: A raised armrest or an unoccupied seat will also cause the ECM to turn off the hydrostatic pilot solenoid and the parking brake solenoid.

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Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01994638

Work Tool Interlock

SMCS - 7630

The work tool interlock uses the following components:

- Switch (armrest)
- Switch (seat)
- Switch (door)
- Switch (parking brake)
- Switch (hydraulic lockout)
- Solenoid valve (work tool pilot)
- Indicator (armrest)

When power is applied to the ECM, the outputs for the pilot solenoid valve for the work tool will be off. The output will remain off until the ECM receives valid inputs from the following switches:

- Switch (armrest)
- Switch (seat)
- Switch (door)
- Switch (parking brake)
- Switch (hydraulic lockout)

When the ECM receives signals that indicate that the seat is occupied and the armrest is lowered, the ECM will turn off the armrest indicator.

When the ECM receives inputs from the parking brake switch, the door switch (if applicable) and the hydraulic lockout switch, the ECM will turn on the output for the pilot solenoid valve for the work tool.

The solenoid valve enables the hydraulics for the work tool. Pressing the lockout switch for the work tool will de-energize the pilot solenoid valve for the work tool.

Note: A raised armrest or an unoccupied seat will also cause the ECM to turn off the pilot solenoid valve for the work tool.

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Systems Operation
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Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01994648

Diagnostic Operation

SMCS - 7630

The interlock ECM (electronic control module) has the capability to detect invalid inputs and invalid outputs. The ECM will flash the armrest indicator and/or the parking brake indicator when an electrical fault is detected. The invalid inputs and invalid outputs can be any of the following components:

- switch (armrest)
- switch (seat)
- switch (parking brake)
- solenoid valve (hydrostatic pilot)
- solenoid valve (work tool pilot)
- coil (detent)

Armrest/seat switch

Invalid inputs from the combination of the armrest switch and the seat switch will result in the disabling of the machine until a valid combination is seen by the ECM. The hydrostatic pilot solenoid, the parking brake solenoid, and the work tool pilot solenoid will be turned off when this condition is present.

Note: The armrest indicator will flash and the parking brake indicator will be illuminated.

Parking brake switch

Invalid inputs on the parking brake switch will result in the disabling of the hydrostatic system and engaging the parking brake. The hydrostatic pilot solenoid and the parking brake solenoid will be turned off when this condition is present.

Note: The parking brake indicator will flash.

Hydrostatic pilot solenoid

A short to ground on a hydrostatic pilot solenoid that is energized will result in the disabling of the hydrostatic system and engaging the parking brake. The hydrostatic system will remain disabled and the parking brake engaged, until the short to ground is removed and the parking brake switch is pressed.

Note: The parking brake indicator will flash.

A short to the +battery on the hydrostatic pilot solenoid can only be detected when the hydrostatic system is disabled. The short must be removed before the ECM will enable the hydrostatic system and the ECM will release the parking brake.

Note: The parking brake indicator and the armrest indicator will flash.

An open circuit on the hydrostatic pilot solenoid can only be detected when the hydrostatic system is enabled. If an open circuit is detected, the ECM will disable the hydrostatic system and the ECM will engage the parking brake. The hydrostatic system will remain disabled and the parking brake engaged until the fault is removed.

Note: The parking brake indicator will flash.

Work tool pilot solenoid or detent coil

A short to ground on a work tool pilot solenoid or a short to ground on the detent coil will result in a disabled work tool joystick control. The work tools will remain disabled until the short to ground is removed and the parking brake switch is pressed twice. Pressing the switch once sets the parking brake. Pressing the switch again releases the parking brake.

Note: The armrest indicator will flash and the parking brake indicator will be illuminated.

A short to the +battery on the work tool pilot solenoid can only be detected when the work tools are disabled. If a short is detected, the ECM will not allow the work tool joystick control to be enabled until the short is removed.

Note: The parking brake indicator and the armrest indicator will flash.

An open circuit on the work tool pilot solenoid can only be detected when the work tools are enabled. If an open circuit is detected, the ECM will disable the work tool joystick control. The work tools will remain disabled until the fault is removed and the parking brake switch is pressed twice.

Note: The armrest indicator will flash.

Solenoid return wire

A short to ground or an open on the solenoid return wire will be detected when the work tools are disabled. The ECM will not allow the work tool joystick control to be enabled until the problem is removed.

Note: The parking brake indicator and the armrest indicator will flash.

Electrical system voltage

The interlock ECM will not be able to diagnose problems with the electrical system voltage. Low system voltage could result in intermittent operation. The Auxiliary hydraulic ECM will monitor the voltage, if equipped. Use Auxiliary Hydraulic Electronic Control System, RENR6418, if the machine is equipped with this option.

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Systems Operation

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01991038

Electronic Control Module (ECM)

SMCS - 7630

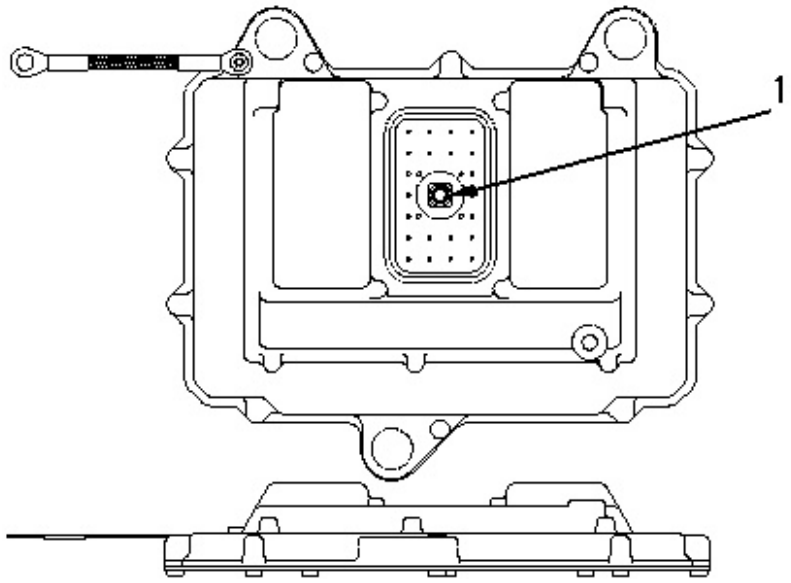


Illustration 1 g00532313

Interlock ECM

(1) J1 connector



Illustration 2 g01032312

Access to the interlock ECM

The interlock ECM is located beneath the floorplate on the left side of the machine.

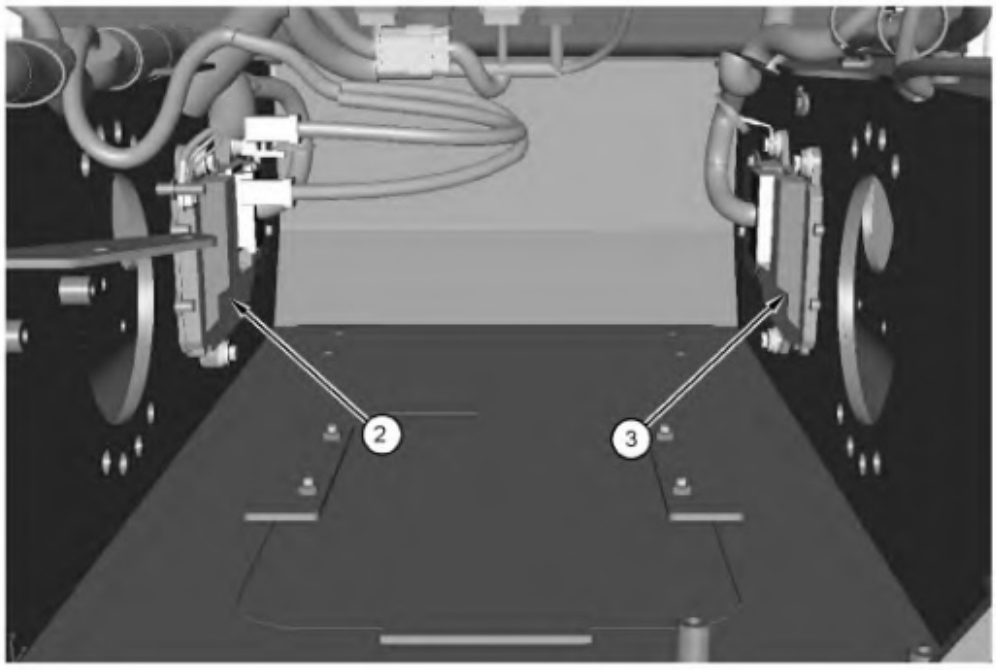


Illustration 3 g01032468

(2) The Interlock ECM is located on the left side of the machine.

(3) The Auxiliary Hydraulic ECM is located on the right side of the machine.

Table 1

Contact Description		
No.	**Function**	**Type**
J1-1	+Battery	Power

J1-3	-Battery	Ground
J1-11	Indicator (Armrest)	Output
J1-13	Solenoid Valve (Parking Brake)	Output
J1-24	Solenoid Valve (Work Tool Pilot)	Output
J1-29	Solenoid Valve (Hydrostatic Pilot)	Output
J1-42	Switch (Parking Brake)	Input
J1-47	Switch (Armrest)	Input
J1-58	Switch (Armrest/Seat Switch)	Input
J1-60	Switch (Hydraulic Lockout Door)	Input
J1-62	Switch (Key Start Switch)	Input
J1-64	Relay (Start)	Relay Output
J1-66	Relay (Start) (Return wire) Relay (Engine Fuel Shutdown) (Return wire)	Ground
J1-68	Common	Ground
J1-70	Indicator (Parking Brake)	Output

Operation

Decisions are made by the circuits in the interlock ECM. Software in the ECM activates the electronic circuits in the appropriate way to correctly operate the machine.

A connector joins the wiring harness to the inputs and the outputs of the ECM. There is one connector (J1) with 70 contacts. Only 14 contacts of the 70 contacts are used.

Reference: Refer to Table 1 for the connections of the connector (J1).

The ECM monitors the condition of the machine for proper system operation. Components sense the condition of the machine. Components then send electrical signals to the inputs of the ECM. The ECM compares the information from the inputs to the stored information. The ECM then decides if outputs should be activated. The activation is performed by sending electrical signals through the outputs to an electronic circuit.

Inputs

The +battery and ground types of inputs provide information to the ECM. The inputs provide information about the status of the machine system and the operator's requests to the ECM. These inputs receive information from the switches that are shown below:

- Switch (key start switch)
- Switch (parking brake)
- Switch (armrest)
- Switch (armrest/seat switch)

- Switch (hydraulic door lockout)

Outputs

The interlock ECM applies a voltage to the appropriate outputs that energize relays and solenoids. The solenoid driver outputs are connector contacts 13, 24, and 29. The relay outputs are connector contacts 11, 64, and 70. These outputs control the following components:

- Solenoid valve (hydrostatic pilot)
- Solenoid valve (work tool pilot)
- Solenoid valve (parking brake)
- Coil (work tool detent)
- Relay (start)
- Relay (fuel shutoff)
- Indicator (parking brake)
- Indicator (armrest)

The armrest indicator and the parking brake indicator allows the operator to know the state of certain functions of the interlock ECM. If a system fault is detected, the ECM will flash the appropriate indicator. Systems Operation, "Diagnostic Operations".

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i02005143

Solenoid Valve

SMCS - 5479

Solenoid Valve (Parking Brake)

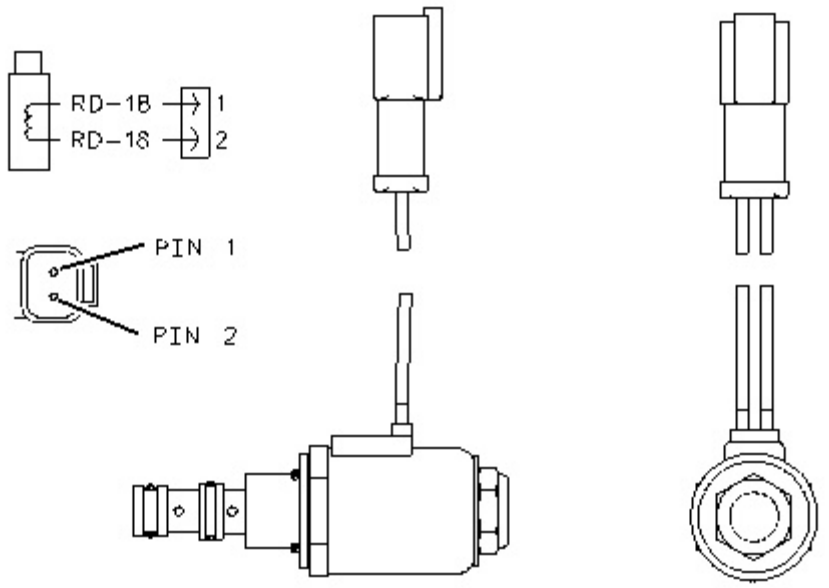


Illustration 1 g00561427

Solenoid valve (parking brake)



Illustration 2 g00779764

Location of the solenoid valve for the parking brake

The solenoid valve for the parking brake is located beneath the cab behind the left hand joystick. The solenoid valve for the parking brake is located within the valve body. The solenoid valve for the parking brake is mounted to the machine frame.

The interlock ECM controls the solenoid valve for the parking brake. The solenoid valve will engage the parking brake or the solenoid valve will disengage the parking brake. When the solenoid valve is off, the parking brake will be engaged.

There are no diagnostics that are associated with the solenoid valve.

Solenoid Valve (Hydrostatic Pilot)

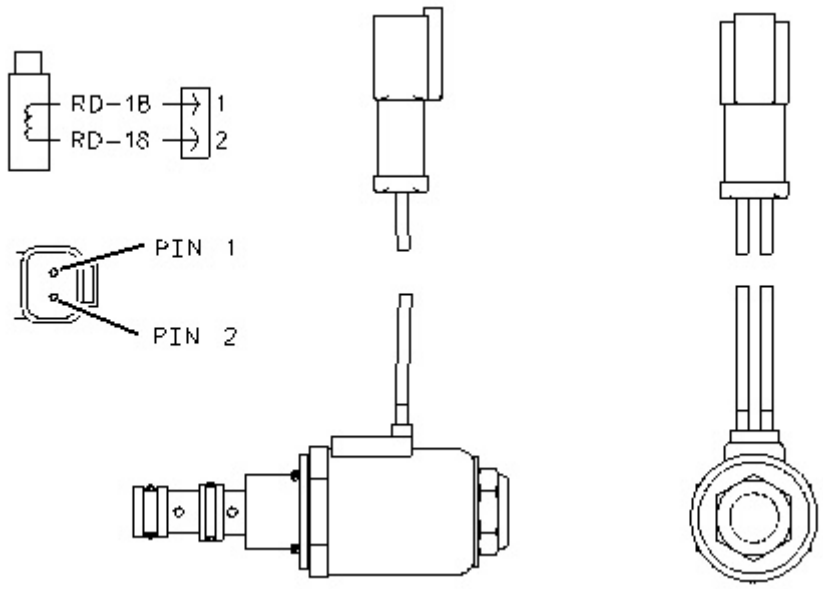


Illustration 3 g00561427



Illustration 4 g00779967

Location of the solenoid valve for the hydrostatic pilot

The solenoid valve for the hydrostatic pilot is located within the valve body. The solenoid valve for the hydrostatic pilot is located in the lever for the speed/direction control.

The interlock ECM controls the solenoid valve for the hydrostatic pilot. The solenoid valve allows the flow of hydraulic oil to the speed/direction control.

The interlock ECM monitors the circuit for any faults. If a fault is detected, the ECM will flash the parking brake indicator or the armrest indicator.

Solenoid Valve (Work Tool Pilot)

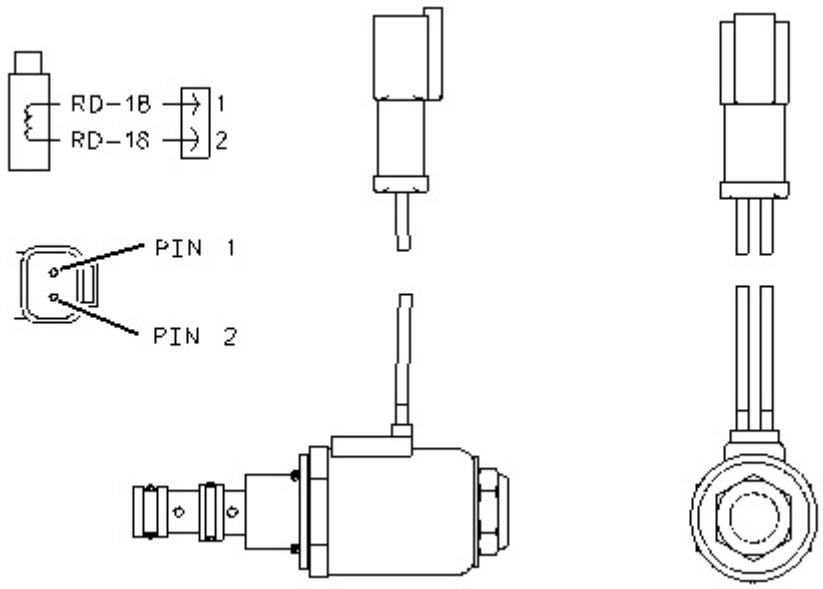


Illustration 5 g00561427

Solenoid valve (work tool pilot)



Illustration 6 g00780047

Location of the solenoid valve for the work tool pilot

The solenoid valve for the work tool pilot is located within the valve body. The solenoid valve for the work tool pilot is located in the lever for the work tool control.

The interlock ECM controls the solenoid valve for the work tool pilot. The solenoid valve allows the flow of hydraulic oil to the work tool control.

The interlock ECM monitors the circuit for any faults. If a fault is detected, the ECM will flash the parking brake indicator or the armrest indicator.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995441

Relays

SMCS - 4493

The relays have five terminals. Two of the terminals (85, 86) are for the coil. One of the terminals (30) is common. One of the terminals (87) is for a normally open contact and one of the terminals (87a) is for a normally closed contact.

Relay (Start)

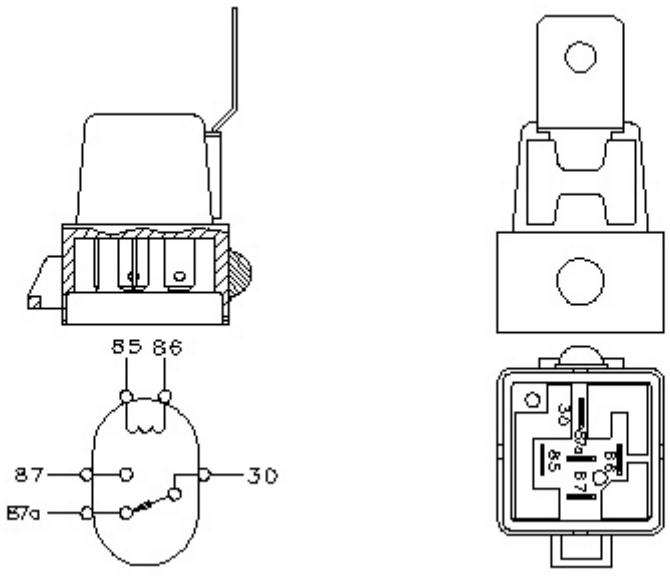


Illustration 1 g00780225

Relay (start)



Illustration 2 g01032817

Location of the relay for the starter

The start relay is located in the engine compartment above the air cleaner.

The interlock ECM controls the start relay. The relay connects to the connector contact J1-64. The relay closes a set of normally open contacts in order to engage the solenoid for the starting motor.

There are no diagnostics that are associated with the relay.

Relay (Fuel Shutdown)

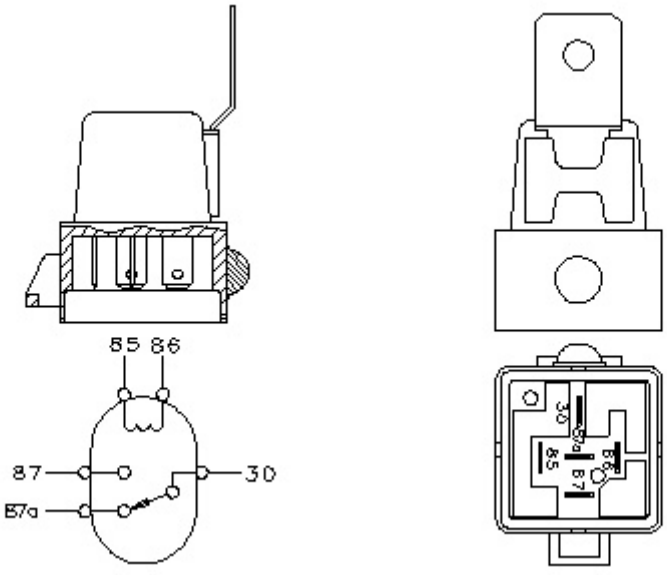


Illustration 3 g00780225

Relay (fuel shutdown)



Illustration 4 g01032822

Location of the relay for the fuel shutdown relay

The fuel shutdown relay is located in the engine compartment above the air cleaner.

The interlock ECM controls the relay. The relay is on the same circuit as the start relay. The relay connects to the connector contact J1-64. The relay closes a set of normally open contacts in order to energize the fuel shutdown solenoid.

There are no diagnostics that are associated with the relay.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995519

Related Components

SMCS - 7630

Coil (Work Tool Detent)

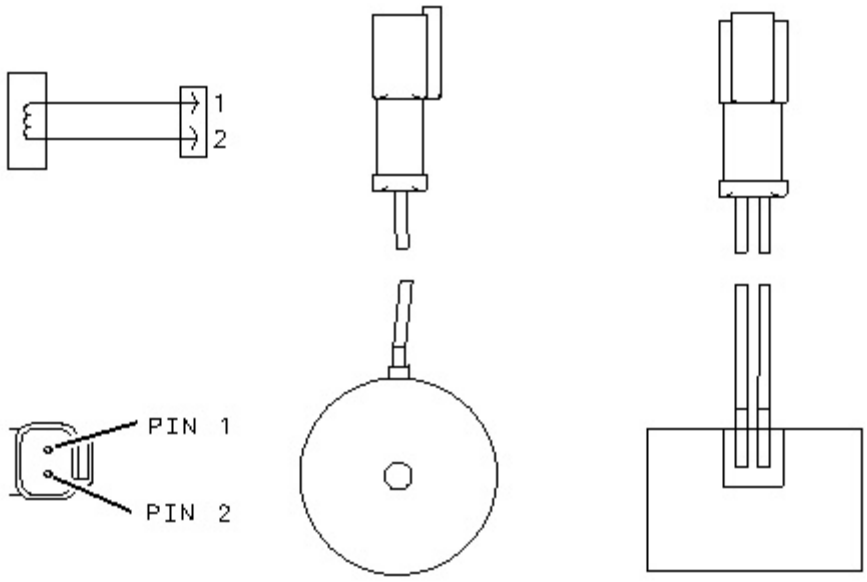


Illustration 1 g00779707

Coil (work tool detent)



Illustration 2 g00780049

Location of the work tool detent

The coil for the work tool detent is located on the lever for the work tool control.

The interlock ECM controls the coil for the work tool detent. The coil for the work tool detent is on the same circuit as the solenoid valve for the work tool pilot. The coil allows the work tool control to be held in a detent position.

The interlock ECM monitors the circuit for any faults. If a fault is detected, the ECM will flash the parking brake indicator or the armrest indicator.

Auxiliary Hydraulic ECM

The auxiliary hydraulic ECM (if equipped) allows the use of auxiliary hydraulic work tools.

The auxiliary hydraulic ECM will generate CID-FMI flash codes. The auxiliary hydraulic ECM is equipped with the CAT Data Link. This feature allows the service personnel to use CAT Electronic Technician (ET) in order to aid in troubleshooting.

Reference: Use Troubleshooting, RENR6418, if the machine is equipped with auxiliary hydraulics.

The following switch inputs are common to both electronic control modules:

- Switch (parking brake)
- Switch (armrest)
- Switch (seat)
- Switch (hydraulic lockout)

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02558823

Electrical System

SMCS - 1400; 1550; 1900

The electrical system is a negative ground system. The charging circuit operates when the engine is running. The alternator in the charging circuit produces direct current for the electrical system.

The components of the electrical system for the engine are described in this section.

- Electric starting motor
- Alternator
- Glow plugs

Electric Starting Motor

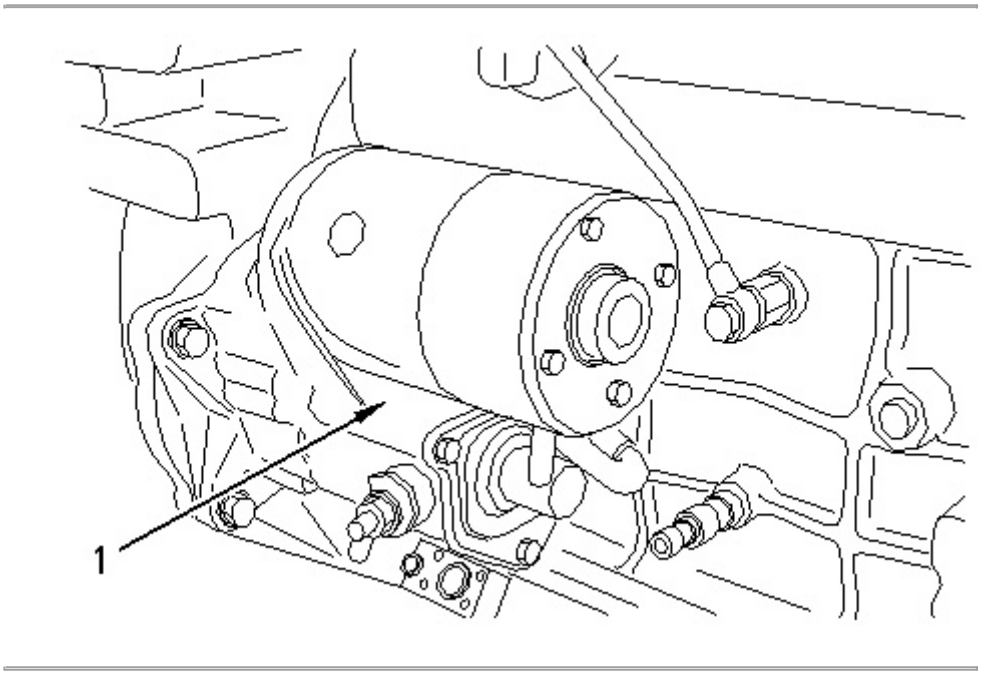


Illustration 1 g00986944

(1) Electric starting motor

Electric starting motor (1) turns the engine flywheel. The rpm must be high enough in order to initiate a sustained operation of the fuel ignition in the cylinders.

The starting motor has a solenoid. When the ignition switch is activated, voltage from the electrical system will cause the solenoid to move the pinion toward the flywheel ring gear of the engine. The electrical contacts in the solenoid close the circuit between the battery and the starting motor barely before the pinion engages the ring gear. This causes the starting motor to rotate. This type of activation is called a positive shift.

When the engine begins to run, the overrunning clutch of the pinion drive prevents damage to the armature. Damage to the armature is caused by excessive speeds. The clutch prevents damage by stopping the mechanical connection. However, the pinion will stay meshed with the ring gear until the ignition switch is released. A spring in the overrunning clutch returns the clutch to the rest position.

Alternator

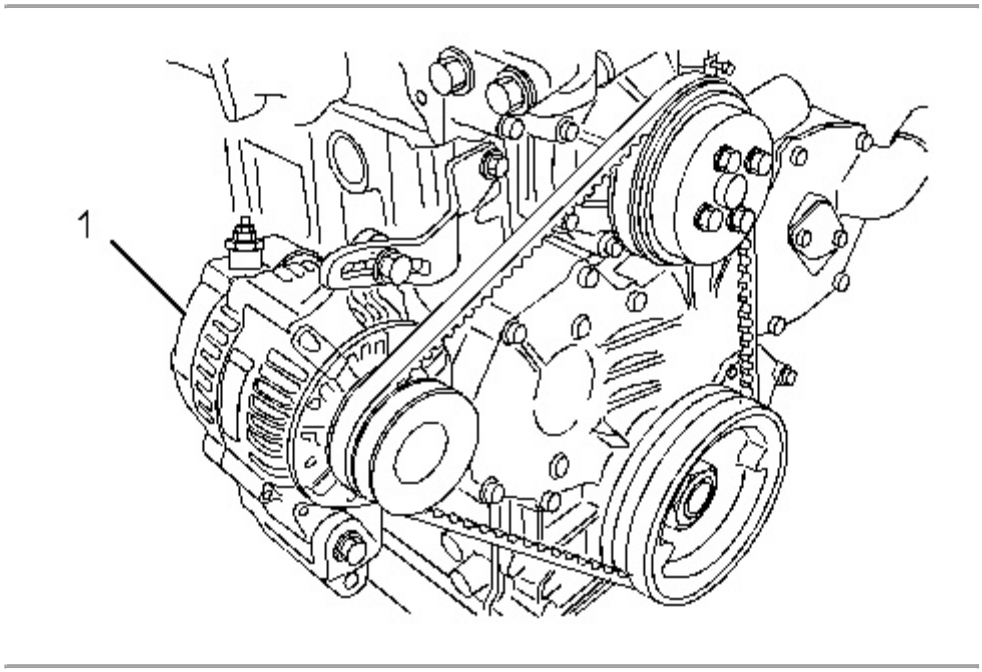


Illustration 2 g01280832

(1) Alternator

Alternator (1) is an electro-mechanical component that is driven by a belt from the crankshaft pulley. The alternator charges the storage battery during the engine operation.

The alternator converts the mechanical energy and the magnetic energy into alternating current and voltage. This conversion is done by rotating a direct current electromagnetic field on the inside of a three-phase stator. The electromagnetic field is generated by electrical current flowing through a rotor. The stator generates alternating current and voltage.

The alternating current is changed to direct current by a three-phase, full-wave rectifier. Direct current flows to the output terminal of the alternator. The rectifier has three exciter diodes. The direct current is used for the charging process.

A solid-state regulator is installed on the rear end of the alternator. Two brushes conduct current through two slip rings. The current then flows to the rotor field. A capacitor protects the rectifier from high voltages. The regulators are sealed and repair is not possible.

The alternator is cooled by an internal fan which is covered by the alternator housing. The fan pulls air through the holes in the front of the alternator. The air exits through the holes in the back of the alternator.

The diodes, the resistors, and the brushes are also covered by the alternator housing in order to protect the components from dirt and moisture.

The alternator is connected to the battery through the ignition switch. Therefore, alternator excitation occurs when the switch is in the ON position.

Glow Plugs

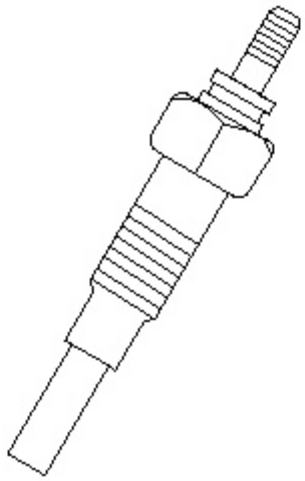


Illustration 3 g00986945

Typical example

The electrically operated glow plugs are installed in the cylinder head near the fuel injection nozzles. The glow plugs are connected by a bus bar.

On naturally aspirated engines (indirect injection), the tips of the glow plugs reach into the precombustion chamber in the cylinder head.

On turbocharged engines (direct injection), the tips of the glow plugs reach into the combustion chamber in the piston crown.

When the glow plugs are energized, the tips become very hot in order to improve the combustion during cold start conditions.

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Systems Operation
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02978729

Pressure Switch (Refrigerant)

SMCS - 1435-PX; 7320-QW

Air Conditioning High Low Pressure Switch

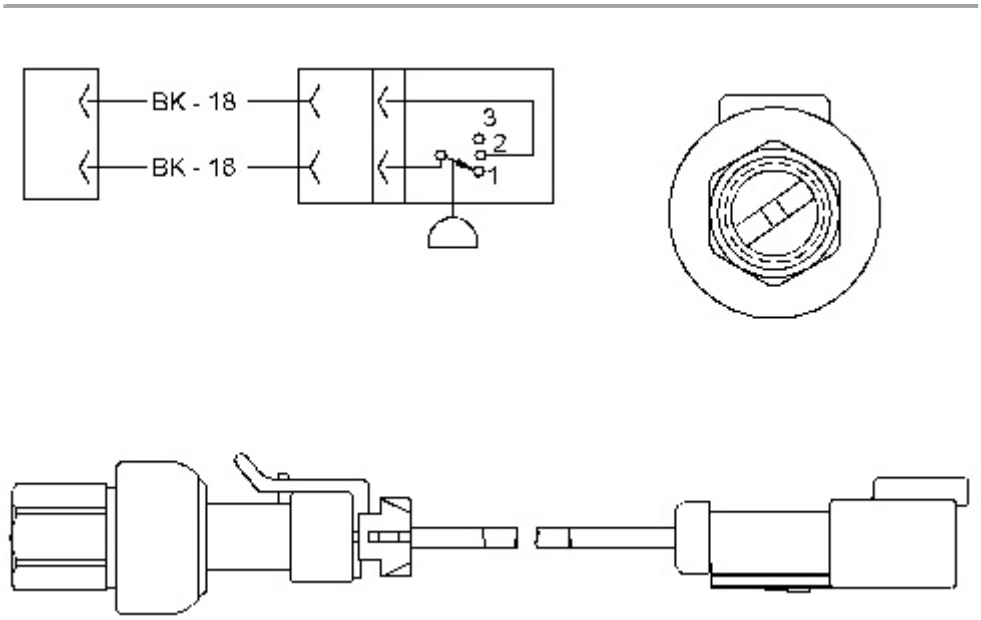


Illustration 1 g01506776

Schematic symbol and drawing for the high low pressure switch

The High Low pressure switch is used in order to monitor the refrigerant pressure that is coming out of the discharge side of the refrigerant compressor. The pressure switch prevents the compressor from operating when the pressure in the discharge line exceeds a specific pressure range or when the pressure in the discharge line fails to maintain a specific pressure range. This switch is electrically connected in series with the magnetic clutch for the refrigerant compressor, and the evaporator coil thermostat. Similarly to the thermostat switch, the compressor will not operate when the High-Low pressure switch is OPEN. When the High-Low pressure switch is

CLOSED, the current moves through the switch and through the coil assembly in the magnetic clutch. This causes the compressor to operate.

The High-Low pressure switch has two pressure set points that will cause the switch contacts to OPEN. For a low pressure condition, the switch contacts will move OPEN whenever the pressure value for the discharge line decreases to less than 170 kPa (25 psi). The switch contacts will remain in the OPEN position until the pressure value increases to 275 kPa (40 psi) or more. For the high pressure condition, the switch contacts will move OPEN whenever the pressure value for the discharge line exceeds 2800 kPa (405 psi). The switch contacts will remain in the OPEN position until the pressure value decreases to 1750 kPa (255 psi) or less.

Air Conditioning Low Pressure Switch

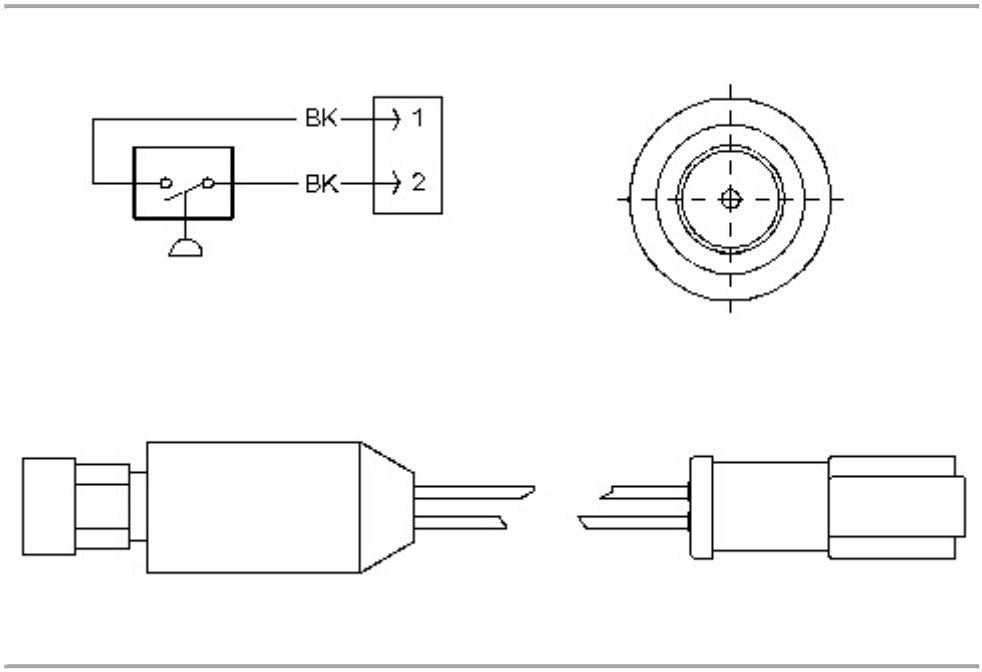


Illustration 2 g01506713

Schematic symbol and drawing for the low pressure switch

The Low pressure switch is used only in applications for the machine that also use the compressor protection time delay relay. The Low pressure switch is used to monitor the refrigerant pressure that comes into the suction side of the refrigerant compressor. The pressure switch prevents the compressor from operating when the pressure for the suction line fails to maintain a specific pressure range. This switch is electrically connected in series with the compressor protection time delay relay, the high low pressure switch, and the thermostat for the evaporator coil. The compressor will not operate when the Low pressure switch is OPEN. When the Low pressure switch is CLOSED, a ground signal is sent to the compressor protection time delay relay. A CLOSED low pressure switch indicates that the pressure for the suction line is high enough to allow the refrigerant compressor to operate. The compressor protection time delay relay will then turn on causing the compressor to operate.

The switch contacts on the low pressure switch will move OPEN whenever the pressure value for the suction line decreases to less than 34 kPa (5 psi). The switch contacts will remain in the OPEN position until the pressure value increases to 104 kPa (15 psi) or more.

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Systems Operation
C3.4 Engines for Caterpillar Built Machines
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i02558823

Electrical System

SMCS - 1400; 1550; 1900

The electrical system is a negative ground system. The charging circuit operates when the engine is running. The alternator in the charging circuit produces direct current for the electrical system.

The components of the electrical system for the engine are described in this section.

- Electric starting motor
- Alternator
- Glow plugs

Electric Starting Motor

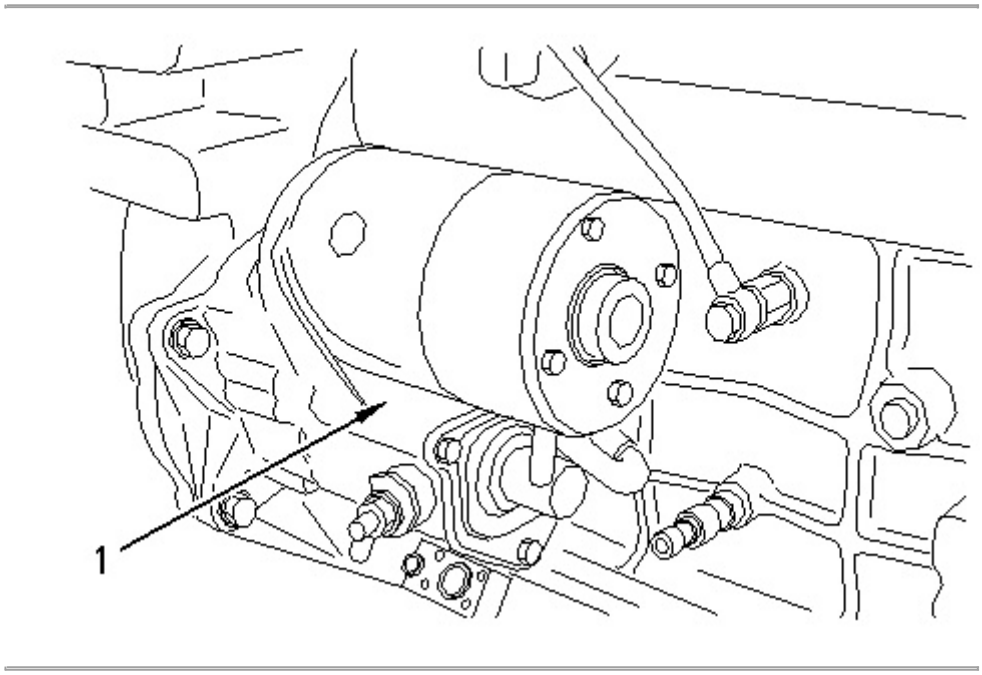


Illustration 1 g00986944

(1) Electric starting motor

Electric starting motor (1) turns the engine flywheel. The rpm must be high enough in order to initiate a sustained operation of the fuel ignition in the cylinders.

The starting motor has a solenoid. When the ignition switch is activated, voltage from the electrical system will cause the solenoid to move the pinion toward the flywheel ring gear of the engine. The electrical contacts in the solenoid close the circuit between the battery and the starting motor barely before the pinion engages the ring gear. This causes the starting motor to rotate. This type of activation is called a positive shift.

When the engine begins to run, the overrunning clutch of the pinion drive prevents damage to the armature. Damage to the armature is caused by excessive speeds. The clutch prevents damage by stopping the mechanical connection. However, the pinion will stay meshed with the ring gear until the ignition switch is released. A spring in the overrunning clutch returns the clutch to the rest position.

Alternator

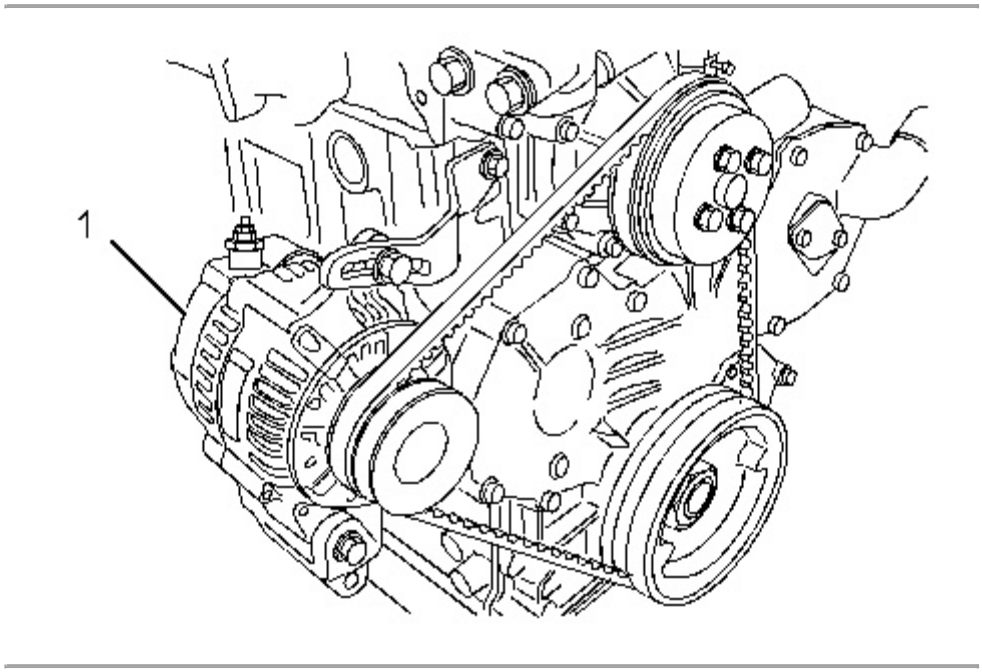


Illustration 2 g01280832

(1) Alternator

Alternator (1) is an electro-mechanical component that is driven by a belt from the crankshaft pulley. The alternator charges the storage battery during the engine operation.

The alternator converts the mechanical energy and the magnetic energy into alternating current and voltage. This conversion is done by rotating a direct current electromagnetic field on the inside of a three-phase stator. The electromagnetic field is generated by electrical current flowing through a rotor. The stator generates alternating current and voltage.

The alternating current is changed to direct current by a three-phase, full-wave rectifier. Direct current flows to the output terminal of the alternator. The rectifier has three exciter diodes. The direct current is used for the charging process.

A solid-state regulator is installed on the rear end of the alternator. Two brushes conduct current through two slip rings. The current then flows to the rotor field. A capacitor protects the rectifier from high voltages. The regulators are sealed and repair is not possible.

The alternator is cooled by an internal fan which is covered by the alternator housing. The fan pulls air through the holes in the front of the alternator. The air exits through the holes in the back of the alternator.

The diodes, the resistors, and the brushes are also covered by the alternator housing in order to protect the components from dirt and moisture.

The alternator is connected to the battery through the ignition switch. Therefore, alternator excitation occurs when the switch is in the ON position.

Glow Plugs

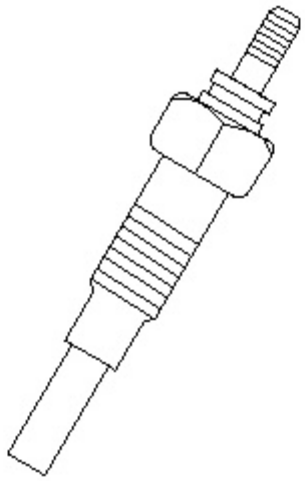


Illustration 3 g00986945

Typical example

The electrically operated glow plugs are installed in the cylinder head near the fuel injection nozzles. The glow plugs are connected by a bus bar.

On naturally aspirated engines (indirect injection), the tips of the glow plugs reach into the precombustion chamber in the cylinder head.

On turbocharged engines (direct injection), the tips of the glow plugs reach into the combustion chamber in the piston crown.

When the glow plugs are energized, the tips become very hot in order to improve the combustion during cold start conditions.

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Systems Operation
EquipmentManager Dealer Administrator Manual
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i03319401

General Information

SMCS - 7600; 7606

Use of this Manual

EquipmentManager provides valuable information that allows remote monitoring of either a single machine or a fleet of machines. Customers can perform the following tasks if the customer can provide the location of the machine, Service Meter Unit (SMU), and information about the health of the machine:

- Manage the location and the basic usage of engines and machines.
- Schedule maintenance that is planned and schedule major repairs.
- Manage fault codes or diagnostic codes.
- Detect problems before problems cause a major component failure.
- Increase the availability and the productivity for the machines by avoiding unexpected downtime for repairs.
- Identify the need for training in order to improve the efficiency of the operator.

EquipmentManager is part of Dealer Web site and works with other applications such as PartStore and EquipmentManager. EquipmentManager enables customers to remotely manage fleets. The customer is alerted to only those machines that need immediate attention.

The "EquipmentManager Dealer Administrator Manual" includes the following information:

- Setting up Product Link Modules (PLM)
- Registering PLM
- Setting up and maintaining the accounts of the customer
- Customizing EquipmentManager for optimum use
- Managing EquipmentManager functions

This manual also provides suggestions for using the features of EquipmentManager.

Assumptions

The "EquipmentManager Dealer Administrator Manual" assumes that the user is a Dealer Administrator. The"EquipmentManager Dealer Administrator Manual" also assumes the following:

- The user is familiar with Dealer Web site and related applications.
- The user is able to access the dealership's Dealer Web site.
- The user is familiar with using and entering information in forms that are found in web sites, performing searches on the web, and submitting information via the web.

Terms and Definitions

Table 1 defines common acronyms and terms that are used throughout this manual.

Table 1

Term or Acronym	Definition
Dealer Web site	Dealer Web site is an application on the internet that is used to access EquipmentManager.
ECM	Electronic Control Module
I/O	Input/Output
PLM	Product Link Module This on board hardware communicates with any ECM that is on the machine. Additionally, the hardware sends information to the satellites and from the satellites.
PM	Preventive Maintenance
SMU	Service Meter Units
S·O·S	Scheduled Oil Sampling This is a program that analyzes samples of fluid. This program is designed to be an easy way to monitor the impact of maintenance programs, applications, and operational factors on machine health.
UCID	Universal Customer ID
CWS	Corporate Web Security

Related Documentation

ReferenceRefer to the following documents for additional EquipmentManager information and related applications.

- Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121SR/321SR"
- Special Instruction, REHS2365, "Product Link PL121SR and PL300 Installation Guide"
- Systems Operation, KENR6303, "EquipmentManager User Manual"

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Getting Started

SMCS - 7600; 7606

Overview

The following provides an overview of EquipmentManager. This overview instructs you on the steps that are necessary to begin using EquipmentManager in order to manage the life cycle of your equipment and the equipment of your customers.

There are five steps:

1. Enable EquipmentManager.
2. Verify the records for the machine and the ownership of the machine.
3. Manage the users.
4. Install Product Link Modules.
5. Set up the subscriptions.

Some of the steps that are outlined in this section may be completed in a different order. Following the steps in the order that is suggested here is recommended strongly by the Caterpillar Dealer Solution Network (DSN).

Note: Use your web browser to select your preferred language.

Note: Caterpillar does not recommend using software to block popup software while EquipmentManager is active.

EquipmentManager and the Product Link System

EquipmentManager is an upgrade of a previous application that was known as Product Link Web. Many of the features of EquipmentManager are similar to this application.

EquipmentManager is an application that is used on the Internet. This application allows you to better manage the maintenance, health, and utilization of your machines. EquipmentManager uses a combination of Product Link hardware, satellites, wireless technology, a Caterpillar database, and a Caterpillar server in order to manage the machines.

Illustration 1 illustrates the EquipmentManager and the Product Link System.

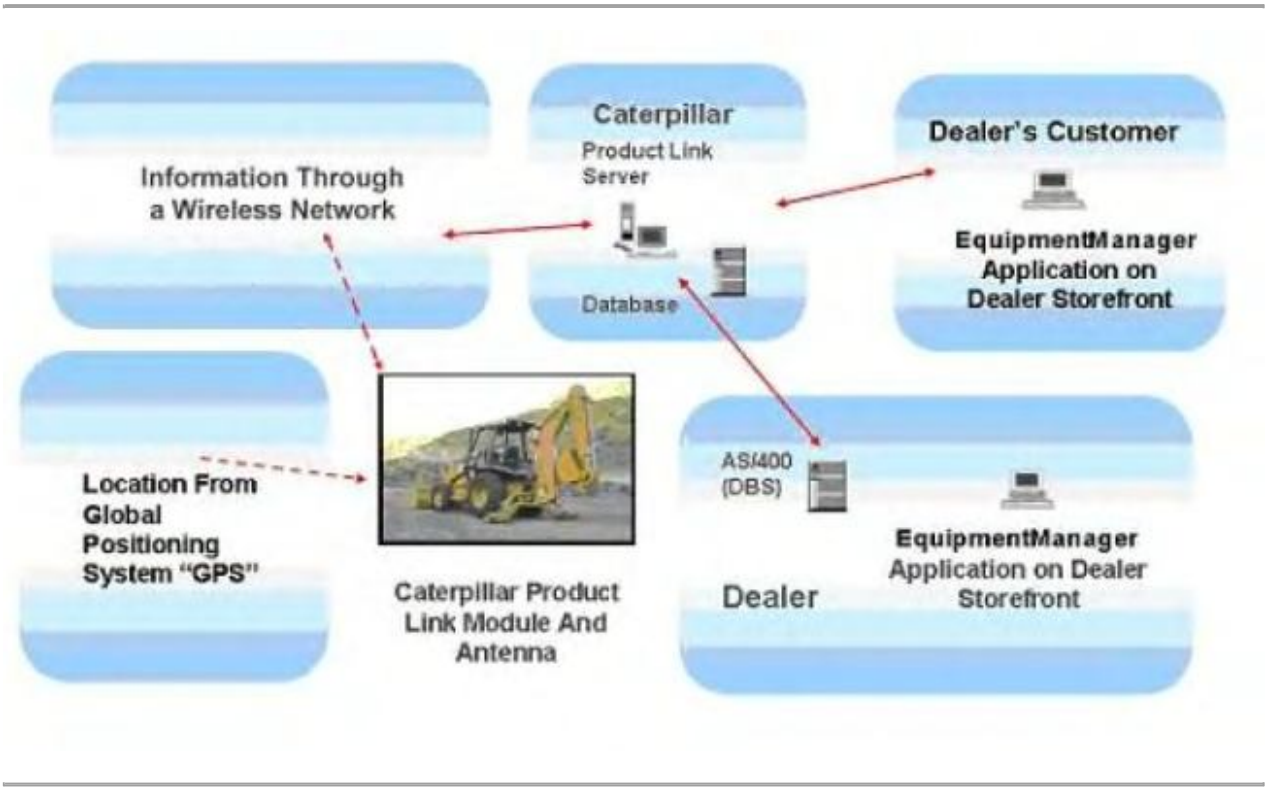


Illustration 1 g01243520

EquipmentManager and Product Link System

Each piece of machinery is equipped with Product Link hardware. Each machine can be managed by using EquipmentManager. Information is sent to the machine and information is received from the machine via a Product Link Module (PLM) through a wireless network.

Note: For more information about the available PLMs and installation of the PLMs, refer to Systems Operation, "Install Product Link Modules".

The location of the machine is determined by using a Global Positioning System (GPS). Wireless networks send the information that is received from the PLMs to a central database for Product Link that is provided by Caterpillar. This information can then be viewed with EquipmentManager.

If you are using the Caterpillar Dealer Business System you will have the option of receiving daily updates from Product Link Service Meter Units (SMU). EquipmentManager can store these updates in your DBS database.

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Enable Program

SMCS - 7600; 7606

Access Requirements

Equipment Data

Equipment Data acts as the equipment database for EquipmentManager. Caterpillar recommends that the Administrator for EquipmentManager is provided with administrative access to Equipment Data. Consult with the Web site Administrator at your dealership.

Service Information System (SIS)

EquipmentManager links to or accesses Service Information System (SIS) from within the application. Caterpillar recommends that EquipmentManager Administrators are provided with access to SIS. Consult with the SIS Administrator at your dealership.

PartStore™

EquipmentManager links to or accesses the PartStore™ System from within the application. Caterpillar recommends that EquipmentManager Administrators are provided with access to the PartStore™ System. Consult with the Web site Administrator at your dealership.

Dealer Web Site

In order to access your Dealer's Web site, you need a dealership username and a password. Record this information in a secure location.

UCID Tool

The Universal Customer ID Tool (UCID Tool) is the application that is used to add, edit, and delete customer information and UCIDs. This tool is accessed through Dealer Maintenance. Caterpillar recommends that administrators for EquipmentManager are provided with access to the UCID Tool. Consult with Web site Administrator at your dealership.

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Verify Machine Records and Ownership

SMCS - 7600; 7606

Verify Machines in Equipment Data

Verify that the machines exist in Equipment Data before you install Product Link Modules (PLM) on machines. After you install PLM, configure PLM and register PLM in order to communicate with the EquipmentManager application. If the machines do not already exist in Equipment Data (ED), you must add the machines.

Note: Equipment Data allows customers to manage the customer's equipment across dealerships. Equipment Data provides a central equipment database for use in Caterpillar developed applications. Equipment Data is delivered through Caterpillar Dealer Web sites.

The following features are included in Equipment Data:

- Automatic updates of the Equipment Data equipment record from the Dealer's Business System (DBS)
- Updates that are sent to the DBS/DBSi when changes are made in the Equipment Data
- Equipment grouping functionality

The PartStore System and EquipmentManager users will often have access to Equipment Data. Caterpillar recommends that the Dealer Administrator for EquipmentManager is provided with access to the Equipment Data application.



Illustration 1 g01243624

"Equipment Data Home" screen

In order to search for machines in the existing equipment population within Equipment Data, access the home page of Equipment Data and then click on "Search Equipment". If no existing equipment population can be found, then use Add Equipment to add the machine to the equipment population.

Note: Refer to Caterpillar Equipment Data Dealer Manual Release 2.0 for complete instructions on the Equipment Data Application.

UCID Conflict Management

Once you have verified that the necessary machines exist in Equipment Data, you must then resolve any ownership conflicts that may exist on that machine. Ownership conflicts arise when a single serial number within Equipment Data has been associated with two or more Universal Customer ID's (UCID). Within EquipmentManager, detailed information about a single serial number is not displayed if the ownership data for that equipment has a UCID conflict.

In order to resolve an ownership conflict by consolidating UCIDs, complete the following procedure:

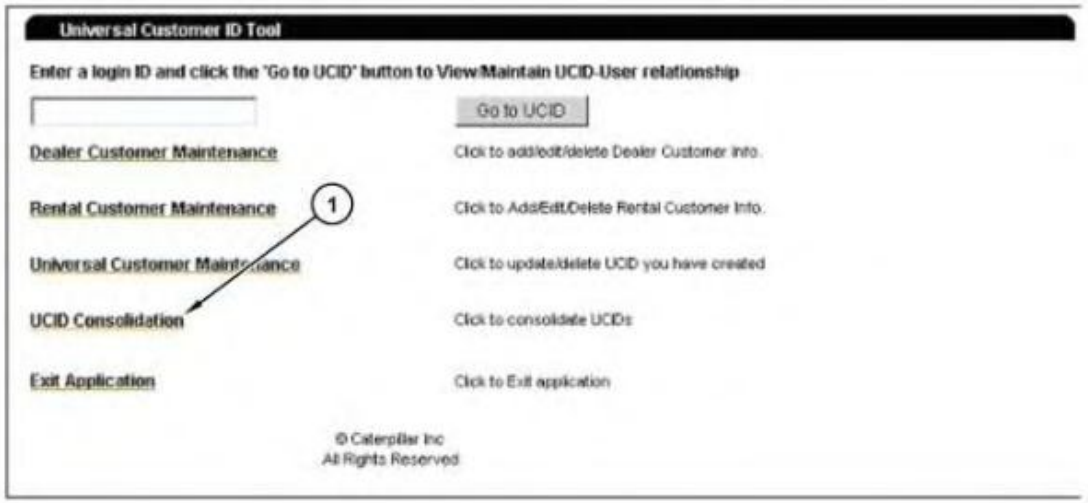


Illustration 2 g01732433

"Univeral Customer ID Tool" main screen

(1) "UCID Consolidate" link

1. From the "Univeral Customer ID Tool" main screen in Equipment Data, click on the "UCID Consolidate" link. The "UCID Consolidation" screen will be displayed.

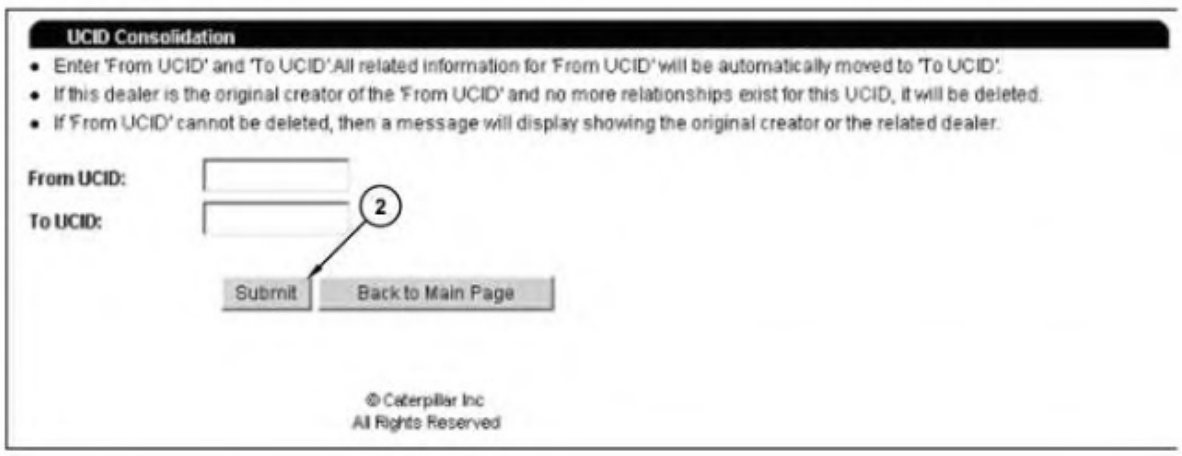


Illustration 3 g01732434

"UCID Consolidation" screen

(2) "Submit" button

2. In the "From UCID" field, enter the UCID location of the data.
3. In the "To UCID" field, enter the UCID of the new location for the data.
4. Click on the "Submit" button.



Illustration 4 g01243632

Message for a UCID tha is "not Valid".

If one of the UCID that was entered into either the "From UCID" field or the "To UCID" field is not a valid UCID a red alert message will appear at the top of the screen. Refer to Illustration 4.



Illustration 5 g01243633

UCID alert message

If you created the original From UCID, then the From UCID will be deleted after the information from one UCID is consolidated into another UCID. However, if you did not create the original From UCID, then the From UCID will not be deleted. If you consolidate a UCID that you did not create the meesage shown in Illustration 4 wil appear. If the message in Illustration 5 appears, contact the other dealer and ask the dealer to delete the UCID.

Once you have resolved all ownership conflicts, you can proceed to setting up the users, installing the PLM, and setting up subscriptions.

Note: Refer to Caterpillar Equipment Data Dealer Manual Release 2.0 and Caterpillar Universal Customer Identification Recommended Practices for more information about Equipment Data and the UCID.

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Manage Users

SMCS - 7600; 7606

Set Up New Users

There are four different types of user roles that are available in EquipmentManager. The tables below list the four types of roles. Under each of the roles the permissions that are available for that role are listed.

Table 1

Customer User Permissions	
Features	Administration
Hours and Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Assign Groups (to user level)
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	**Event Tracking**
Planned Maintenance	None
Request quote	**Upload Data**
View Planner	Repair History
Enter PM Notes	Refueling History
Mark PM Complete	**Manage Exiting User**

View Checklists	Limited to Customer User Level
View Parts lists	**Time and Geo. Fence Descriptions**
Major Repair	Inclusive / Exclusive Descriptions
Request Quote	Time Based Descriptions
View Planner	**Manage Planned Maintenance**
Mark Repair Complete	Customize PM Intervals
View History Details	Edit PM Check List
Fuel Information	Customize PM Schedule
View Fuel Level History	General
View Fuel Level Graph	Search
View Fuel History	Export
View Status History	Preferences
Update Fuel Level Status	Equipment Details
Fault Codes	Registration Details
View Fault Code History	Optional Permissions
Update Fault Code Status	Order Parts [(1)]
View Status History	OTA Configuration
View Troubleshooting Procedures [(2)]	Send Commands
Reports	Address Book
View Product Usage Report	Event Reactions
View Product Monitoring Report	
View OM&M	
View Equipment Usage Summary	

[(1)] Contingent on Partstore access

[(2)] Contingent on SIS access

Table 2

Customer Administrator Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments

Time & Geo Fence	Manage Hardware
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	Over the Air Commands
Planned Maintenance	Send Commands
Request quote	**Event Tracking**
View Planner	Address Book
Enter PM Notes	Event Reactions
Mark PM Complete	**Upload Data**
View Checklists	Repair History
View Parts lists	Refueling History
Order Parts [1]	**Manage Exiting User**
Major Repair	Customer User or Admin Level
Request Quote	**Time and Geo. Fence Descriptions**
View Planner	Inclusive / Exclusive Descriptions
Mark Repair Complete	Time Based Descriptions
View History Details	**Manage Planned Maintenance**
Fuel Information	Customize PM Intervals
View Fuel Level History	Edit PM Check List
View Fuel Level Graph	Customize PM Schedule
View Fuel History	General
View Status History	Search
Update Fuel Level Status	Export
Fault Codes	Preferences
View Fault Code History	Equipment Details
Update Fault Code Status	Registration Details
View Status History	Manage Subscriptions
View Troubleshooting Procedures [2]	
Reports	
View Product Usage Report	
View Product Monitoring Report	
View OM&M [2]	

View Equipment Usage Summary	

(1) Contingent on Partstore access

(2) Contingent on SIS access

Table 3

Dealer User Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	**Event Tracking**
Planned Maintenance	None
Request quote	**Upload Data**
View Planner	Repair History
Enter PM Notes	Refueling History
Mark PM Complete	**Manage Exiting User**
View Checklists	Limited to Dealer User or Customer User or Admin Level
View Parts lists	**Time and Geo. Fence Descriptions**
Major Repair	Inclusive / Exclusive Descriptions
Request Quote	Time Based Descriptions
View Planner	**Manage Planned Maintenance**
Mark Repair Complete	Customize PM Intervals
View History Details	Edit PM Check List
Fuel Information	Customize PM Schedule
View Fuel Level History	General
View Fuel Level Graph	Search
View Fuel History	Export

View Status History	Preferences
Update Fuel Level Status	Equipment Details
Fault Codes	Registration Details
View Fault Code History	Optional Permissions
Update Fault Code Status	Order Parts [1]
View Status History	OTA Configuration
View Troubleshooting Procedures [2]	Send Commands
Reports	Address Book
View Product Usage Report	Event Reactions
View Product Monitoring Report	
View OM&M [2]	
View Equipment Usage Summary	

[1] Contingent on Partstore access

[2] Contingent on SIS access

Table 4

Dealer Administrator Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	Over the Air Commands
Planned Maintenance	Send Commands
Request quote	**Event Tracking**
View Planner	Address Book
Enter PM Notes	Event Reactions
Mark PM Complete	**Upload Data**

View Checklists	Repair History
View Parts lists	Refueling History
Order Parts [1]	**Manage Exiting User**
Major Repair	Dealer User or Admin Level
Request Quote	Customer User or Admin Level
View Planner	**Time and Geo. Fence Descriptions**
Mark Repair Complete	Inclusive / Exclusive Descriptions
View History Details	Time Based Descriptions
Fuel Information	**Manage Planned Maintenance**
View Fuel Level History	Customize PM Intervals
View Fuel Level Graph	Edit PM Check List
View Fuel History	Customize PM Schedule
View Status History	General
Update Fuel Level Status	Search
Fault Codes	Export
View Fault Code History	Preferences
Update Fault Code Status	Equipment Details
View Status History	Registration Details
View Troubleshooting Procedures [2]	Manage Subscriptions
Reports	
View Product Usage Report	
View Product Monitoring Report	
View OM&M [2]	
View Equipment Usage Summary	

[1] Contingent on Partstore access

[2] Contingent on SIS access

A user role may only be given to another user by a user that is equal or higher than the user that is being assigned. For example, a Dealer Administrator may create another Dealer Administrator, but a dealer user cannot create a "Dealer Administrator".

Use the following procedure in order to create a new user:



Illustration 1 g01698693

The Dealer Web site with the "Applications" drop-down menu

(1) "Applications" drop-down menu

1. Log in to your Dealer Web site. The home screen of Dealer Web site appears.

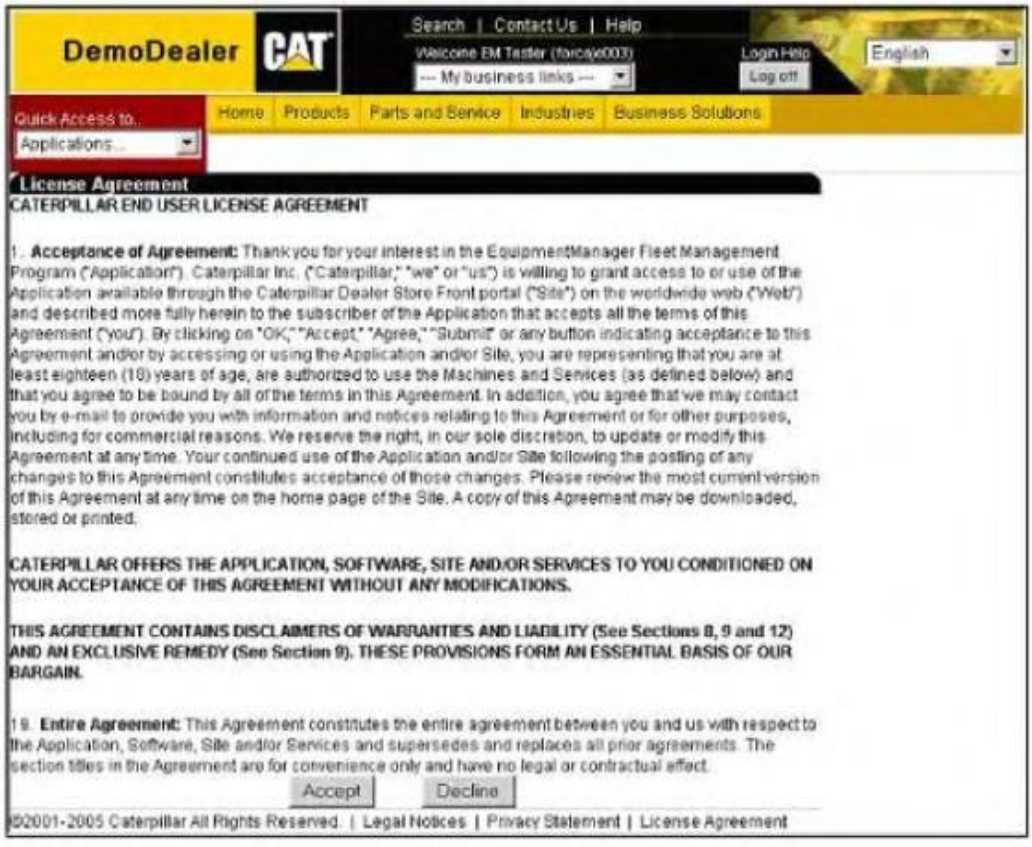


Illustration 2 g01244205

"End User License Agreement"

Note: If this is your first time to log in to EquipmentManager, then an "End User License Agreement" (EULA) appears. Refer to Illustration 2. Scroll to the bottom of the EULA and click "Accept". The screen for setting the user preferences will appear. Refer to Systems Operation, "Preferences".

2. Select "EquipmentManager" from the "Applications" drop-down menu (1) . Refer to Illustration 2. The home page of EquipmentManager will appear.



Illustration 3 g01698734

EquipmentManager home page

(2) "Administration" tab

3. From the left navigation, click the "Administration" tab (2) . The "Administration" screen will be displayed.



Illustration 4 g01698776

"Administration" screen

(3) "View" drop-down menu

(4) "Manage User"

(5) "Setup a New User" link

4. Select "Set Up New User" (5) under "Manage User" (4) . The "Setup a New User" screen will be displayed.

   Note: "View" drop-down menu (3) contains same links that appear on the "Administration" page.



Illustration 5 g01698833

"Setup a New User" screen

(6) "Enter a:" field

5. In the "Enter a:" field (6) , enter a last name or login ID.
6. Click on the "Display Accounts" button.



Illustration 6 g01699073

"Display accounts" on the "Setup a New User" screen

(7) "Login Id" of a user

7. Select the "Login Id" of a user (7) to setup from the list of users that appear below the "Display Accounts" button. The "User Permission" screen will be displayed.

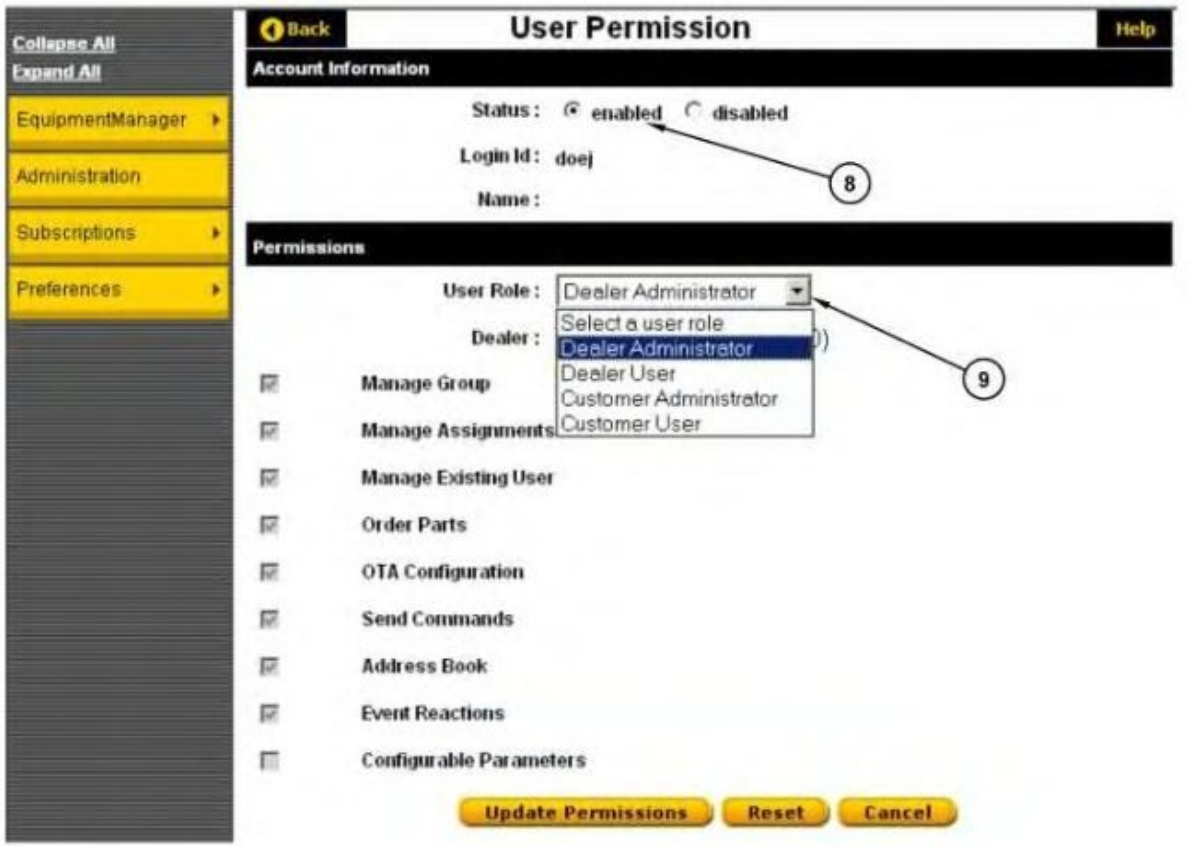


Illustration 7 g01699701

"User Permissions" screen

(8) "Enable" radio button

(9) "User Role" drop-down menu

8. Select the "enabled" radio button (8) next to "Status" in the "Account Information" section. Select the check box next to the permissions in order to apply the change.

9. In the "Permissions" section, select a user role for the user from the "User Role" drop-down menu (9) .

   Note: If you selected "Dealer Administrator" or "Customer Administrator", all of the check boxes next to the available permissions that can be granted to these two users will be selected because an administrator is automatically given all permissions. You will not be able to unselect particular permissions. If you selected "Dealer User" or "Customer User", the check boxes next to "Manage Group" and "Manage Assignments" will be selected and unavailable. The remaining check boxes will be available for selection.

10. Click the "Update Permissions" button. The "Do you want to proceed with the assignments?" dialog box will be displayed.



Illustration 8 g01244272

Proceed with the "Assignments" dialog box.

11. Click on "OK". The "Confirmation – User Permission" screen will be displayed.



Illustration 9 g01699776

"Confirmation: User Permissions" screen

(10) "The user permission(s) have been successfullu updated" message

(11) Check boxes

12. The "The user permission(s) have been successfullu updated" message (10) will appear. Also, green check marks in the check boxes (11) will appear in order to indicate that the user was given that specific authorization. Select "OK". The "Setup a New User" screen will be displayed.



Illustration 10 g01699797

"Setup a New User" with a "No results found for the search" message

(12) "No results found for the search" message

The last name or login id that was entered in Step 5 will appear again in the "Enter a:" field. Below the "Display Accounts" button, a message will appear that reads "No results found for the search" (12) . This is because the user that you added no longer appears in the list of users that are not registered with the EquipmentManager application. Your newly created user now appears in the list of existing users.

Manage Existing Users

In addition to adding new users, as a Dealer Administrator you may edit the user roles and permissions of existing users.

In order to manage an existing user, use the following procedure.

1. From the "Administration" screen or the "View" drop-down menu, select "Manage Existing User". The "Manage Existing User" screen will be displayed.

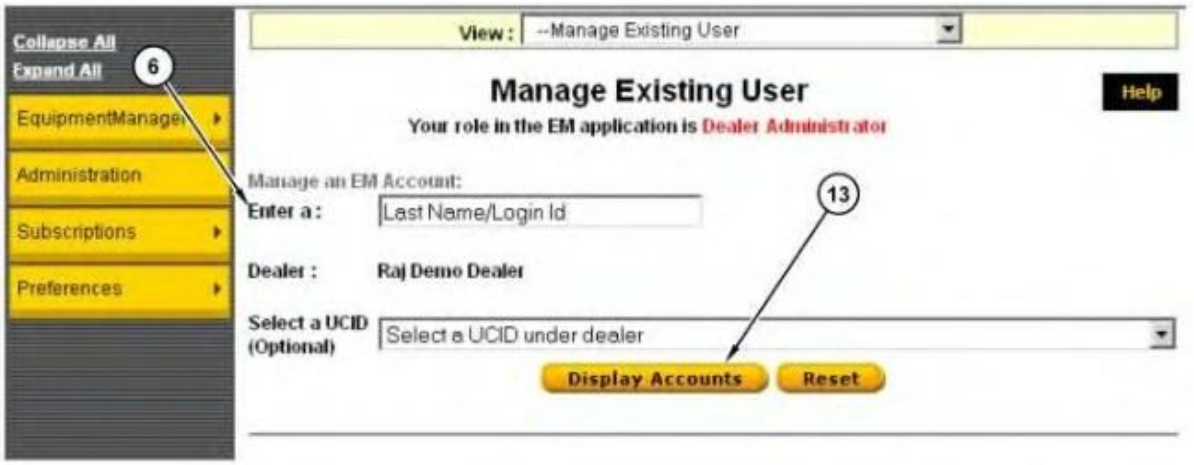


Illustration 11 g01699875

"Manage Existing User" screen

(6) "Enter a:" field

(13) "Display Accounts" button

2. Enter a last name or login id in the "Enter a:" field (6) . Select the "Display Accounts" button (13) .

   The system searches for the last name or login id among the list of registered EquipmentManager users. The system will display a list of all the available matches.



Illustration 12 g01700273

Manage Existing Users : User List

(7) "Login Id" of a user

3. Click on the login id of a user (7) you wish to edit. The "User Permission" screen will be displayed.

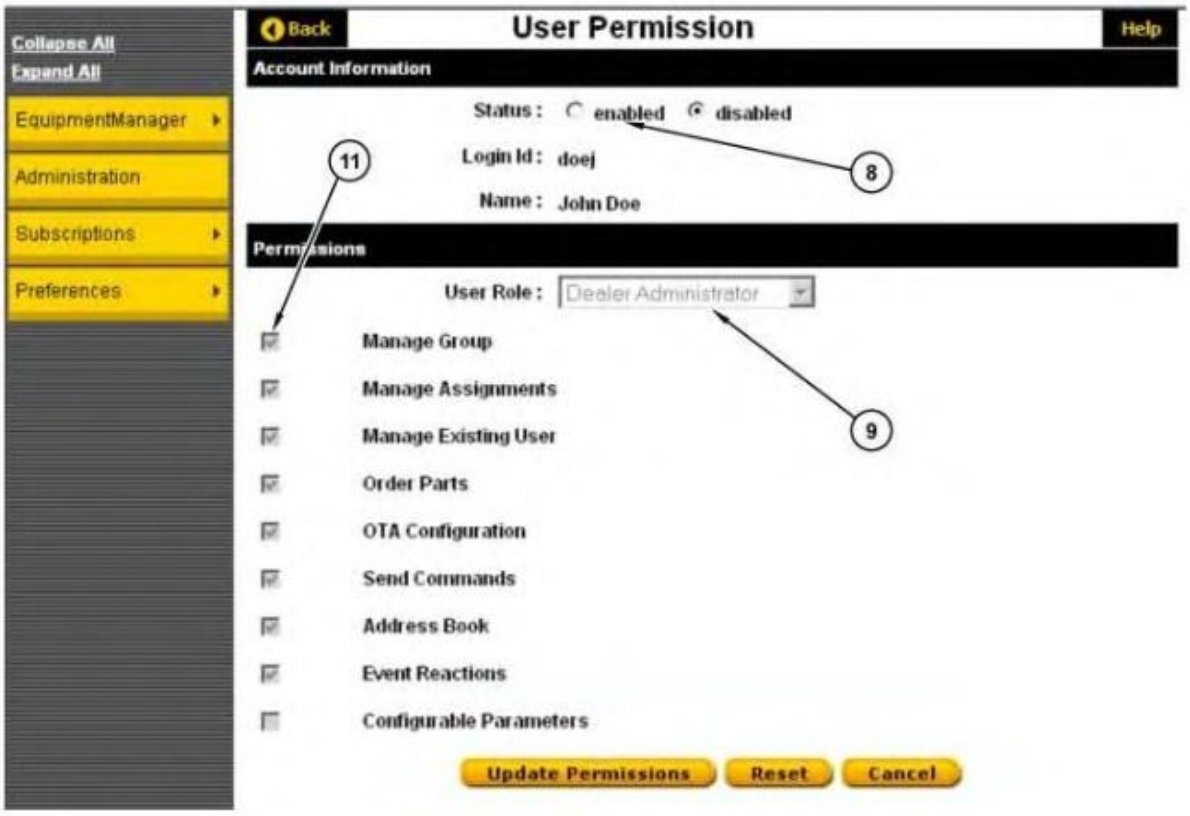


Illustration 13 g01698675

Existing "User Permission" screen

(8) Enable radio button

(9) "User Role" drop-down menu

(11) Check boxes

4. Update the "User Role" in the "Status" by clicking one of the buttons highlighted in Ilustration 13.
   a. Select the enable radio button (8) .
   b. Select a different role from the "User Role" drop-down menu (9) .
   c. Update permissions by selecting or clearing the available check boxes (11) next to the permissions.
5. When you have finished making your changes, click the "Update Permissions" button at the bottom. The "Confirmation – User Permission" screen will be displayed.



Illustration 14 g01700354

"Confirmation: User Permissions" screen

(10) Confirmation message

(11) Check boxes

6. Click on "OK". You have successfully updated the existing user and will be returned to the "Manage Existing User" screen.

   Note: Check marks in the check boxes (11) indicate permissions that are granted to the user. Permissions that display the letter "X" over the check mark indicate that these permissions are not granted to the user.

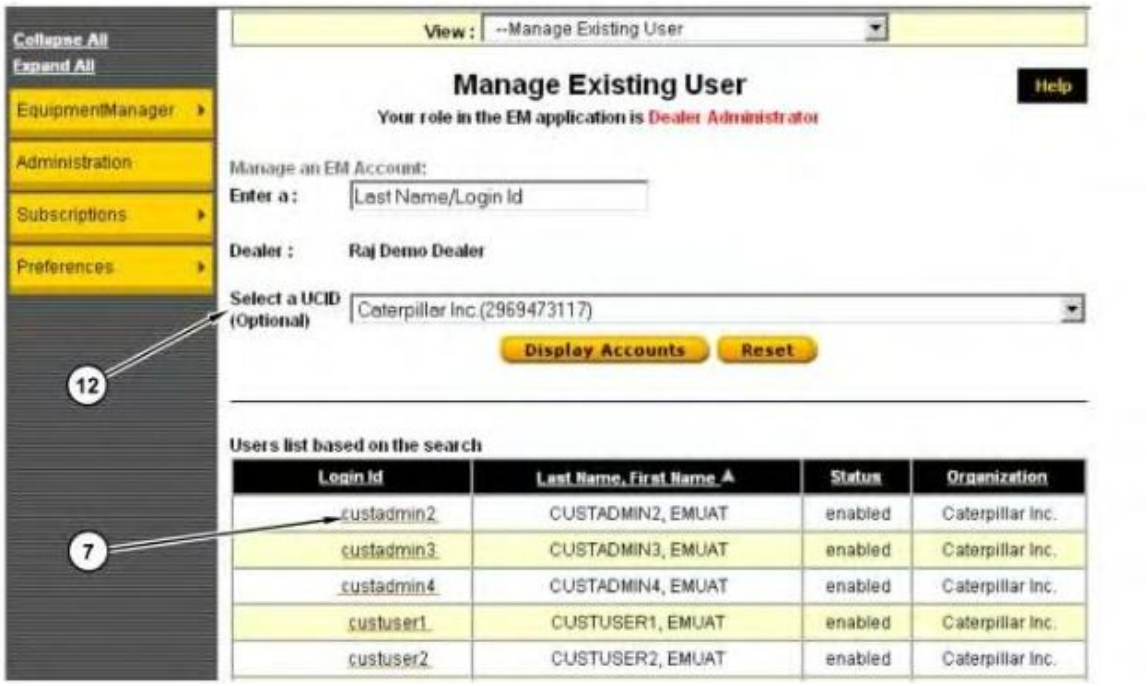


Illustration 15 g01700398

Manage Existing User : List by UCID

(7) "Login Id" of a user

(12) "Select a UCID (Optional)" drop-down menu

An existing user can be search for from the "Manage Existing User" screen. Select a UCID from the "Select a UCID (optional)" menu (12) . EquipmentManager will return a list of users associated with that UCID.

Click the login id of a user (7) for editing. Repeat steps 2 through 5.

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i02941638

Product Link Installation

SMCS - 7600; 7606

Modules

The Product Link Modules are the systems onboard hardware components. These components allow data to be transmitted over a secure Caterpillar wireless network. Data is sent to machines and data is received from machines. The Product Link hardware consists of: antenna, data module and interconnecting wire harness. The antenna consists of two separate components. One component is for receiving location information from the Global Positioning satellite (GPS) system. The second component is for receiving and transmitting signals from and to a wireless network. The second component also has a taller whip antenna.

The GPS signal provides data about the location of the machine. This data is sent to the Product Link data module from the GPS antenna. The signal is processed by the Product Link data module. After the signal is processed, it is transmitted to the wireless network through the whip antenna.

The Service Meter Unit (SMU) is data captured from the "R" terminal on the alternator. The SMU represents the number of hours that the engine has run. Some data drift from meters in the cab or SMU accumulation on other modules is possible. Product Link PL321 systems conform to onboard SYNC clock strategies. This strategy will synchronize the SMU with the designated master Electronic Control Module (ECM).

Date and time stamps are captured onboard with Product Link using Greenwich Mean Time (GMT). The SMU data will be displayed according to users preference for the time zone. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121/321" for details.

Product Link Module Types

The table shows the Product Link Modules that are available.

Table 1

Module	Capabilities	Watch Coverage
PL121SR		Asset Watch

	Hours Location Time & Geographic Fencing	
PL321SR	Hours Location Time and Geographic Fencing I/O Switch Channels Events and Diagnostic codes	Asset Watch Health Watch



Illustration 1 g01244806

PL121SR



Illustration 2 g01244807

PL321SR

Installation

Once you have purchased a Product Link Module, you must install the module on the machine. A comprehensive Installation Guide comes with your Product Link Module. Refer to Special Instruction, REHS2365, "An Installation Guide for the Product Link PL121SR and for the PL300".

Note: The instructions that are mentioned above are for installing the PL121SR and PL300. The PL321SR is the combination of the PL121SR Radio and PL300 ECM.

Configure and Register

Product Link modules are configured and registered by using Caterpillar Electronic Technician (CAT ET). After installing the Product Link module on the machine, a laptop computer with Cat ET software is connected to the module. The Dealer technician uses Cat ET to set up the module for that specific machine. Included with each Product Link is a Special Instructions that explain the product installation and product registration procedures.

For additional information on configuration and registration of your Product Link Module, refer to Systems Operation Troubleshooting, Testing and Adjusting:, RENR7911, "Product Link 121/321".

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i03322221

Setup Subscriptions

SMCS - 7600; 7606

Activating and Deactivating Subscriptions

Once the installation, the configuration and the registrations of the Product Link Module (PLM) has been performed, the subscriptions must be activated in order to view the data from the machine or from the engine. The following subscriptions are available. Refer to Table 1.

Table 1

Subscription	Features
Asset Watch	Machine Location Machine Location Mapping Machine Location History Non-reporting Machine Identification Machine Service Meter Hour Reading Machine Service Meter Hour Report History Time and Geo-fencing Time and Geo-fence Alerts
Maintenance Watch	Planned Maintenance (PM) History PM Notes Next PM Due (date and hour based) PM Alerts PM Checklist PM Parts List Customized PM Checklist PM and Repair Planner On-line Parts Ordering Manage Major Repairs Repair History PM or Repair Request for Quote
Health Watch (Requires Asset Watch)	Event and Diagnostic Codes Event and Diagnostic Code Troubleshooting Procedures Event and Diagnostic Code Alerts Event and Diagnostic Code History Fuel Level Fuel Used Fuel Level Alert Fuel Used History and Graphic Display

	Fuel Level History Refueling History 4 Digital Switch Channels

Note: Health Watch information is dependent upon the machine model, the year of production, and the PLM that is installed. Machines that were produced with electronic engines and transmissions that are equipped with Product Link Module PL321SR normally can provide this information.

Only the dealer administrator and/or a customer administrator can upgrade subscriptions or downgrade subscriptions for equipment. Subscriptions are upgraded and downgraded through the "Edit Subscriptions" option in EquipmentManager.

Note: "Automatic Subscription" option may also be available.

Automatic Subscriptions

The "Automatic Subscription" feature will automatically activate a subscription to EquipmentManager when a PLM is registered. Subscriptions will initially be activated at the dealer subscription level. In order to process new subscriptions, the "Automatic Subscription" option in EquipmentManager must be accessed.

Automatic Activation of Subscriptions

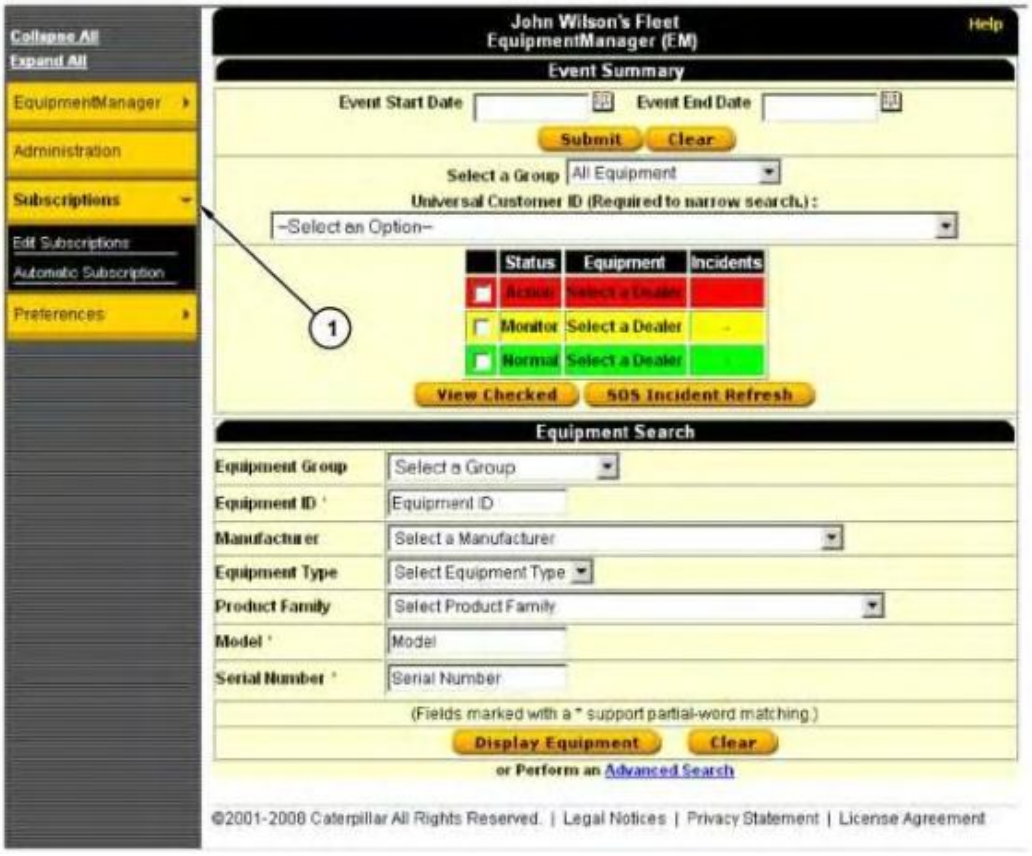


Illustration 1 g01700695

Initial page of EquipmentManager

(1) "Automatic Subscriptions" link

1. In order to access the "Automatic Subscription" page, click the arrow next to "Subscriptions", and then click "Automatic Subscription" link (1) . The "Automatic Subscription" screen will appear.

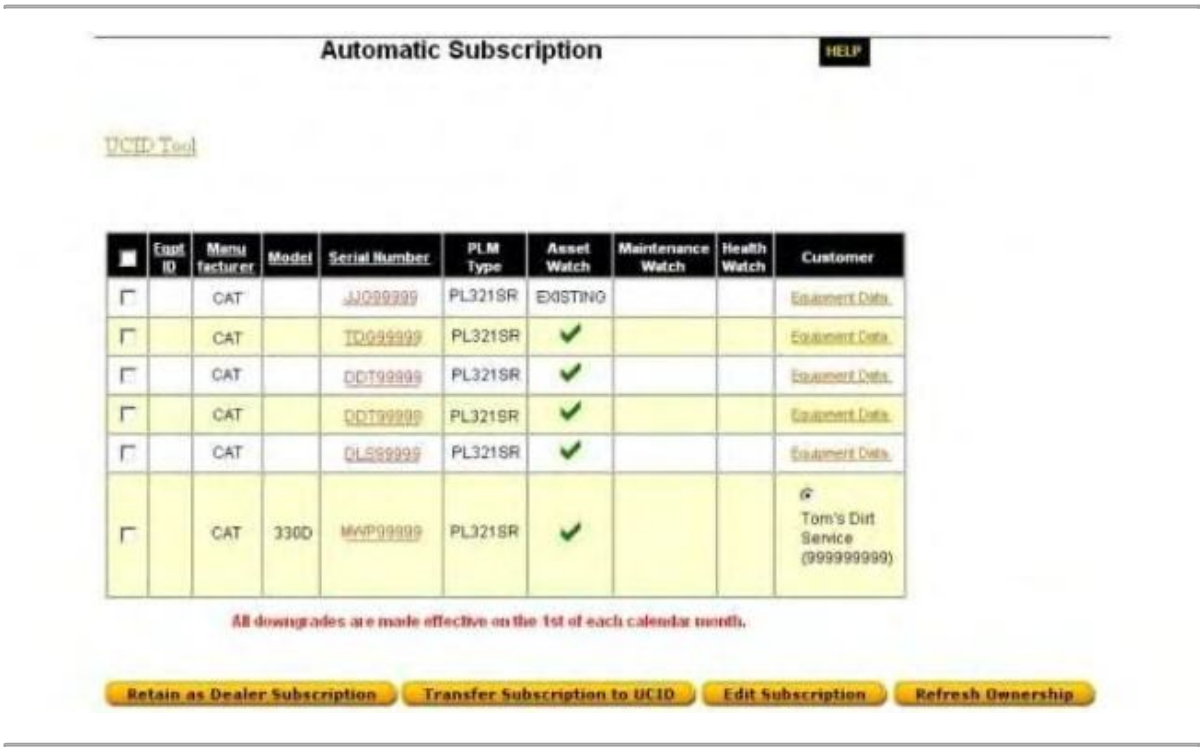


Illustration 2 g01700696

"Automatic Subscription" Screen

2. This screen displays a list of equipment with new, successful PLM registrations. In order to process a subscription, select the check box that corresponds to the piece of equipment that applies to the subscription. A green check mark will appear in the appropriate "Watch" column for the items that are appropriate for the PLM that has been installed and registered.

3. In order to accept the new subscription at the dealer level, click "Retain as Dealer Subscription".

4. In order to transfer the subscription to the customer or UCID, click "Transfer Subscription to UCID".

5. Click "Edit Subscription" in order to split the activations for the subscriptions between the dealer and the customer. This will also activate the Maintenance Watch subscription or the Health Watch subscription for either the dealer or the customer.

   If the customer information is not displayed, select the "Equipment Data" link. This link will alllow you to quickly access the equipment data in order to make the ownership association. After the equipment data updates are complete, select the "Refresh Ownership" button in order to display the new customer information.

   A link to Universal Customer ID Tool (UCID) is also provided at the top of the page for quick access in order to create the UCID for the customer.

   Note: If the customer id or UCID displayed in "Automatic Subscription" is not the correct customer, then exit "Automatic Subscription" and update the machine ownership in "Equipment Data". When "Automatic Subscription" is accessed again, the correct ownership will be displayed.

Once the subscription is processed or accepted from "Automatic Subscription", the subscription is no longer displayed on the "Automatic Subscription" screen. Any changes to subscriptions after the initial registration must be made through the "Edit Subscription" button.

Rules for Automatic Subscription

The following rules apply to "Automatic Subscription":

- When purchasing subscriptions on machines that are equipped with PLM, Maintenance Watch and Health Watch cannot be purchased without a subscription to Asset Watch.
- "Automatic Subscription" will only activate Asset Watch. Maintenance Watch and Health Watch will not be subscribed automatically.



Illustration 3 g01390330

- If a module is registered and subscriptions already exist, "EXISTING" will be displayed in the Asset Watch, the Maintenance Watch, or the Health Watch column. Move the pointer over the word "EXISTING" in order to display the UCID number for the customer with an active subscription. "Automatic Subscription" will not change existing subscriptions.



Illustration 4 g01390332

- If a new subscription is activated and a UCID conflict exists, the check box will be disabled. The UCID conflict must be resolved before the subscription can be processed.

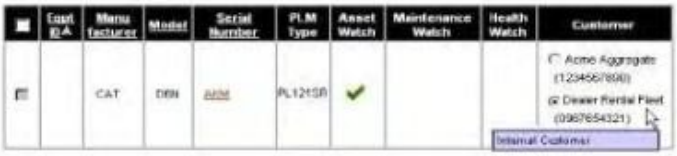


Illustration 5 g01390333

- Occasionally, equipment is associated with multiple UCIDs but is not in UCID conflict. For example, this is common with dealer rental fleets. In this case, all customers will be displayed. Move the pointer over the customer name or UCID number in order to reveal if the customer is internal or

external, and select the option button for the appropriate customer. Next, click the "Transfer Subscription to UCID" button.

- If PLM registration is successful and equipment does not exist in equipment data or is not associated with a Customer or UCID, the customer field will be blank. Caterpillar recommends to create the equipment record in equipment data and complete the UCID association before accepting the subscription in "Automatic Subscription".
- The "Automatic Subscription" feature will not activate a subscription if it has been previously downgraded. In this case, the manual downgrade flag is retained and accepted.
- When a subscription is purchased at a customer level, the customer will see the data from the purchase date of the subscription. The dealer view of subscriptions at either the customer or the dealer level allows the view of data from registration date.

Rules for Automatic Downgrade

The following rules apply to automatic downgrades:

- Automatic downgrades occur to existing subscriptions if customer (UCID) ownership changes between registrations.

Note: The subscription will be downgraded for the previous customer (UCID), and the "Automatic Subscription" screen will display the new customer (UCID).

- Automatic downgrades occur to existing subscriptions if a module is registered again under a new dealer code.

Note: The subscriptions will be downgraded for the previous customer (UCID) and/or dealer as applicable. The subscriptions will be displayed on the "Automatic Subscription" screen for the new dealer that is registering.

Note: EquipmentManager history is associated with the previous customer will not be viewable by the new customer.

Edit Subscriptions

Edit Dealer or Customer Subscriptions

In order to upgrade or downgrade a dealer subscription, complete the following procedure:

Note: Only the dealer administrator and the customer administrator can upgrade or downgrade subscriptions for equipment, which is done through the "Edit Subscription" option in EquipmentManager.

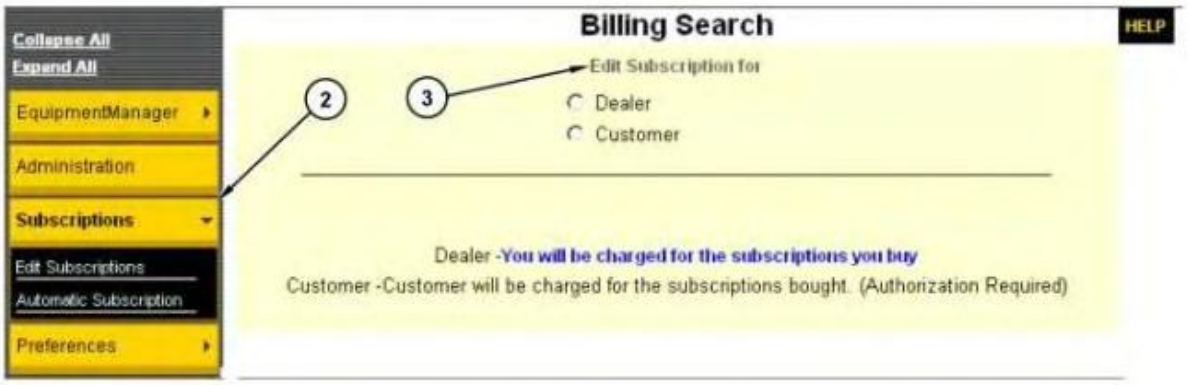


Illustration 6 g01700697

"Edit Subscription for" on the "Billing Search" screen

(2) "Subscriptions" tab

(3) "Edit Subscription for"

1. Click on the "Subscriptions" tab (2) on the left navigation bar. The "Edit Subscription for" (3) on the "Billing Search" screen will be displayed.

2. Select either "Dealer" or "Customer". The screen will load again and a find equipment form will appear.

   Note: A customer administrator or a customer user is not given the option of searching the dealer subscriptions. The customer administrator or the customer user skip Step 3 and go directly to Step 4.



Illustration 7 g01703194

"Billing Search" screen for finding the equipment

(4) "Universal Customer ID" drop-down menu

(5) "Display Equipment" button

3. Select a UCID from the "Universal Customer ID" drop-down menu (4) . If the UCID that was selected has multiple customer numbers, an additional drop-down menu with the customer numbers will appear below the UCID drop-down menu. If this is the case, proceed to Step 4. If this is not the case, proceed to Step 5.

   Note: Selecting a UCID from the drop-down menu is required. In order to find all of the machines from your dealership regardless of the customer of that machine, select "All Dealer Machines" from the drop-down menu.

   Note: If the UCID select has multiple customer numbers, an additional drop-down menu that contains all customer numbers will appear below the UCID drop-down menu. If this is applicable, select a customer number in the "Customer Number" drop-down menu.

4. Complete the following fields:"Equipment Group", "Equipment ID", "Manufacturer", "Model" and "Serial Number"

5. The "Search Results" Screen will be displayed.



Illustration 8 g01703195

"Search Results" screen for editing a subscription

(6) Current status of the subscriptions

(7) "Update Checked" button

Icon	Meaning
	Subscription purchased in the past remains unchanged during the billing cycle.
	Subscription downgraded (removed) during the billing cycle.
	Subscription upgraded (added) during the billing cycle.
	Subscription downgraded automatically because of preference in purchase rights.

Illustration 9 g01244842

6. Check the box next to all the machines in the "Search Results" for editing the subscriptions.

   In the "Search Results" table, there are columns that represent Asset Watch, Maintenance Watch, and Health Watch. An icon is displayed in each of these columns for each individual piece of equipment that is listed in the results from the search. These icons represent the status of the subscription on that machine. If there has been no subscription at any time during the current billing cycle, (if the PLM is newly installed for example) then no icon will appear. Refer to Illustration 9 for the other possible icons that may appear in these columns.

7. Click the "Update Checked" button. The "Update Your Billing" screen will be displayed.

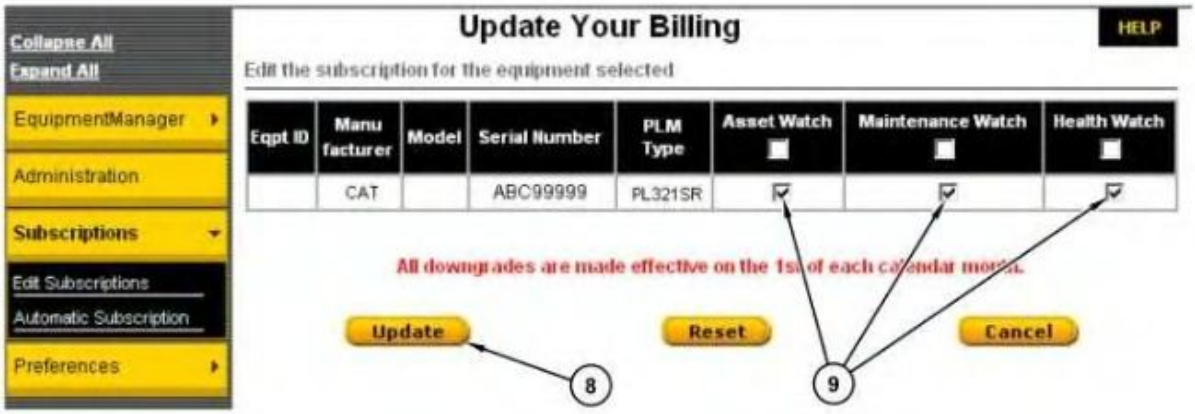


Illustration 10 g01703196

"Update Your Billing" screen

(8) "Update" button

(9) Check box for a subscription

8. In order to activate a subscription, check the box that corresponds to the subscription that is desired and for the piece of equipment.

   In order to activate a subscription for a piece of equipment, select the corresponding check box for the subscription (9) of choice. In order to deactivate a subscription, unselect the appropriate box.

   Note: Maintenance Watch and Health Watch cannot be purchased without a subscription to Asset Watch, this rule and prerequisite apply to the purchase of subscriptions on machines that are equipped with PLM.

   Note: Asset Watch and Health Watch cannot be purchased. Also, Maintenance Watch can be purchased but machine hours must be entered manually by the user. These rules and prerequisites apply to the purchase of subscriptions on machines that are not equipped with PLM.

9. Click on the "Update" button (8) . A "Confirmation" screen will be displayed with the changes that were made to the subscription or subscriptions.

10. Click on "OK" in order to complete the update.

Subscription Messages

As subscriptions are created or as subscriptions are edited, a message may appear. This message indicates that your actions were incomplete or that more input may be required. These messages occur under the following conditions:

- Subscription message for manual equipment
- Subscription message for prerequisite
- Subscription message for downgrading a prerequisite



Illustration 11 g01244849

Subscription message for manual equipment

If an attempt is made to activate a subscription to either Asset Watch or Health Watch on a machine that does not have a PLM, the message in Illustration 11 will appear.

Click on "OK" and no subscription will be added. The only way to add this subscription is to equip the machine with a PLM.



Illustration 12 g01244850

Subscription message for prerequisite

If an attempt is made to activate a subscription for Maintenance Watch or Health Watch on a machine with a PLM without a subscription to Asset Watch, the message in Illustration 12 will appear.

Click on "OK" in order to check the Asset Watch check box. This will also add a subscription to Asset Watch in addition to the other subscriptions activated. If you click on "Cancel", no subscriptions will be added.



Illustration 13 g01244851

Subscription message for downgrading a prerequisite

If an attempt is made to deactivate a subscription for Asset Watch while subscriptions to Maintenance Watch and/or Health Watch still exist, the message in Illustration 13 will appear.

Click on "OK" in order to automatically unselect the Health Watch and/or Maintenance Watch check boxes. This will also deactivate the subscriptions and the Asset Watch subscription. If you click on "Cancel" no subscriptions will be changed.

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Administration

SMCS - 7600; 7606

You can customize EquipmentManager in the "Administration" section of EquipmentManager in order to enable the most effective use of the tool, productive use of the tool, and efficient use of the tool. While the "Preferences" primarily affect the way information is displayed in EquipmentManager, the "Administration" functions are where you will group equipment, set up and assign event reactions, manage the registry parameters of the Product Link Modules (PLM), upload repair and refueling history, set up fences, manage planned maintenance, and so on. These functions, once configured, should not need to be changed on a daily basis.



Illustration 1 g01700556

"Administration" screen

(1) "Administration" link

To reach the "Administration" screen, click on the "Administration" link (1) in the left navigation.

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i03355415

Manage Equipment Groups

SMCS - 7600; 7606

Introduction

Being able to create predetermined groupings of equipment is particularly useful when managing large numbers of equipment through EquipmentManager. These groups that you create will allow you to work more efficiently because you can quickly select one of your predefined groups upon which to perform any of the asset watch, maintenance watch or health watch tasks rather than entering individual serial numbers or performing advanced searches each time.

Equipment Groups

Equipment groups can be created. Existing equipment groups can be modified or deleted.

Create Equipment Group

Use the following procedure in order to create an equipment group:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Group". The "Equipment Search" screen will be displayed.



Illustration 1 g01729973

"Create Equipment Group" - "Equipment Search"

(1) "Display Equipment" button

2. Enter your search criteria in the "Equipment Search" fields and click the "Display Equipment" button (1) . The "Create Equipment Group" screen will be displayed. The results of the search will be displayed in the "Equipment List" section of this screen.

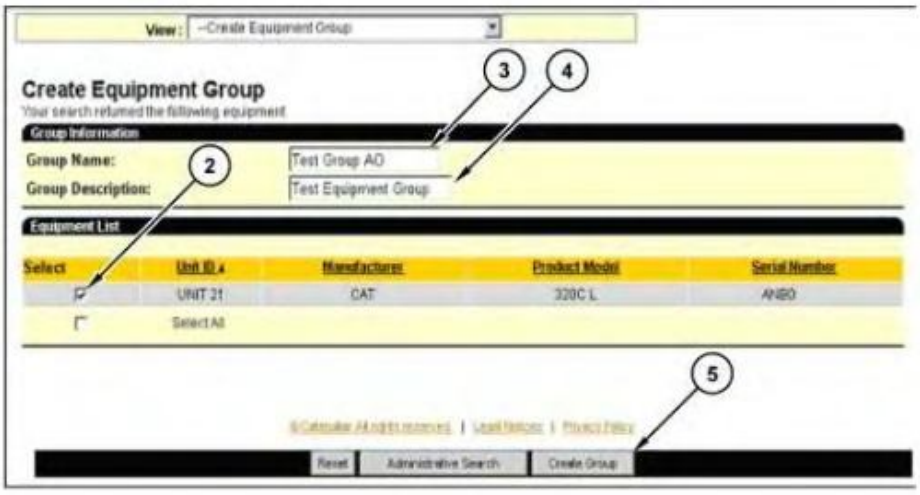


Illustration 2 g01730034

"Create Equipment Group" - "Group Information" and "Equipment List"

(2) Check box

(3) "Group Name" field

(4) "Group Description" field

(5) "Create Group" button

3. In the "Group Information" section, enter a name for the new equipment group in the "Group Name" field (3) .
4. In the "Group Information" section, enter a description of the new equipment group in the "Group Description" field (4) .
5. In the "Equipment List" section, select the check box (2) next to each piece of equipment that you wish to add to the new equipment group.



Illustration 3 g01270513

"Create Equipment Group Confirmation" screen

6. Click the "Create Group" button (5) at the bottom. The selected equipment is added to the new group and the "Create Equipment Group Confirmation" screen will be displayed.

Modify Equipment Group

Once you have created an equipment group, you may decide to add or remove equipment from the group or change the name and/or description of the group.

In order to modify an existing equipment group, use the following procedure:

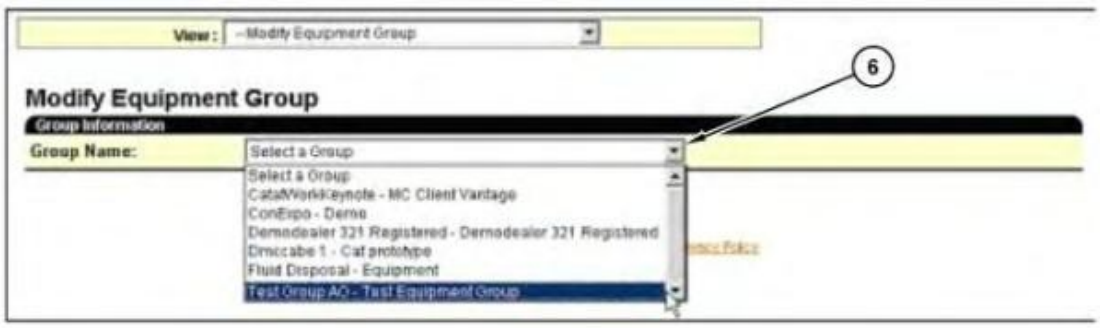


Illustration 4 g01730035

"Modify Equipment Group"

(6) "Group Name" drop-down menu

1. From either the "Equipment Groups" drop-down menu section of the "Administration" screen or the "View" drop-down menu, select "Modify Equipment Group". The "Modify Equipment Group" screen will be displayed.
2. Select the name of the group from the "Group Name" drop-down menu (6) in order to modify the group. The "Group Information" and "Equipment List" sections appear on the "Modify Equipment Group" screen for the selected equipment group.

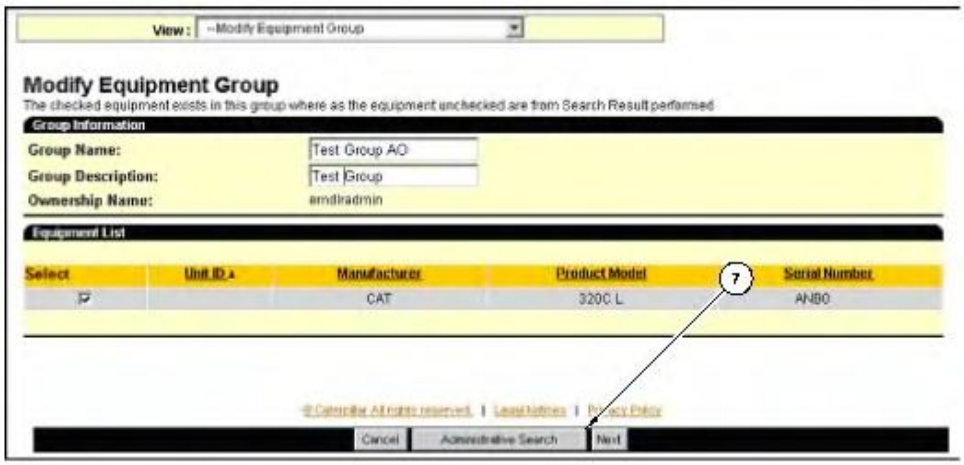


Illustration 5 g01730037

"Modify Equipment Group" - "Group Information" and "Equipment List"

(7) "Administrative Search" button

3. If you wish to add equipment to the equipment group, click on the "Administrative Search" button (7) , or else skip to Step 5. The "Equipment Search" screen will be displayed.

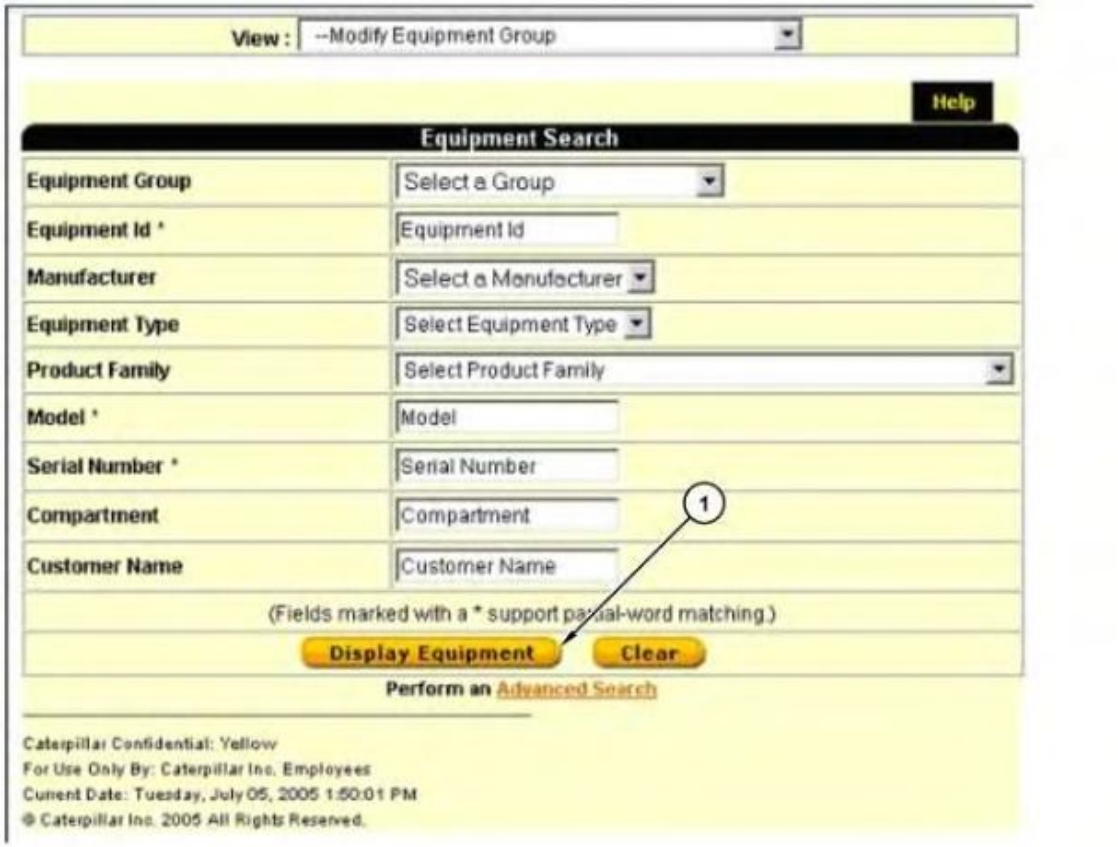


Illustration 6 g01730039

"Equipment Search"

(1) "Display Equipment" button

4. Enter your search criteria in the search fields and click the "Display Equipment" button (1) . The "Modify Equipment Group" screen will be displayed with the equipment in the existing group. The equipment list is also displayed in the "Equipment List" section of the screen.

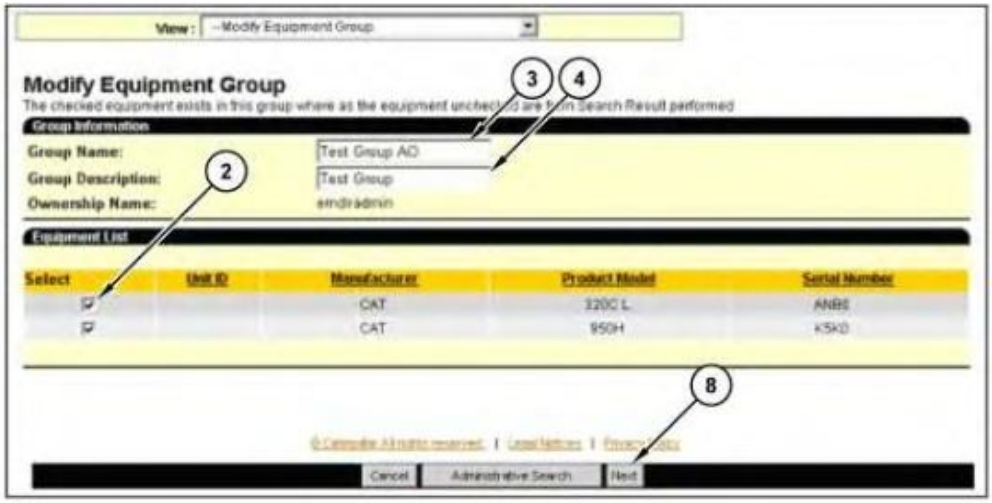


Illustration 7 g01730042

Updating" Equipment List"

(2) Check box

(3) "Group Name" field

(4) "Group Description" field

(8) "Next" button

5. In the "Group Information" section, edit the name in the "Group Name" field (3) .
6. In the "Group Information" section, edit the description in the "Group Description" field (4) .
7. In the "Equipment List", select the check box (2) for the equipment you want to add to the group. Clear the check box for the equipment that you want to remove from the group.



Illustration 8 g01270517

"Modify Equipment Group Detail"

8. Click the "Next" button (8) . The "Modify Equipment Group Detail" screen will be displayed.

Delete Equipment Group

Just as you may create and modify groupings of equipment, you may also delete equipment groups completely.

In order to delete an equipment group, use the following procedure:

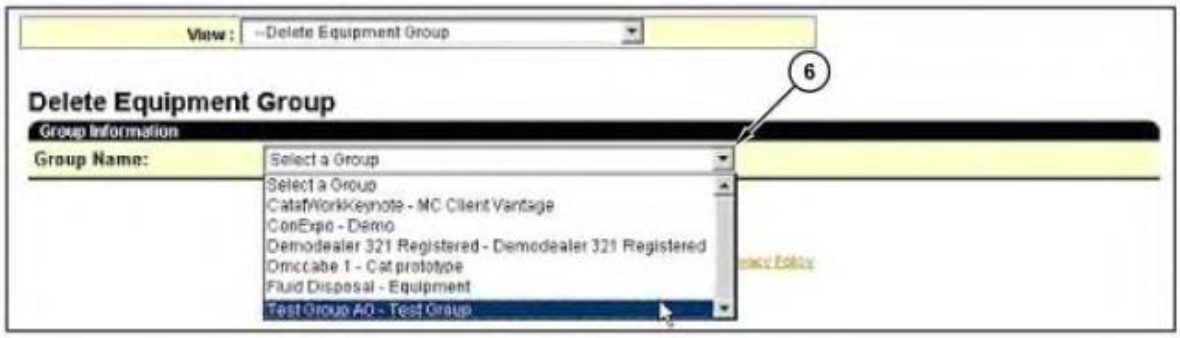


Illustration 9 g01730044

"Delete Equipment Group" screen

(6) "Group Name" drop-down menu

1. Either from the "Equipment Groups" section of the "Administration" screen or from the "View" drop -down menu, select "Delete Equipment Group". The "Delete Equipment Group" screen will be displayed.
2. Select the name of the equipment group you wish to delete from the "Group Name" drop-down menu (6) . The "Delete Equipment Group" screen is displayed with the details of the equipment group that you selected.

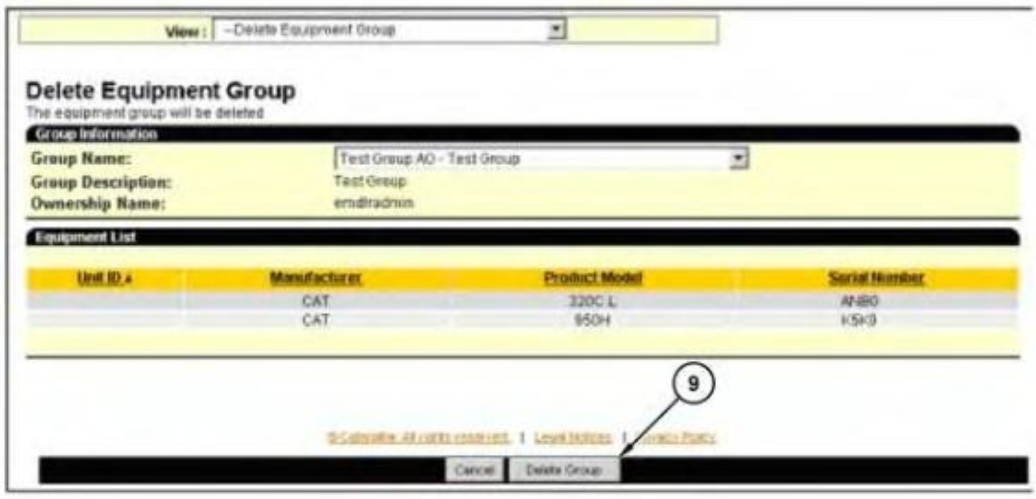


Illustration 10 g01730046

"Delete Equipment Group" details

(9) "Delete Group" button

3. Click the "Delete Group" button (9) . A window will appear with a "Delete" confirmation message.



Illustration 11 g01246611

"Delete" confirmation message

4. Click "OK". The equipment group is deleted.

Equipment Subgroups

In addition to creating groupings of equipment, you can use these equipment groups to create subgroups. Equipment subgroups are subsets of existing equipment groups that are given a name and description, and then saved. For example, a dealer could create an equipment group of all the equipment. The Dealer could then create a subgroup that contains all of the equipment from multiple locations.

Similar to equipment groups, equipment subgroups can be selected on the EquipmentManager search screens in order to save time entering search criteria into the search and advanced search fields. The procedures to create, modify, and delete an equipment subgroup are similar to those you performed when you created, modified, and deleted an equipment group

Create Equipment Subgroup

In order to create an equipment sub group, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Sub Group". The "Create Equipment Subgroup" screen will be displayed.



Illustration 12 g01730048

"Create Equipment Subgroup" screen

(6) "Group Name" drop-down menu

2. Select the name of the equipment group from which you wish to create a subgroup from the "Group Name" drop-down menu (6) . The "Create Equipment Subgroup" screen is displayed with the "Subgroup Information" section and the "Equipment List".

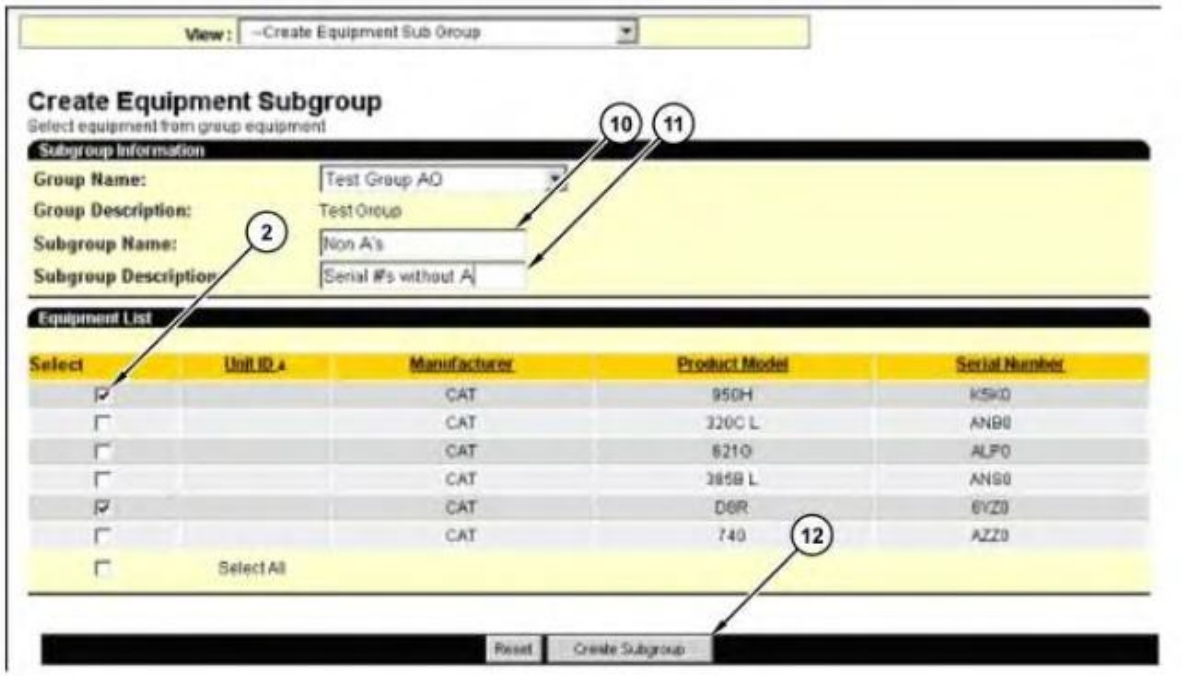


Illustration 13 g01730049

"Create Equipment Subgroup" screen

(2) Check box

(10) "Subgroup Name" field

(11) "Subgroup Description" field

(12) "Create Subgroup" button

3. In the "Subgroup Information" section, enter a name for the new subgroup in the "Subgroup Name" field (10) .

4. In the "Subgroup Information" section, enter a description for the new subgroup in the "Subgroup Description" field (11) .

5. In the "Equipment List" section, select the check box (2) next to each piece of equipment in the group that you wish to be added to the new subgroup.

6. Click the "Create Subgroup" button (12) . The "Create Equipment Subgroup Confirmation" screen will be displayed.

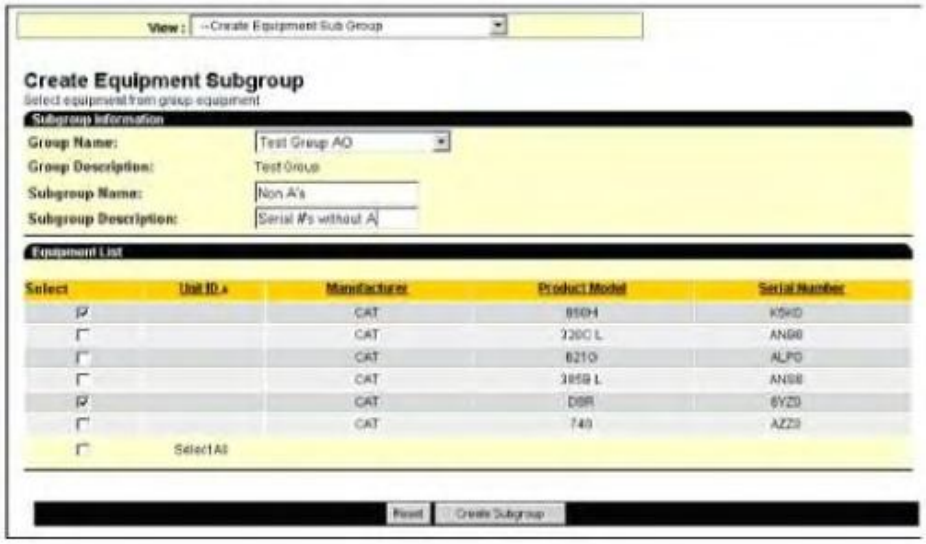


Illustration 14 g01270520

"Create Equipment Subgroup" confirmation

7. Click the "Done" button. The new subgroup has been created.

Modify Equipment Subgroup

You have the ability to change the name and/or the description of an equipment subgroup as well as add or remove pieces of equipment from the subgroup.

In order to modify an equipment subgroup, use the following procedure:

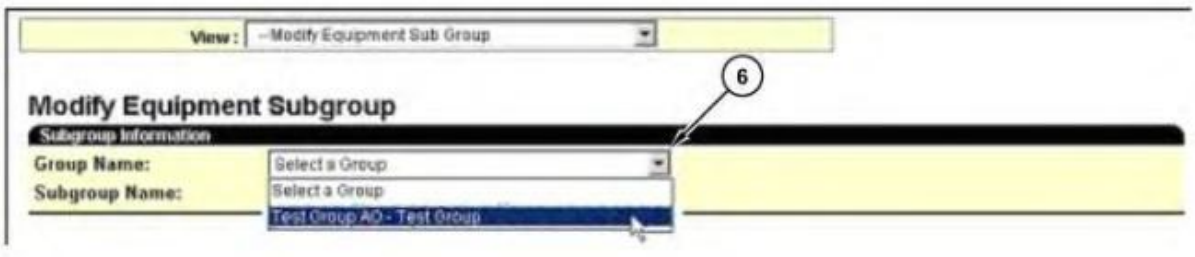


Illustration 15 g01730050

"Modify Equipment Subgroup"

(6) "Group Name" drop-down menu

1. From either the "Equipment Groups" section of the "Administration" screen, or from the "View" drop-down menu, select "Modify Equipment Sub Group". The "Modify Equipment Sub Group" screen will be displayed.

2. Select the name of the group for the subgroup that you wish to modify from the "Group Name" drop-down menu (6) . The subgroups that pertain to the selected group will be populated in the "Subgroup Name" drop-down menu.

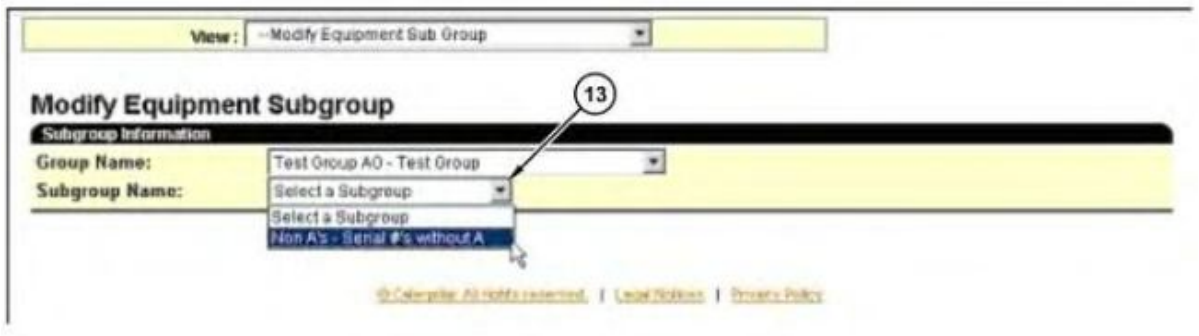


Illustration 16 g01730052

"Modify Equipment Subgroup"

(13) "Subgroup Name" drop-down menu

3. Select the name of the subgroup you wish to modify from the "Subgroup Name" drop-down menu (13) . The "Modify Equipment Subgroup" screen will be displayed with the "Subgroup Information" and "Equipment List" sections.

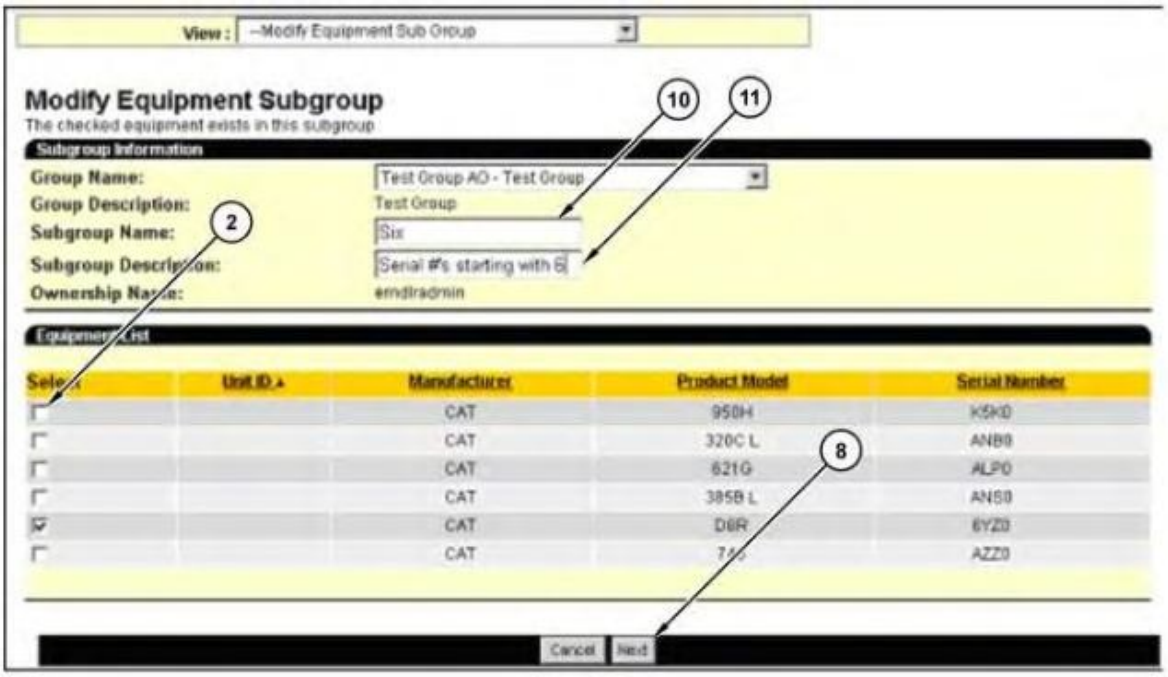


Illustration 17 g01730053

Editing "Subgroup Information" and "Equipment List"

(2) Check box

(10) "Subgroup Name" field

(11) "Subgroup Description" field

(8) "Next" button

4. In the "Subgroup Information" section, edit the name in the "Subgroup Name" field (10) .
5. In the "Subgroup Information" section, edit the description in the "Subgroup Description" field (11) .
6. In the "Equipment List" section, select the check box (2) for the equipment you want to add to the subgroup. Clear the check box for the equipment that you want to remove from the subgroup.
7. Click the "Next" button (8) . The subgroup is modified and the "Modify Equipment Subgroup Detail" screen will be displayed.



Illustration 18 g01270523

"Modify Equipment Subgroup Detail"

Delete Equipment Subgroup

In order to delete an equipment subgroup, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Delete Equipment Sub Group". The "Delete Equipment Subgroup" screen will be displayed.

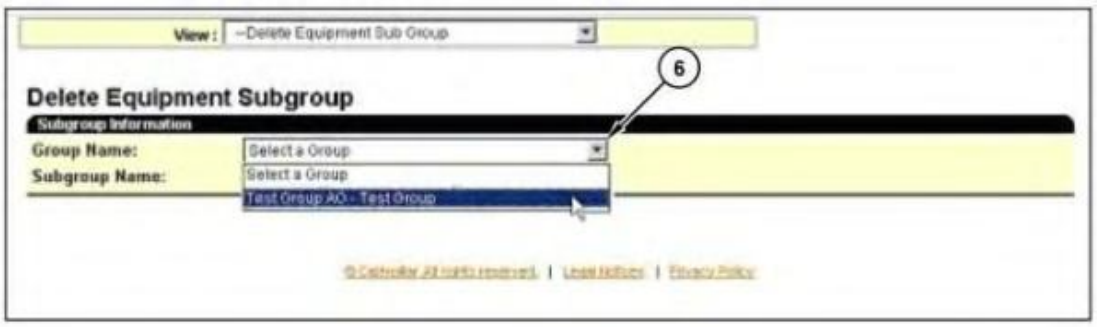


Illustration 19 g01730054

"Delete Equipment Subgroup"

(6) "Group Name" drop-down menu

2. Select the name of the group for the subgroup you wish to delete from the "Group Name" drop-down menu (6) . The "Subgroup Name" drop-down menu is populated with all the subgroup names that match the selected group.

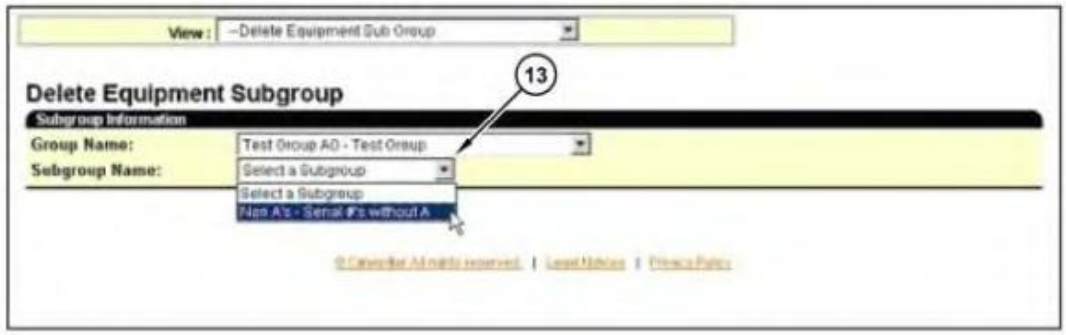


Illustration 20 g01730055

"Delete Equipment Subgroup"

(13) "Subgroup Name" drop-down menu

3. Select the name of the subgroup you want to delete from the "Subgroup Name" drop-down menu (13) . The "Delete Equipment Subgroup Details" screen will be displayed.

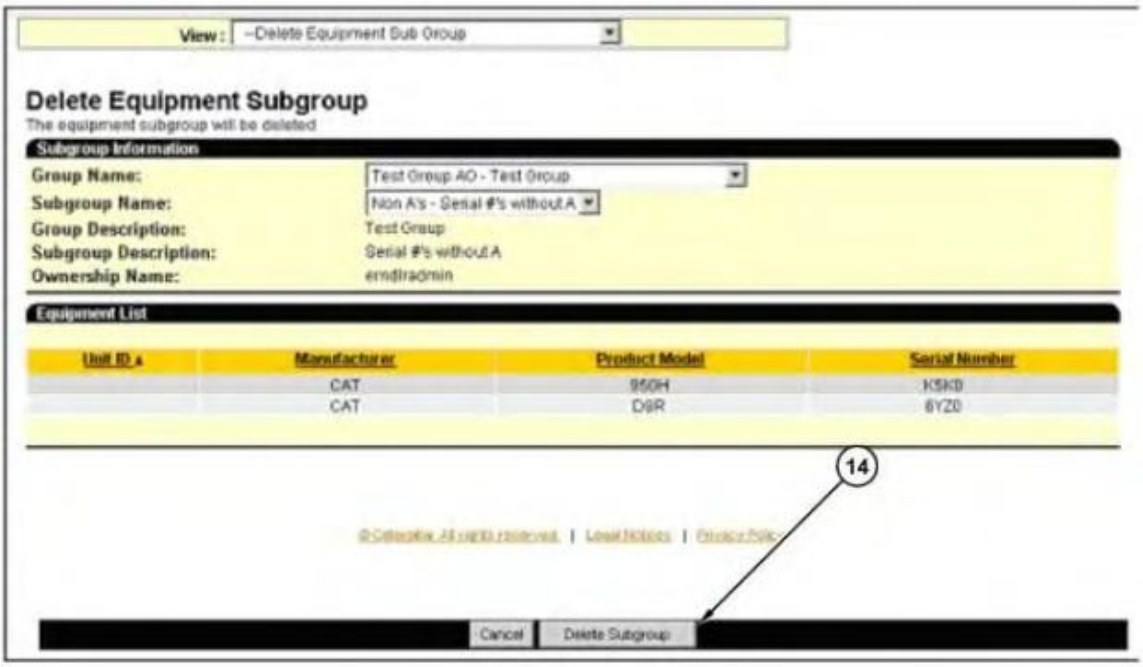


Illustration 21 g01730057

"Delete Equipment Subgroup" details

(14) "Delete Subgroup" button

4. Click the "Delete Subgroup" button (14) . A window will appear with a "Delete" confirmation message.



Illustration 22 g01246657

"Delete" confirmation message

5. Click "OK". The equipment subgroup is deleted.

Equipment Group Assignment

As an EquipmentManager dealer administrator, you have the ability to assign other dealers, customers, and users to equipment groups and equipment subgroups. Those groups that you assign will appear in the

"Equipment Group" drop-down menu of the related search screens. You can share equipment groups with users that would not otherwise have access. You can assign also the management of groups of equipment to individual employees.

Assign Equipment Group to Dealer

In order to assign an equipment group to a dealer, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Group Assignment". The "Create Equipment Group Assignment" screen will be displayed.



Illustration 23 g01730058

"Create Equipment Group Assignment" for the dealer

(6) "Group Name" drop-down menu

(15) "Group Assignment" drop-down menu

(16) "Dealer" drop-down menu

(17) "Start Date" field

(18) "End Date" field

(8) "Next" button

2. Select the name of the group you wish to assign to a dealer from the "Group Name" drop-down menu (6) .

3. Select "Dealer" from the "Group Assignment" drop-down menu (15) . The "Dealer" drop-down menu (16) will appear below the "Group Assignment" drop-down menu.

4. Select the name of the dealer you wish to assign the group to from the "Dealer" drop-down menu (16) . Every dealer level user from the assigned dealership will have access to this group in the "Group Name" drop-down menu (6) .

5. Enter the timeframe for this assignment by clicking the calendar icons next to the "Start Date" field (17) and "End Date" (18) field and selecting a date.

   If you wish the assignment to be indefinite, do not complete this step.



Illustration 24 g01246668

"Create Equipment Group Assignment Detail" for the dealer

6. Click the "Next" button (8) . The assignment is created and the "Create Equipment Group Assignment Detail" screen will be displayed.

Assign Equipment Group to Customer

In order to assign an equipment group to a customer, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Group Assignment". The "Create Equipment Group Assignment" screen will be displayed.

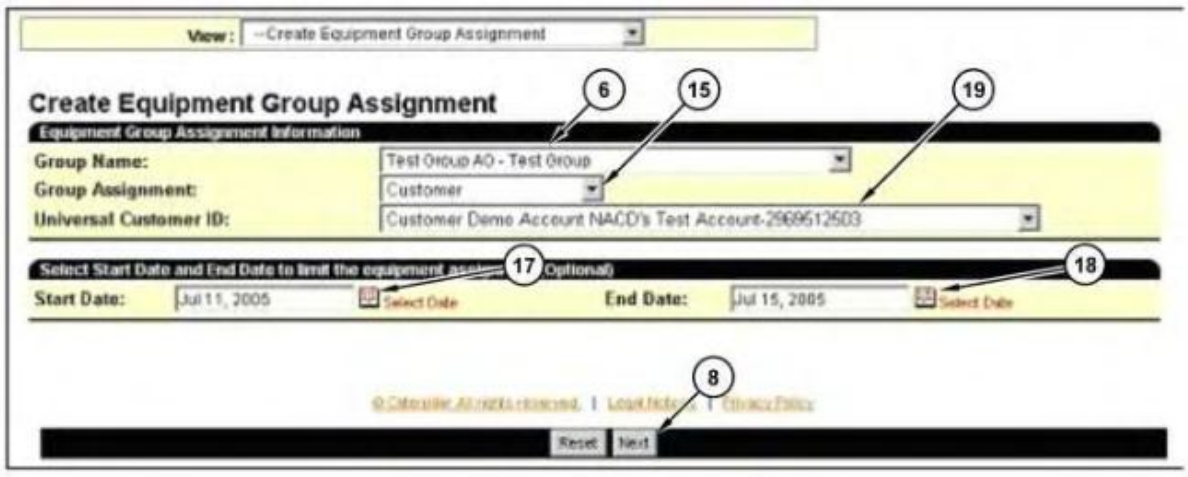


Illustration 25 g01730059

"Create Equipment Group Assignment" for the customer

(6) "Group Name" drop-down menu

(15) "Group Assignment" drop-down menu

(19) "Universal Customer ID" drop-down menu

(17) "Start Date" field

(18) "End Date" field

(8) "Next" button

2. Select the name of the group you wish to assign to a customer from the "Group Name" drop-down menu (6) .
3. Select "Customer" from the "Group Assignment" drop-down menu (15) . The "Universal Customer ID" drop-down menu (19) will appear below the "Group Assignment" drop-down menu.
4. Select the "Universal Customer ID" of the customer you wish to assign the equipment group from the "Universal Customer ID" drop-down menu (19) .
5. Enter the timeframe for this assignment to last by clicking the calendar icons next to the "Start Date" field (17) and "End Date" (18) field and selecting a date.

   If you wish the assignment to be indefinite, do not complete this step.



Illustration 26 g01730060

"Create Equipment Group Assignment Detail" for the customer

6. Click the "Next" button (8) . The assignment is created and the "Create Equipment Group Assignment Detail" screen will be displayed.

Assign Equipment Group to User

In order to assign an equipment group to a user, use the following procedure:

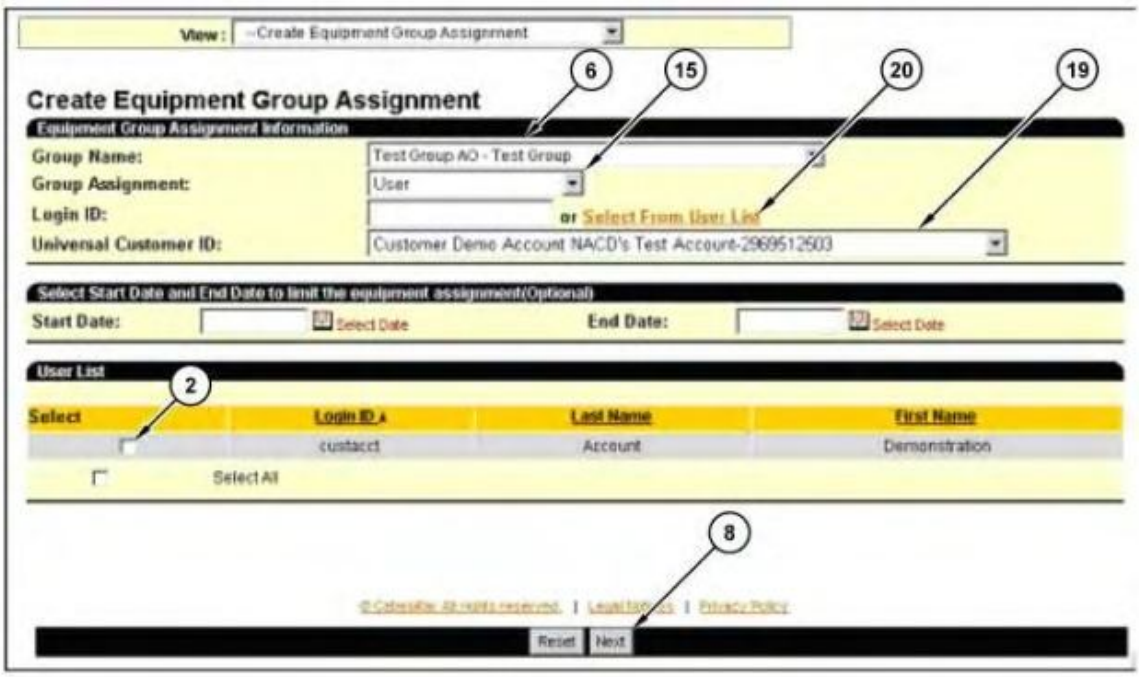


Illustration 27 g01730061

"Create Equipment Group Assignment" for the user

(6) "Group Name" drop-down menu

(15) "Group Assignment" drop-down menu

(20) "Login ID" field and "Select From User List" link

(19) "Universal Customer ID" drop-down menu

(2) Check box

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Group Assignment". The "Create Equipment Group Assignment" screen will be displayed.
2. Select the name of the group you wish to assign to a user from the "Group Name" drop-down menu (6) .
3. Select "User" from the "Group Assignment" drop-down menu (15) . The "Login ID" field and "Select FromUser List" link (20) will appear below the "Group Assignment" drop-down menu.
4. Enter a valid CWS-ID in the "Login ID" field or click the "Select From User List" (20) .

   If you entered a CWS-ID, skip to Step 6. If you clicked "Select From User List", a "Universal Customer ID" drop-down menu (19) will appear below the "Login ID" field.
5. From the "Universal Customer ID" drop-down menu (19) , select the UCID for which the user you wish to assign the equipment group pertains.

   The users that pertain to the selected UCID appear in the "User List" section
6. Enter the timeframe for the assignment to last by clicking the calendar icons next to the "Start Date" field and "End Date" field and selecting a date.

If you wish the assignment to be indefinite, do not complete this step.

7. Select the check box (2) next to all users in the "User List" section that you wish to assign the equipment group.
8. Click the "Next" button (8) . The "Create Equipment Group Assignment Detail" screen will be displayed.



Illustration 28 g01246747

"Create Equipment Group Assignment Detail" for the user

9. Click the "Create Equipment Group Assignment" button. The equipment group assignment is created.

Delete Equipment Group Assignment

You can delete an indefinite equipment group assignment or an assignment before the assignment is set to expire by using the "Delete Equipment Group Assignment" functionality.

In order to delete an equipment group assignment, use the following procedure:

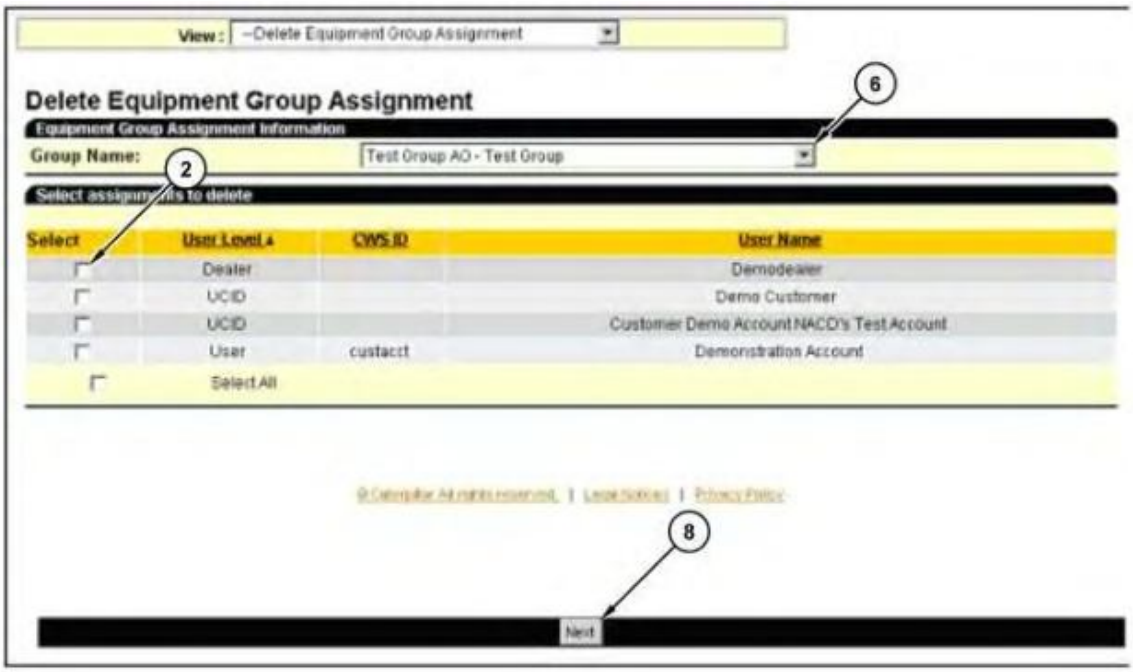


Illustration 29 g01730062

"Delete Equipment Group Assignment"

(6) "Group Name" drop-down menu

(2) Check box

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Delete Equipment Group Assignment". The "Delete Equipment Group Assignment" screen will be displayed.
2. In the "Group Name" drop-down menu (6) , select the name of the group from which you wish to delete an assignment.

   The "Select assignments to delete" section is populated with a list of all assignments made to the selected group.
3. Select the check box (2) next to all of the assignments you wish to delete.
4. Click the "Next" button (8) . The "Delete Equipment Group Assignment Detail" screen will be displayed.



Illustration 30 g01246752

"Delete Equipment Group Assignment Detail"

5. Click the "Delete Equipment Group Assignment" button. The equipment group assignments are deleted.

Equipment Subgroup Assignment

Assign Equipment Subgroup to Dealer

Equipment subgroup assignments are subsets of existing equipment group assignments. As with equipment group assignments, you can assign these subgroups to Dealers, customers, and users.

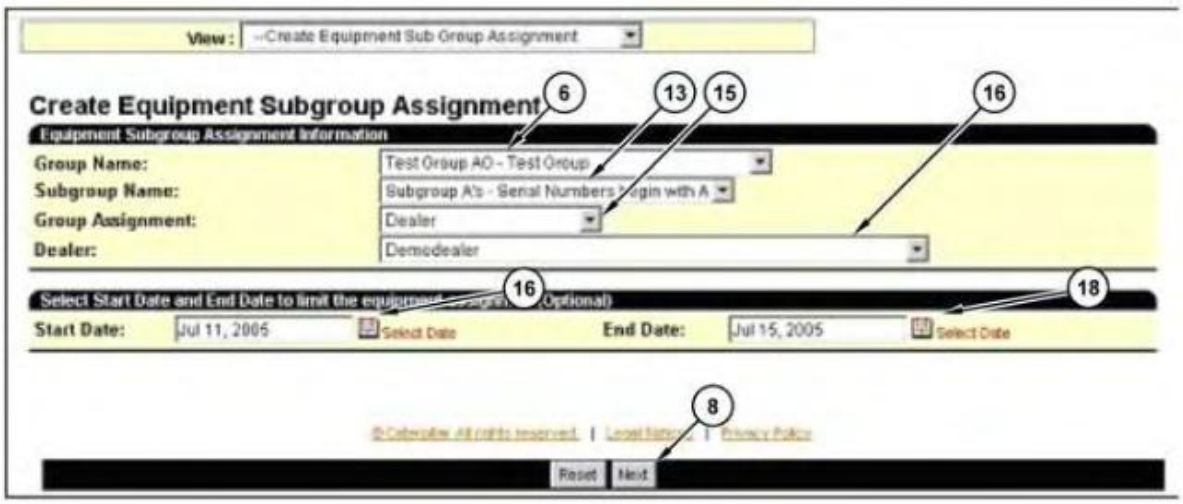


Illustration 31 g01730064

"Create Equipment Subgroup Assignment" for a dealer

(6) "Group Name" drop-down menu

(13) "Subgroup Name" drop-down menu

(15) "Group Assignment" drop-down menu

(16) "Dealer" drop-down menu

(17) "Start Date" field

(18) "End Date" field

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Sub Group Assignment". The "Create Equipment Subgroup Assignment" screen will be displayed.
2. Select the name of the group for the subgroup you wish to assign to a dealer from the "Group Name" drop-down menu (6) .
3. Select the name of the subgroup you wish to assign to a dealer from the "Subgroup Name" drop-down menu (13) .
4. Select "Dealer" from the "Group Assignment" drop-down menu (15) . The "Dealer" drop-down menu (16) will appear below the "Group Assignment" drop-down menu.
5. Select the name of the Dealer you wish to assign the group to from the "Dealer" drop-down menu (16) .
6. Enter the timeframe in which you wish this assignment to last by clicking the calendar icons next to the "Start Date" field (17) and "End Date" (18) field and selecting a date.

   If you wish the assignment to be indefinite, do not complete this step.
7. Click the "Next" button (8) . The assignment is created and the "Create Equipment Group Assignment Detail" screen will be displayed.

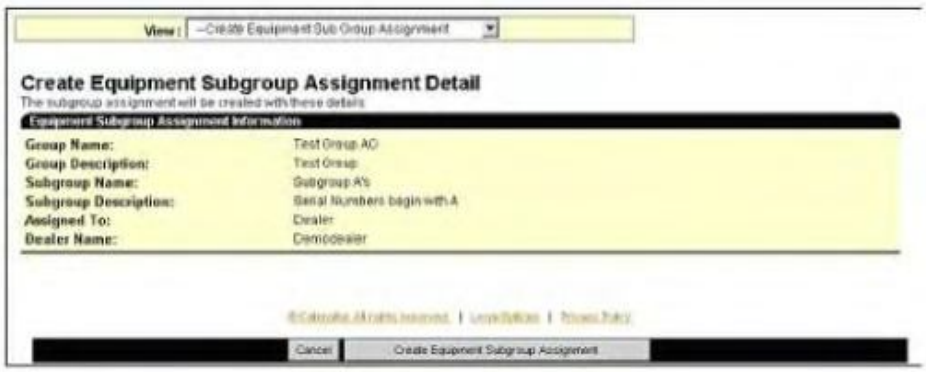


Illustration 32 g01246759

Assign Equipment Subgroup to Customer

In order to assign a subgroup to a customer, use the following procedure:

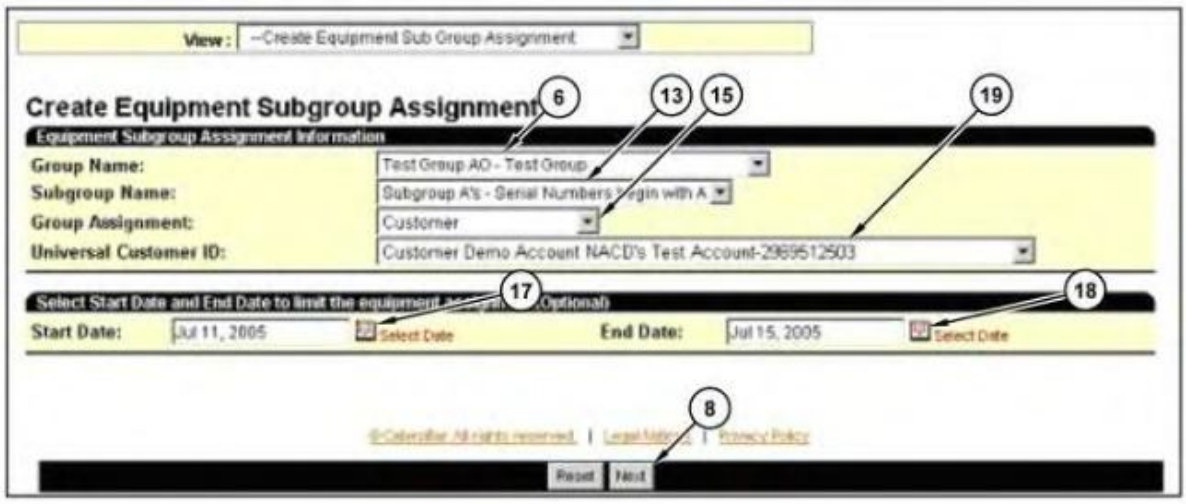


Illustration 33 g01730068

"Create Equipment Subgroup Assignment" for the customer

(6) "Group Name" drop-down menu

(13) "Subgroup Name" drop-down menu

(15) "Group Assignment" drop-down menu

(19) "Universal Customer ID" drop-down menu

(17) "Start Date" field

(18) "End Date" field

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Sub Group Assignment". The "Create Equipment Subgroup Assignment" screen will be displayed.
2. Select the name of the Group for the Subgroup you wish to assign to a customer from the "Group Name" drop-down menu (6) .
3. Select the name of the subgroup you wish to assign to a customer from the "Subgroup Name" drop-down menu (13) .
4. Select "Customer" from the "Group Assignment" drop-down menu (15) . The "Universal Customer ID" drop-down menu (19) will appear below the "Group Assignment" drop-down menu.
5. Select the Universal Customer ID of the customer you wish to assign the equipment group from the "Universal Customer ID" drop-down menu (19) .

6. Enter the timeframe in which you wish this assignment to last by clicking the calendar icons next to the "Start Date" field (17) and "End Date" (18) field and selecting a date.

   If you wish the assignment to be indefinite, do not complete this step.

7. Click the "Next" button (8) . The assignment is created and the "Create Equipment Group Assignment Detail" screen will be displayed.

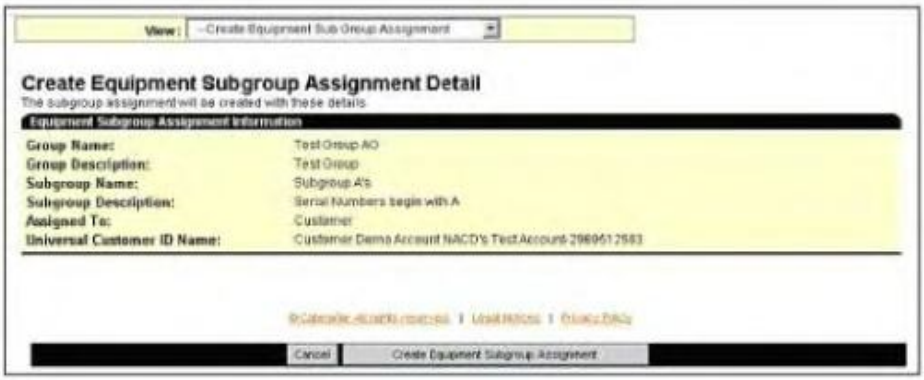


Illustration 34 g01246833

"Create Equipment Subgroup Assignment Detail" for the customer

Assign Equipment Subgroup to User

In order to assign a subgroup to a user, use the following procedure:

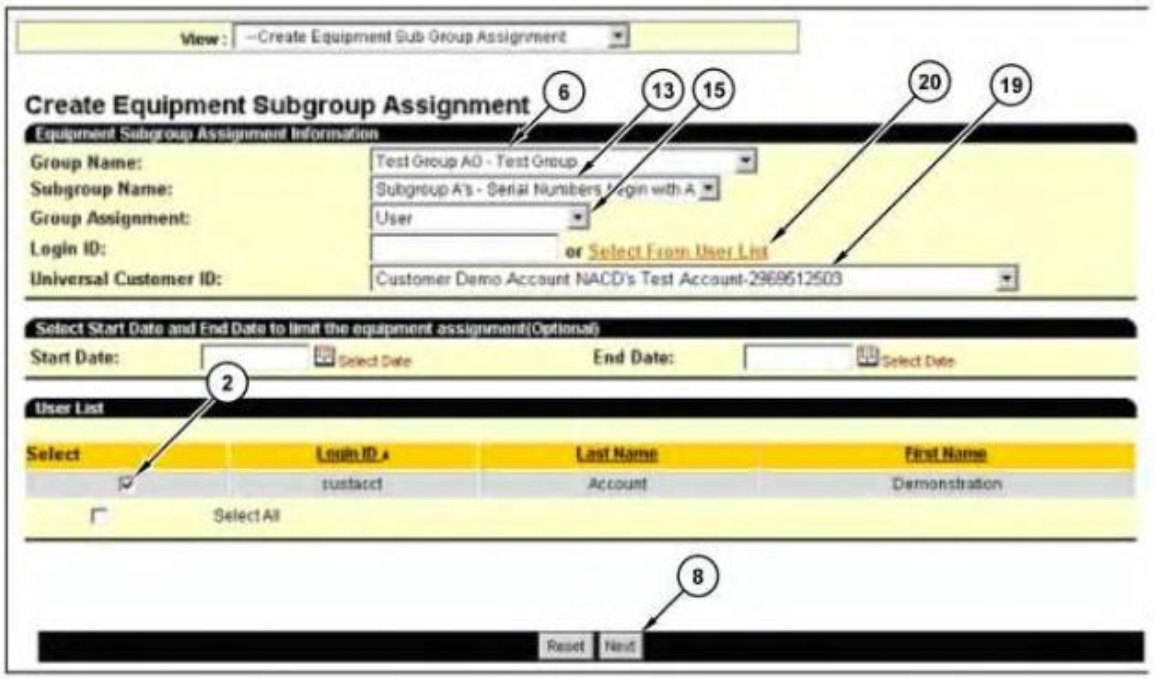


Illustration 35 g01731874

"Create Equipment Subgroup Assignment" for a user

(6) "Group Name" drop-down menu

(13) "Subgroup Name" drop-down menu

(15) "Group Assignment" drop-down menu

(20) "Login ID" field and "Select From User List" link

(19) "Universal Customer ID" drop-down menu

(2) Check box

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Sub Group Assignment". The "Create Equipment Subgroup Assignment" screen will be displayed.
2. Select the name of the Group for the Subgroup you wish to assign to a user from the "Group Name" drop-down menu (6) .
3. Select the name of the subgroup you wish to assign to a user from the "Subgroup Name" drop-down menu (13) .
4. Select "User" from the "Group Assignment" drop-down menu (15) . The "Login ID" field and "Select FromUser List" link (20) appear below the "Group Assignment" drop-down menu.
5. Enter a valid CWS-ID in the "Login ID" field or click the "Select From User List" link (20) .

   If you entered a CWS-ID, skip to Step 7. If you clicked "Select From User List", a "Universal Customer ID" drop-down menu (19) will appear below the "Login ID" field.
6. From the "Universal Customer ID" drop-down menu (19) , select the UCID for which the user you wish to assign the equipment group pertains. The users that pertain to the selected UCID appear in the "User List" section.

7. Enter the timeframe in which you wish this assignment to last by clicking the calendar icons next to the "Start Date" field (17) and "End Date" (18) field and selecting a date.

   If you wish the assignment to be indefinite, do not complete this step.

8. Select the check box (2) next to all users in the "User List" section that you wish to assign the equipment group.

9. Click the "Next" button (8) . The "Create Equipment Group Assignment Detail" screen will be displayed.



Illustration 36 g01730071

"Create Equipment Subgroup Assignment Detail" for a user

(21) "Create Equipment Group Assignment" button

10. Click the "Create Equipment Group Assignment" button (21) . The equipment group assignment is created.

Delete Equipment Subgroup Assignment

You can delete an indefinite equipment subgroup assignment or an assignment before the assignment is set to expire by using the "Delete Equipment Sub Group Assignment" functionality.

In order to delete an equipment subgroup assignment, use the following procedure:

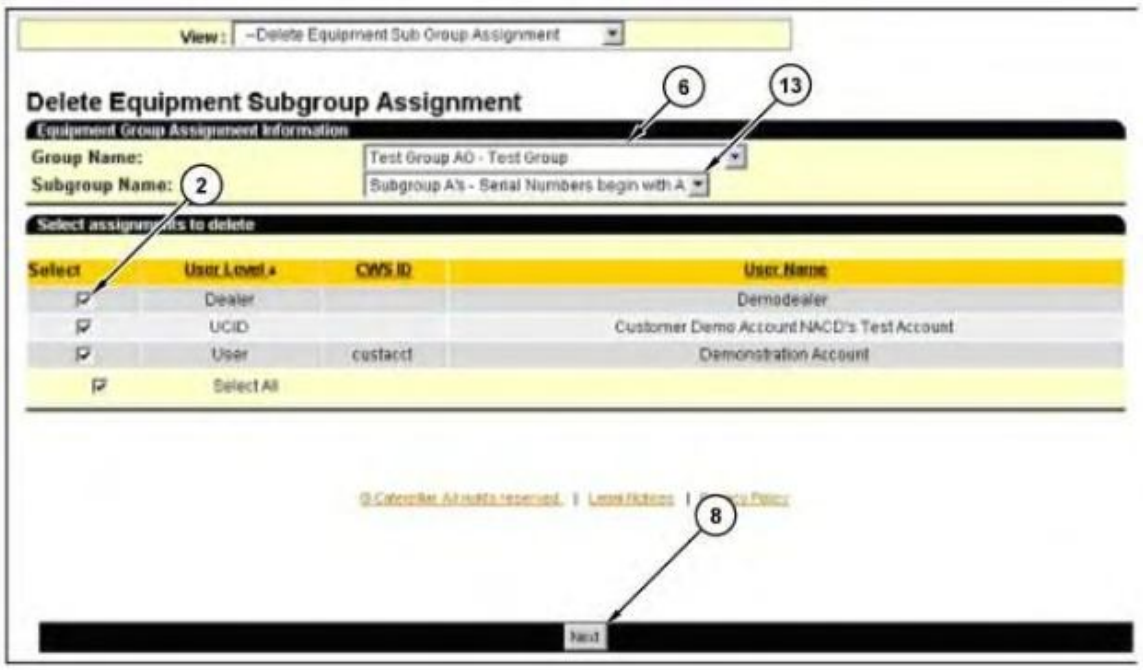


Illustration 37 g01730072

"Delete Equipment Subgroup Assignmen"

(6) "Group Name" drop-down menu

(13) "Subgroup Name" drop-down menu

(2) Check box

(8) "Next" button

1. From either the "Equipment Groups" section of the "Administration" screen or from the "View" drop -down menu, select "Delete Equipment Subgroup Assignment". The "Delete Equipment Subgroup Assignment" screen will be displayed.
2. In the "Group Name" drop-down menu (6) , select the name of the Group for the Subgroup from which you wish to delete an assignment.
3. In the "Subgroup Name" drop-down menu (13) , select the name of the subgroup from which you wish to delete an assignment.

   The "Select assignments to delete" section is populated with a list of all assignments made to the selected subgroup.
4. Select the check box (2) next to all of the assignments you wish to delete.
5. Click the "Next" button (8) . The "Delete Equipment Subgroup Assignment Detail" screen will be displayed.

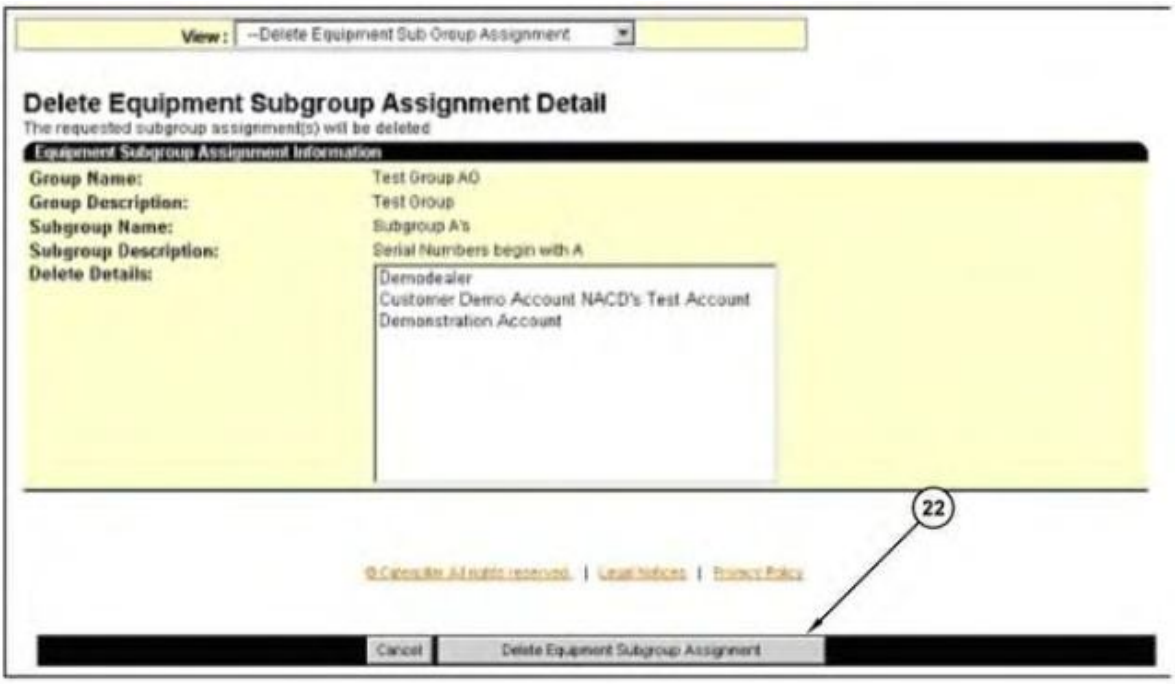


Illustration 38 g01730073

"Delete Equipment Subgroup Assignment Detail"

(22) "Delete Equipment Subgroup Assignment" button

6. Click the "Delete Equipment Subgroup Assignment" button (22) . The selected equipment subgroup assignments are deleted.

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Systems Operation
EquipmentManager Dealer Administrator Manual
Media Number -KENR6304-08 **Publication Date -01/05/2010** **Date Updated -18/05/2010**

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Manage Hardware

SMCS - 7600; 7606

Introduction

The technician registers the Product Link Modules (PLM) when the modules are installed on a piece of equipment for the first time. The technician then sets the parameters of the configuration that can be viewed and can be changed by using the "Over the Air Configuration" feature from EquipmentManager. Caterpillar recommends providing these parameters to the technician before the installation process begins.

The "Administration" screens of EquipmentManager display the details for the registry of your equipment in the following categories:

- "General Registry"
- "Digital Registry"
- " "Transmission Registry""
- "Send Commands"
- ""Product Link Module Status Report""

"General Registry"



Illustration 1 g01396363

"General Registry" screen

Once one or more of the equipment has been selected and the "General Registry" has been selected from either "View" drop-down menu or the"Administration" screen the "General Registry" screen will appear. Refer to Illustration 1.

Table 1 lists the fields that appear on the "General Registry" screen.

Table 1

The fields on the "General Registry" Screen		
Field	**Description**	**Sample Values**
"Eqpt ID"	This is the ID of the equipment that has the installed PLM.	UNIT 4
"Manufacturer"	This is the manufacturer of the equipment.	CAT
"Model"	This is the name of the model of the equipment.	D8R
"Serial Number"	This is the serial number of the equipment. The "Serial Number" is a link. Clicking the link takes you to the "Equipment Registration Detail" screen.	6YZ#####
"Last Reg/Admin Date & Time"	This is the date and time that the last registration or administration message was received.	07/15/2002 02:43:16 AM
"Status"	This indicates that the PLM has been installed and registered. If PLM is not registered, the "Subscriptions not available. Contact Administrator" message will appear across remaining fields.	Registered
"First Report Time"	This indicates the first time for each day the PLM reports.	06:19 AM
"Report Type"	This is the indicates the type of report that is sent from PLM. Choices are "Position", "SMU", or both. Position reports contain information about the location of the equipment. "SMU" reports contain the data about the Service Meter Units that are used.	Position SMU
"Frequency"		(0-4)/Day

	This indicates the number of reports for each day that are sent by the PLM.	
"Global Gram"	"Global Grams" are used in areas of the world that have no ground stations. If the machine will operate in areas that have no ground stations, select "Enabled". Otherwise, leave the parameter set to the default of "Disabled". If you have any questions about "Global Gram", contact your Technical Communicator.	Enabled Disabled
"PLM ID"	This is the ID number of the Product Link Module.	DQ0000######Q1
"Module Type"	This is the type of the PLM.	PL201 PL321
"Data Link Type"	This field describes the type of data link that is used. Most Product Link Modules use the CDL or the Cat Data Link (CDL).	CDL SAE 1708 SAE 1939
"Block Data Transfer"	"Block Data Transfer" is a technology that is used to pull large blocks of data from a machine. "Block Data Transfer" exists for future use. Leave this parameter set to "Disabled".	Disabled Enabled
"Software Revision"	This is the version of the software for Product Link that is onboard at the time of last registration message.	1.6 2.1

From the "General Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to ""Over the Air Configuration"" for more details.

"Equipment Details"

The "Equipment Details" screen provides all the details about the selected equipment.

In order to view the "Equipment Details" of a machine, select the serial number for the equipment from the "Serial Number" column on the "General Registry" screen. The "Equipment Details" screen will be displayed.



Illustration 2 g01390762

"Equipment Details" screen

Click the "Back" button in order to return to the "General Registry" screen. Table 2 describes the fields that are found on the "Equipment Details" screen.

Table 2

"Equipment Details" Screen		
Field	**Description**	**Sample Value**
Customer Information		
"Universal Customer ID:"	UCID Name – UCID Number	Acme Aggregate 1234567890
"Customer Account Number"	Customer Name – Dealer Customer Number	Acme SW Quarry

		1234567
"Customer Address"	Street, City, State, Zip	100 Any Street Any Town, USA
	Dealer Information	
"Last Dealer Update"	Primary Dealer Name Date of last Equipment Record Maintenance	Demo Dealer 9/27/2006
"Other Assigned Dealer"	Other Dealers associated with selected equipment	Other Dealer Name
	Dealer Specific Equipment Information	
"Equipment ID"	The ID of the equipment upon which the PLM is installed	UNIT 4
"Location/Jobsite"	Equipment's assigned location or jobsite	Southeast Quarry
"Purchase Date"	Equipment Purchase Date for current owner	1-Sep-02
"Ownership Status"	Current ownership status of the equipment	Owned Leased Rented
	Equipment Details – Product Link/EquipmentManager Information	
"PLM ID"	The "ID" number of the Product Link Module. The "PLM ID" is a link. Clicking the link will display the "Equipment Registration Detail" screen.	DQ0000012345
"Module Type"	The type of PLM	PL201 PL321
"Global Gram"	Global Grams are used in geographical areas that have no ground stations. If the machine will operate in areas without ground stations, select "Enabled". Otherwise, leave the parameter set to the default Disabled. If you have questions about "Global Gram", contact your Marketing Company.	Enabled Disabled
"Dealer"	Dealer through which the subscriptions are purchased	Dealer Name
"Status"	Indicates that the PLM has been installed and has been registered.	Registered Deregistered
"Subscription Level"	The table shows the subscriptions that are active and for whom they are purchased. Includes link to "Edit Subscriptions"	AW, MW, HW
	Equipment Information	
"Serial Number"	The serial number of the equipment	6YZ#####
"Manufacturer"	The manufacturer of the equipment	CATERPILLAR, INC.
"Product Industry"	Industry in which the selected equipment is primarily used	Quarry + Aggregates

"Product Use"	Describes for what the equipment is used	Sand & Gravel
"Application"	Describes the machine application	Light Medium Heavy
"Meter Indicator"	Unit of measure for equipment usage meter	Hours Miles Kilometers
"Related Serial Number(s)"	Vehicle Identification Number if the equipment is an engine, or related serial numbers and descriptions if machine. Related serial numbers may be the engine, transmission, etc. Four related serial numbers can be listed	2BR#####, Engine 1YS##### Transmission Attachment
"Equipment Type"	Describes the type for the selected equipment	Engine/Power System Machine
"Product Model"	The model name of the equipment	D8R
"Model Year"	The year of the equipment was manufactured	2001
"Meter Reading Date"	Date of last meter reading update	27-Sep-06
"Meter Reading"	Last service meter reading value	214
"Arrangement Number"	Equipment arrangement or configuration number	157-0818
Equipment Groups		
"Equipment Groups"	Names of group(s) in which selected equipment is included	Sample Group
"Group Owner"	Login ID of the group owner	smithxx

"Equipment Registration Details"

The "Equipment Registration Detail" screen provides details about the current configuration of the onboard PLM.

In order to view the details of the registration, click the "PLM ID" of a machine in the "PLM ID" column on the "General Registry" screen. The "Equipment Registration Detail" screen will be displayed.

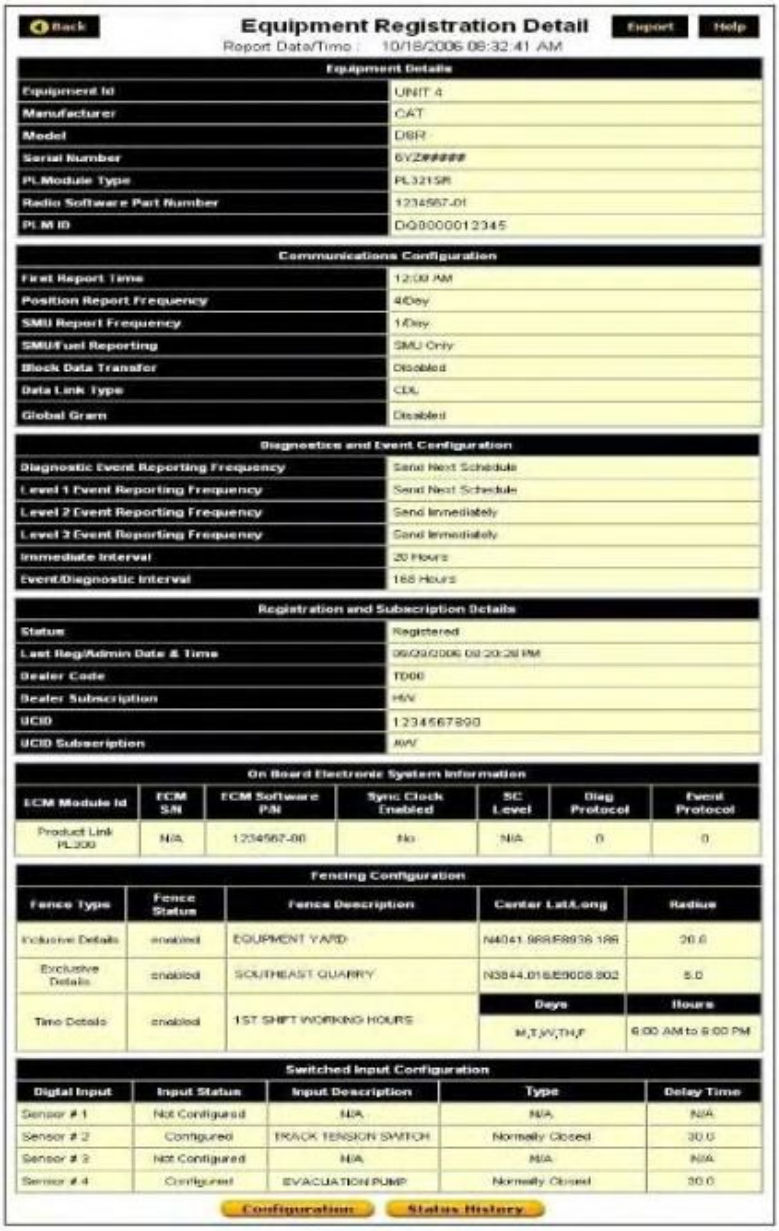


Illustration 3 g01390775

"Equipment Registration Details" screen

Table 3 describes the fields that are found on the "Equipment Registration Detail" screen. Click the "Back" button in order to return to the "General Registry" screen.

Table 3

"Equipment Registration Detail" Screen		
Field	**Description**	**Sample Value**
Equipment Details		
"Equipment Id"	The ID of the equipment upon which the PLM is installed	UNIT 4
"Manufacturer"	The Manufacturer of the equipment	CAT

"Model"	The model name of the equipment	D8R
"Serial Number"	The serial number of the equipment. The serial number is a link. Clicking the link will display the Equipment Detail screen.	6YZ#####
"PLModule Type"	The type of Product Link Module	PL201 PL321
"Radio Software Part Number"	On-board Product Link software part number.	1234567-01
"PLM ID"	The ID number of the Product Link Module	DQ000012345
	Communications Configuration	
"First Report Time"	Indicates the first time each day the PLM reports.	12:00 AM
"Position Report Frequency"	Frequency of which location is reported	4/Day
"SMU Report Frequency"	Frequency of which service meter units are reported	1/Day
"SMU/Fuel Reporting"	Defines whether the SMU or Fuel consumption report is sent as part of the daily standard message.	Fuel Only SMU Only Alternate SMU/Fuel
"Block Data Transfer"	A technology that is used to pull large blocks of data from a machine. Block Data Transfer exists for future use. Leave this parameter set to Disabled.	Disabled Enabled
"Data Link Type"	The type of data link that is used. Most PLMsuse Caterpillar Data Link (CDL).	CDL SAE 1708 SAE 1939
"Global Gram"	"Global Grams" are used in geographical areas that have no ground stations. If the machine will operate in areas without ground stations, select "Enabled". Otherwise, leave the parameter set to the default "Disabled". If you have questions about "Global Gram", contact your Technical Communicator.	Enabled Disabled
	"Diagnostics and Event Configuration"	
"Diagnostic Event Reporting Frequency"	Defines when to send messages from the Product Link system when a diagnostic event is reported from other ECMs on the machine.	Immediate: sends a message when an event occurs.
"Level 1 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 1 event is reported from other ECMs on the machine.	Next: queues messages about events and sends the messages in a batch based on the next scheduled interval that is calculated from the report start time.

"Level 2 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 2 event is reported from other ECMs on the machine.	Never: Never log messages or send messages about the events.
"Level 3 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 3 event is reported from other ECMs on the machine.	
"Event/Diagnostic Interval"	Determines when the Product Link will report a recurrence of an event or a diagnostic code, measured in units of machine operating hours. All events and diagnostics are recorded and may be viewed with the Electronic Technician.	Minimum value: 4 hours
"Immediate Interval"	The default value of 20 hours means that an event or diagnostic update message will not be present for a specific event or diagnostic update until the machine has operated for 20 hours after the last transmitted occurrence of that event or diagnostic update. At the next event or diagnostic occurrence after the time period elapses, another message will be sent.	Default value: 20 hours
"Event/Diagnostic Interval"	Sets the time period before an event or diagnostic message update is sent, measured in units of real time or clock hours. This time period is calculated from the Report Start Time.	Minimum value: 24 hours
"Event/Diagnostic Interval"	The default value of 168 hours or 1 week is only valid if the event or diagnostic report intervals are set to Next.	Default value: 168 hours or 1 week
	Registration and Subscription Details	
"Status"	This indicates that the PLM has been installed and registered. If PLM is not registered, the "Subscriptions not available. Contact Administrator" message will appear across remaining fields.	Registered Deregistered
"Last Reg/Admin Date & Time"	The Date and Time of the last time of registration of the PLM	##########
"Dealer Code"	Defines the Dealer code for which subscriptions are purchased	TD00
"Dealer Subscription"	Defines which subscriptions are owned at Dealer Level	AW, MW, HW
"UCID"	Defines the Universal Customer ID for which subscriptions are purchased	1234567890
"UCID Subscription"	Defines which subscriptions are owned at customer level	AW, MW, HW
	On Board Electronic System Information	
"ECM Module ID"	Lists all Electronic Control Modules detected on the data link of the machine.	Engine, Transmission, Product Link PL300
"ECM S/N"	Indicates serial numbers for all Electronic Control Modules detected on the data link of the machine.	XXX12345

"ECM Software P/N"	Indicates the software part number for all Electronic Control modules detected on the data link of the machine.	1234567-00
"Sync Clock Enabled"	Indicates Sync Clock enabled on each Electronic Control Module detected on the data link of the machine.	Yes, No
"SC Level"	Indicated the Sync Clock Level for each Electronic Control Module that is Sync Clock Enabled	Slave, Master
"Diag Protocol"	Displays the diagnostic protocol for each Electronic Control Module	0
"Event Protocol"	Displays the event protocol for each Electronic Control Module	0
Fencing Configuration		
"Fence Type"	Lists all Geographic and Time Fence Types	Inclusive, Exclusive, Time
"Fence Status"	Indicates fence type is enabled or disabled	enabled, disabled
"Fence Description"	Displays user defined fence descriptions	Equipment Yard, Working Hours
"Center Lat/Long"	Indicates the latitude and longitude center point for configured fence	N1234.0000/ E1234.0000
"Radius"	Indicates the radius of configured fence	20.0, 5.0
"Days"	Indicates working days of configured fence	M,T,W,TH,F,
"Hours"	Indicates start time and end time of configured fence	6:00 AM to 6:00 PM
Switched Input Configuration		
"Digital Input"	Sensor identification	Sensor #1
"Input Status"	Defines whether the Digital Input Sensor is configured.	Configured, Not Configured
"Input Description"	Describes the condition that the switch is monitoring.	Track Tension Switch Maximum of 24 characters
"Type"	Defines whether a switch is attached. If the switch is attached, the defines the state of the switch contacts under normal operating conditions.	Not Configured Normally Closed Normally Open
"Delay Time"	Defines the delay time before an alarm condition is recorded. If the normal condition of the switch is open and the delay time is set to the default time of 30.0 sec, an alarm condition will be sent when the switch is closed for 30.0 sec.	30.0 sec (default) 0.1 sec - 1200 sec

"Status History"

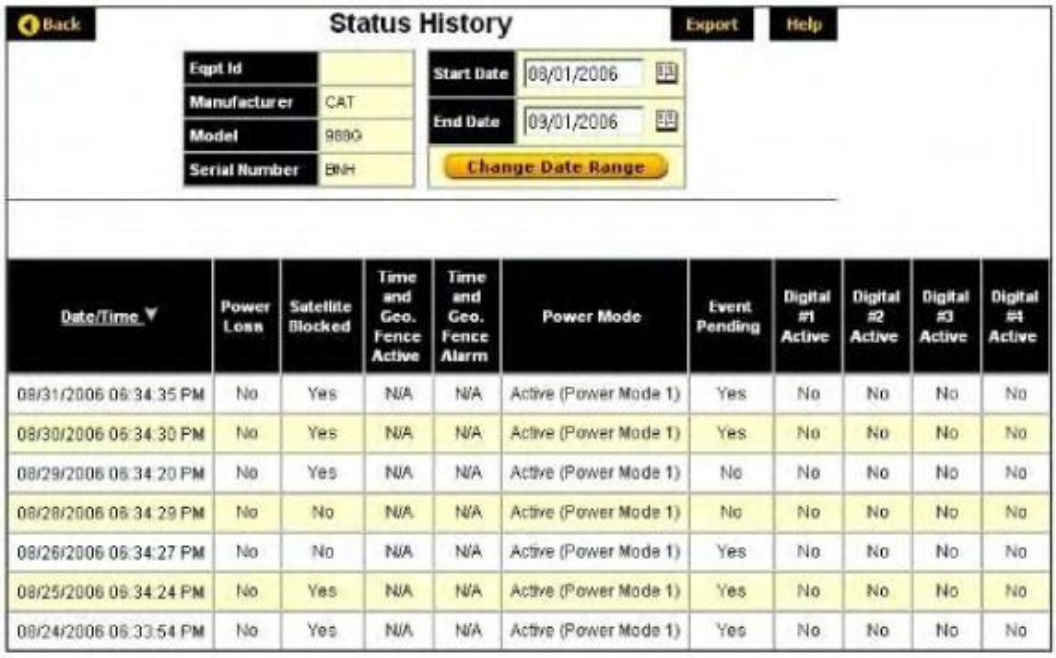


Illustration 4 g01390790

"Status History" screen

The "Status History" is a record of all the status reports that are sent by the PLM. The status report contains information about the status of the actual PLM.

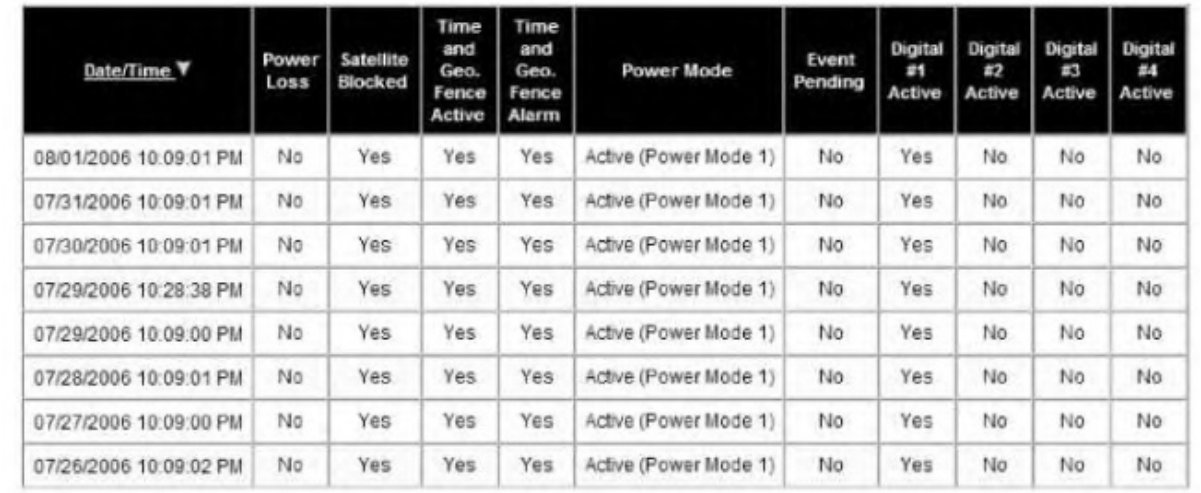
In order to view the "Status History" of a PLM, click the "Status History" button that is on the "Equipment Registration Detail" screen.



Illustration 5 g01390794

Top of the "Status History" screen

In order to change the range of the date to reflect an appropriate time period for the status history, click the "Calendar" icon next to the "Start Date" and "End Date" boxes, respectively. Then, select a desired date from the applicable calendar.



Date/Time ▼	Power Loss	Satellite Blocked	Time and Geo. Fence Active	Time and Geo. Fence Alarm	Power Mode	Event Pending	Digital #1 Active	Digital #2 Active	Digital #3 Active	Digital #4 Active
08/01/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/31/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/30/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/29/2006 10:28:38 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/29/2006 10:09:00 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/28/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/27/2006 10:09:00 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/26/2006 10:09:02 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No

Illustration 6 g01390795

Bottom of the "Status History" screen

When you are done, click the "Change Date Range" button. The "Status History" table will again load the date in order to reflect the updated range of the date. Click the "Back" button in order to return to the "Equipment Registration Detail" screen.

Note: The "Change Date Range" function works similarly in many views or screens throughout the application.

Table 4 describes fields that are found on the "Status History" screen. Click the "Back" button in order to return to the "General Registry" screen.

Table 4

"Status History" Screen		
Field	**Description**	**Values**
"Date/Time"	Displays the date and time of the status report. If the PLM is set to send status once per day, these values should be approximately one day apart each time.	
"Power Loss" (Low Voltage)	Indicates that the PLM experienced a loss of power or low voltage sometime between this status report and the last status report.	Yes, No
"Satellite Blocked"	Indicates that the PLM was blocked from the satellite sometime between this status report and the last status report.	Yes, No
"PW Active"	Indicates that "Time and Geographic Fencing" is active.	Yes, No, N/A
"PW Alarms"		

	Indicates that a "PW Alarm" has occurred sometime between this status report and the last.	Yes, No, N/A
"Power Mode"	Indicates the "Power Mode" of the PLM. Power mode has the following "Status" levels: Active (1) – The machine has operated in the last 48 hours. Sleep (2) – The machine has not operated for greater than 48 hours but less than one week. The PLM will wake up every six hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters. Hibernate (3) – The machine has not operated for more than one week. The PLM will wake up every 24 hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Active (1) Sleep (2) Hibernate (3)
"Event Pending"	Indicates that an event was recorded and will be sent (PL321 system only).	Yes, No
"Digital # Active"	Indicates that the digital switch is active (PL321 system only).	Yes, No

"Digital Registry"

The Product Link system uses up to four digital switches in order to monitor the equipment status. By installing switches and configuring the state during normal operating conditions, which are open or closed, you can be alerted when this normal state has changed.



Illustration 7 g01247670

"Digital Registry" screen

When some equipment has been selected and the " Digital Registry" from the "View" drop-down menu has been selected, the "Digital Registry" screen will appear. Notice that the fields in the "Equipment Information" section of this screen are the same fields that are on the "General Registry" screen. Table 5 describes the information that is found on the "Digital Registry" screen.

Table 5

"Digital Registry" Screen		

Field	Description	Sample Values
"Type"	Defines whether a switch is attached. If the switch is attached, defines the state of the switch contacts under normal operating conditions.	Not Configured Normally Closed Normally Open
"Delay"	Defines the delay time before an alarm condition is recorded. If the normal condition of the switch is open and the delay time is set to the default time of 30.0 sec, an alarm condition will be sent when the switch is closed for 30.0 sec.	30.0 sec (default) 0.1 sec - 1200 sec
"Description"	Field used to describe the condition that the switch is monitoring.	Track Tension Switch Maximum of 24 characters.
"Monitoring Condition"	Defines the monitoring condition for the digital input. When will the switch be monitored?	All Conditions (default) Key Off/Engine Off Key On/Engine Off Key On/Engine On

On the "Digital Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to the "Over the Air Configuration" topic for more details.

"Transmission Registry"

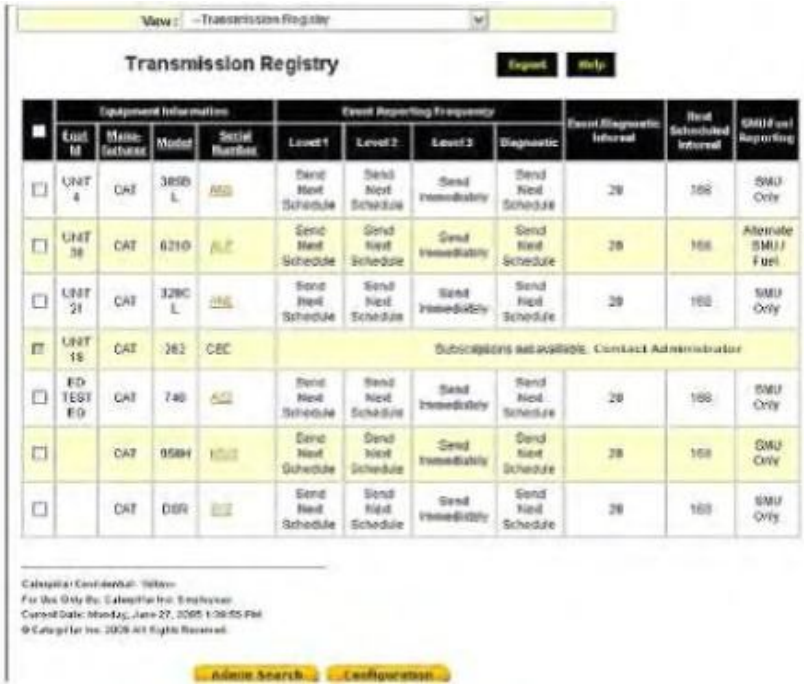


Illustration 8 g01247675

"Transmission Registry" screen

The "Transmission Registry" screen will display the parameters for the registration that have been set for determining the types of information that are transmitted from the PLM and the frequency that the information is transmitted. Notice that the fields in the "Equipment Information" section of the screen are the same fields that are on the "General Registry" screen and "Digital Registry" screen. Table 6 describes the information that is found on the "Transmission Registry" screen.

Table 6

"Transmission Registry" Screen		
Field	**Description**	**Sample Values**
"Event Reporting" "Frequency: Level 1"	Defines when to send messages from the Product Link system when a level 1 event is reported from other ECMs on the machine.	Immediate: sends a message when an event occurs. Next: queues messages about events and sends the messages in a batch based on the next scheduled interval that is calculated from the report start time. Never: never log messages or send messages about the events.
"Event Reporting" "Frequency: Level 2"	Defines when to send messages from the Product Link system when a level 2 event is reported from other ECMs on the machine.	
"Event Reporting" "Frequency: Level 3"	Defines when to send messages from the Product Link system when a level 3 event is reported from other ECMs on the machine.	
"Event Reporting" "Frequency: Diagnostic"	Defines when to send messages from the Product Link system when a diagnostic event is	

	reported from other ECMs on the machine.	
"Event/Diagnostic Interval"	Determines when the Product Link will report a recurrence of an event or a diagnostic code, measured in units of machine operating hours. All events and diagnostics are recorded and may be viewed with the Electronic Technician.	Minimum value is 4 hours. The default is 20 hours, meaning that an event or diagnostic update message will not be present for a specific event or diagnostic update until the machine has operated for 20 hours after the last transmitted occurrence of that event or diagnostic update. At the next event or diagnostic occurrence after the time period elapses, another message will be sent.
"Next Scheduled Interval"	Sets the time period before an event or diagnostic message update is sent, measured in units of real time or clock hours. This time period is calculated from the "Report Start Time".	Minimum value is 24 hours. Default value is 168 hours or 1 week. This value is only valid if the event or diagnostic report intervals are set to "Next".
"SMU/Fuel Reporting"	Defines whether the SMU or Fuel consumption report is sent as part of the daily standard message.	Fuel Only SMU Only Alternate SMU/Fuel

From the "Transmission Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to ""Over the Air Configuration"".

"Over the Air Configuration"

You can use EquipmentManager over the air in order to change the configurable parameters for the registration of the PLM. This screen can be reached from the following screens by selecting the "Configuration button" that appears on each screen:

- "General Registry"
- "Equipment Registration Detail"
- "Digital Registry"
- "Transmission Registry"

Refer to the following procedure in order to configure parameters for the registration over the air from the "Equipment Registration Detail" screen:

1. In order for the "Over The Air Configuration" screen to appear , select the "Configuration" on the "Equipment Registration Detail" screen. The "Over The Air Configuration" screen will appear.

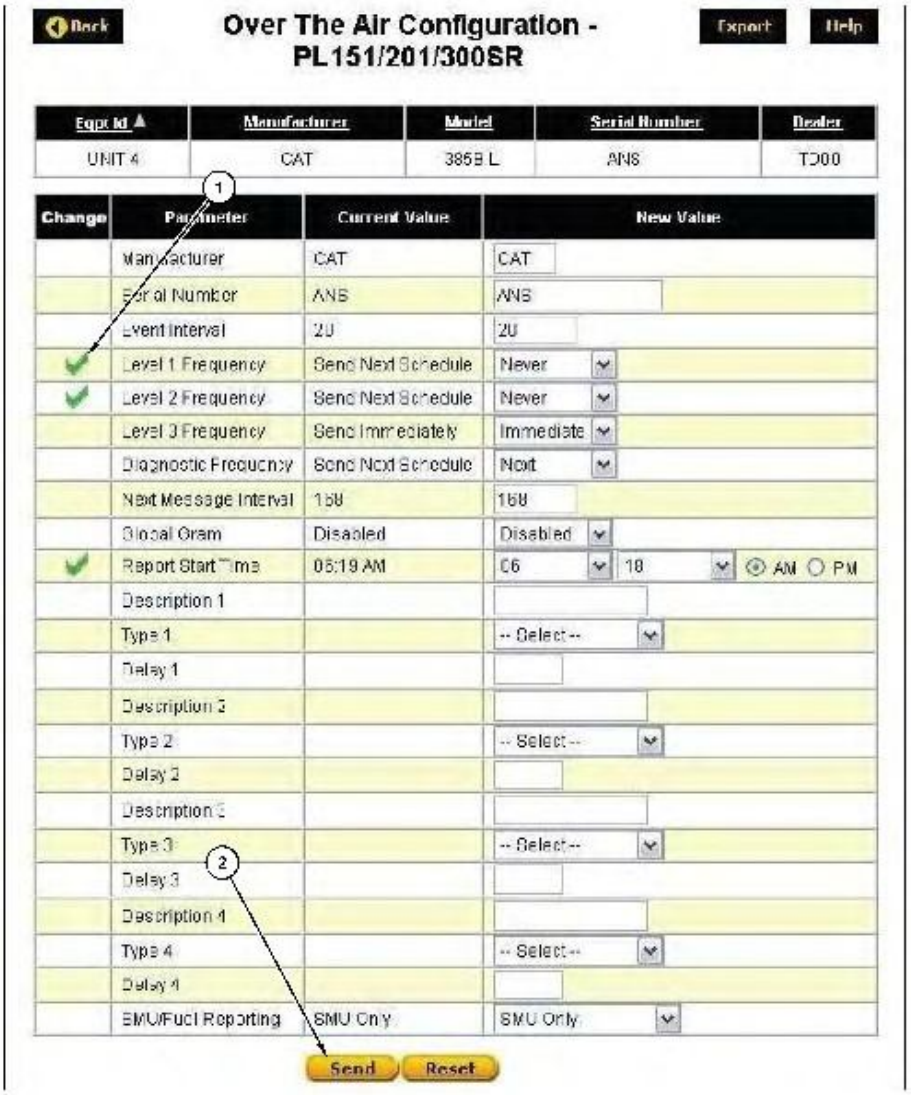


Illustration 9 g01721395

"Over the Air Configuration" screen

(1) Green check mark

(2) "Send" button

2. Change the desired parameters of the configuration by either typing new values into the text fields or selecting new values from the drop-down menus that appear in the "New Value" column of the table.

   A green check mark (1) will appear in the "Change" column next to any parameter that has been changed.

   ReferenceRefer to Systems Operation, "General Registry", Systems Operation, "Digital Registry", and Systems Operation, "Transmission Registry" for more information about the parameters and values.

   Note: Machine "Start Time" and "Stop Time" are supported by PL321 systems with the current software version. This configuration can only be set by using the "Over the Air Configuration" feature. When the "Start Time" and "Stop Time" feature is available, the "Start Time" and the "Stop Time" parameters will appear and the parameters can be set to "On" or "Off".

Note: In some cases, the parameter name on the "Over the Air Configuration" screen is different from the parameter name that appears on the "Transmission Registry" screen.

The following list shows the parameter name on the "Over the Air Configuration" screen and the equivalent parameter name on the "Transmission Registry" screen:

- Event Internal = Event/Diagnostic Interval Next Message
- Interval = Next Scheduled Interval

3. Click the "Send" button (2) . A popup window for a confirmation will appear.



Illustration 10 g01721396

Successful message for sending of the configuration parameters

4. Click the "OK" button. The parameters are updated and the "Configuration Parameters Sent Successfully" screen will be displayed.

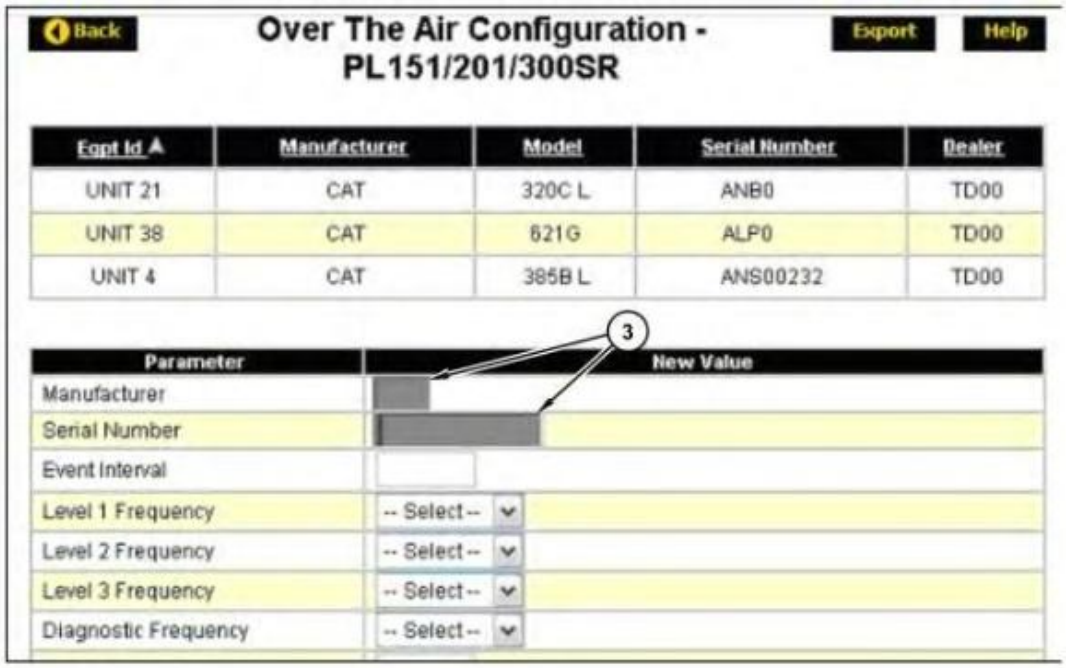


Illustration 11 g01721397

The "Over the Air Configuration" screen due to selecting multiple equipment

(3) "Manufacturer" parameter and "Serial Number" parameter

Note: If you select more than one piece of equipment for configuration at the same time, you must set all the parameters to the same value. Only the "Manufacturer" parameter and "Serial Number" parameter (3) can be set separately. These fields can not be edited on the "Over The Air Configuration" screen if multiple machines have been selected.

"Send Commands"

The "Send Commands" feature enables you to force the PLM to immediately send messages rather than waiting for the next interval of transmission. This could be useful if you needed to know information such as the immediate location or SMU of the machine. "Send Commands" is also where you can register and deregister the PLM for purposes of moving the module from one machine to another.

In order to send commands, use the following procedure:

1. From the "Administration" screen or the "View" drop-down menu, select "Send Commands". The "Equipment Search" screen will appear.

2. Select the criteria of your search and/or type the criteria of your search. Then click "Display Equipment". The "Send Commands" screen will appear and the screen will display the results of the search.

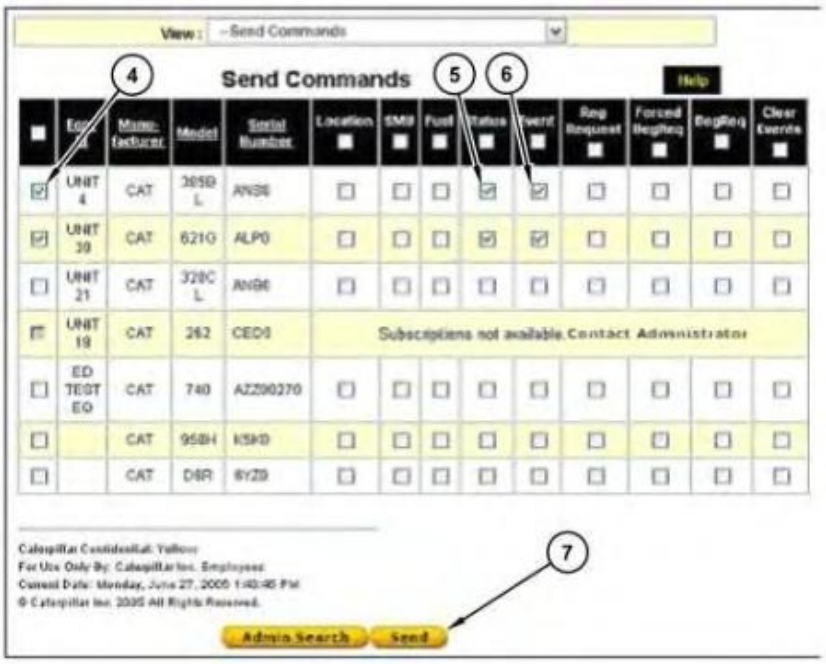


Illustration 12 g01721398

"Send Commands"

(4) Check boxes

(5) "Status" check box

(6) "Event" check box

(7) "Send" button

3. In order to send commands, select the check box that corresponds to the machine from the most left column. In the remaining columns, select the check box that corresponds to the type of command.

   Note: Selecting the check box (4) in the first column of the "Send Commands" table automatically selects the "Status" check box (5) and "Event" check box (6) for that selected item. Because the "Status" command returns reports about "Location", "SMU" and "Fuel", there is no reason to send any of these three commands if "Status" is selected.

   Table 7 describes the type of commands that can be sent.

Table 7

"Send Commands" Options

Subscriptions			Command	Description
Asset Watch	**Maint. Watch**	**Health Watch**		
X			Location	Sends report with location information of machine.
X			SMU	Sends report with information about current Service Meter Units.
		X	Fuel	

				Sends report with information about fuel consumption.
X			Status	Sends report with information about Location, SMU, and Fuel.
	X		Event	Sends report with Level 1, 2 and 3 event messages that have been collected from ECMs on machine since last transmission.
X	X	X	Reg Request	Request that a new registration message be sent.
X	X	X	Forced DegReg	The "Forced Deregistration" is useful if you know that a module has been removed without being de-registered from the old machine. The "Forced Deregistration" will remove the registration from EquipmentManager.
X	X	X	DegReg	Use the "Deregistration" command when you are removing a PLM from a machine. (1)
X	X	X	Clear Events	Send this command in order to clear all of the event messages that have been logged and are waiting until the next transmission interval to be sent.

(1) Deregistering the PLM does not affect the billing status. You must deactivate billing separately.

4. Click the "Send" button (7) . The "Send Commands" confirmation message will be displayed.

   Note: The configuration message is sent over the air via a satellite to the onboard PLM. The PLM will return a status message when the command has been successfully received at the module. This two-way communication will take a few minutes. Communication can be completed assuming that the machine is running or the master switch is open.



Illustration 13 g01721399

"Send Commands" confirmation message

5. Click "OK". The "Send Commands" page will display a successful message.



Illustration 14 g01721401

"Send Commands" with a successful message

6. Click"OK".

"Product Link Module Status Report"

The "PLM Status Report" will display the "Product Link Module Details". In order to display these details perform the following procedure:



Illustration 15 g01458356

"Product Link Module Details" screens

1. Select "Product Link Module Statue Report" from the "Administration" menu.
2. Enter the "Product Link Module ID" in the "Search" field.
3. Click "Display Details"

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Systems Operation
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i03369021

Manage Event Tracking

SMCS - 7600; 7606

There are many events that EquipmentManager reports that may be time sensitive, such as "Time and Geo Fence Alarms" and some "Fault Codes". EquipmentManager enables you to configure these event alerts to be sent to an e-mail account or text messaging device. This enables immediate notification of these events so the events can be addressed in a timely manner.

By establishing an "Address Book" and telling EquipmentManager the specific events to track ("Reactions"), you can be sure that the correct person is notified when certain alarms, planned maintenance, diagnostic, events, and levels occur.

Address Book

Before you can assign reactions to individuals, you must enter the individual in the EquipmentManager "Address Book".

Add an Address

In order to add a person to the address book, use the following procedure:



Illustration 1 g01248267

"Add Address" screen

1. On the "Administration" screen, in the "View" box, select "Address Book". The "Address Book" screen will appear.
2. In the "Description" box, type a description of the address. In the "Address" box, type a valid e-mail address.
3. Click "Add Address". The address appears in the upper area of the screen.

Edit an Address

In order to edit an existing address, use the following procedure:



Illustration 2 g01739413

The "Address Book" screen while editing an address

(1) Pencil and paper icon

1. From the "Address Book" screen, click the pencil and paper icon (1) next to the address to be edited. The "Edit Address" section is displayed at the bottom of the screen.
2. Edit the description in the "Description" field.
3. Edit the address in the "Address" field.
4. Click the "Save" button. The updated address appears in the list of addresses at the top of the screen.

Delete an Address

In order to delete an existing address from the address book, use the following procedure:

1. From the "Address Book" screen, select the check box next to the address you wish to delete.
2. Click the "Delete Addresses" button. The "Delete Address" confirmation window will appear.



Illustration 3 g01248269

Address Book - Delete Address

3. Click "OK".

   If there are currently no "Event Reactions" that are ready to be sent to the address that is selected, the "Confirm Deletion of Targets" screen is displayed with a corresponding message.

   If there are "Event Reactions" that are ready to be sent to the address that is selected, the "Confirm Deletion of Targets" screen contains a table that lists these reactions.

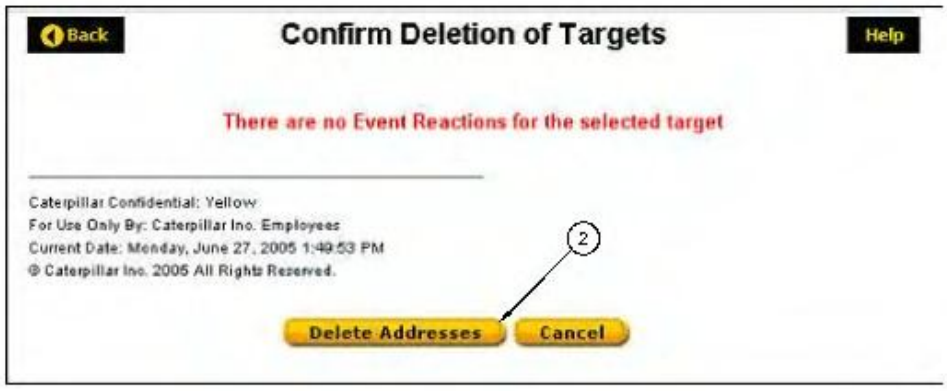


Illustration 4 g01739414

Confirm message for deleting address without "Event Reactions"

(2) "Delete Addresses"



Illustration 5 g01739415

Confirm message for deleting address with "Event Reactions"

(2) "Delete Addresses"

4. Click "Delete Addresses" (2) . The address is deleted from the address book.

"Reactions"

Once you have addresses in the EquipmentManager "Address Book", you can configure EquipmentManager to send e-mail messages to those addresses when alarms, events, diagnostics, planned maintenance notifications, and warnings are received.

Note: Event reactions that are delivered to email are provided in English only.

Add or Edit "Event Reactions"

In order to add or edit an "Event Reactions", perform the following procedure:

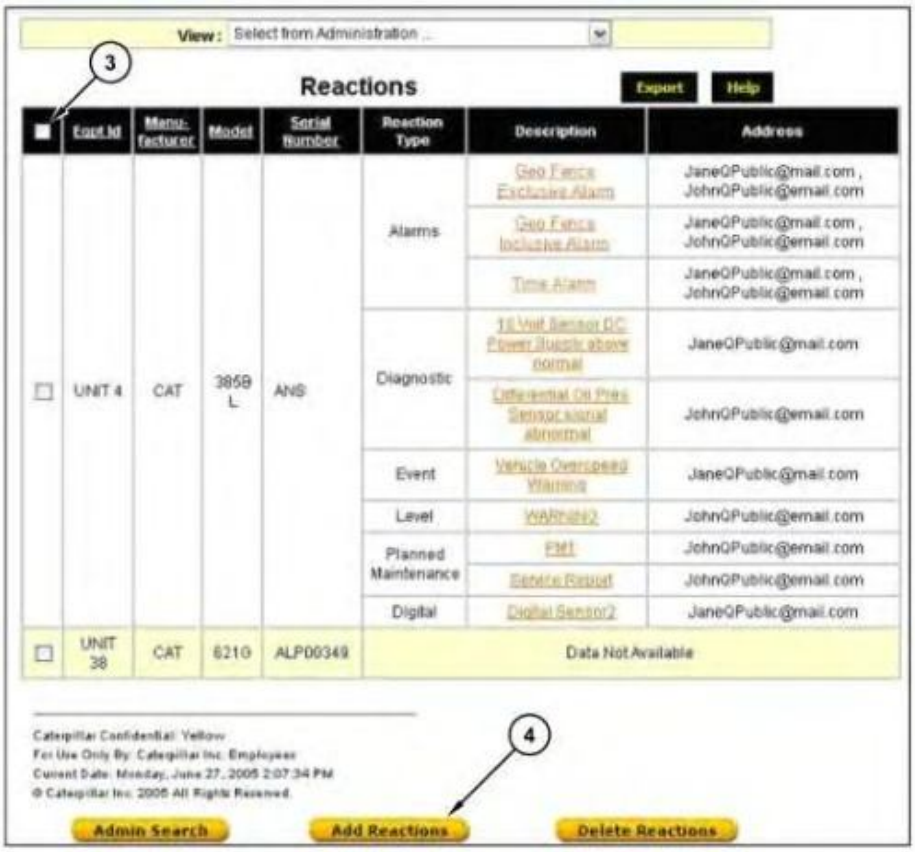


Illustration 6 g01739416

"Reactions" screen

(3) check box

(4) "Add Reactions" button

1. From the "Administration" screen or the "View" drop-down menu, select "Reactions".

   If you have equipment that is already selected, the "Reactions" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to Step 2.

2. Select the check box (3) of the machine that you want to add or edit reactions.

3. Click the "Add Reactions" button (4) . The "Add/Edit Reactions" screen will be displayed.



Illustration 7 g01739417

"Add/Edit Reactions" screen

(5) "Reaction Types" drop-down menu

4. From the "Reaction Types" drop-down menu (5) , select a reaction type. The left of the "Description" list box is populated with the available reactions for the type that is selected.
5. Select the events that are to be tracked from the left "Description" list box.
6. Click the "Add" button. The event is moved from the left "Description" list box to the right box.
7. If there are events that are to be removed from the reaction, select the events in the right list box.
8. Click the "Remove" button. The event is moved from the right list box to the left list box.
9. From the "Addresses" list box, select the address you wish an email message to be sent to when the selected events occurs.
10. Click the "Add" button. The address is moved from the "Addresses" list box to the "Add New Addresses" list box.
11. If there are addresses that are to be removed from the reaction, select the addresses from the "Add New Addresses" list box.
12. Click the "Remove" button. The address is moved from the "Add New Addresses" list box to the "Addresses" list box.
13. Click the "Save Reactions" button. The reaction is saved.

Alarm Reaction Types

The Alarm "Reaction Types" menu is used for defining the parameters for Time and Geo Fence alarm notification.

In order to receive notification of a fence violation you must select the type of violation you wish to alarm. Select one of the following types of fence violation alarms:

- "Geo. Fence Exclusive Alarm"
- "Geo. Fence Inclusive Alarm"
- "Time Alarm"

In order to receive notification of fence configuration failure you must select one of the following fence configuaration alarms:

- "Geo. Fence Inclusive Initialization Failure"
- "Time and Geo. Fence Application Not Enabled"
- "Time and Geo. Fence Invalid Command Length"
- "Time and Geo. Fence Invalid Configuration Alarm"
- "Time and Geo. Fence Invalid End Time"
- "Time and Geo. Fence Invalid Location Flag"
- "Time and Geo. Fence Invalid Start Time"
- "Time and Geo. Fence Password Failure"

In order to receive notification when equipment returns to inclusive boundary select "Geo. Fence Inclusive Return Alert".

Note: AID: 0 is not supported.

Level "Reaction Types"

One of the "Reaction Types" that can be added or edited is the "Level" reaction type. The the "Add/Edit Reactions" screen has the following "Reaction Types" levels:"Derate", "Severe", "Unknown Severity" and "Warning".

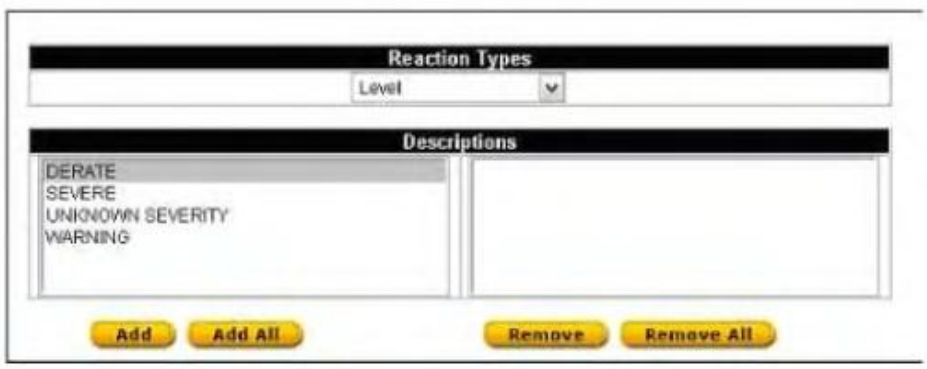


Illustration 8 g01248874

"Reaction Type" with levels

The "Level" reaction types correspond to the Electronic Technician (ET) defined diagnostic severity levels. Note that the "Add/Edit Reactions" screen is the only place that these levels are given alternate names. On the "Transmission Registry", these levels are still referred to by the Electronic Technician names. The following table lists the "Event Reactions" term and the corresponding ET diagnostic severity level.

Table 1

Corresponding "ET Diagnostic" Severity Level for "Reactions"	
"Reaction Type" Level	**"ET Diagnostic" Severity Level**
Derate	Level 2
Severe	Level 3
Unknown Severity	Level 0 No Level
Warning	Level 1

"Delete Reactions"

In order to delete an "Event Reactions", use the following procedure:

1. From the "Reactions" screen , select the check box next to the machine(s) with the reactions you wish to delete.
2. Click the "Delete Reactions" button. The "Delete Reactions" screen will be displayed in a new window.

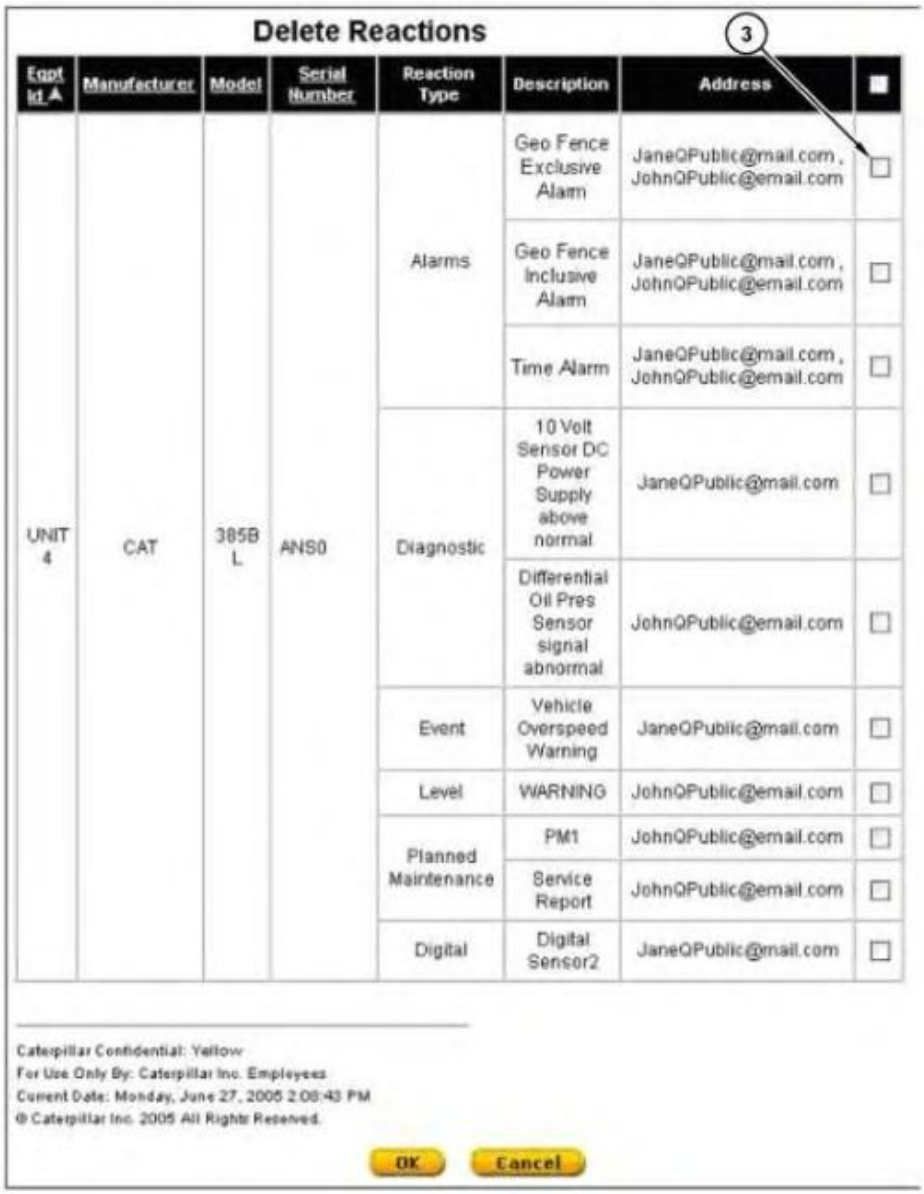


Illustration 9 g01739418

"Delete Reactions"

(5) Check box

3. Select the check box (5) in the far right column that corresponds with the reaction you wish to delete.
4. Click the "OK" button. The reaction is deleted.

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i03365020

Upload Data

SMCS - 7600; 7606

The Caterpillar EquipmentManager database only begins storing information about a machine when the Product Link Module (PLM) has been installed and registered, subscriptions have been purchased and the PLM has begun submitting reports.

"Repair History"

There are two methods for uploading the repair history for a machine. The first method is by entering the information about each individual service by using a form. Refer to "Upload "Repair History" Using Form". The second method is by uploading a file that contains information about one or more services that were performed on one or more machines. Refer to "Upload "Repair History" by Importing From a File". Both of these methods are available on the "Repair History Upload" screen.

Upload "Repair History" Using Form

In order to upload the repair history by using the form, use the following procedure:

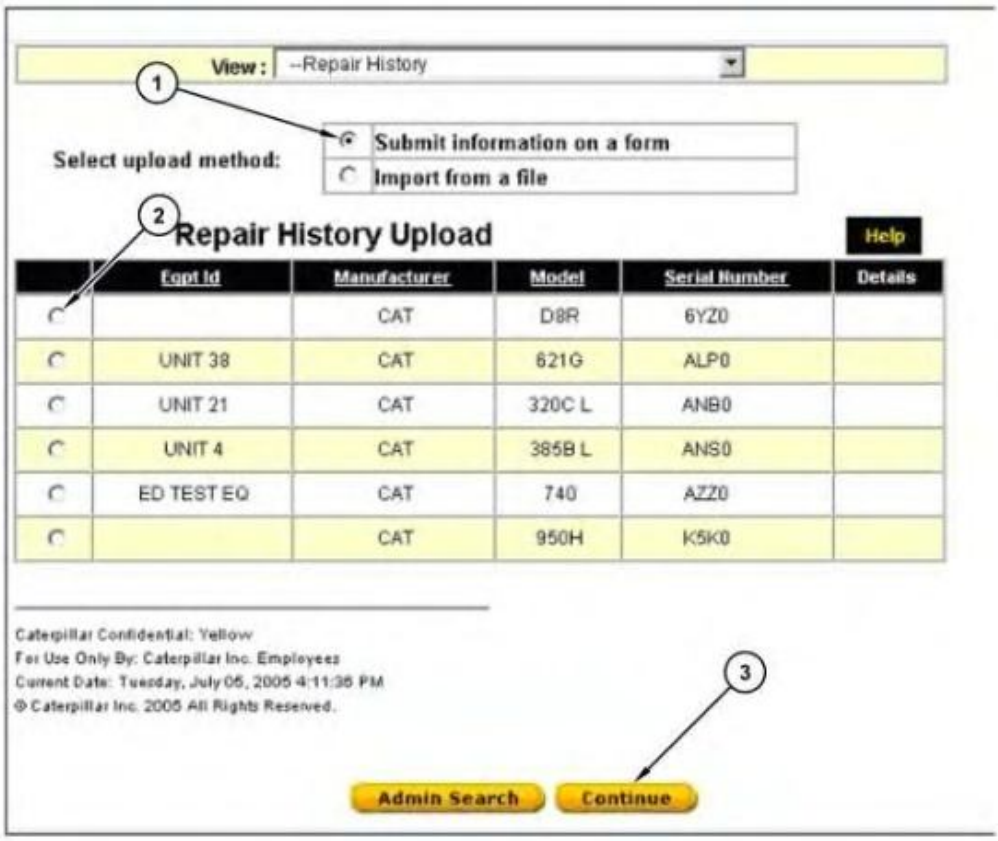


Illustration 1 g01740013

"Repair History Upload" screenusing a form

(1) "Submit information on a form" radio button

(2) Radio button

(3) Continue

1. From either the "Administration" screen or the "View" menu, select "Repair History".

   If equipment has already been selected, the "Repair History Upload" screen is displayed.

   If you have not already selected equipment, the "Equipment Search" screen is displayed. Perform your search, and then click the "Display Equipment" button. The "Repair History Upload" screen will appear.

2. Select the "Submit information on a form" radio button (1) if "Submit information on a form" is not already selected.

3. Select the radio button (2) that is next to the desired machine in order to upload the repair history.

4. Click the "Continue" button (3) .

   The "Report Service" screen will be displayed.



Illustration 2 g01249465

"Report Service" screen

5. In the "Service Report Common Info" section, select the appropriate checkbox for the service that was performed.

   If you selected "Dealer", a dropdown appears below the radio buttons. Select the name of the "Dealer" that serviced the equipment and proceed to Step 7.

   If you selected "Others", a text field appears below the radio buttons. Type the name of the person or entity that serviced the equipment and proceed to Step 7.

6. Enter the work order number in the "Work Order" text field.

7. Enter the segment number in the "Segment" text field.

8. Enter the date that the service was performed by clicking the calendar icon that is next to the "Repair Date" field. Select the date from the popup calendar.

9. Enter the Service Meter Units in the "Service Meter" text field. If the units were measured in hours, select the "H" radio button. If the units were measured in miles, select the "M" radio button. If the units were measured in kilometers, select the "KM" radio button.

10. Enter a description of the repair in the "Repair Description" text field.

11. Enter the time in hours that the machine was unavailable while being serviced in the "Downtime Labor" text field.

12. Enter Information about faulty parts in the "Part Causing Failure" table including the part name, manufacturer, quantity, defect code, and group number.

    Click the "Add Part" button in order to create a new row in the table for additional parts. Select the checkbox that is next to a part. Click the "Delete Part" button in order to remove the part from the list.

13. Click the "Save" button. The repair history is uploaded.

Upload "Repair History" by Importing From a File

In order to import the repair history from a file, use the following procedur:

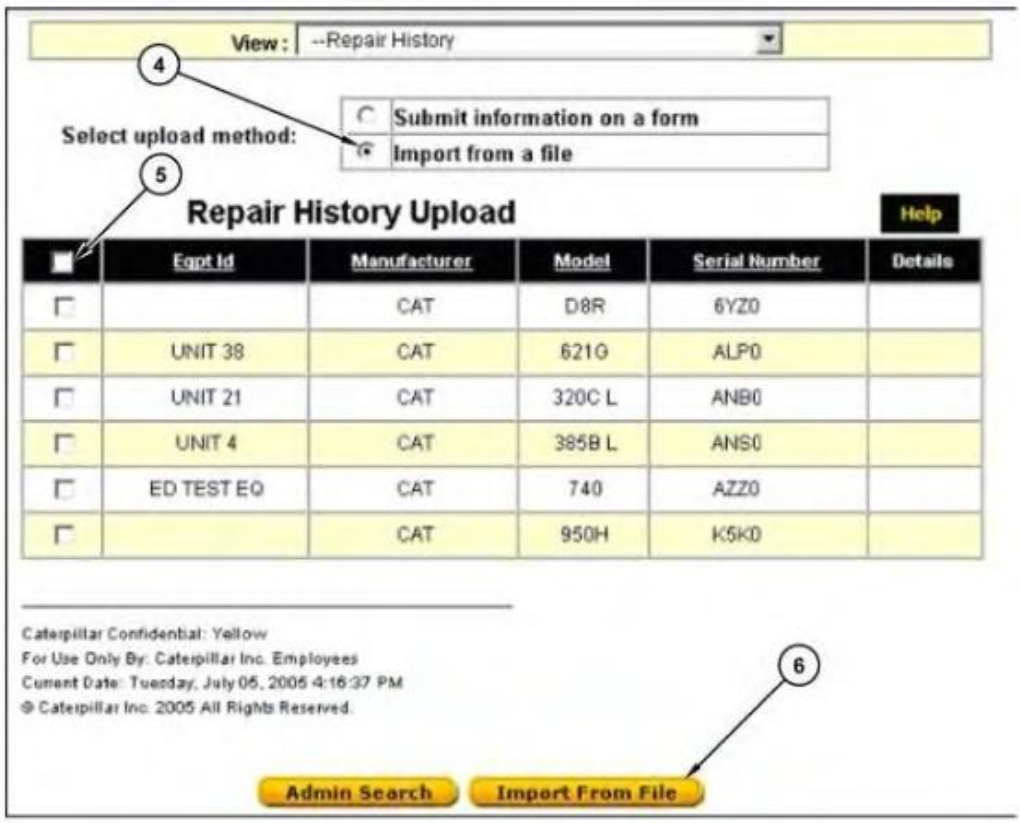


Illustration 3 g01740014

"Repair History Upload" screen by importing from a file

(4) "Import from a file" radio button

(5) Check box

(6) "Import From File" button

1. From the "Repair History Upload" screen, select the "Import from a file" radio button (4) .
2. Select the check box (5) next to the pieces of equipment to which you wish to upload repair history.
3. Click the "Import From File" button (6) . The "Import From File" screen is displayed in a new window.



Illustration 4 g01249475

"Import From File" screen browsing for a file

4. Click the "Browse" button. Navigate to the file that contains the repair history to be added. Click the "Open" button. The name of the file that was selected appears in the "File" text field.
5. Click "OK". The repair history is uploaded.

Preparing a Repair History Upload File



Illustration 5 g01249480

Sample of a Microsoft® Excel file using "Repair History Upload"

In order for a "Repair History Upload" file to be successfully uploaded, the file must contain the correct fields and files. Also, the files must be formatted in a specific way. Illustration 5 is an example of a spreadsheet that was used to create an upload file.

In order to create a "Repair History Upload" file, use the following procedure:

1. Open a new Microsoft® Excel spreadsheet.

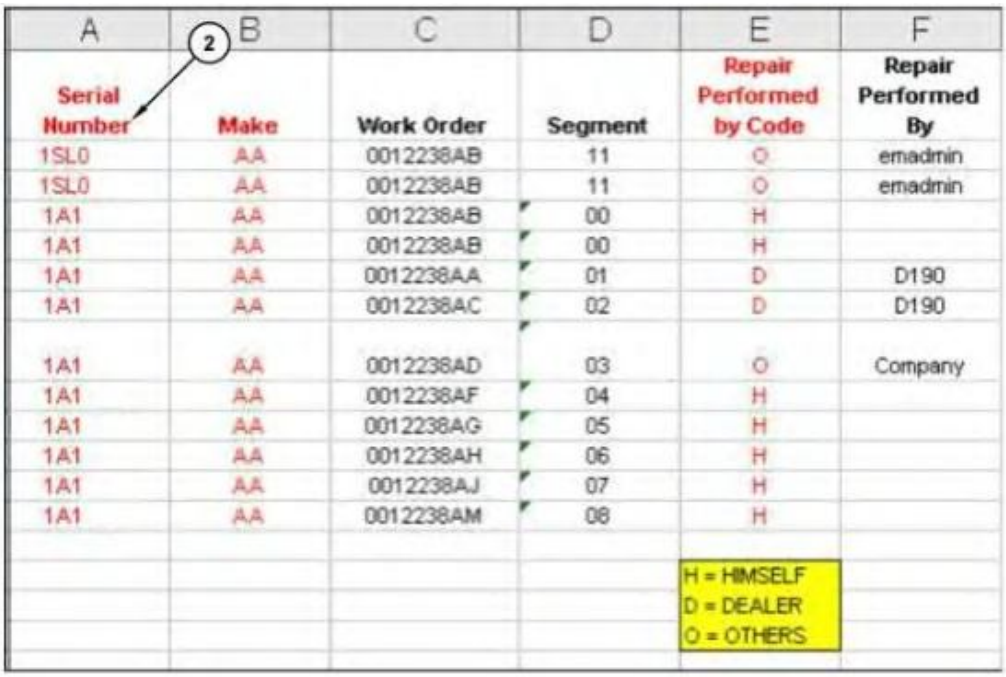


Illustration 6 g01740015

"Repair History Upload" Microsoft Excel - Columns A through F

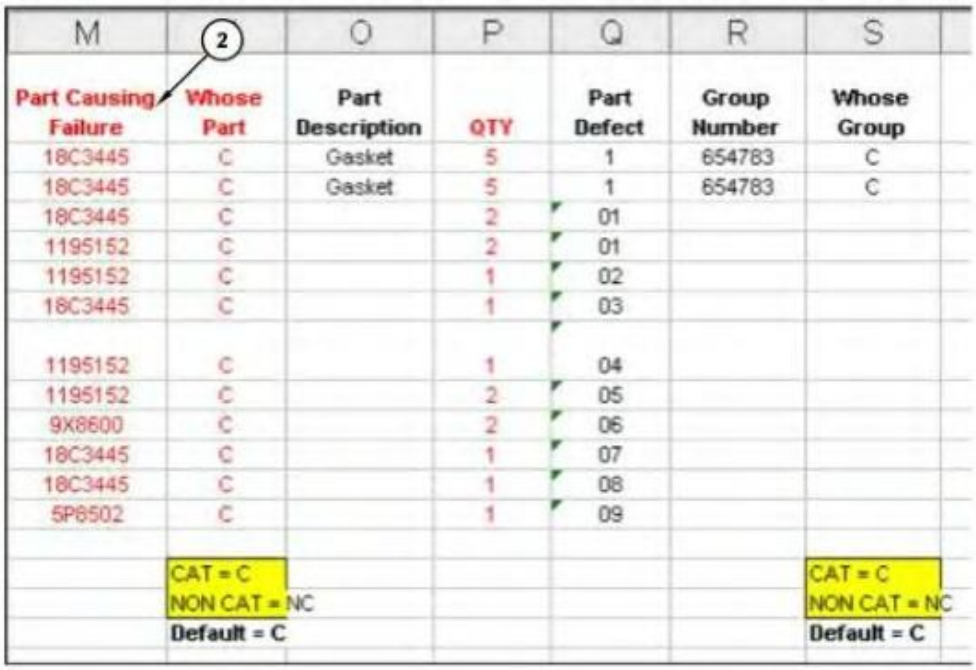
(6) Column headers



Illustration 7 g01740808

"Repair History Upload" Microsoft Excel - Columns G through L

(6) Column headers



M	(2)	O	P	Q	R	S
Part Causing Failure	Whose Part	Part Description	QTY	Part Defect	Group Number	Whose Group
18C3445	C	Gasket	5	1	654783	C
18C3445	C	Gasket	5	1	654783	C
18C3445	C		2	01		
1195152	C		2	01		
1195152	C		1	02		
18C3445	C		1	03		
1195152	C		1	04		
1195152	C		2	05		
9X8600	C		2	06		
18C3445	C		1	07		
18C3445	C		1	08		
5P8502	C		1	09		
	CAT = C NON CAT = NC Default = C					CAT = C NON CAT = NC Default = C

Illustration 8 g01740016

"Repair History Upload" Microsoft Excel - Columns M through S

(6) Column headers

2. Enter the repairs in the spreadsheet one repair per row. Refer to Illustrations 6 through 8 as examples of the columns and values that should appear in the spreadsheet. Items that are displayed in red indicate mandatory items.
3. Once you have finished entering data, delete the column headers (6) .
4. Go to "File", "Save As" and pick "CSV (Comma Delimited)" and save the file.

"Refueling History"

For "Repair History", information can be submitted as a form or an upload from a file. However, there is only one method to upload the refueling history.

Import Refueling History from File

In order to import refueling history from a file, use the following procedure:

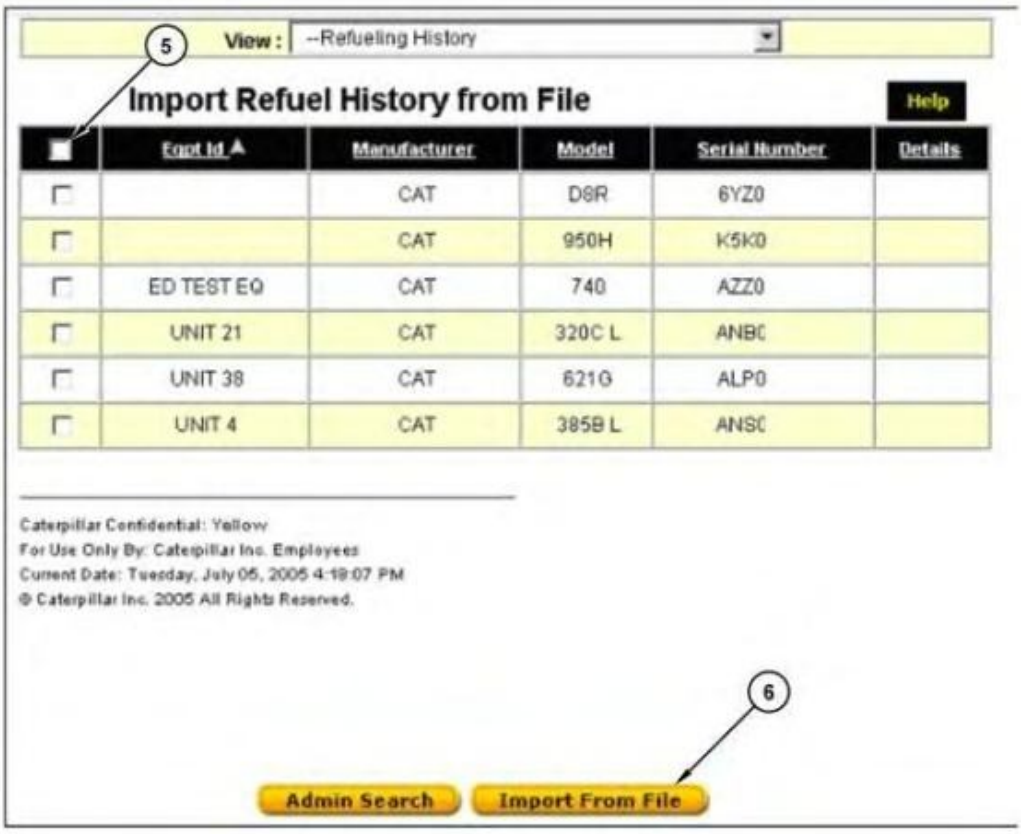


Illustration 9 g01740017

"Import Refuel History from File" screen

(5) Check box

(6) "Import From File" button

1. From either the "Administration" screen or the "View" menu, select "Refueling History".

   If equipment has already been selected, the "Import Refuel History from File" screen is displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

2. Select the check box () next to the pieces of equipment to which you wish to upload refueling history.

3. Click the "Import from File" button () . The "Import from File" screen opens in a new window.

4. Click the "Browse" button. Navigate to the file that contains the refueling history that is to be added. Click the "Open" button. The name of the file that was selected will appear in the "File" text field.

5. Click "OK". The refueling history is uploaded.

Preparing a Refueling History Upload File

In order for a "Refuel History Upload" file to be successfully uploaded, use the following procedure:

1. Open a new Microsoft Excel spreadsheet.

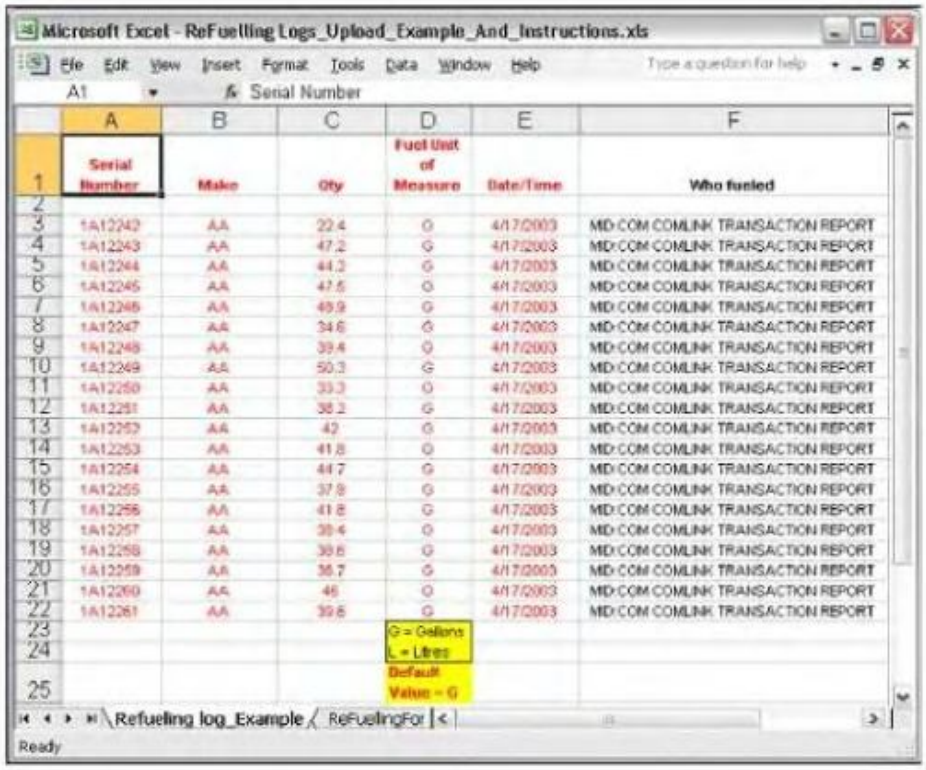


Illustration 10 g01249493

Sample of a Microsoft Excel file using "Refuel History" with headings

2. Enter the refuelings in the spreadsheet one refueling per row. Refer to Illustration 10 as an example of the columns and values that should appear in the spreadsheet. Items that are displayed in red indicate mandatory items.
3. After you have finished entering data, delete the column headers.
4. Go to "File", "Save As" and pick "CVS (Comma Delimited)" and save the file.

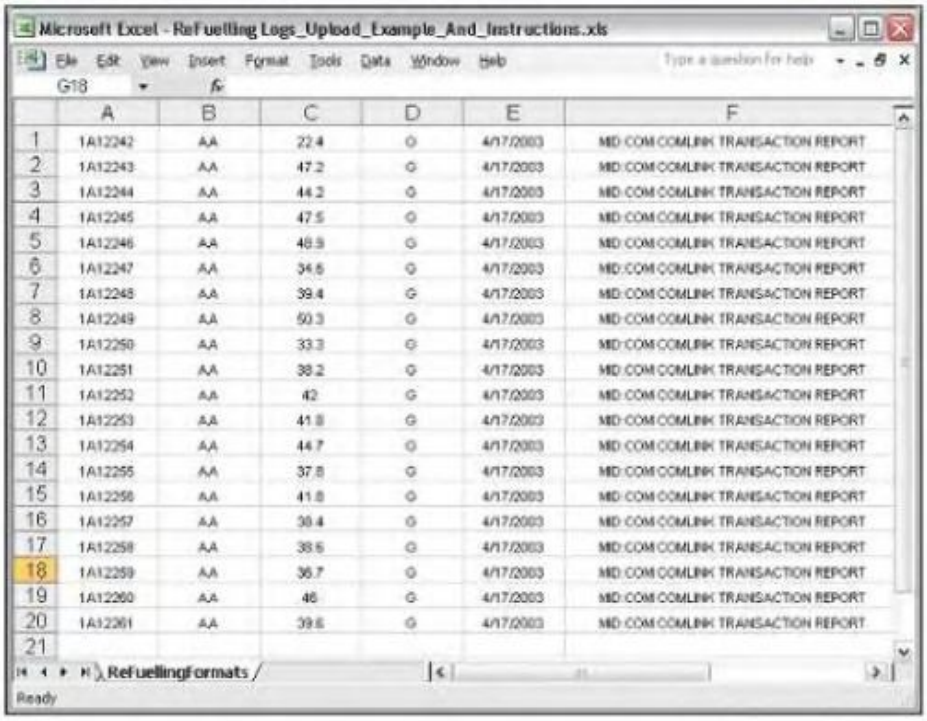


Illustration 11 g01249521

Sample or a Microsoft Excel file using "Refuel History" without headings

Illustration 11 shows the final file without the headers.



Illustration 12 g01249494

".cvs" alert message

If you attempt to upload a file that is not of the ".csv " file type, you will get the message displayed in Illustration 12.

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i03365163

Manage Major Repair Tracking

SMCS - 7600; 7606

Track Major Repairs

EquipmentManager can track major repairs in the same way that EquipmentManager can track planned maintenance schedules. You must configure EquipmentManager to track major repairs through the Administration screens.

In order to add or remove the tracking of major repairs, use the following procedure:

1. From either the "Administration" screen or the "View" dropdown, select "Track Major Repairs".

   If equipment has already been selected, the "Track Major Repairs Results" screen is displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

2. Select the radio button next to the pieces of equipment for which major repairs are to be tracked.

3. Click the "Track Major Repairs" button. The "Track Major Repairs" screen will be displayed.

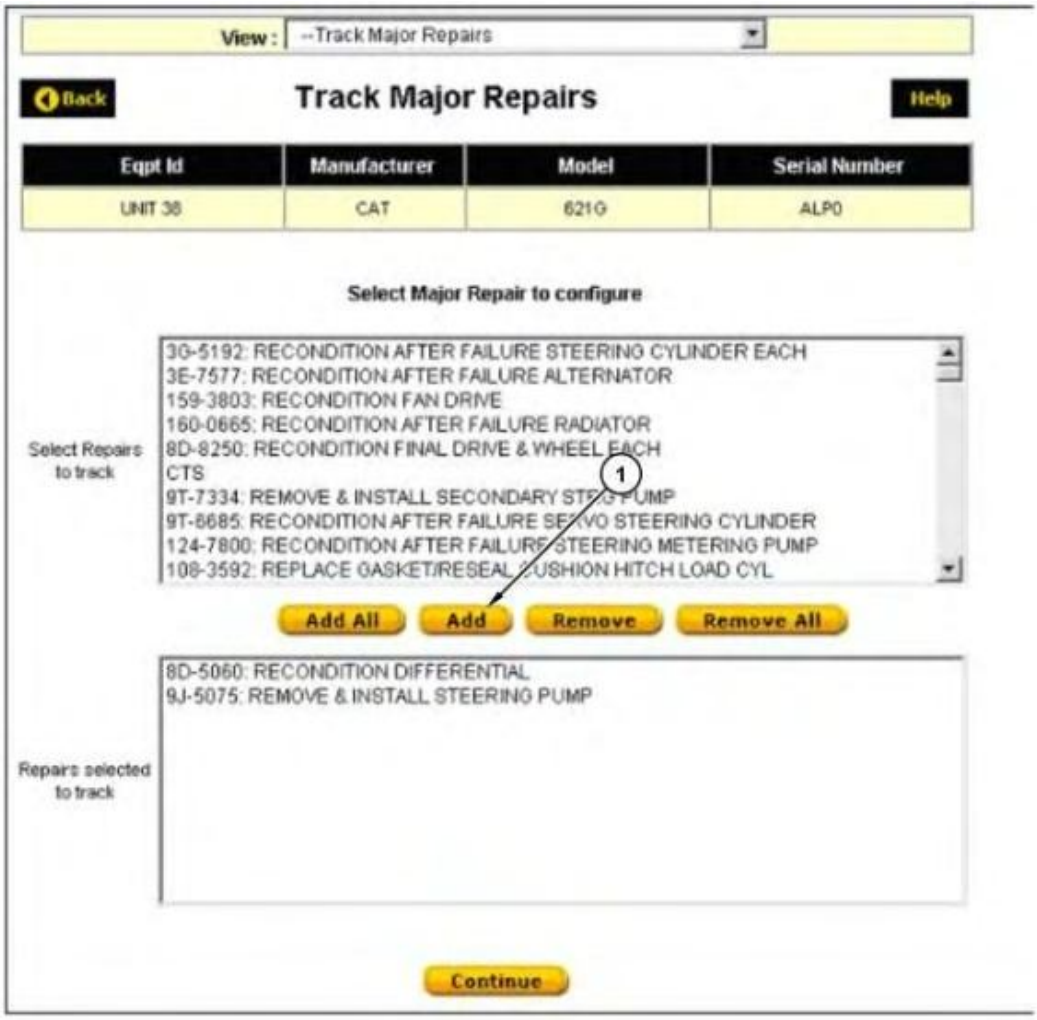


Illustration 1 g01737054

"Track Major Repairs"

(1) "Add" button

4. From the "Select Repairs to track" list box, select all major repairs you wish to add to the repair tracking.

   Note: Multiple repairs can be selected by holding down the "Ctrl" key and clicking on the items you wish to select.

5. Click the "Add" button (1). The repair is moved from the "Select Repairs to track" list box to the "Repairs selected to track" list box.

6. From the "Repairs selected to track" list box, select all repairs you wish to remove from the repair tracking.

7. Click the "Remove" button. The repair is moved from the "Repairs selected to track" list box to the "Select Repairs to track" list box.

8. Click the "Continue" button.

   The "Configure Repair Tracking intervals" screen will be displayed.

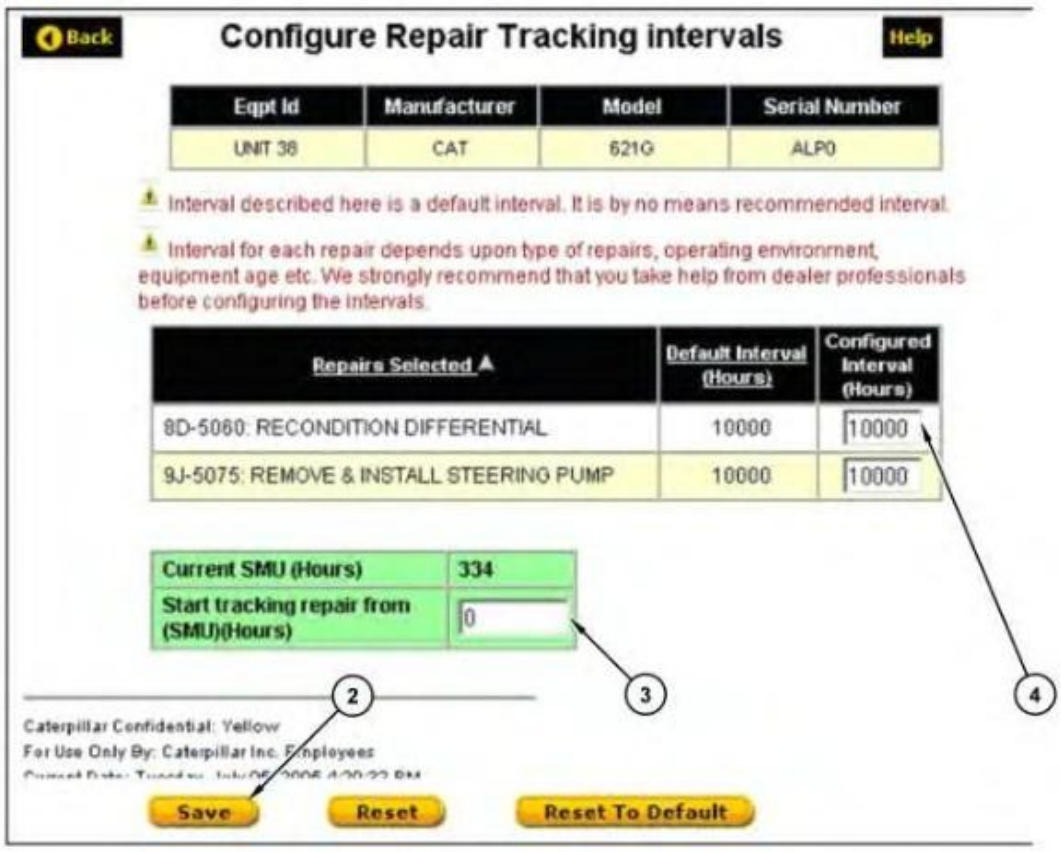


Illustration 2 g01737055

"Configure Repair Tracking intervals" screen

(2) "Save" button

(3) "Start tracking repair from" text field

(4) "Configured Interval" text field

9. In the "Configured Interval" text field (4), enter the number of hours that represents the interval for each repair.
10. In the "Start tracking repair from" text field (3), enter the SMU hours you wish the repair to begin being tracked.
11. Click the "Save" button (2). The "Confirmation – Configure Repair Tracking Intervals" screen will be displayed.



Illustration 3 g01737056

"Confirmation – Configure Repair Tracking Intervals" screen

12. Click "OK". The major repair tracking is saved.

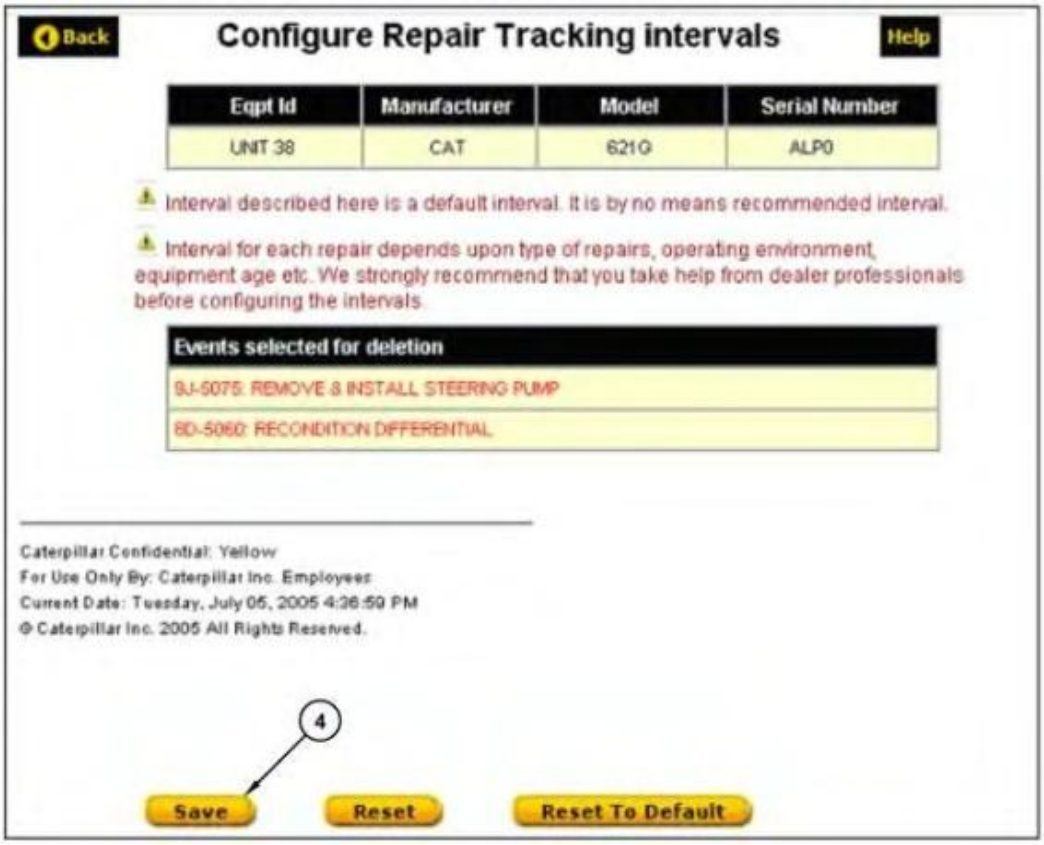


Illustration 4 g01737057

"Configure Repair Tracking intervals" screen if repairs have been deleted from "Track Major Repair" details

(2) "Save" button

If you removed any events or major repairs, clicking the "Save" button (2) will result in Illustration 4.

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i03365722

Manage Time Fence and Geographic Fence

SMCS - 7600; 7606

Geographic Fences and Time Fences

During normal working conditions, machines can move in and out of yards. Machines can also move to different job sites. A machine will not normally travel beyond a designated work area. The EquipmentManager software will record the location of a machine as history, unless the machine travels beyond the normal work area.

The EquipmentManager software uses the following features in order to track the machines:

Inclusive Geographic Fencing and Exclusive Geographic Fencing - The ability to be alerted when one of your machines is either inside or outside of a particular geographical area

Time Fencing - The ability to be alerted when one of your machines is operating either outside or inside of a designated time of the day

In the "Administration" section of EquipmentManager you use Asset Watch in order to set up the fences that can be applied to individual machines or to groups of machines. Refer to the Systems Operation, "Time Fence and Geographic Fence" for detailed descriptions.

Inclusive and Exclusive Descriptions

Inclusive and exclusive descriptions are descriptions of the geographical areas that make up the geographic fences. You can create as many descriptions as desired. Creating and storing these descriptions in advance, so that you can apply them to your equipment when needed, will save you time.

When creating the descriptions, inclusive and exclusive are the same. When assigning a machine to a geographic fence, you must choose whether the fence is inclusive or exclusive.

Note: The information in the Systems Operation, "Time Fence and Geographic Fence" describes some practical scenarios where previously created geographic and time fences can be assigned to machines. In this module, you will focus on creating these descriptions.

Add Descriptions

In order to add descriptions by using a map, use the following procedure:

1. In the "View" box, select "Inclusive/Exclusive Descriptions". The "Inclusive/Exclusive Descriptions" screen will appear.



Illustration 1 g01397246

2. Click "Map Lat/Long". The "Internet Map" screen will appear.

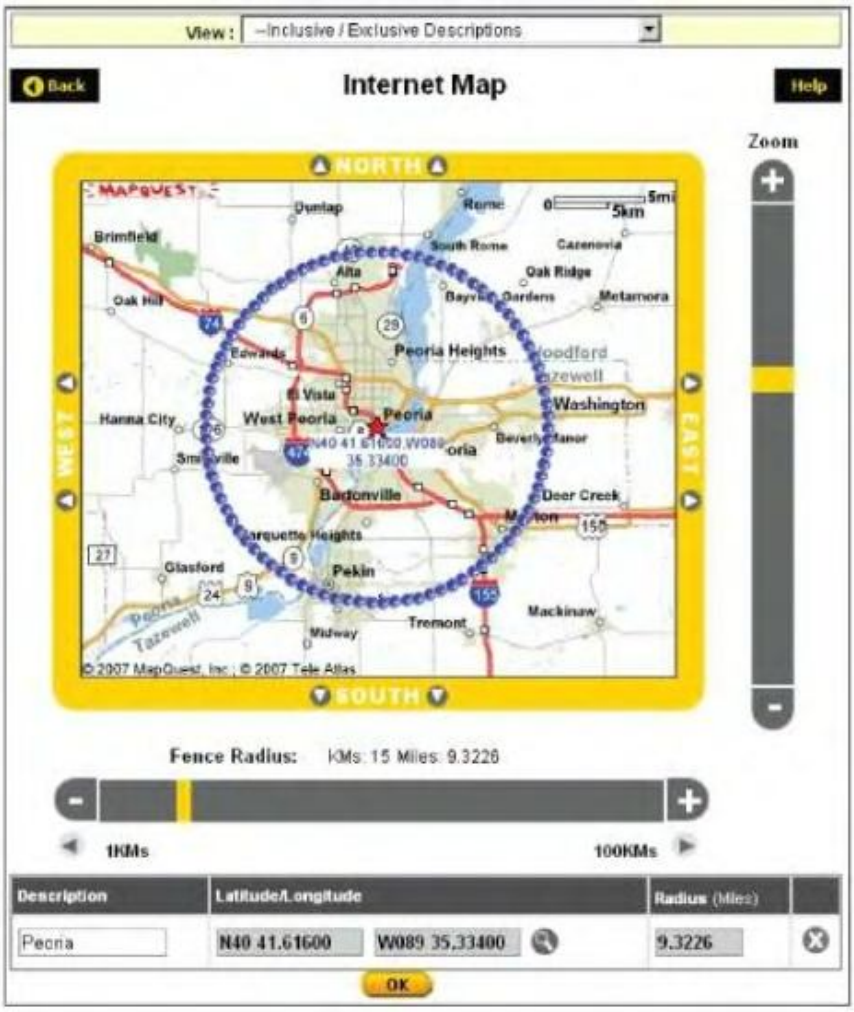


Illustration 2 g01397249

3. In the "Description" box, type a description for the new fence.
4. Define the center of a geographic fence by using one of the following methods:
   - In the "Latitude/Longitude" boxes, type the desired values.
   - Click a point on the map. In order to help establish the desired location, you can use the zoom in button and zoom out button to the right of the map. You can also use the "North", "South", "East", and "West" buttons on the borders of the map.
   - Select the icon of a magnifying glass. This enables you to enter a street address, city, state, and/or zip code.

   Note: The options for entering a street address, city, state, and/or zip code are only available in North America.
5. Configure the radius of the fence by dragging the "Fence Radius" slider to the appropriate location.

   Note: The fence radius values will display in whole kilometers. If your units of measure preference is miles, the fence will be configured in kilometers, converted to miles, and then displayed in miles.
6. Click "OK". The "Inclusive/Exclusive Descriptions" screen displays the new values in the "Add New Description" section.
7. Click "Add Location". A confirmation message will appear.



Illustration 3 g01397252



Illustration 4 g01737653

"Inclusive/Exclusive Descriptions" screen with the added location

(1) Pencil and paper icon

8. Click "OK". The location is added to the list of descriptions at the top of the "Inclusive/Exclusive Descriptions" screen. Refer to Illustration 4.

Edit "Inclusive/Exclusive Descriptions"

In order to edit an inclusive/exclusive description on the "Inclusive/Exclusive Descriptions" screen, click the pencil and paper icon (1) to the right of the description that you want to edit. Refer to Illustration 4. The "Edit Description" section appears. Use the procedure described earlier for changing the parameters using the map. When the changes have been made, click "Save".

Delete "Inclusive/Exclusive Descriptions"

In order to delete an inclusive/exclusive description, use the following procedure:



Illustration 5 g01397261

"Inclusive/Exclusive Descriptions" screen for deleting

1. On the "Inclusive/Exclusive Descriptions" screen, select the check box for the description that you want to delete.
2. Click "Delete Location Descriptions". A confirmation window will appear.



Illustration 6 g01397267

3. Click "OK". The description is deleted.

Time Based Descriptions

In order to create a "Time Based Description", use the following procedure:

1. From either the "Administration" screen or the "View" drop down menu, select "Time Based Descriptions". The "Time Based Descriptions" screen will be displayed.

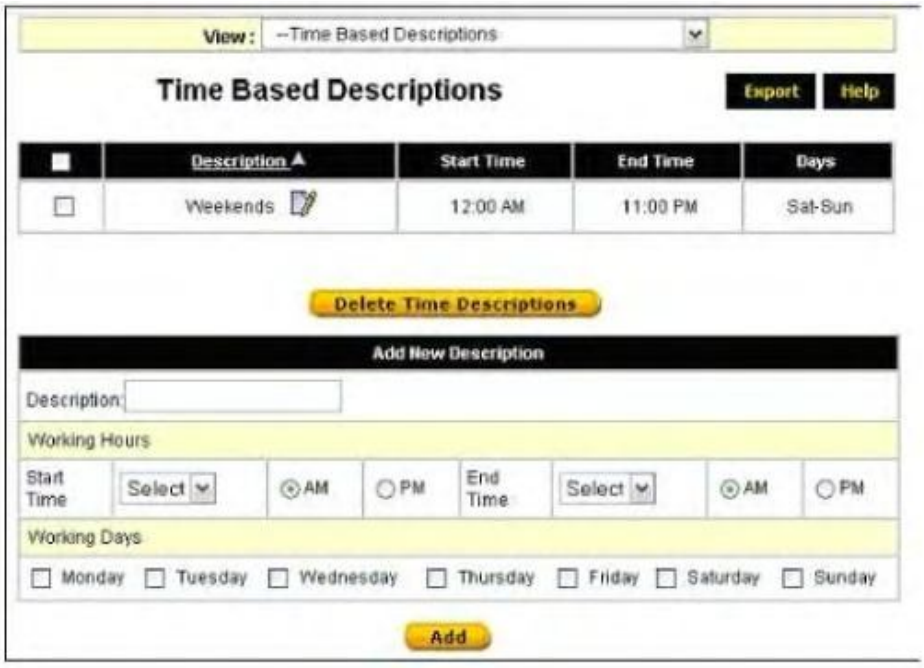


Illustration 7 g01249897

"Time Based Descriptions" with "Add New Description"

2. In the "Add New Description" section, enter a description of the new time fence in the "Description" text field.
3. In the "Working Hours" section, select an hour from the "Start Time" drop down menu.
4. Select the radio button next to the "Start Time" "AM" or "PM".



Illustration 8 g01249898

"End Time greater than Start Time" alert message

5. Repeat Steps 3 and 4 for the End Time.

   Note: If you enter an "End Time" that is less than the S"tart Time" the window in Illustration 8 will appear.

6. In the "Working Days" section, select the checkbox next to the days of the week to which you want the fence to apply.

7. Click the "Add" button. The new description is added to the list at the top of the screen.

Edit a Time Based Description

In order to edit a time based description, use the following procedure:

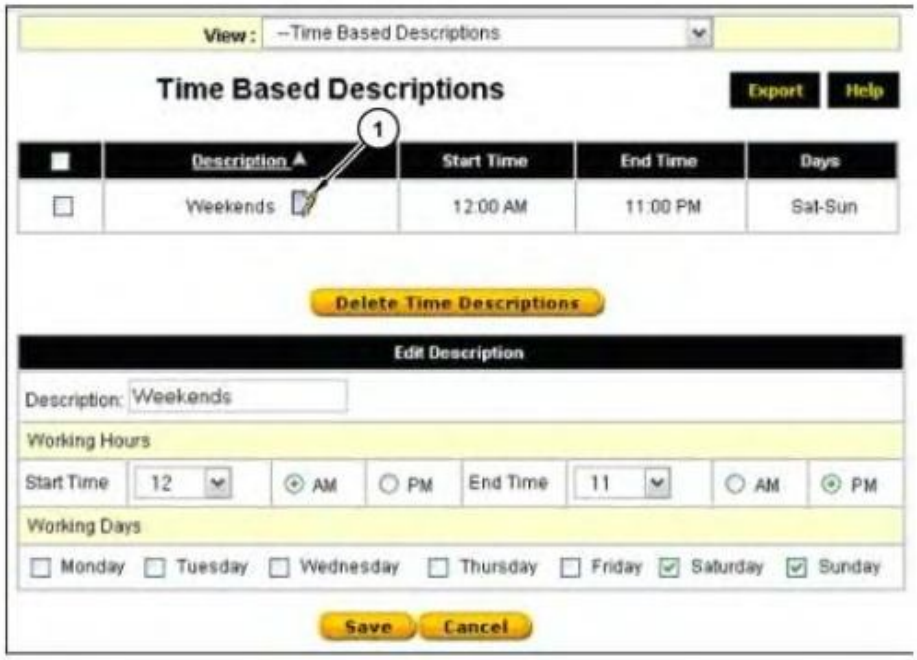


Illustration 9 g01737654

Editing "Time Based Description"

(1) Pencil and paper icon

1. From the "Time Based Descriptions" screen, click the pencil and paper icon (1) next to the description you wish to edit. The "Edit Description" section will be displayed.

2. In the "Edit Description" section, edit the description of the time fence in the "Description" field.

3. Edit the "Start Time" and "End Time" hours and "AM" or "PM".

4. Edit the selected "Working Days".

5. Click the "Save" button. A confirmation window will appear.



Illustration 10 g01249903

Confirmation message for editing "Time Based Description"

6. Click "OK". The updated description appears in the list at the top of the screen.

Delete a Time Based Description

In order to delete a time based description, use the following procedure:

1. From the "Time Based Descriptions" screen, select the checkbox next to the description you wish to delete. Refer to Illustration 10.
2. Click the "Delete Location Descriptions" button. Refer to Illustration 10. A confirmation window will appear.



Illustration 11 g01249904

3. Click "OK". The description is deleted.

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Systems Operation
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i03371424

Manage Planned Maintenance

SMCS - 7600; 7606

One of the ways that EquipmentManager helps you manage your equipment is by organizing the often complex task of managing planned maintenance for your equipment. Through the administration section of EquipmentManager, you can customize the intervals at which planned maintenance is performed, edit the checklists that are used to guide the planned maintenance, and customize the scheduling of the planned maintenance for individual or groups of equipment.

Customize PM Intervals

For each piece of equipment you are managing, default planned maintenance intervals exist. These default intervals are defined in the Operation Maintenance Manual specific to each Caterpillar models. Default intervals are applied to a manufactures models other than Caterpillar. The intervals indicate the Service Meter Unit (SMU) that when reached by the machine, should trigger a planned maintenance. You have the option of setting these intervals to values other than the defaults.

In order to customize PM Intervals, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Customize PM Intervals".

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

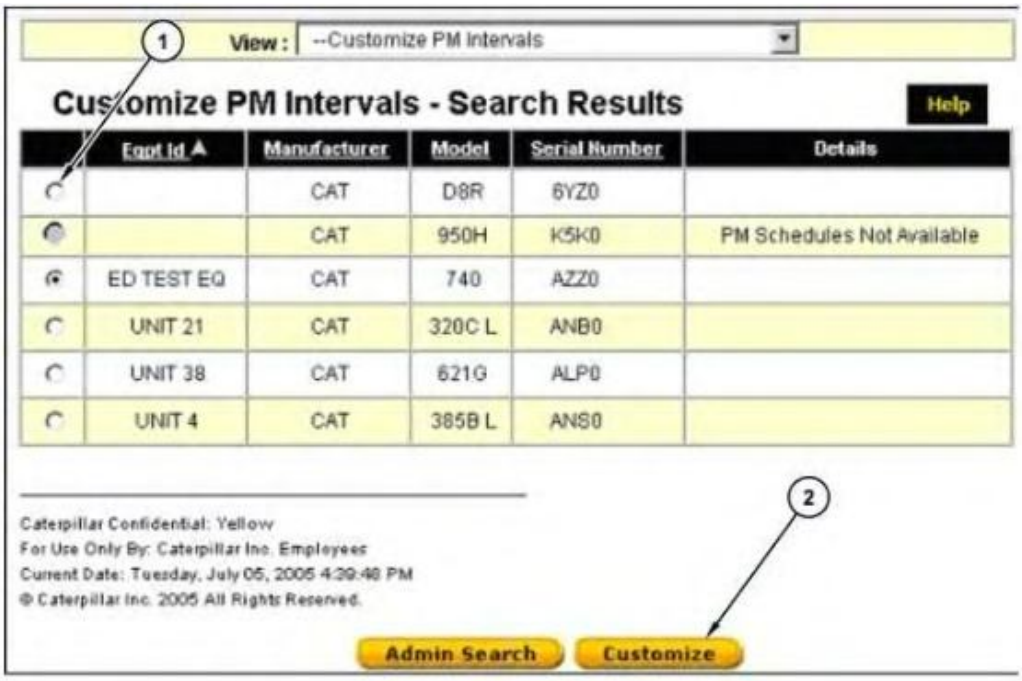


Illustration 1 g01732833

"Customize PM Intervals - Select Results" screen

(1) Radio buttons

(2) "Customize" button

2. Select the radio button (1) next to the piece of equipment in order to customize the "PM Interval" for the equipment.



Illustration 2 g01250076

Warning for trusting the applet

3. Click the "Customize" button (2) . A warning for trusting the applet will appear. Refer to Illustration 2.

4. Click "Yes". The "Customize PM Intervals" screen will be displayed.

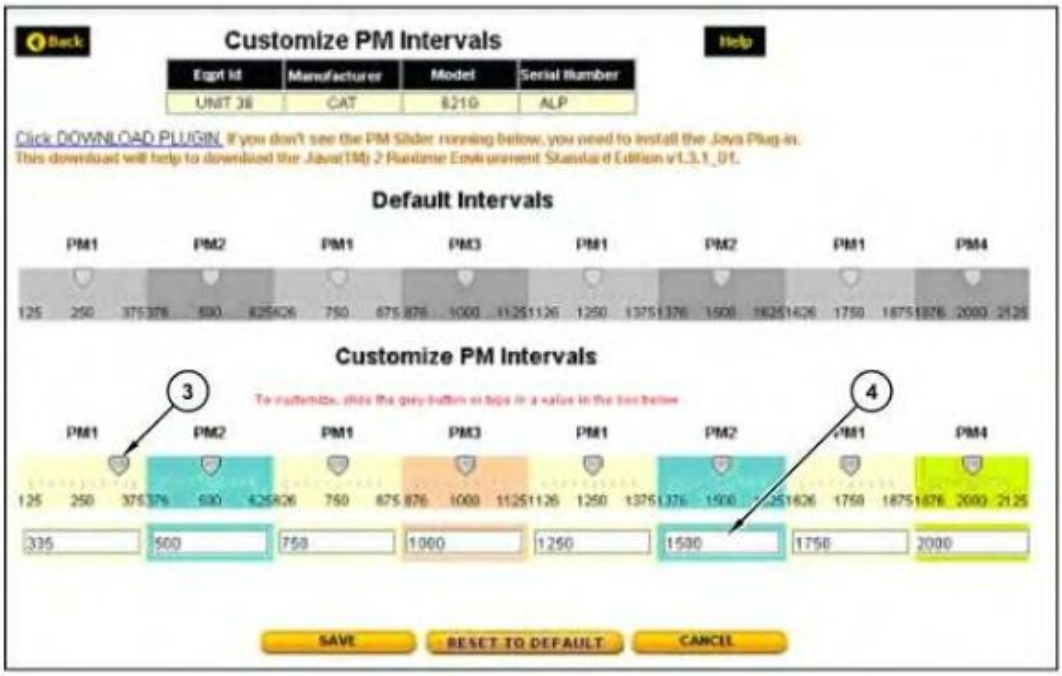


Illustration 3 g01732834

"Customize PM Intervals"

(3) Gray slider

(4) Text field

5. In order to change the " PM Interval", drag the gray slider (3) to the desired value (measured in SMUs) or edit the value in the text field (4) that appears below the PM.



Illustration 4 g01250081

The "Successful" message for "Customize PM Intervals"

6. Click the "Save" button. A successful message will be displayed. Refer to Illustration 4.
7. Click "OK". The PM Intervals have been customized.



Illustration 5 g01250119

"Reset All PM Intervals" confirmation message

If you choose to click the "Reset to Default" button on the "Customize PM Intervals" screen, the window as shown in Illustration 5 will appear.



Illustration 6 g01250121

No "PM Interval" changes message

If you click the "Save" button on the "Customize PM Intervals" screen and have not changed from the defaults, the window as shown in Illustration 6 will appear.

Edit PM Check List

The PM Checklist is a description of the steps that should be taken when performing a planned maintenance. The steps can include everything from checking fluid levels to replacing parts. Through EquipmentManager you can edit these checklists to add, edit, or remove steps.

Note: Complete checklists that are applied for Caterpillar models and serial numbers from model year 2000 or newer. Generic checklists that are applied for Caterpillar models and serial numbers older than 2000 as well as other manufacture models.

"Edit PM Check List"

In order to edit a step in a check list, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Edit PM Check List".

   If you have equipment already selected, the "Edit PM Check List - Search Results" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

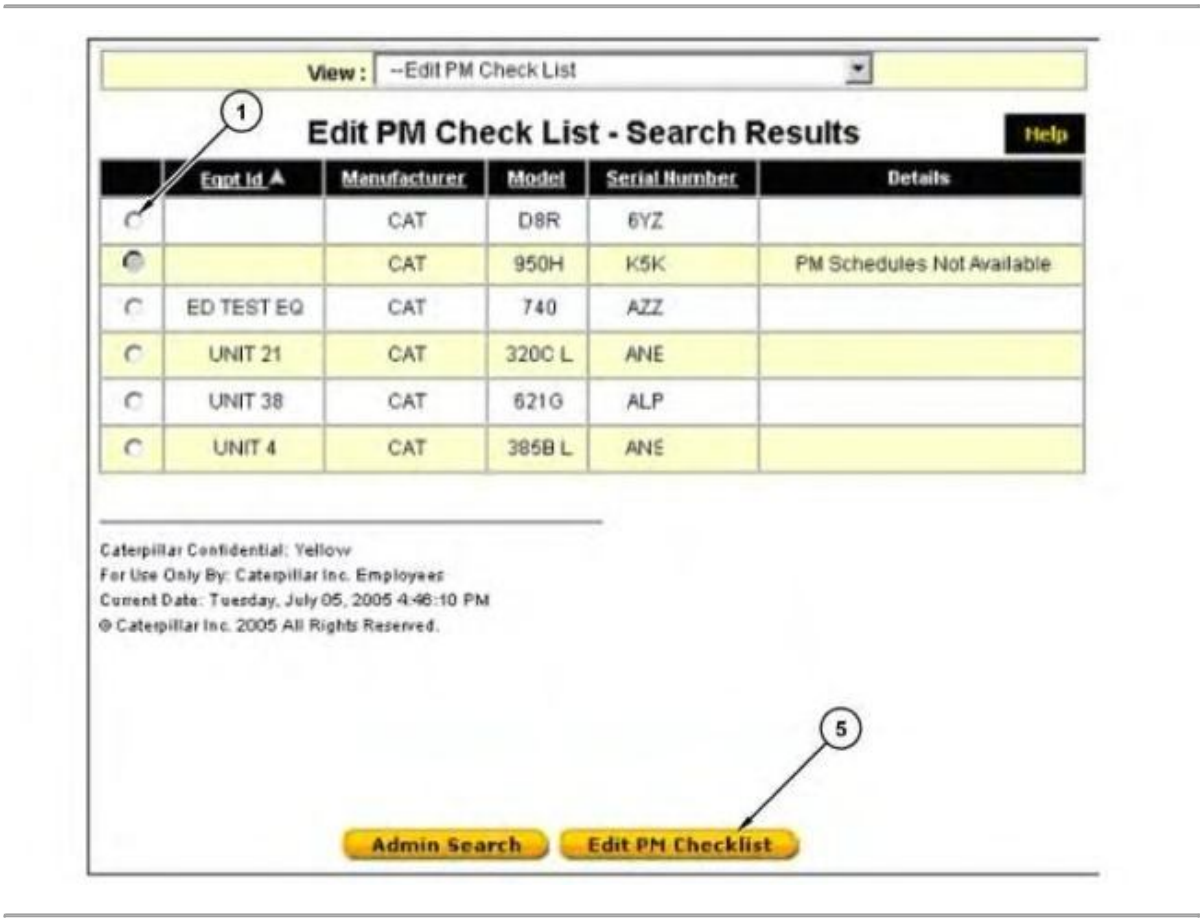


Illustration 7 g01732835

"Edit PM Checklist - Select Results" screen

(1) Radio button

(5) "Edit PM Checklist" button

2. Select the radio button (1) next to the piece of equipment for which you wish to edit a PM Checklist.
3. Click the "Edit PM Checklist" button (5) . The "Edit PM Check List" screen will be displayed.

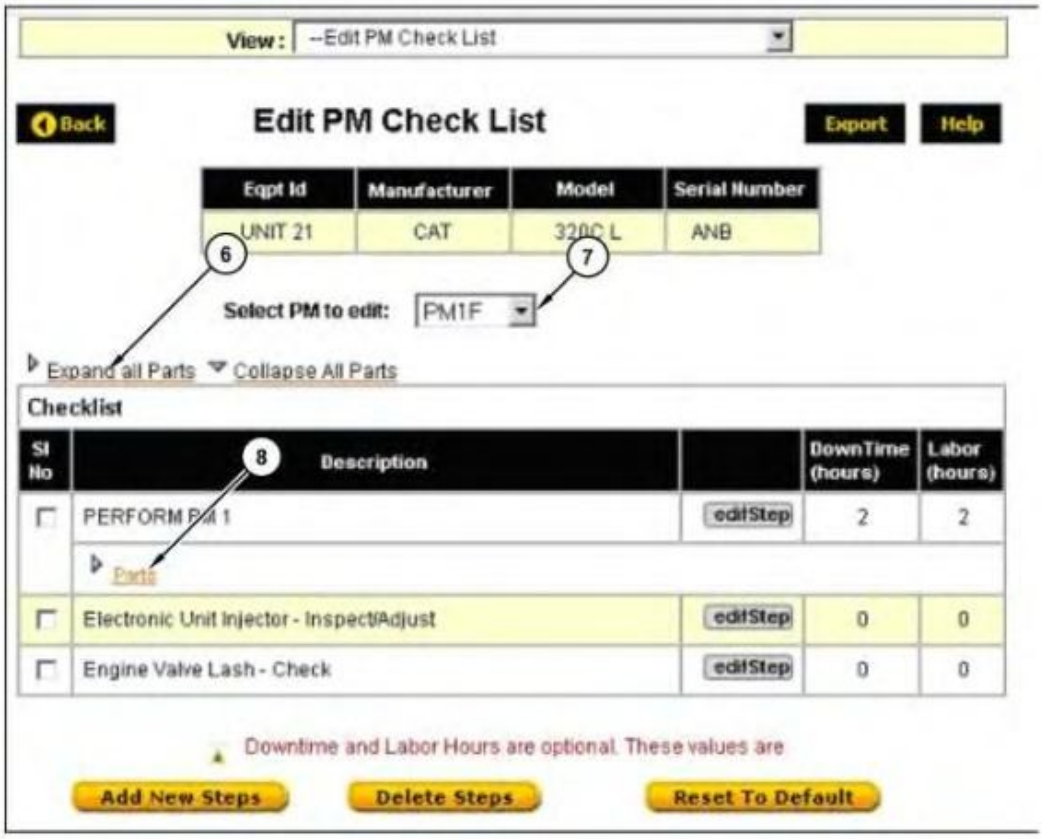


Illustration 8 g01732836

"Edit PM Check List" screen with the "Parts" collapsed

(6) "Expand all Parts" link

(7) "Select PM to edit" drop-down menu

(8) "Parts" link

4. Select the planned maintenance you wish to edit from the "Select PM to edit" drop-down menu (7) .
5. In order to view the parts associated with a step, click the blue triangle icon or the "Parts" link (8) . In order to view all parts in the checklist click the blue triangle icon or the "Expand all Parts" link (6) . The expanded checklist will be displayed.

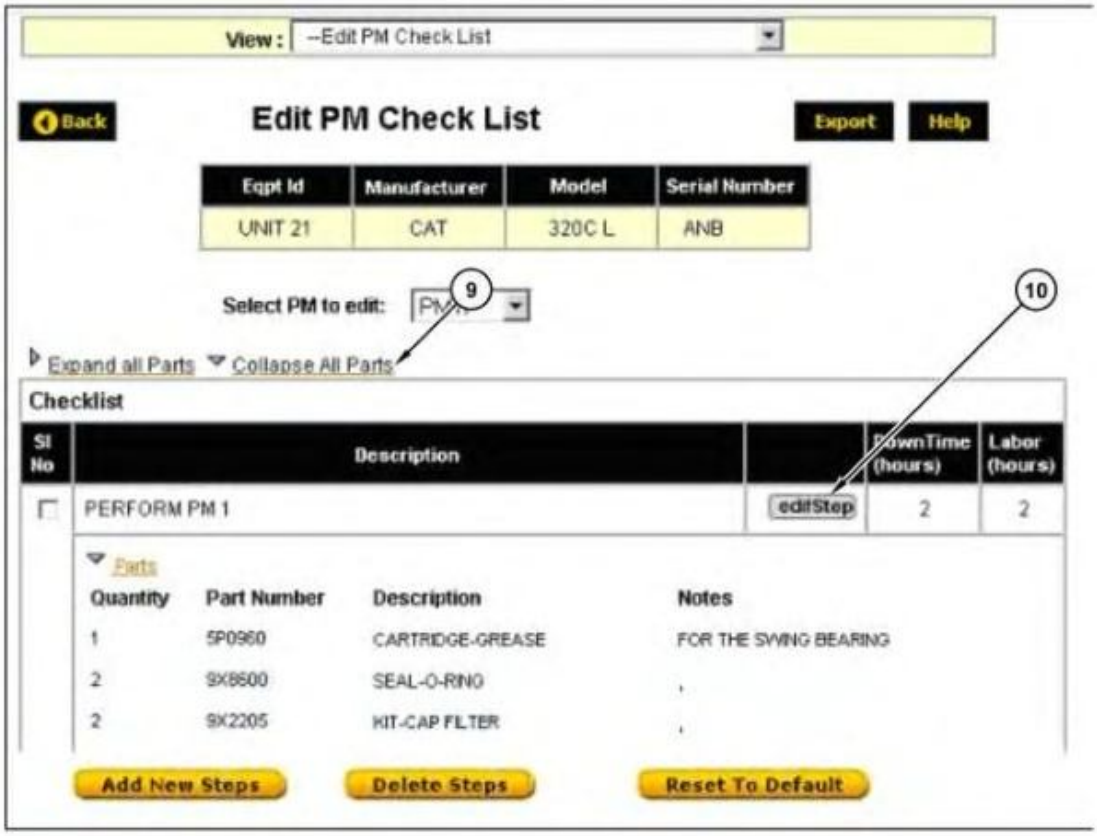


Illustration 9 g01732837

"Edit PM Check List" screen with the "Parts" expanded

(9) " Collapse all Parts"

(10) "editStep" button

6. Click the "editStep" button (10) next to the step that you wish to edit. The "Edit Step" window will be displayed.

   Note: In order to collapse all the parts in the checklist click the blue triangle icon or the " Collapse all Parts" link (9) .



Illustration 10 g01732838

"Edit Step" window

(11) "Description" field

(12) "Additional Parts" button

7. Edit the description of the step in the "Description" field (11) .
8. Edit the number of hours in the "Down Time" text field.
9. Edit the number of hours in the "Labor" text field.
10. If you wish to add a part to the step, click the "Additional Parts" button (12) . A row with part fields will appear below the step description.



Illustration 11 g01250140

"Edit Step" window with additional parts options

11. Enter a quantity in the "Quantity" text field.



Illustration 12 g01250143

"Enter Part Quantity" alert message

Note: If you fail to enter a part quantity, the message in Illustration 12 will appear

12. Enter a part number in the "Part Number" field.
13. Select either the "Solid" or "Fluid" radio button.
14. Enter a description of the part in the "Description" text field.
15. Enter notes in the "Notes" text field.
16. Repeat Steps 9 through 14 until you have added all the desired parts.
17. If you wish to remove a part from the step, select the check box next to the part you wish to delete.
18. Click the blue "Delete Parts" button.
19. Repeat Steps 17 and 18 until you have removed all desired parts.
20. Click the "Save" button. The edited checklist step is saved.

Add New Step to Checklist

In order to add a new step to a checklist, use the following procedure:

1. From the "Edit PM Checklist" screen, click the "Add New Steps" button. Refer to Figure 8. The "Add New Steps" window will be displayed.

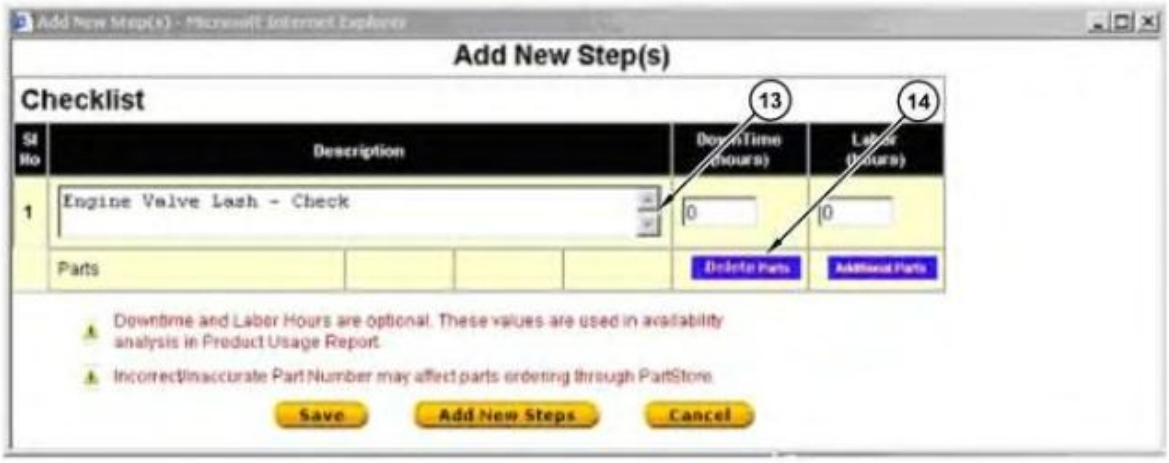


Illustration 13 g01732839

"Add New Step(s)" screen

(13) "Add New Steps" button

(14) "Delete Parts" button

2. Complete the fields on the "Add New Steps" screen. The fields are the same as the fields that are in the "Edit Step" window.
3. If you wish to add more than one step, click the "Add New Steps" button (13) and repeat Step 2.

Note: If you need to delete parts, click the blue "Delete Parts" button (14) .



Illustration 14 g01732840

Attaching a new step to a PM

(15) Check box

(16) "Save" button

4. Once you have added all desired steps and parts, click the "Save" button (16) . The "Higher PM details" window will be displayed.
5. The new steps you added will be added to the planned maintenance that you selected from the drop-down menu, but you can also add these steps to other PMs. Select the check box (15) next to all of the PMs to which you wish to add the new steps.
6. Click the "Save" button. The new steps are added to the planned maintenance.



Illustration 15 g01250153

Confirmation message for no additional PM's being attached

Note: If you did not select any additional PMs to add the step to, the confirmation window in Illustration 15 will appear. Click the "OK" button.

"Customize PM Schedule"

You can customize the interval at which planned maintenances are scheduled. PM schedule intervals can be hour based or date based. You can also apply an offset to the schedule if desired (default is no offset applied). Each interval and its description follows:

"Hour based" - Interval schedule based on hour (SMU) accumulation of the equipment.

"Date based" - Interval schedule based on calendar days.

"Offset" - Next scheduled service calculated from previous service details. If offset is not applied (default), the schedule will ignore previous service details and adhere to fixed" PM Intervals".

Configuring Equipment for Hour Based PM Scheduling

In order to configure equipment for hour based PM scheduling, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Customize PM Schedule".

   If you have equipment already selected, the "Customize PM Schedule - Select Equipment" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

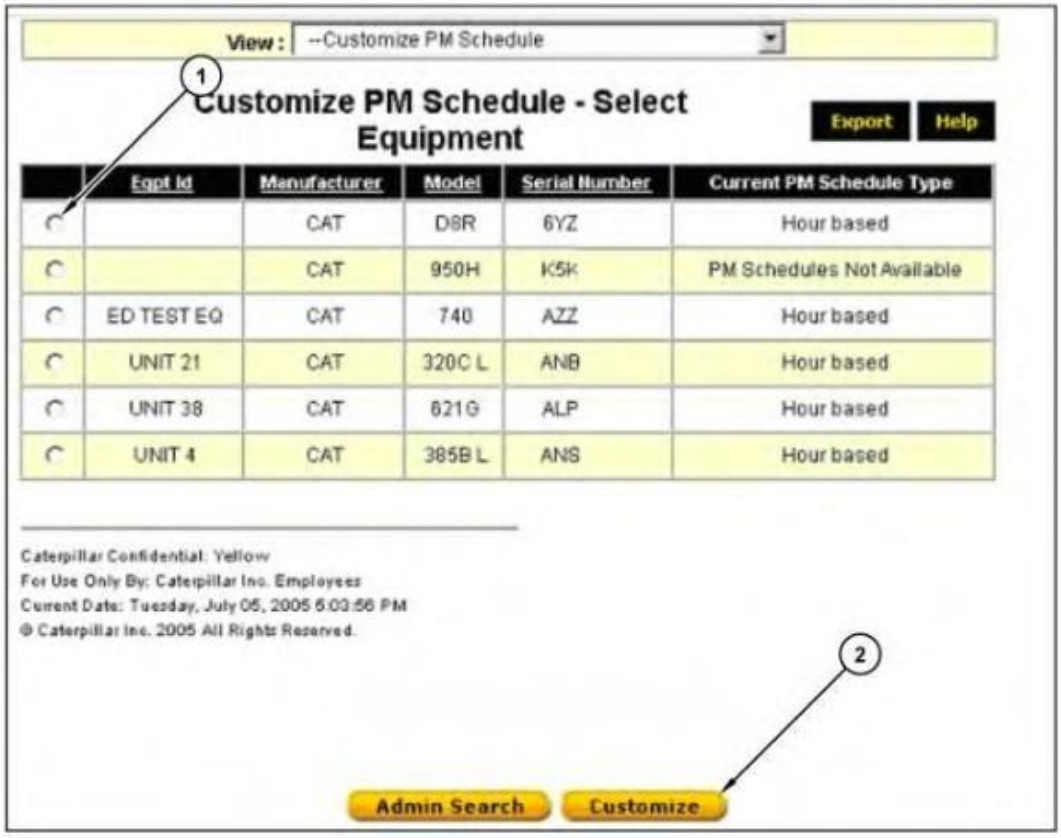


Illustration 16 g01732841

"Customize PM Schedule - Select Equipment"

(1) Radio buttons

(2) "Customize" button

2. Select the radio button (1) next to the piece of equipment you wish to configure for hour based scheduling.
3. Click the "Customize" button (2) . The "Customize PM Schedule" screen will be displayed.

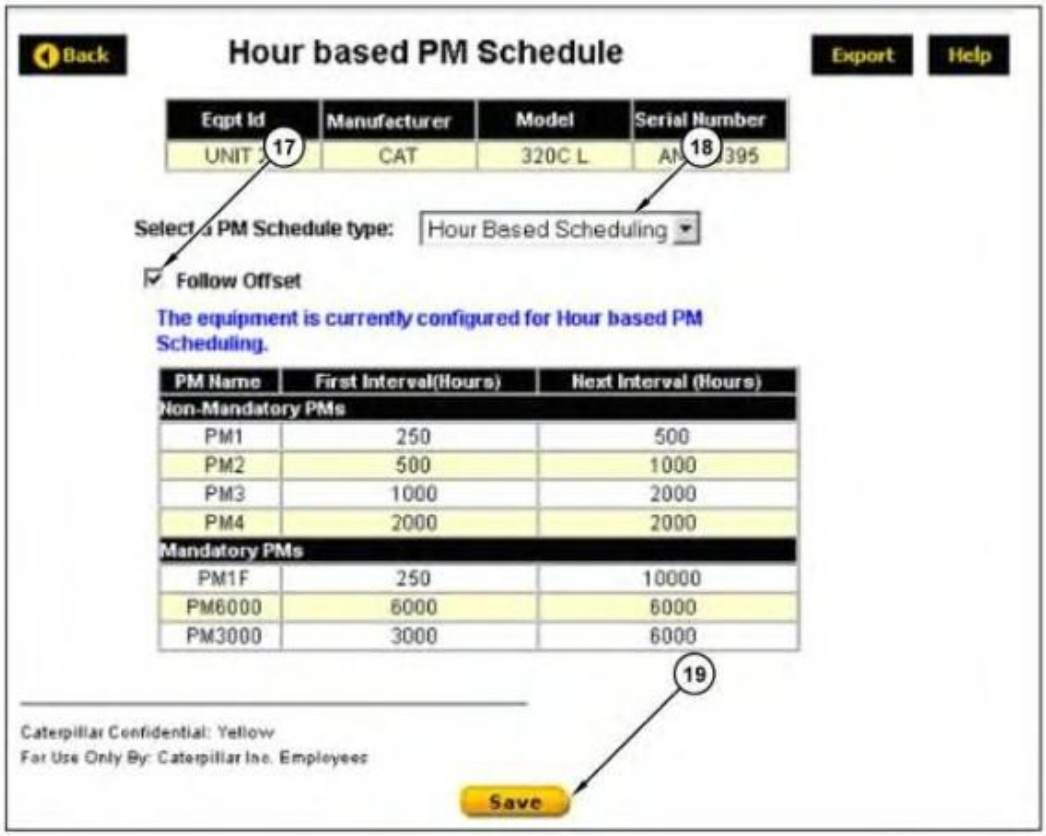


Illustration 17 g01732842

"Hour Based PM Scheduling"

(17) "Follow Offset" check box

(18) "Select a PM Schedule type" drop-down menu

(19) "Save" button

4. If not already selected, select "Hour Based Scheduling" from the "Select a PM Schedule type" drop-down menu (18) .
5. In order for the PM Schedule to follow offset, select the "Follow Offset" check box (17) .

Note: If you select Follow Offset, the next planned maintenance will be scheduled at the interval starting from when the last planned maintenance was performed. For example, if a planned maintenance is scheduled for every 500 SMUs and the first PM is performed after 600 SMUs, the next PM will be scheduled for 1100 SMUs rather than 1000.

If you do not select Follow Offset, the next planned maintenance will be scheduled at a fixed interval. For example, if the PM is scheduled for every 500 SMUs and the first PM is performed after 600 SMUs, the next PM will still be scheduled for 1000 SMUs.

6. Click the "Save" button (19) . The "Hour based PM Schedule Success" screen will be displayed.



Illustration 18 g01732843

"Hour based PM Schedule" configuration successful message

(20) "OK" button

7. Click the "OK" button. The equipment has been configured for hour based PM scheduling.

Configuring Equipment for Date Based PM Scheduling

Date based PM schedules are available for equipment that do not apply to an hour based schedule. One example would be a standby generator set. In order to configure equipment for date based PM Scheduling, use the following procedure:

1. From the "Customize PM Schedule - Select Equipment" screen, select the radio button next to the piece of equipment you wish to configure for date based PM scheduling. Refer to Figure 16.
2. Click the "Customize" button. Refer to Figure 16. The "Customize PM Schedule" screen will be displayed.

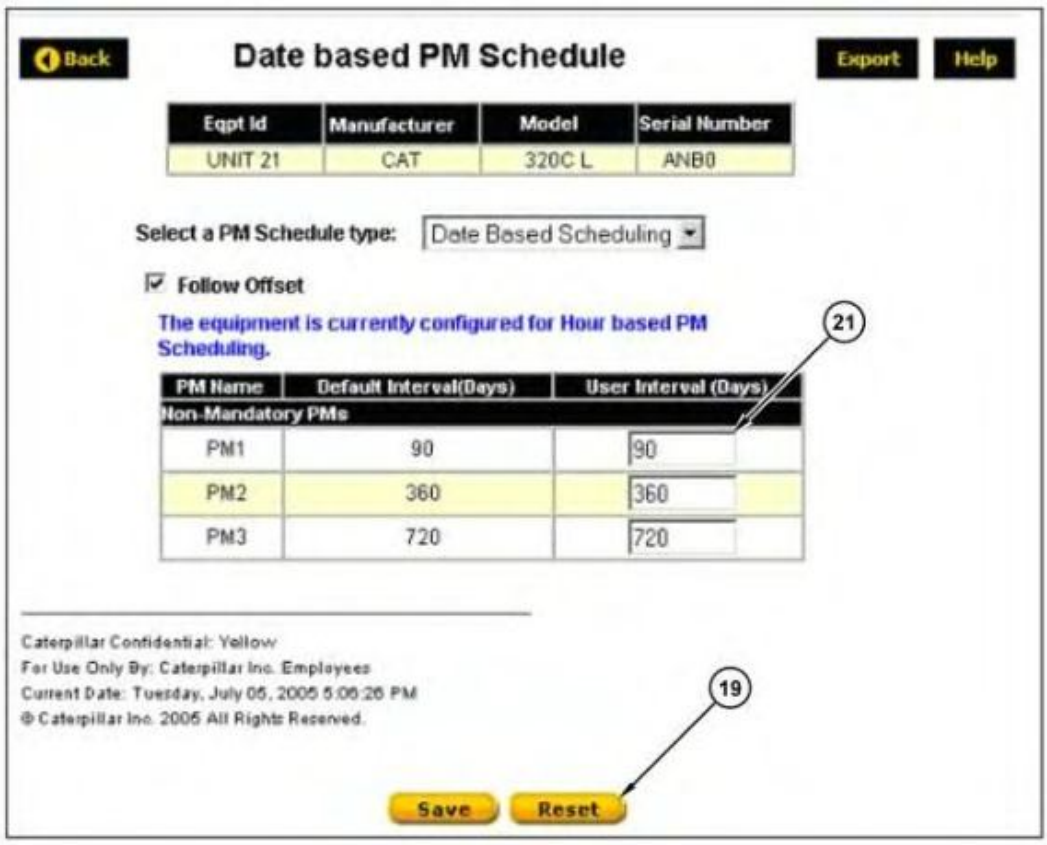


Illustration 19 g01732844

Customizing the "Date based PM Schedule"

(21) "User Interval" text fields

(19) "Save" button

3. If not already selected, select "Date Based Scheduling" from the "Select a PM Schedule type:" drop-down menu.
4. Select whether or not you wish the "PM Schedule" to follow offset or not by selecting or deselecting the "Follow Offset" check box.
5. If you want the scheduling interval to be different than the default interval, enter the number of days in the "User Interval" text fields (21) .

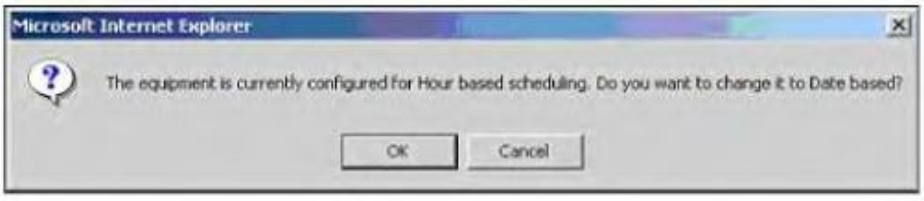


Illustration 20 g01250175

Confirmation message for change "PM Schedule" from hour based to date based

6. Click the "Save" button (19) . If you changed the scheduling type from hour based to date based, the "Date based" confirmation message will appear. If not, skip to Step 8.
7. Click "OK". The "Date based PM Schedule Success" screen will be displayed.



Illustration 21 g01732845

"Date based PM Schedule" configuration successful message

(20) "OK" button

8. Click "OK". The equipment has been successfully configured for date based PM scheduling.

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i03332823

Preferences

SMCS - 7600; 7606

Overview

Each person that uses EquipmentManager to manage equipment may use EquipmentManager in slightly different ways. For this reason, each EquipmentManager user can set the preferences in order to utilize the application more efficiently and effectively. This provides individual levels of customization of the application that will fulfill individual process needs.

"Set Your Preferences"

Complete the following procedure, in order to set your preferences for the first time or change your preferences:

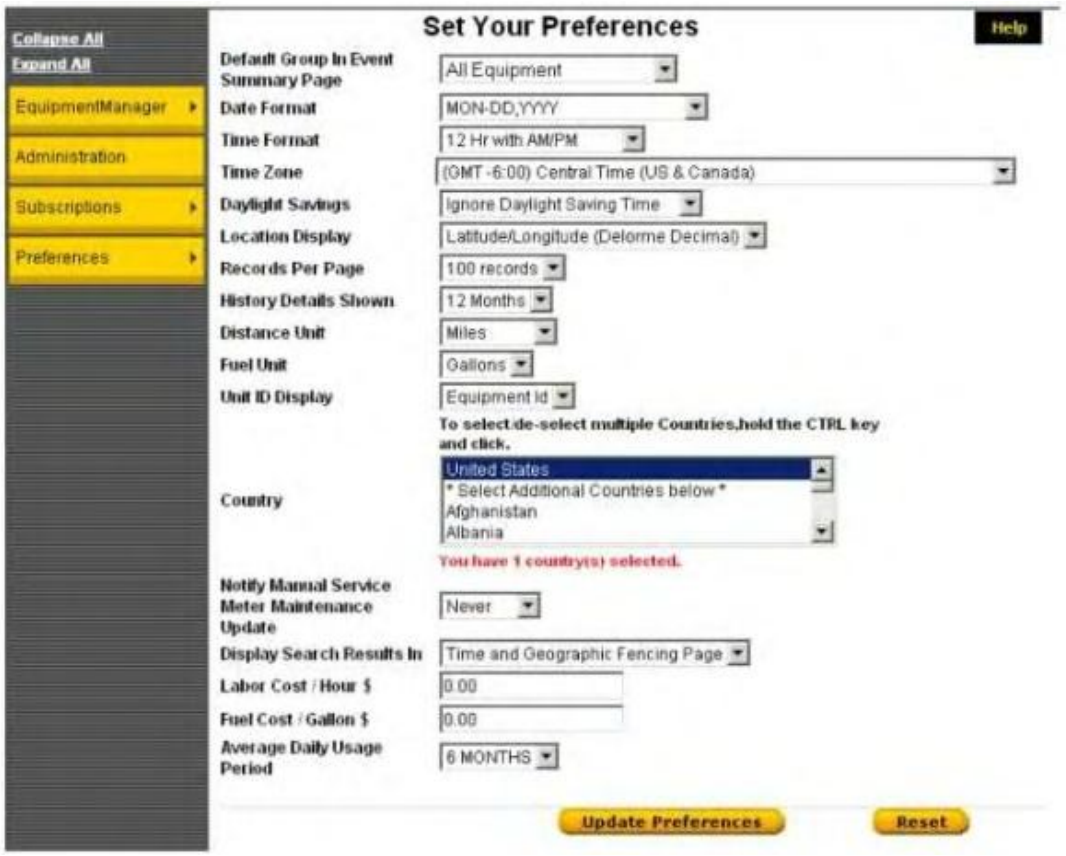


Illustration 1 g01710637

"Set Your Preferences" screen

1. From the left navigation, click the "Preferences" tab. The "Set Your Preferences" screen will be displayed.
2. Set the preferences or edit the preferences by changing values in the drop-down menus, input boxes, and list boxes that appear next to the names of the preference.
3. Click "Update Preferences". The "Confirmation – Set Your Preferences" screen will be displayed.



Illustration 2 g01710636

"Confirmation - Set Your Preferences" screen

4. Click the "OK" button at the very bottom of the screen. Your preferences will be saved and the "Set Your Preferences" screen will be displayed.

Available Preference Values

The following table lists the available values for each of the preferences that appear on the "Set Your Preferences" screen.

Table 1

Name of Preference	Available Values
"Default Group In Event Summary Page"	"All Equipment" (Equipment Groups you created) (Equipment Groups you have been assigned)
"Date Format"	"MM/DD/YYYY " "DD/MM/YYYY" "DD-MON-YY" "DD-MON-YYYY" "MON-DD,YYYY"
"Time Format"	"12 Hr Format" "24 Hour (Military Time)" "12 Hr with AM/PM"
"Time Zone"	(A list of all time zones appears in the drop-down menu)
"Daylight Savings"	"Observe Daylight Savings Time" "Ignore Daylight Savings Time"
"Location Display"	"Nearest City" "Latitude/Longitude (Deg/Min/Sec)" "Latitude/Longitude (Delorme Decimal)"
"Records Per Page"	"10 records" "20 records" "50 records" "100 records"
"History Details Shown"	"3 Months" "6 Months" "9 Months" "1 Year" "2 Years" "3 Years" "5 Years"
"Distance Unit"	"Miles" "Kilometers"
"Fuel Unit"	"Gallons" "Liters"
"Unit ID Display"	"Unit ID" "Equipment ID"
"Country"	(A list of over 240 countries appears in the list box)

"Notify Manual Service Meter Maintenance Update"	"Weekly" "Monthly" "Never" "6 Weeks"
"Display Search Results In"	"Event Summary Results Page" "S· O· S Results Page" "Remote Monitoring Report" "Utilization Monitoring Report" "Planned Maintenance Page" "Fault Code Results Page" "Time and Geographic Fencing Alarms Page" "Location/SMU Page"

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i03323941

Preference Detail

SMCS - 7600; 7606

"Default Group In Event Summary Page"



Illustration 1 g01707378

Setting the preference for the default for "Select a Group"

(1) "Select a Group" drop-down menu

The default preference is "All Equipment" for the "Select a Group" drop-down menu (1). Other options will appear in this drop-down menu only when groups of documents have been created or you have been given access to groups of documents that were created by other users.

If you select a group from the drop-down menu and you update your preferences, from that time forward the value in the "Select a Group" drop-down menu (1) in the "Event Summary" section of the "EquipmentManager Home" screen will default to the group that was selected on the "Set Your Preferences" screen. For example, if the preferences of "DocGrp" was chosen, Illustration 1 is an

example of the "Event Summary" section of the "EquipmentManager Home" screen that will appear after the initial time.

Also, EquipmentManager allows you to manage your equipment by an exception. There are three "Status" levels of events.

Action (red) - The "Action" status indicates an event that is deemed of the highest importance. "Action" events should be given the most attention and "Action" events should be resolved first.

Monitor (yellow) - The "Monitor" status indicates an event that should have attention, but this event does not require immediate resolution.

Normal (green) - The "Normal" status indicates an event that is deemed least important of the actions that require attention or resolution.

"Date Format" and "Time Format" Preferences

The "Date Format" and the "Time Format" that are used to display all dates and times throughout EquipmentManager may be set to your preference.

In the "Time Zone" drop-down menu, the time may be set to the time zone of your dealership, the time zone of the location of your equipment, or any other time zone.

In the "Time Format" drop-down menu, the time may be viewed with the following options: "12 Hr Format", "12 Hr with AM/PM" and "24 Hour (Military Time)".

In the "Daylight Savings" drop-down menu, the daylight savings time may be chosen.

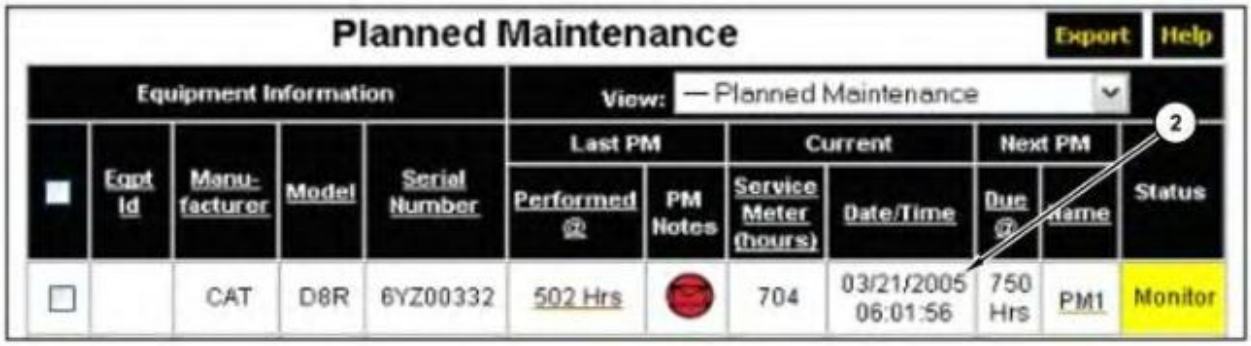


Illustration 2 g01708096

Example of the "Date Format" and the "Time Format"

(2) "Date/Time"

The "Planned Maintenance" screen is an example that displays "Date/Time" (2) within EquipmentManager. Refer to Illustration 2.

"Location Display"

EquipmentManager uses GPS to determine the location (3) of your equipment. On the "Set Your Preferences" screen, you can choose to display the location in any one of the following three formats:

- "Nearest City"

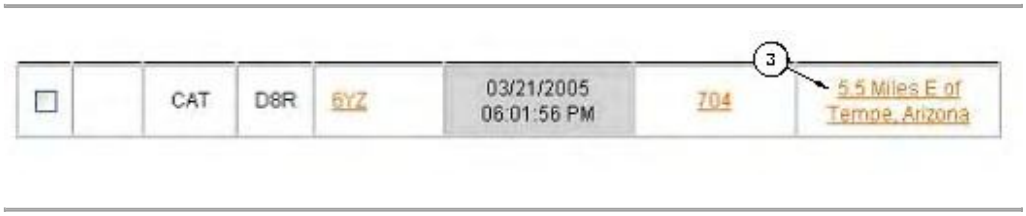


Illustration 3 g01708145

Format for the "Nearest City"

(3) Location

- "Latitude/Longitude (Deg/Min/Sec)"

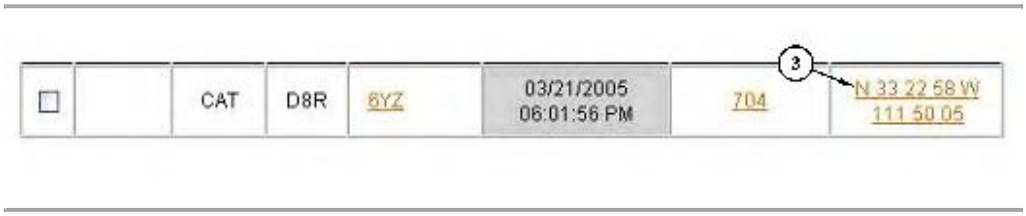


Illustration 4 g01708146

Format for the "Latitude/Longitude (Deg/Min/Sec)"

(3) Location

- "Latitude/Longitude (DeLorme Decimal)"

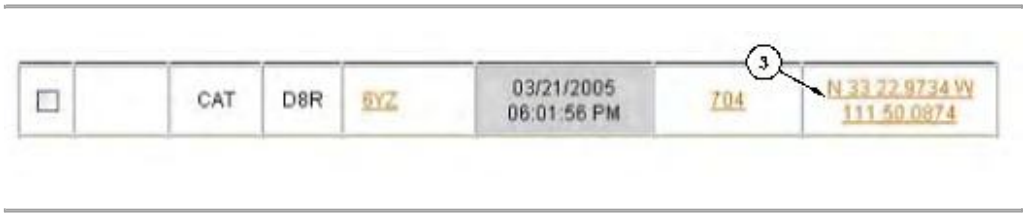


Illustration 5 g01708147

Format for the" Latitude/Longitude (DeLorme Decimal)"

(3) Location

"Records Per Page"

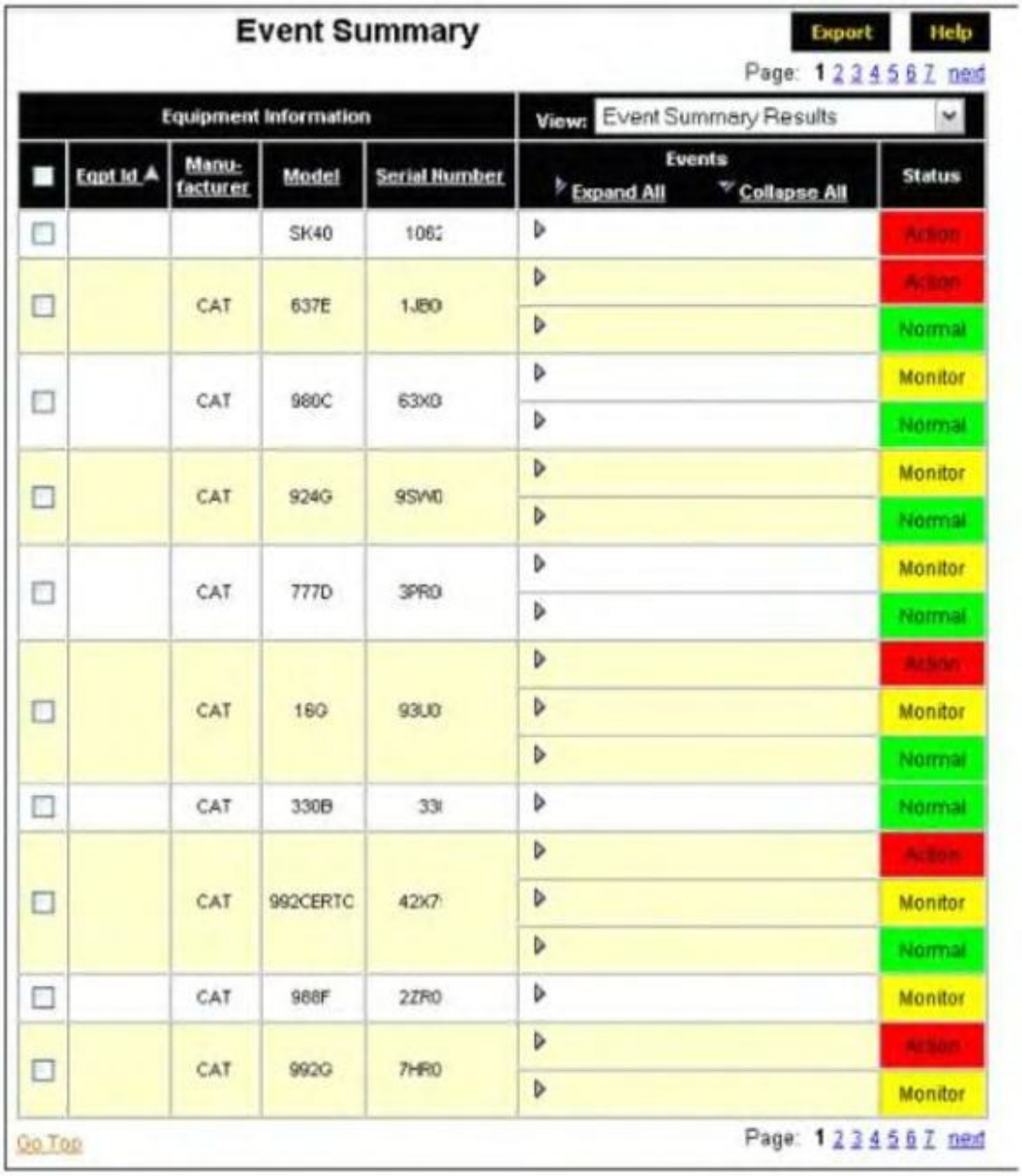


Illustration 6 g01708149

The preference of 10 records for the records per page

The number of records that are displayed per page may be set for the list of information of the equipment that is returned from EquipmentManager. Illustration 6 indicates an "Event Summary" list with 68 machines that have been divided into 10 results per page. If the same list was divided into 50 records per page, there would be only two pages instead of seven pages.

"History Details Shown"



Illustration 7 g01708734

"History Details Shown" preference

(4) "Start Date"

(5) "End Date"

When the page for the "Repair & Maintenance History" of a machine is being viewed, a "Start Date" (4) and an "End Date" (5) may be entered in order to indicate the span of history for viewing. By setting a "History Details Shown" preference, you are setting the default values that will appear in the "Start Date" and "End Date" fields. For example, if you set a "History Details Shown" preference of three months, the "End Date" field will default to the current date and the "Start Date" will default to a date that is exactly three months prior to the current date.

Units

There are two types of preferences for units that can be set:

- "Distance Unit"
- "Fuel Unit"

The first type of preference is the "Distance Unit".

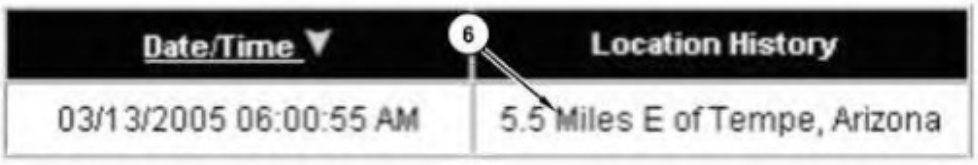


Illustration 8 g01708151

"Distance Unit" preference

(6) "Miles"

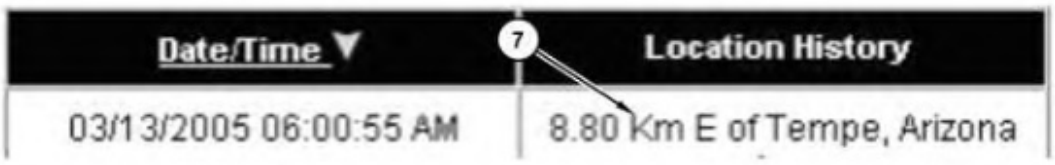


Illustration 9 g01708152

"Distance Unit" preference

(7) "Kilometers"

You may select either "Miles" (6) or "Kilometers" (7) .

The second type of preference that can be set is the "Fuel Unit".

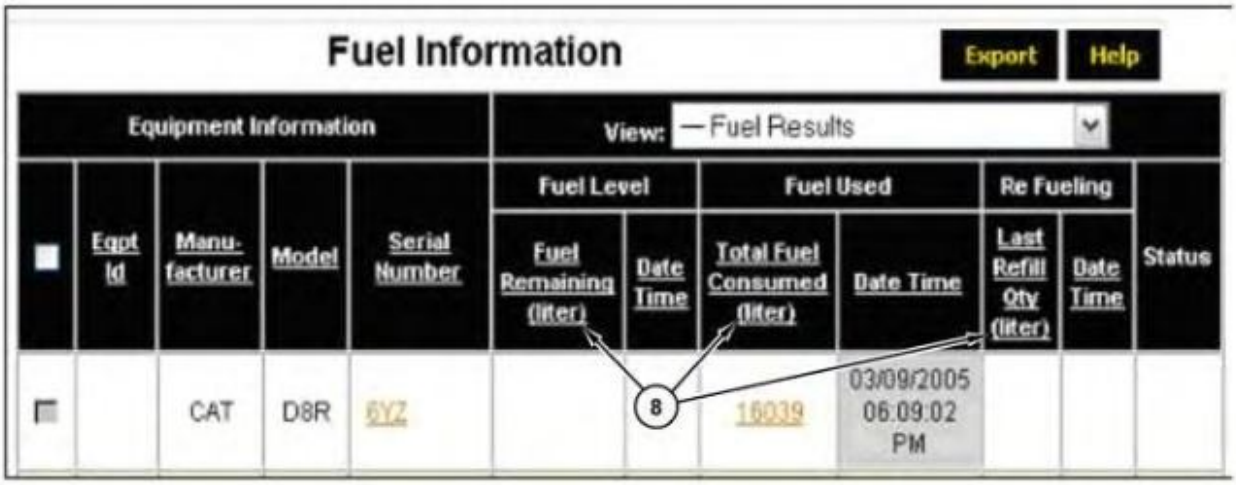


Illustration 10 g01708153

"Fuel Units" preference

(8) Liters

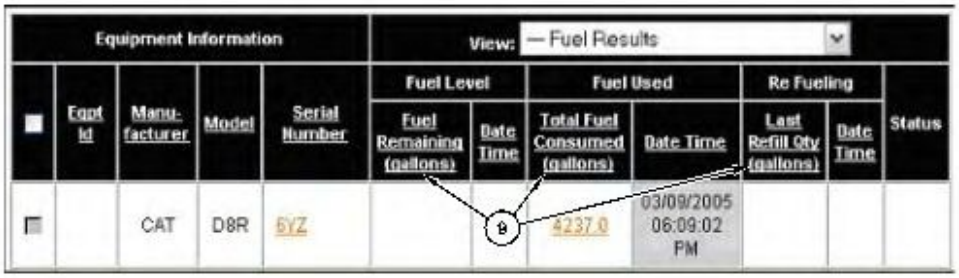


Illustration 11 g01708154

"Fuel Unit" preference

(9) Gallons

You may select either "Liters" (8) or "Gallons" (9) .

Country

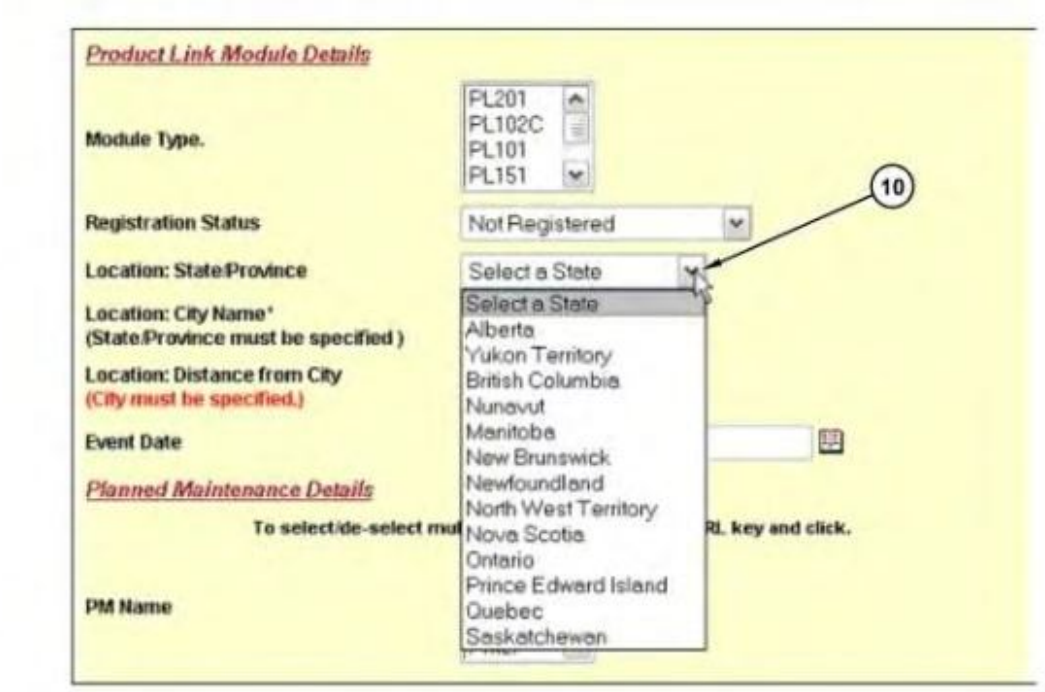


Illustration 12 g01708155

"Product Link Module Details" section of the "Advanced Search" screen

(10) "Location: State/Province" drop-down menu

From the "Set Your Preferences" screen in the "Country" drop-down menu, a country or multiple countries may be selected. The preference for the country or countries will determine the states or provinces that will appear in the "Location: State/Province" drop-down menu (10) on the "Advanced Search" screen. For example, if the preference for a country is set to "Canada", the "Location: State/Province" field will be filled with the Canadian provinces on the "Advanced Search" screen. Refer to Illustration 12.

"Notify Manual Service Meter Maintenance Update"

EquipmentManager can be used to manage "Planned Maintenance" on equipment that does not contain a Product Link Module (PLM). In this case, the dealer or the customer subscribes to Maintenance Watch. With Maintenance Watch and no PLM on the equipment, you must enter the "Service Meter Update" manually. From the "Set Your Preferences" screen in the "Notify Manual Service Meter Maintenance Update" drop-down menu, you may indicate the frequency of notification

from EquipmentManager. This frequency will be used for the entry of data of service meter units for equipment with Maintenance Watch subscriptions. The following values are available: "Weekly", "Monthly", "6 Weeks" and "Never".



Illustration 13 g01708156

The "Planned Maintenance" screen with "Load SMU"

(11) "Load SMU" link

Illustration 13 above displays the "Planned Maintenance" screen for a piece of equipment that has no PLM and a Maintenance Watch subscription. Notice that "Load SMU" link (11) is present in the "Current" column. In order to update the SMU manually, select this link. After clicking this link, the "Manual Maintenance – Service Meter Update" window will be displayed.



Illustration 14 g01708158

"SMU Update" window

(12) Radio buttons

In the "SMU Update" window, the frequency of notification for updating the service meter units can be changed by selecting one of the radio button (12) .

"Display Search Results In"

When you perform a search for EquipmentManager data about a given set of equipment, the display of the results for the search default to the "Event Summary Results Page". By using the "Set Your Preferences" screen, you may change the page of the results from the search that are first displayed. For example, if you use EquipmentManager most often to check the location of your equipment, you can change your "Display Search Results In" preference to "Location/SMU Page". Then, when you perform the next search, the results will be displayed first in "Location/SMU Page".

The following values for the "Display Search Results In" preferences are available:

- "Event Summary Results Page"
- "S·O·S Results Page"
- "Remote Monitoring Report"
- "Utilization Monitoring Report"

- "Planned Maintenance Page"
- "Fault Code Results Page"
- "Time and Geographic Fencing Alarms Page"
- "Location/SMU Page"

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Systems Operation
EquipmentManager Dealer Administrator Manual
Media Number -KENR6304-08 **Publication Date -01/05/2010** **Date Updated -18/05/2010**

i03333061

Asset Watch

SMCS - 7600; 7606

Overview

The Asset Watch subscription is used for monitoring and managing the usage and the location of your equipment.

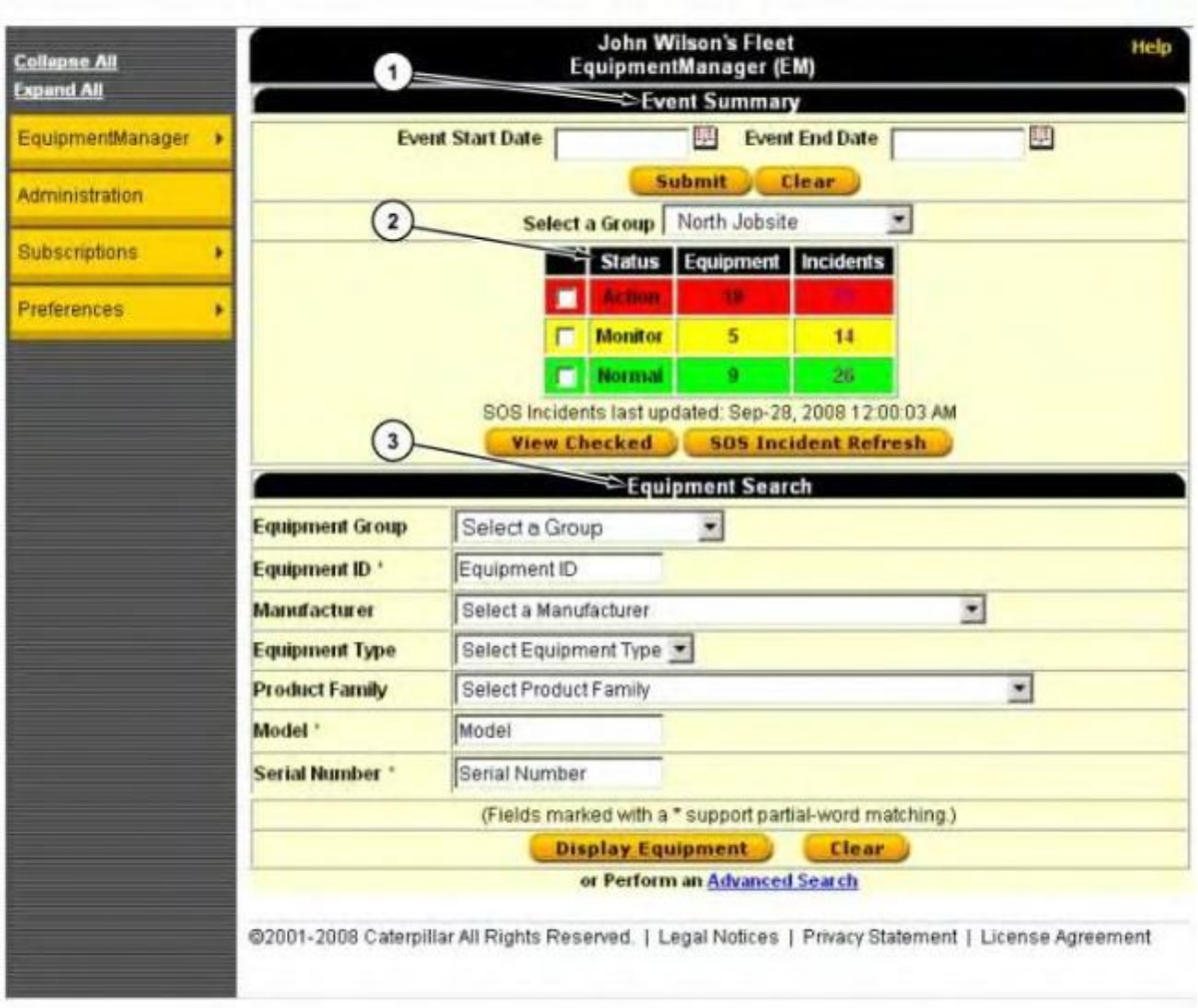


Illustration 1 g01710930

"Exception Dashboard"

(1) "Event Summary" section

(2) "Status" levels

(3) "Equipment Search" section

The default home screen of EquipmentManager is known as the "Exception Dashboard". Refer to Illustration 1. This screen features the following two sections:

- "Event Summary" section (1)
- "Equipment Search" section (3)

"Event Summary"

EquipmentManager allows you to manage your equipment by an exception. There are three "Status" levels (2) of events:

Action (red) - The "Action" status indicates an event that is deemed of the highest importance. "Action" events should be given the most attention and "Action" events should be resolved first.

Monitor (yellow) - The "Monitor" status indicates an event that should have attention, but this event does not require immediate resolution.

Normal (green) - The "Normal" status indicates an event that is deemed of the least importance of the actions that require attention or resolution.

Search Using "Event Summary"

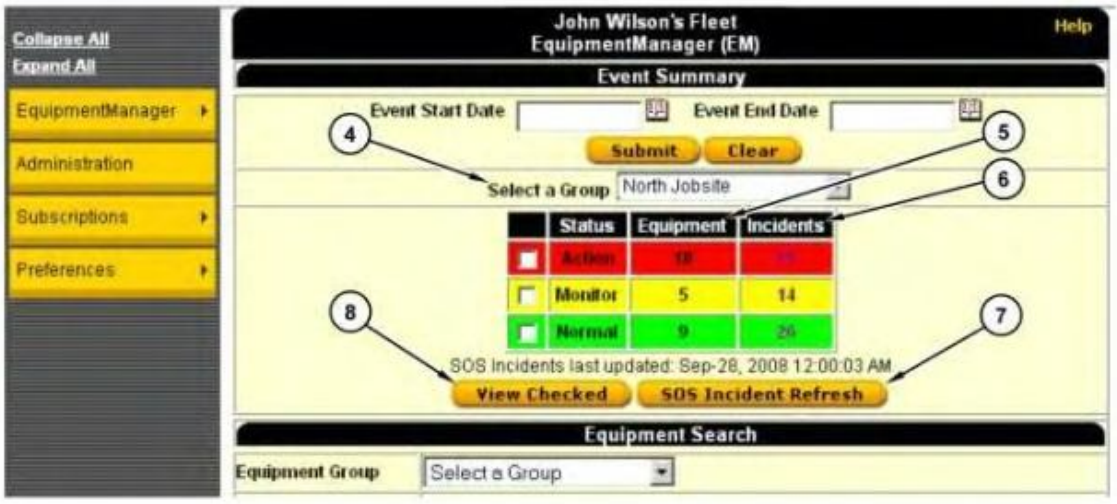


Illustration 2 g01710926

"Event Summary" search with popup text

(4) "Select a Group" drop-down menu

(5) "Equipment" column

(6) "Incidents" column

(7) "S·O·S Incident Refresh" button

(8) "View Checked" button

Perform the following procedure in order to use "Event Summary" section (1) to search for issues and view issues that need to be resolved:

1. Select a group of equipment from the "Select a Group" drop-down menu (4) or select a customer from the "Universal Customer ID" drop-down menu. Once a selection has been made, the "Equipment" column (5) and the "Incidents" column (6) for each "Status" level will be filled with the number of machines and incidents that are outstanding. Refer to Illustration 2.

2. Point to any of the "Incidents" fields for more information of the events that are outstanding and for a count for each level. For example, when you point to the number of incidents in the "Incidents" column (6) , a boxof text will be displayed with a breakdown of the events by category and by quantity.

3. In order to view the detail of the machines with outstanding events, select the check box next to the "Status" level or "Status" levels. Any of the check boxes or all of the check boxes can be selected. Then, click "View Checked" button (8) in order to display results. Results appear on the "Event Summary" screen. Refer to ""Event Summary" Screen" for more information.

   Note: In order to perform a refresh of the S·O·S alerts, press the "S·O·S Incident Refresh" button (7) .

Search Using "Equipment Search"



Illustration 3 g01341562

"Equipment Search"

The lower section of the default EquipmentManager home screen is the "Equipment Search" section (3) . This provides another way to narrow the search of the equipment. This is the same "Equipment Search" form that is used throughout EquipmentManager. Complete at least one of the fields on the form and click "Display Equipment".

"Event Summary" Screen

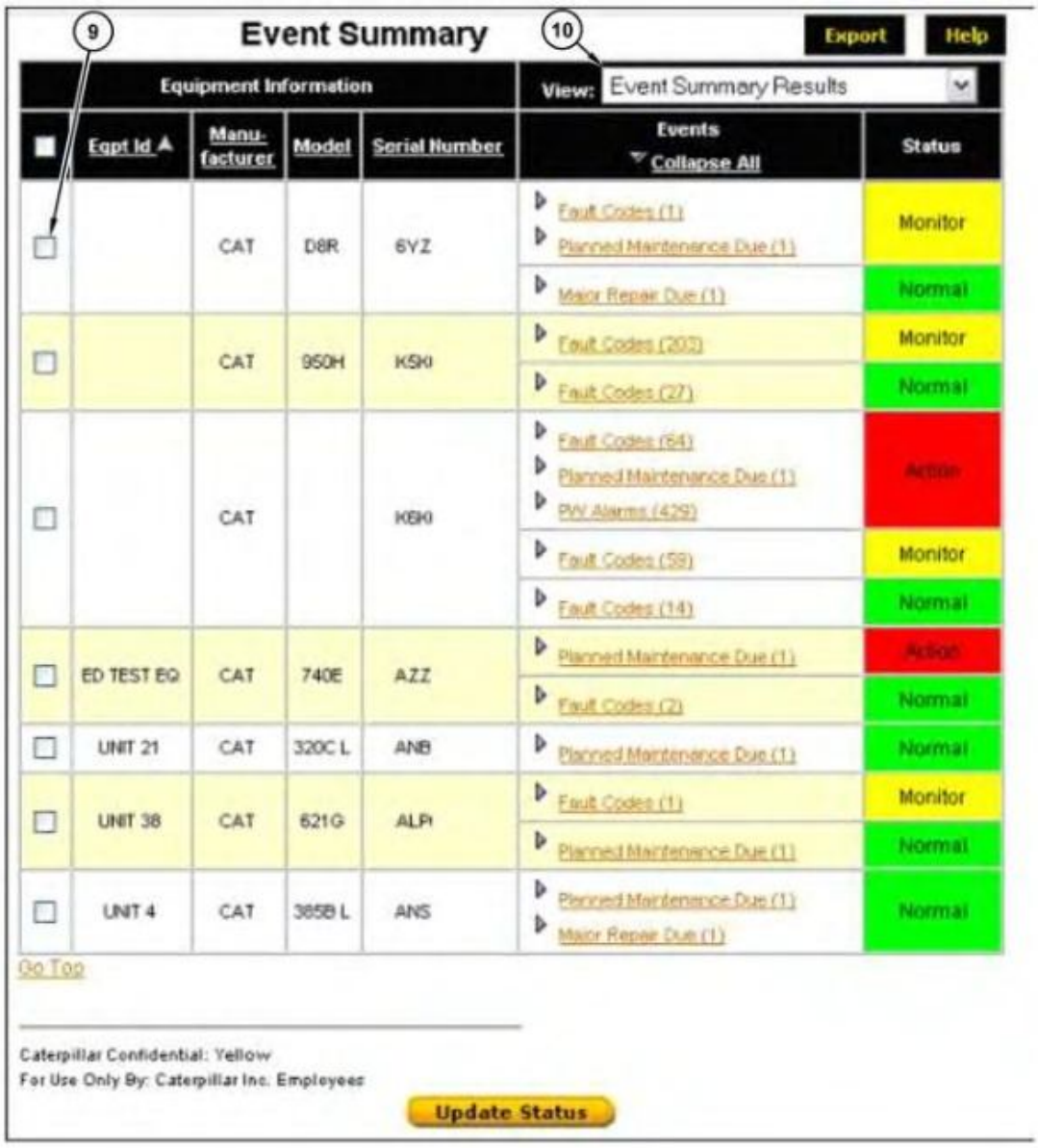


Illustration 4 g01710932

"Event Summary"

(9) Check boxes for the equipment

(10) "View:" drop-down menu

When you perform a search for EquipmentManager data about a given set of equipment, the display of the results default to the "Event Summary" screen. The "Event Summary" table contains the following columns: "Eqpt Id" ("Equipment Id"), "Manufacturer", "Model", "Serial Number", "Events" and "Status".

If a machine has multiple events of the same category, the information can be expanded by clicking the icon that is a blue triangle. This icon will show a brief description of each of the events in that category.

Clicking on the hyperlink of the name of the event will move you to the appropriate detailed screen in EquipmentManager. This screen may be an "Event History" screen, a "Planned Maintenance" screen, a "S·O·S" screen, or another screen.

Select the check box for the equipment (9) in order to update the status. Then, select the "Update Status" button.

Change the view of the results by selecting a option from the "View:" drop-down menu (10) .

Location and Service Meters

On the"Event Summary" screen, select "Location and Service Meters" from the "View" drop-down menu (10) . The "Location and Service Meters" screen will be displayed.

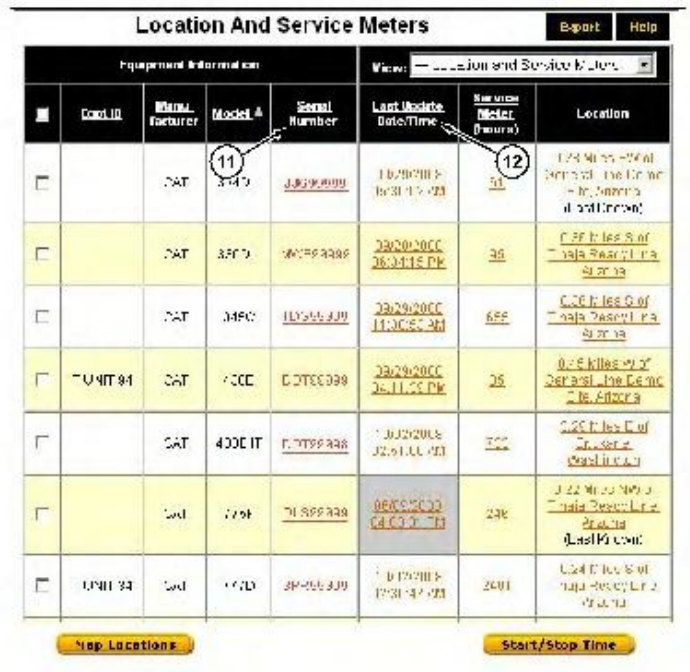


Illustration 5 g01710935

Location and Service Meters

(11) "Serial Number" column

(12) "Last Update Date/Time" column

The links in the "Serial Number" column (11) are linked to the "Equipment Details" screen and the links in the "Last Update Date/Time" column (12) are linked to the "Status History" screen.

"Status History"

The "Status History" is a record of all the status reports that were sent by a Product Link ModulePLM. The "Status" report contains the information about the status of the actual PLM.

To view the "Status History" screen, use the following procedure:

1. From the "Location and Service Meters" screen, click the date of one of the pieces of equipment in the "Last Update Date/Time" column. The "Status History" screen will be displayed.

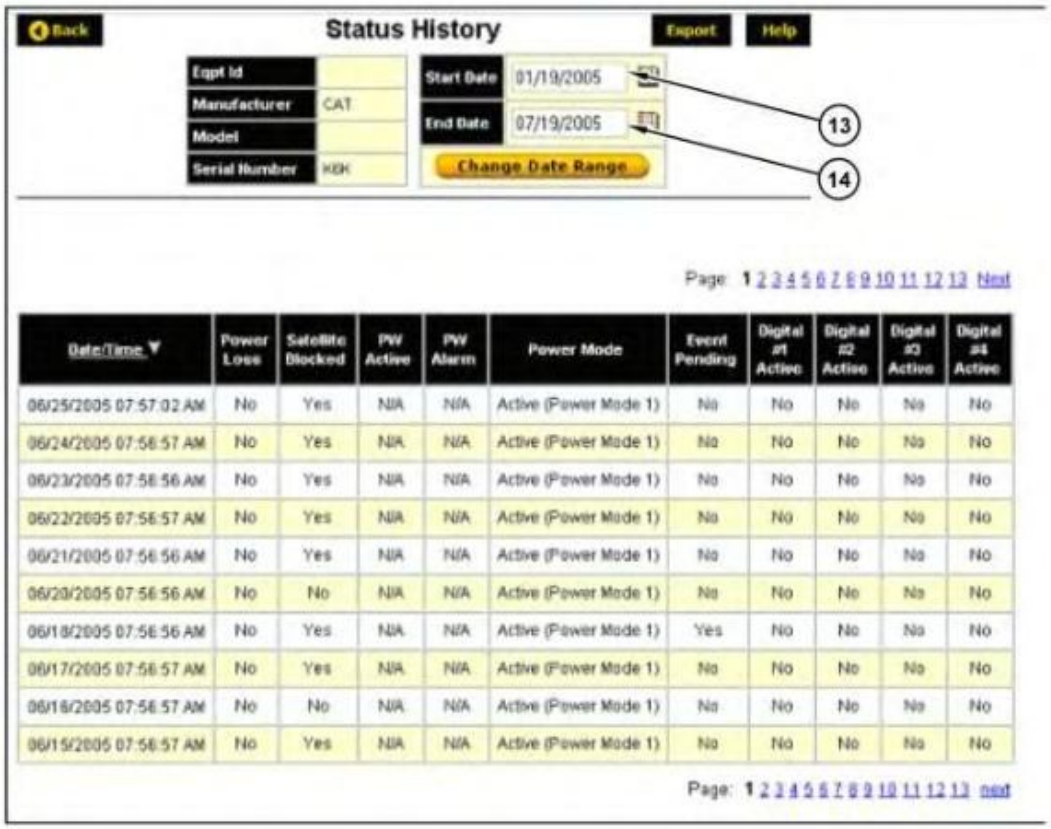


Illustration 6 g01710937

"Status History"

(13) "Start Date" field

(14) "End Date" field

2. The range of the date is set by your preferences. In order to temporarily change the range of the date, click the icon of a calendar that is next to the "Start Date" field (13) and "End Date" field (14) . Then, select a date for indicating a time period for the "Status History".

3. Click the "Change Date Range" button. The "Status History" table will perform a refresh in order to reflect the updated range of the date.

4. Click the "Back" button in order to return to the "Location and Service Meters" screen.

The following table describes the fields that are found on the "Status History" screen.

Table 1

"Status History" screen

Field	Description	Values
"Date/Time"	The date and time of the status report are displayed if the PLM is set to send status once per day. These values should be different by approximately one day for each time.	
"Power Loss" (Low Voltage)	Indicates that the PLM experienced a loss of power or low voltage somewhere between this status report and the last status report.	Yes, No
"Satellite Blocked"	Indicates that the PLM was blocked from the satellite sometime between this status report and the last status report.	Yes, No
"PW Active"	Indicates that "Time and Geographic Fencing" is active.	Yes, No, N/A
"PW Alarms"	Indicates that a "PW Alarm" has occurred sometime between this status report and the last.	Yes, No, N/A
"Power Mode"	Indicates the "Power Mode" of the PLM. Power mode has the following "Status" levels:	
	"Active" (1) – The machine has operated in the last 48 hours.	Active (1)
	"Sleep" (2) – The machine has not operated for greater than 48 hours but less than one week. The PLM will activate every 6 hours in order to send the messages every 6 hours. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Sleep (2)
	"Hibernate" (3) – The machine has not operated for more than one week. The PLM will wake up every 24 hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Hibernate (3)
"Event Pending"	Indicates that an event was recorded and will be sent (PL321 system only).	Yes, No
"Digital # Active"	Indicates that the digital switch is active (PL321 system only).	Yes, No

"Service Meter History"

Use the following procedure in order to view the "Service Meter History":

1. In order to view the "Service Meter History" for a machine, select a service meter reading for a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen.

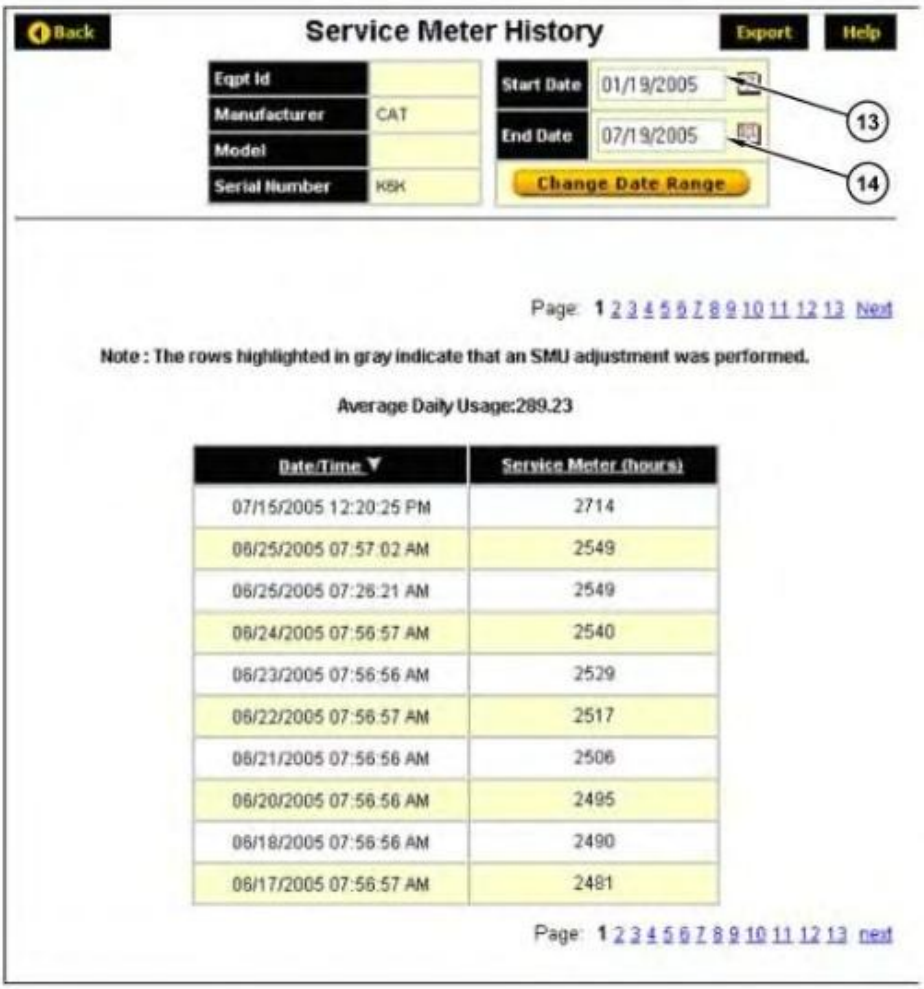


Illustration 7 g01710941

"Service Meter History"

(13) "Start Date" field

(14) "End Date" field

2. Change the range of the date, if necessary. Click "Back" in order to return to the "Location and Service Meters" screen.

"Location History"

Use the following procedure to view the "Location History" of a machine.

1. In order to view the "Location History" for a machine, select the location of a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen.

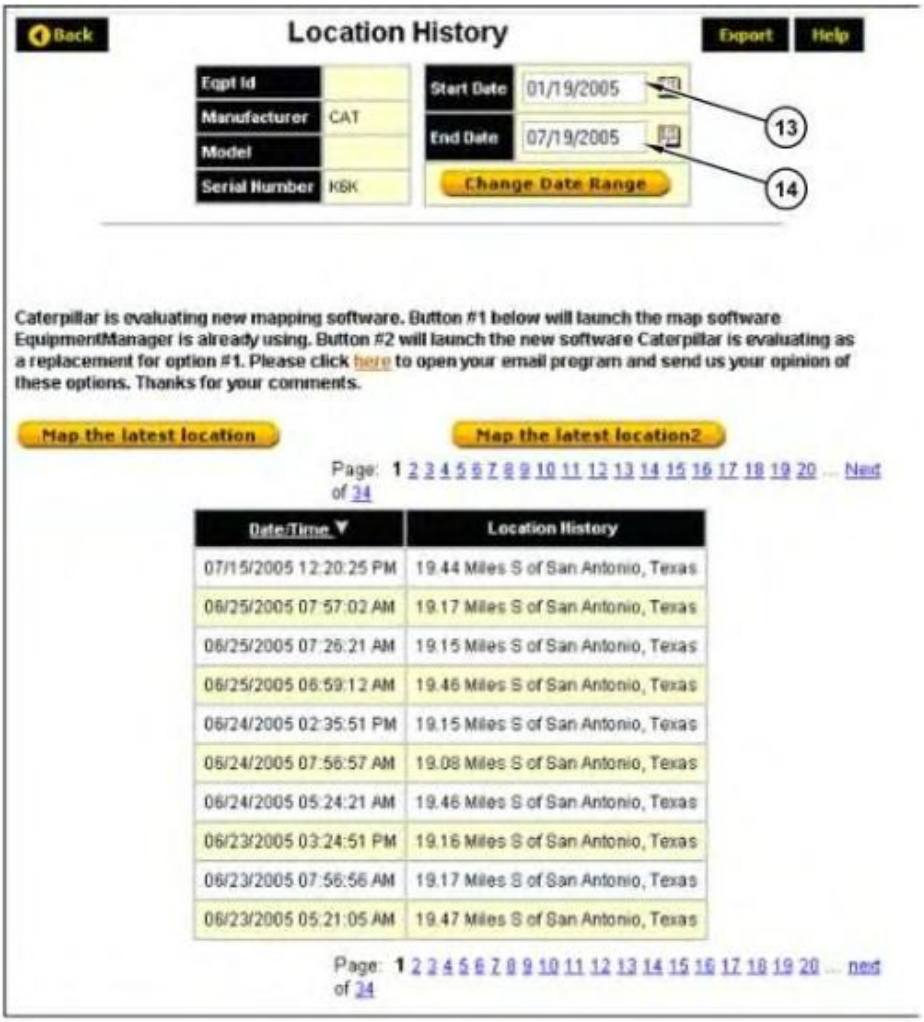


Illustration 8 g01710944

"Location History"

(13) "Start Date" field

(14) "End Date" field

2. The "Location History" screen will appear. Change the range of the date, if necessary. Click "Back" in order to return to the "Location and Service Meter" screen.

"Location Report Frequency"

Product Link is configured to a maximum of four reports of the location per day. The first location report is sent at the Report Start Time. The Position Report Minimum Location Change configuration defines the minimum distance the machine must move since the last report in order for a position report to be sent. If the minimum configured distance has not been met, Product Link will not send a position report. The minimum distance that is permitted is zero meters and the maximum distance is 200 meters. If the parameter is set to zero meters, then the PLM will send a position report 4 times a day regardless of movement. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Manage Hardware", and to Special Instruction, REHS2365, "Product Link PL121SRPL121SR and PL300PL300 Installation Guide".

Last Known Location

If a valid location from the GPS is not obtained in the given time, the last known location will be displayed in EquipmentManager. This "stale" location will be identified with "(Last Known)" in the "Location and Service Meter" view. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Installation Parameters Conifgure" for more information about the GPS Fix Validity Time Duration parameter.

"Map Locations"

There are two options for creating the map of the location of your machine. The machine can be plotted on a map from either the "Location and Service Meters" screen or from the "Location History" screen.

1. In order to view the location of a machine on the map from the "Location and Service Meters" screen that is in the "Equipment Information" section, select the check box next to the machine. Refer to Illustration 5.

2. Click the "Map Locations" button. The "Equipment Location Map" screen will be displayed.



Illustration 9 g01710946

"Equipment Location Map"

(15) Marker for the equipment

3. The location of the machine is plotted on a map with identification of a landmark and a city street. Use the "Zoom In" and "Zoom Out" buttons to change your view of the map. Click near the marker of the equipment (15) that is being viewed in order to center the marker in the window of the map. When you are done, click the "Back" button in the upper left hand corner in order to return to the "Location and Service Meters" screen.

Note: The information of the location will be displayed per user preference. The display for the "Nearest City" will show the location of a machine relative to public landmarks or city centers. The location can also be displayed with the latitude and the longitude. These coordinates can be entered into routing software in order to provide driving directions.

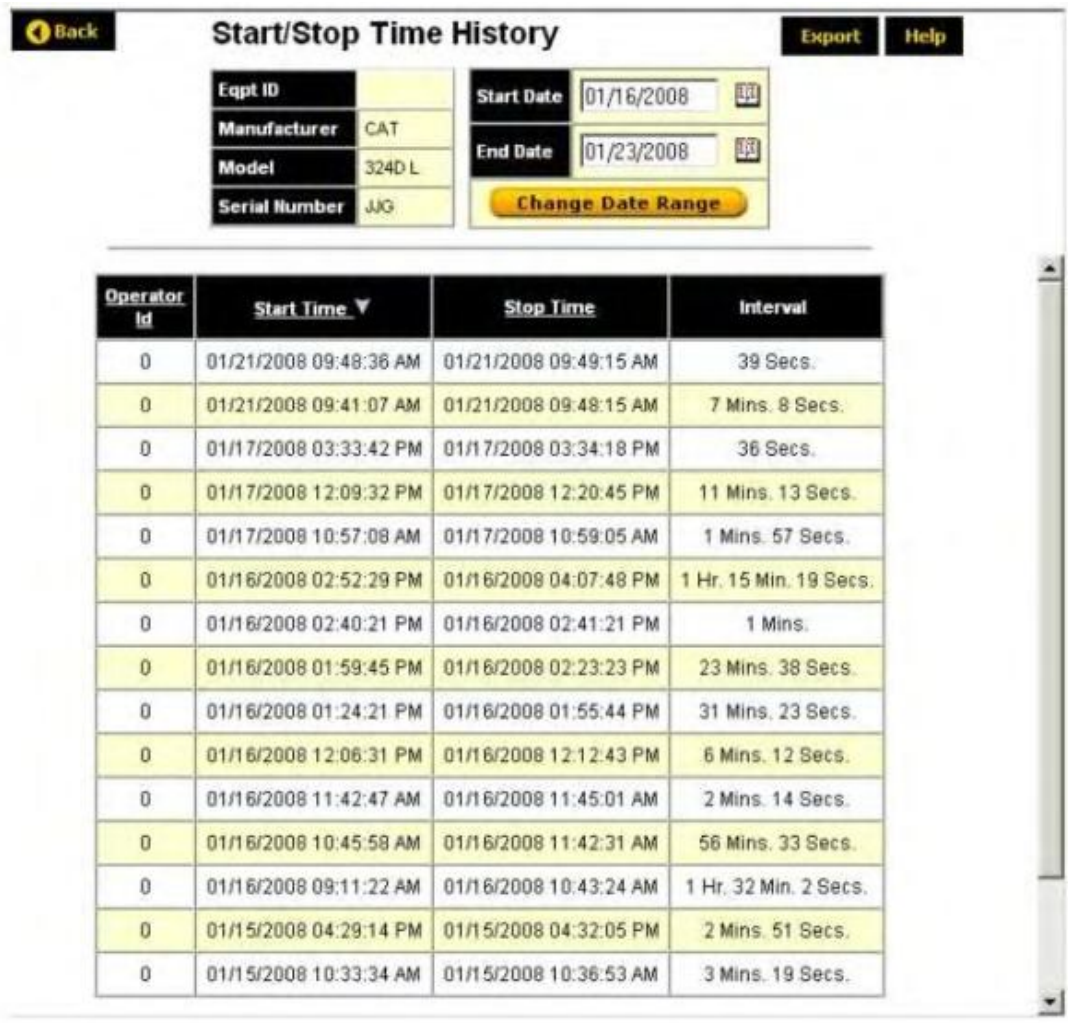
The other way to create the map of the location is from the "Location History" screen.

1. In order to view the "Location History" for a machine, select the location of a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen. Refer to Illustration 5. The "Location History" screen will be displayed. Refer to Illustration 8.

2. Click the "Map the latest location" button. The "Equipment Location Map" screen will be displayed. Refer to Illustration 9.

Note: Click "Map the latest location" button in order to start the EquipmentManager software for maps that is being used currently. Click "Map the latest location 2" in order to start the new software that is being considered by Caterpillar as a replacement to option 1. Click on the "here" link in order to send your comments to Caterpillar about the mapping software.

"Start/Stop Time History"



Operator Id	Start Time ▼	Stop Time	Interval
0	01/21/2008 09:48:36 AM	01/21/2008 09:49:15 AM	39 Secs.
0	01/21/2008 09:41:07 AM	01/21/2008 09:48:15 AM	7 Mins. 8 Secs.
0	01/17/2008 03:33:42 PM	01/17/2008 03:34:18 PM	36 Secs.
0	01/17/2008 12:09:32 PM	01/17/2008 12:20:45 PM	11 Mins. 13 Secs.
0	01/17/2008 10:57:08 AM	01/17/2008 10:59:05 AM	1 Mins. 57 Secs.
0	01/16/2008 02:52:29 PM	01/16/2008 04:07:48 PM	1 Hr. 15 Min. 19 Secs.
0	01/16/2008 02:40:21 PM	01/16/2008 02:41:21 PM	1 Mins.
0	01/16/2008 01:59:45 PM	01/16/2008 02:23:23 PM	23 Mins. 38 Secs.
0	01/16/2008 01:24:21 PM	01/16/2008 01:55:44 PM	31 Mins. 23 Secs.
0	01/16/2008 12:06:31 PM	01/16/2008 12:12:43 PM	6 Mins. 12 Secs.
0	01/16/2008 11:42:47 AM	01/16/2008 11:45:01 AM	2 Mins. 14 Secs.
0	01/16/2008 10:45:58 AM	01/16/2008 11:42:31 AM	56 Mins. 33 Secs.
0	01/16/2008 09:11:22 AM	01/16/2008 10:43:24 AM	1 Hr. 32 Min. 2 Secs.
0	01/15/2008 04:29:14 PM	01/15/2008 04:32:05 PM	2 Mins. 51 Secs.
0	01/15/2008 10:33:34 AM	01/15/2008 10:36:53 AM	3 Mins. 19 Secs.

Illustration 10 g01458443

"Start/Stop Time History" is available if the PLM is configured to record the history. "Start Time" and "Stop Time" details are available when the equipment "Serial Number" will be displayed in bold print.

1. In order to view the "Start/Stop Time History" screen for a machine, select the check box next to the machine. Refer to Illustration 10.

2. Click the "Start/Stop Time" button. The "Start/Stop Time History" screen will be displayed.

   Note: If Machine Security System is installed, the "Key ID" will be displayed in the "Operator Id" column in EquipmentManager.

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Systems Operation
EquipmentManager Dealer Administrator Manual
Media Number -KENR6304-08 **Publication Date -01/05/2010** **Date Updated -18/05/2010**

i02943044

Time Fence and Geographic Fence

SMCS - 7600; 7606

Types of Fences

During normal working conditions, machines can move in and out of yards. Machines can also move to different job sites. A machine will not normally travel beyond a designated work area. The EquipmentManager software will record the location of a machine as history, unless the machine travels beyond the normal work area.

The EquipmentManager software uses time fencing and geographic fencing to trigger some action if a machine travels beyond a designated work area. Time fencing and geographic fencing use inclusive geographic functions, exclusive geographic functions, and functions that are based on time.

Inclusive Geographic Fencing

By applying an inclusive geographic fence to your equipment, any movement of the equipment beyond a predetermined geographical boundary can trigger an alarm. The alarm will indicate when a machine moves beyond a predetermined geographical area.

Exclusive Geographic Fencing

By applying an exclusive geographic fence to your equipment, any movement of the equipment within a predetermined geographical boundary can trigger an alarm. The alarm will indicate that the equipment is inside of a predetermined geographical area.

Time Fencing

By applying a time fence to your equipment, any operation of the equipment beyond a predetermined period of time can trigger an alarm. The alarm will indicate that the equipment is operating beyond a predetermined period of time.

"Time and Geographic Fencing" Screen

Access the "Time and Geographic Fencing" Screen

Use the following procedure to access the "Time and Geographic Fencing" configuration screen.

1. Search for equipment and view the results in the "Event Summary" screen.

2. In the "View" box, select "Time and Geographic Fencing". The "Time and Geographic Fencing" screenwill appear.



Illustration 1 g01397849

View "Time and Geo. Fence Alarm History"

To view a history of time fencing and geographic fencing alarms for a machine, use the following procedure:

1. Access the "Time and Geographic Fencing" screen.
2. View the "Latest Time and Geo. Fence Alarms" column. Select one of the following links in order to view the information for that machine:

   "view history details" - This link displays previous alarms that have been resolved. The data from the alarm is now stored for historical reference.

   "Time and Geo Fence Alarms" - This link displays data for a current alarm. This link will also show the status of an alarm that has been resolved if the alarm has not been updated.



Illustration 2 g01397851

3. Click on a link in the "Fence Description" column in order to view details of the configuration of the fence. The map on the screen will include the fence as well as the location of a machine at the time of an alarm.

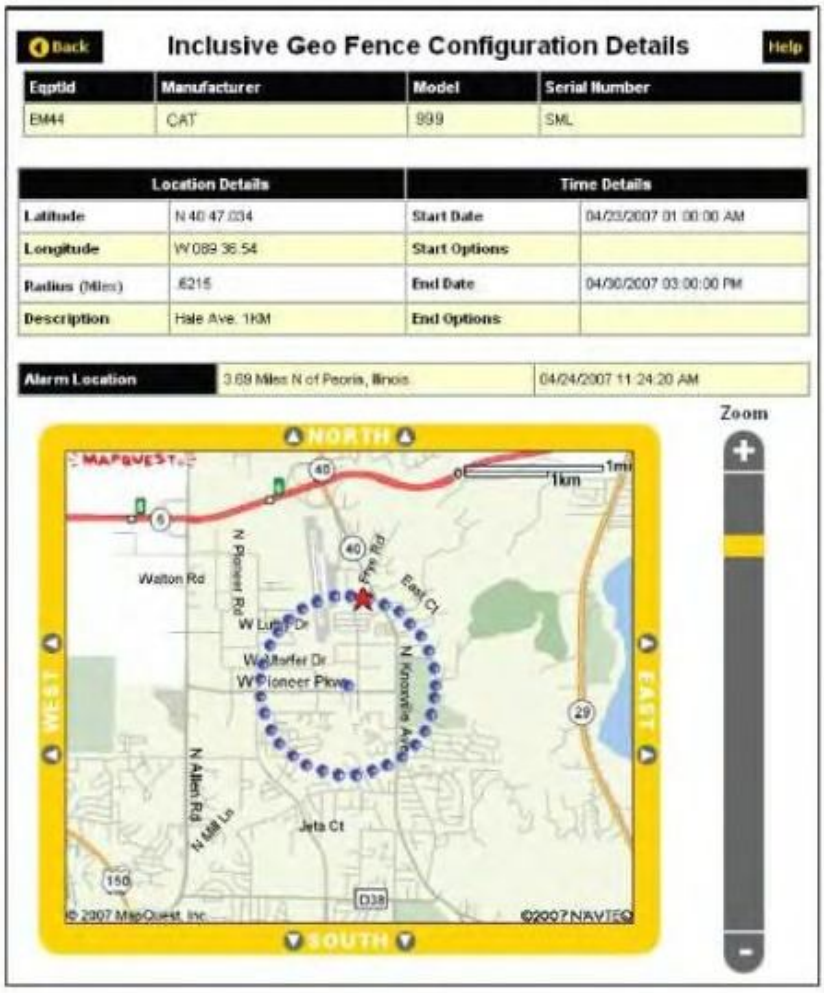


Illustration 3 g01397852

Note: Product Link sends an alarm message immediately when the radius of a fence is violated. However, the speed of a machine may cause the machine to appear closer to the radius of a fence in the map view. For example, a machine traveling at normal road speeds of 40 mph or more may display a fence violation at a location as far as a couple of city blocks from the actual point of the fence violation. After the initial alarm, a subsequent alarm will be sent each day that the equipment remains outside of the radius of the fence. This subsequent message is sent with the first message of each day.

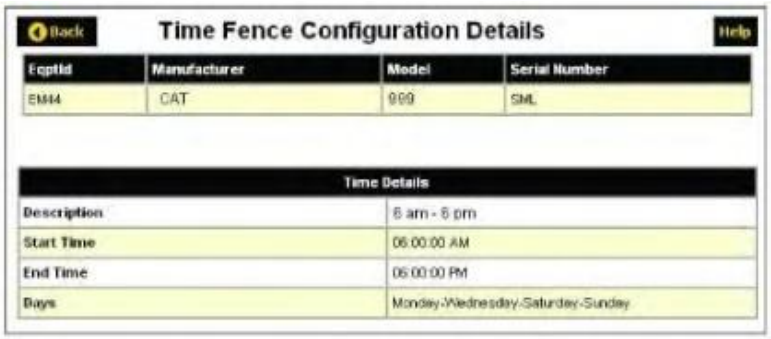


Illustration 4 g01397855

"Update Status"

The EquipmentManager software enables you to update the status of an alarm for time fencing and geographic fencing. If you update the status of the alarm to "Resolved", the status will no longer appear on the "Event Summary "screen. Also, the status will no longer appear on the EquipmentManager home screen. The EquipmentManager home screen is also referred to as the "Exception Dashboard".

To update the status of an alarm in time fencing and geographic fencing, use the following procedure:

1. Navigate to the "Time and Geographic Fencing" screen. Locate the row with the information about your equipment. Click in the box to the left of the equipment.



Illustration 5 g01397856

Note: You can also update the status of an alarm for time fencing and geographic fencing from the "Time and Geo. Fence Alarm History" screen.

2. Click the "Update Status" button at the bottom of your screen. The "Update Status" window will appear. In the "Update Status" menu, select the status for your equipment. Refer to Table 1 for a list of the "Update Status" options.

   Note: "Resolved" will not be displayed on the "Event Summary" screen or on the "Exception Dashboard" screen. However, the details of the alarm are stored in History.

Table 1

"Status"	**"Color"**	**"Importance"**
"Action"	"Red"	"Highest"
"Monitor"	"Yellow"	"Medium"
"Normal"	"Green"	"Lowest"
"Resolved"		



Illustration 6 g01397858

Note: The Status can be changed to any value. A status of "Action", "Monitor", or "Normal" enables the event to remain outstanding. This state will be reflected on the "Exception Dashboard" screen and on the "Event Summary" screen.

3. Click in the box under the "Notes/Comments" column.
4. Type a message in order to describe the reason for the update. The message should describe actions that were taken in order to address the event.
5. Click "Save" in order to update the status of the alarm .

"Setup Fence"

The "Setup Fence" screen allows you to configure the following: inclusive parameters for the fence, exclusive parameters for the fence and parameters for time for the fence. The procedures that follow will demonstrate the features of the "Setup Fence" screen.

Preliminary Steps

1. Navigate to the "Time and Geographic Fencing" screen. Locate your machine from the list of machines. Click in the box in the left hand column next to your machine in order to configure the fence for that machine.
2. Click the "Setup Fence" button. The "Setup Fence " configuration screen will appear. This screen will allow you to add fences for the selected machine. Determine the type of fence required for the application. Follow the procedure for the type of fence selected in order to configure the fence for the machine.

Add Inclusive Geographic Fence

To create an inclusive geographic fence in a map, use the procedure that follows.



Illustration 7 g01397859

1. View the "Inclusive" section of the "Setup Fence" configuration screen. Select the radio button next to the fence that is to be to configured.

   Note: The color on the "Fence Radius" slider coincides with the selected fence.

2. Type a description for the new fence in the "Description" field.

3. Use one of the following methods in order to define the center of a geographic fence:

   - **Click a point on the map.** To help establish the desired location, you can use the "Zoom" tool to the right of the map. You can also use the "North", "South", "East", and "West" buttons. These buttons are located on the borders of the map.

   - **Click on the icon of the magnifying glass.** This method enables you to enter a street address, city, state, and/or zip code. Note that this option is only available in North America.

4. In order to configure the radius of the fence, drag the "Fence Radius" slider to the appropriate location.

   Note: The radius of the fence is displayed in kilometers. If your "Units of Measure" preference is miles, the fence will be configured in kilometers, converted to miles, and then displayed in miles.

"Show/Hide Fence" Button

The radius of the fence will be drawn on the map in order to provide a visual reference for the parameters of the fence. Click the "Show/Hide Fence" button in order to hide a fence. Also click the "Show/Hide Fence" button in order to show a fence. This button is located to the left of the "Description" box.

Load Description Button

You can load an existing fence with the load fence button. This button is located to the right of the "Description" field.

Configure Exclusive Geographic Fence



Illustration 8 g01397861

To configure an exclusive geographic fence with a map, use the following procedure:

1. View the "Exclusive" section of the "Setup Fence" screen. Click the radio button in the exclusive section.

   Note: The color on the indicator for the "Fence Radius" bar will be the same color as the selected fence.

2. Type a description for the new fence in the "Description" field.

3. Use one of the following methods in order to define the center of the geographic fence:
    - **Click a point on the map.** To help establish the desired location, you can use the "Zoom In" and the "Zoom Out " buttons to the right of the map. You can also use the "North", "South", "East", and "West" buttons on the borders of the map.
    - **Click on the icon for the magnifying glass.** This method enables you to enter a street address, city, state, and/or zip code. Note: This option is only available in North America.
4. Configure the radius of the fence. Drag the "Fence Radius" slider to the appropriate location.

    Note: The radius of the fence is displayed in kilometers. If your "Units of Measure" preference is miles, then the fence will be configured in kilometers, converted to miles, and then displayed in miles.
5. You can configure up to five exclusive geographic fences. To add additional fence configurations, click the "Add Fence" button. Repeat the previous steps in order to configure the parameters of each additional fence.

Note: You can also add existing fences with the load description button.

Configure a Time Fence

To configure a time fence, use the following procedure:

1. At the top of the "Setup Fence" screen, click the "Time" tab.
2. In the row for "Days", select the days of the week for which you want the fence to apply.
3. In the "Description" field, enter a description of the time fence.
4. Click "Save".



Illustration 9 g01397864

You can also add existing time fences using the "Load Descriptions" button. For detailed instructions for using this function, refer to Systems Operation, KENR6302, "EquipmentManager User Guide", "Time Fence and Geographic Fence" .

Time and Geographic Fencing Setup Confirmation

To confirm your settings for the time fences, use the following procedure:

1. Click "Save" on the "Time and Geographic Fencing Setup - Edit" screen. A confirmation message appears.



Illustration 10 g01397877

2. Click "OK". The Time and Geo Fence Setup Confirmation screen appears. This screen displays the details of all the fences that you have added. This screen also notifies you that these details will be updated in the database.

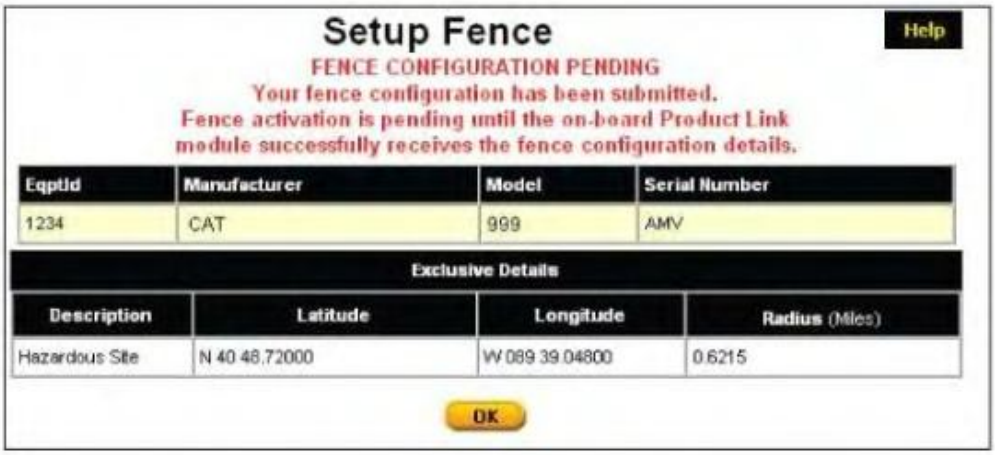


Illustration 11 g01397880

3. Click "OK". The Time and Geo Fence Setup Confirmation screen displays a red success message.

Configuration History

Once a fence is configured with Setup Fence, the fence configuration is sent via satellite to the Product Link module on the machine. The fence state is "Pending" until the onboard configuration completes and a confirmation is received in the EquipmentManager software.

The state of recently configured fences is displayed as an icon in the "Config History" field. The type of icon indicates one of the following states:

Yellow Hour Glass - Pending

Green Check Mark - Successful

Grey Stop Watch - No new activity

The Pending or the Successful icons will be viewable for seven days after the configuration parameters have been sent to the Product Link module. After seven days, the "Successful" status will revert to the grey stop watch icon. If a pending configuration is not confirmed within the seven day time period, then Caterpillar recommends that a new configuration be sent.

To view details of the configuration history, click the icon in the "Config History" column. The Time and Geographic Fencing Configuration History screen appears.

Table 2 lists the descriptions of each of the fields that are in this screen.



Illustration 12 g01397882

Table 2

Field	Description
Request Type	The type of fence that had been configured. Click the link to view configuration details.
Fence Description	The description provided for the fence configured fence.
Configuration Date	The date of the configuration: **Bold Date** – Date the fence was configured in the EquipmentManager software. **Normal Date** – Date Product Link accepted the fence configuration.
State	The state of the configuration request: **Pending** – Yellow hour glass **Successful within the last 7 days** – Green check mark **Successful but older than 7 days** – Grey stop watch

A configuration will remain in the "Pending" state if the machine cannot be reached via satellite. If this condition occurs, ensure that the master switch is closed and that the machine has a clear view to the sky.

If Product Link is not able to receive the message, then the satellite network will continue to try to resend the message for up to one hour. If the message is not received within one hour, then the satellite network will retain the message for five additional days.

The message delivery will be attempted again once Product Link is detected on the network and is sending and receiving messages. After five days, the configuration will no longer be retained and there will be no further attempts to deliver the message to the Product Link module.

Enable and Disable

Once you have configured a machine to use time or geographic fences, remember that those fences are enabled by default. By opening the Enable/Disable screen, you can enable or disable the applied fences.

In order to enable or to disable a time or geographic fence, use the following procedure:

1. Locate the "Equipment Information" section on the **Time and Geographic Fencing** screen.
2. Select the check box that is adjacent to the machine you wish to enable or to disable.
3. Click "Enable/Disable". The "Enable/Disable" screen appears.

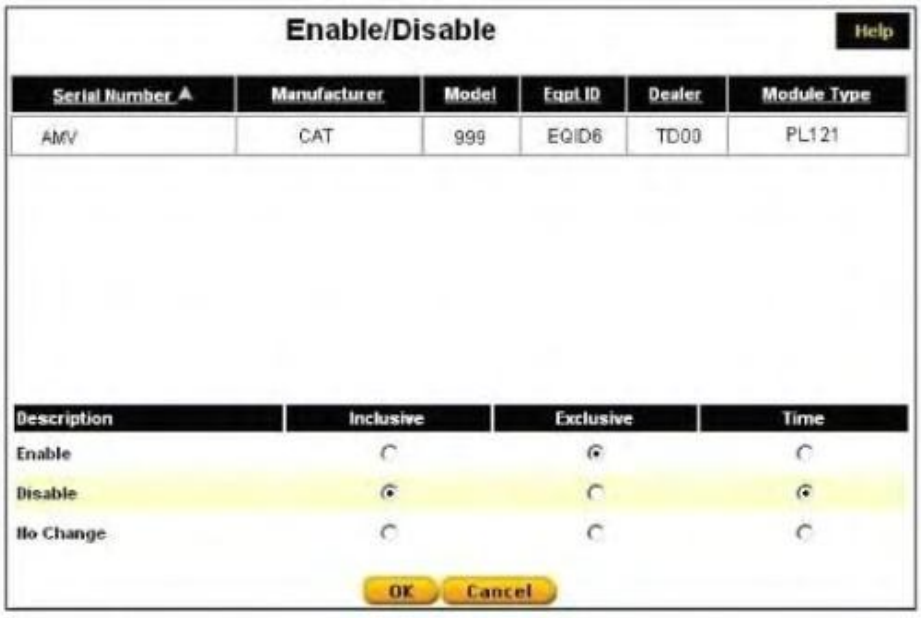


Illustration 13 g01397885

4. Perform the desired action to the Inclusive, Exclusive, or Time fences that are applied to this machine:

   Click on the actions listed below in the appropriate column:

   Enable - This option sends an active fence command to the Product Link module that is on the identified machine.

Disable - This option sends a command to disable an active fence to the Product Link module on the identified machine.

No Change - Select this option if you do not want to send a status change for the chosen fence to the Product Link module on the identified machine.

5. Click "OK" when you have completed all of the appropriate actions. The Enable/Disable Confirmation screen appears. This screen confirms that your changes will be sent to the machine's Product Link module. The changes will be sent as soon as communications with the satellite network can be completed.

   Note: Communication can be completed assuming the machine is running or that the master switch is closed.



Illustration 14 g01397887

6. Click "OK" on the "Enable/Disable Confirmation" screen.

   The Enable/Disable Confirmation screen displays a red success message. This message confirms that the changes will be reflected in the Enable/Disable screen. This screen will list the changes when the confirmation message is returned to the EquipmentManager software from the machine's Product Link module.



Illustration 15 g01397888

Fence Alarm Messages

After the fences have been set, the alarm for the associated fence is triggered. The alarm will occur when the machine crosses the defined fence.

Initial Alarm Message

This message is sent at the time of the fence violation by all supported Product Link modules regardless of the type of module. The supported modules include PL151, PL201, PL121, and PL321.

PL121 only - The EquipmentManager software will not display an alarm on consecutive days (regardless of active status) unless the machine leaves the work site or the machine enters a restricted area again.

PL321 only - If the alarm is still active on consecutive days, the EquipmentManager software will display a new Product Watch Event. The EquipmentManager software will send the appropriate event reaction once with the daily standard message. The EquipmentManager software will send the appropriate event reaction the next time the alarm is activated.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121/321", for more information about the PL121 and PL321 alarms.

Subsequent Alarm Message

A subsequent alarm message may be sent while the Product Link module remains in the alarm state.

The following conditions will cause a subsequent alarm message. The type of message that is sent will depend on the type of Product Link module and the version of software that is on the module.

- **Daily** – The alarm message will be included in the Daily Status Message.
- **Accumulative** – If multiple fences are configured, and a fence is in an alarm state, then all fence alarms will be sent with any alarm message.
- **Machine Start** – While the modules remain in an alarm state, subsequent alarm messages are sent each time that a machine is started.

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EquipmentManager Dealer Administrator Manual
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i02786572

Maintenance Watch

SMCS - 7600; 7606

Overview

Maintenance Watch provides many features that will aid in a proactive maintenance program for your equipment. With a Maintenance Watch subscription, EquipmentManager applies to a machine, the Caterpillar recommended Preventative Maintenance Schedule including intervals, checklists, and part lists. The Maintenance Watch subscription offers the following feature.

- Reports the last PM date and the adherence to the PM schedule
- Builds reference history for use in future repairs
- Schedules the next PM in on-line calendar automatically
- Sends alerts for missed PMs
- Provides PM checklist access
- Contains checklists of predefined PM procedures
- Generates list of parts that are required to complete the PM
- Enables ordering PM parts through the PartStore

Note: Maintenance Watch can be purchased without purchasing Asset Watch.

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Planned Maintenance

SMCS - 7600; 7606

In order to access the "Planned Maintenance" screen, use the following procedure:

1. Search for equipment and view results on the "Event Summary" screen.
2. Select the "Planned Maintenance" option from the "View:" drop-down menu.

   The "Planned Maintenance" screen will then appear.

PM History

By using Maintenance Watch, you can view a record of all previous procedures for the PM that were performed on the equipment and the procedures that were entered through EquipmentManager. In order to view the PM history, use the following procedure:

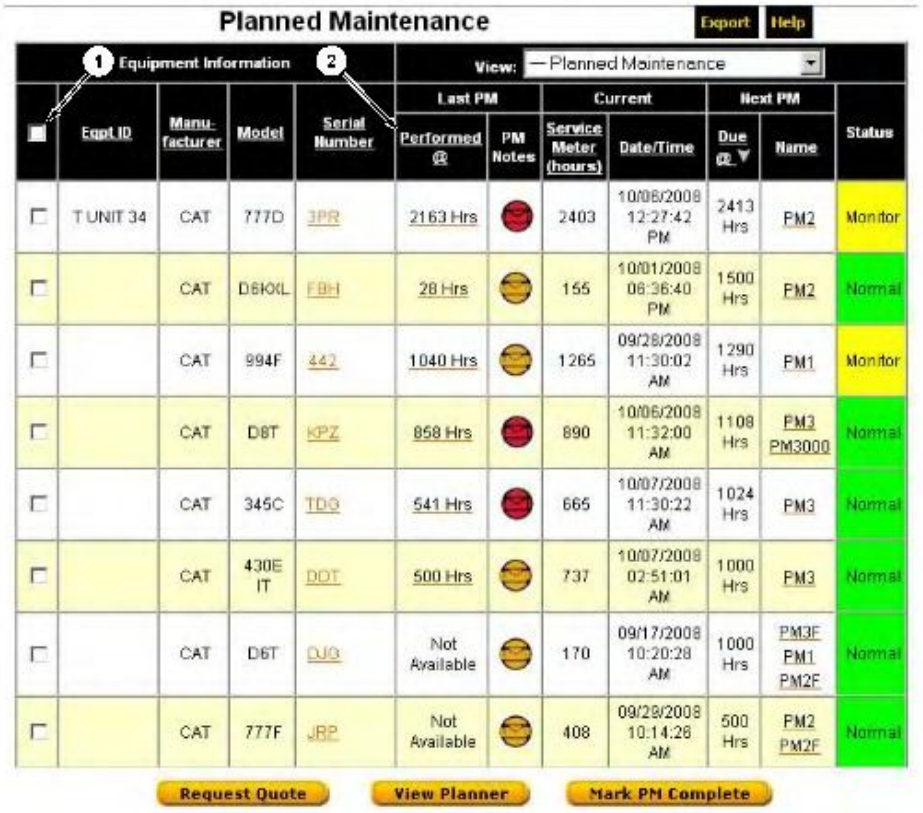


Illustration 1 g01711296

"Planned Maintenance" screen

(1) Check box

(2) "Performed @" column

1. From the "Planned Maintenance" screen, click the number in the "Performed @" column (2) under the "Last PM" column if the number is available.

   The "Planned Maintenance (PM) History" screen will be displayed.

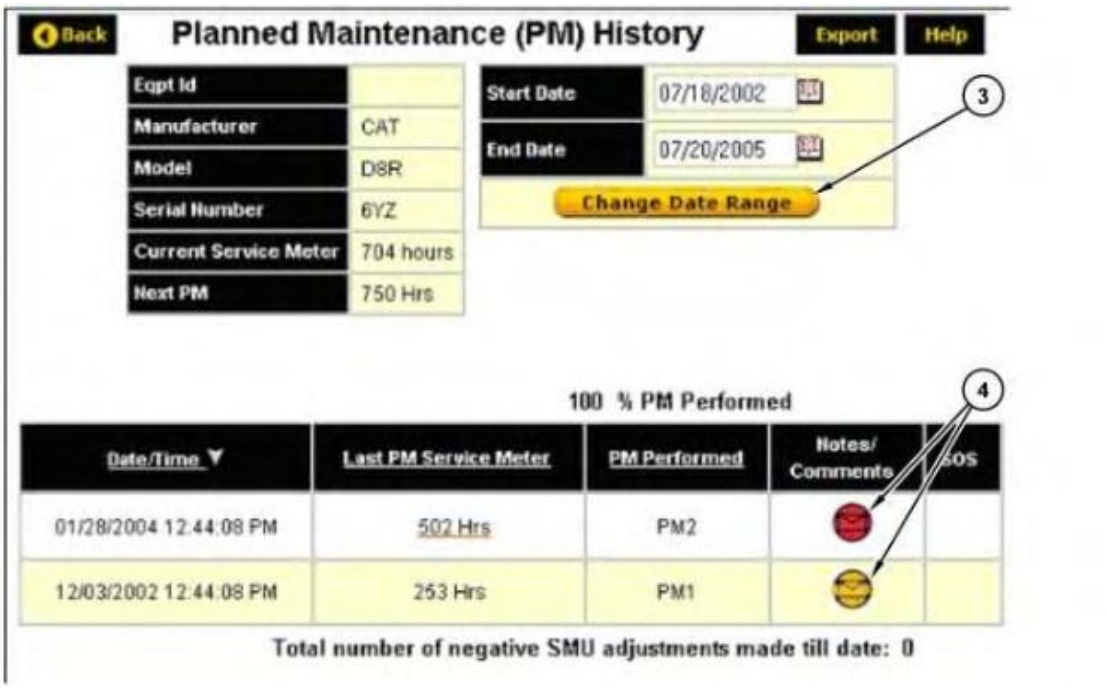


Illustration 2 g01716414

"Planned Maintenance (PM) History"

(3) "Change Date Range" button

(4) Icon of an envelope in a circle

2. Click the icon of a calendar next to the "Start Date" and "End Date" fields. Select a date in order to indicate a time period for the PM history.

3. Click the "Change Date Range" button (3) . The table for the PM history will be loaded again in order to reflect the updated range for the date. The "Change Date Range" function works similarly in many views or screens throughout the application.

"PM Notes"

When a "Planned Maintenance" is completed in EquipmentManager, a field is provided in order to enter notes that pertain to the performed maintenance. On the "Planned Maintenance" screen, the notes for the last "Planned Maintenance" can be viewed.

Use the following procedure in order to view the "PM Notes" and/or update the "PM Notes":

1. From the "Planned Maintenance (PM) History" screen, click the icon of an envelope in a circle (4) that is in the "Notes/Comments" column. The icon will be either red or yellow. Refer to Illustration 2. The "PM Notes" window will appear.



Illustration 3 g01716415

PM Notes

2. If you wish to update the notes, edit notes or add notes in the "PM Notes" text field.
3. Click the "Save" button.

Note: If the icon for the PM note is yellow, the "PM Notes" window does not currently contain notes. If the icon for the PM note is red, the "PM Notes" window contains notes.

Note: The "PM Notes" will attach to the bottom of the checklists for the next "PM Due".

"Past Due" PM

EquipmentManager can be set to send an alert if EquipmentManager schedules a "Planned Maintenance" that is based upon the SMU or the date and that PM passes without being performed. The past due PM details can be accessed from the "Planned Maintenance" screen.

In order to view the procedures for the PM that have been missed, use the following procedure:

1. From the "Planned Maintenance" screen, click "Past Due" in the "Next PM: Due @" column. Refer to Illustration 1. The "Past Due" window will appear.



Illustration 4 g01393298

"Past Due" window

2. In order to close the window, click the "Close Window" button.

PM Checklist

With a Maintenance Watch subscription, a "Planned Maintenance Checklist" can be displayed.

In order to view a PM checklist, use the following procedure:

1. In order to view a PM, click the PM in the "Next PM: Name" column from the "Planned Maintenance" screen. Refer to Illustration 1. The "Planned Maintenance (PM) Checklist" screen will be displayed.

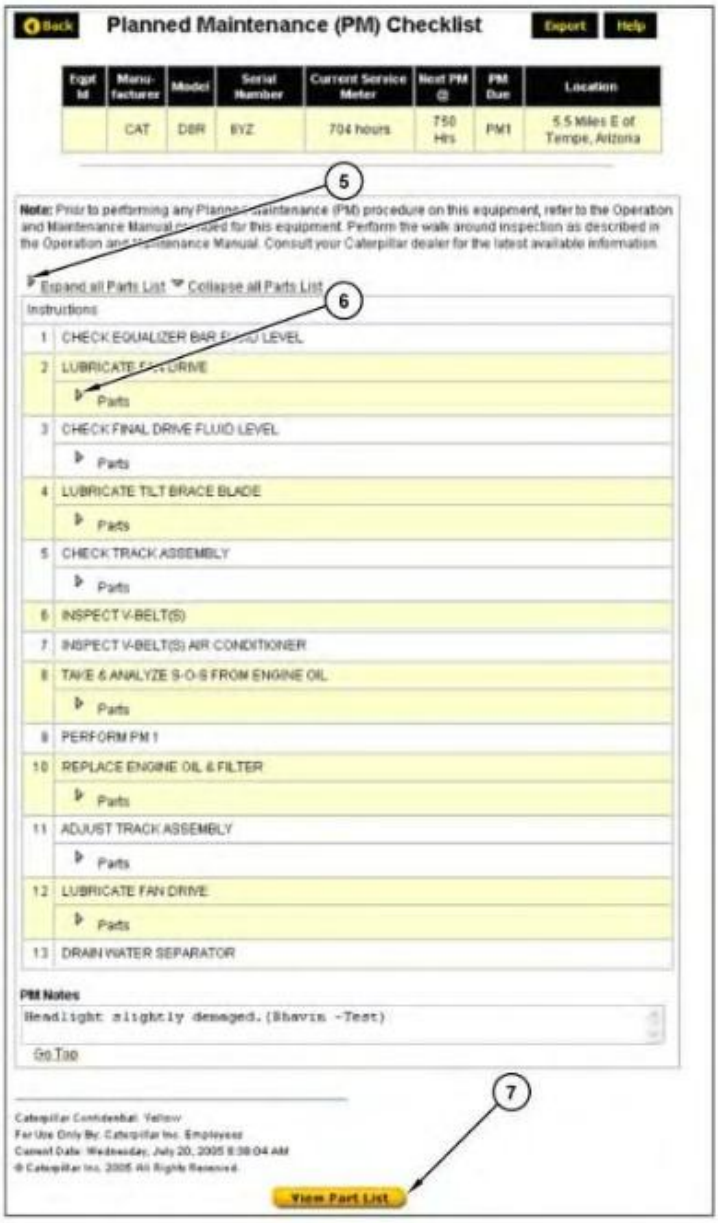


Illustration 5 g01716417

"PM Checklist"

(5) "Expand all Parts List" icon

(6) Icon of a triangle

(7) "View Part List" button

2. In order to view all of the parts list, click the "Expand all Parts List" icon (5) . This action will expand all of the parts lists for all of the steps.



Illustration 6 g01252508

"PM Checklist" with an example of expanded parts

3. To expand the parts list for a single step, click the icon of a triangle (6) below the individual step of that part. The step will expand in order to display the parts that are required to complete the step.

"View Part List"

To assist the technician during a "planned maintenance", a list of all parts that are required for completing the PM can be displayed and exported for printing. In addition, this list of parts can be sent to the PartStore system for ordering.

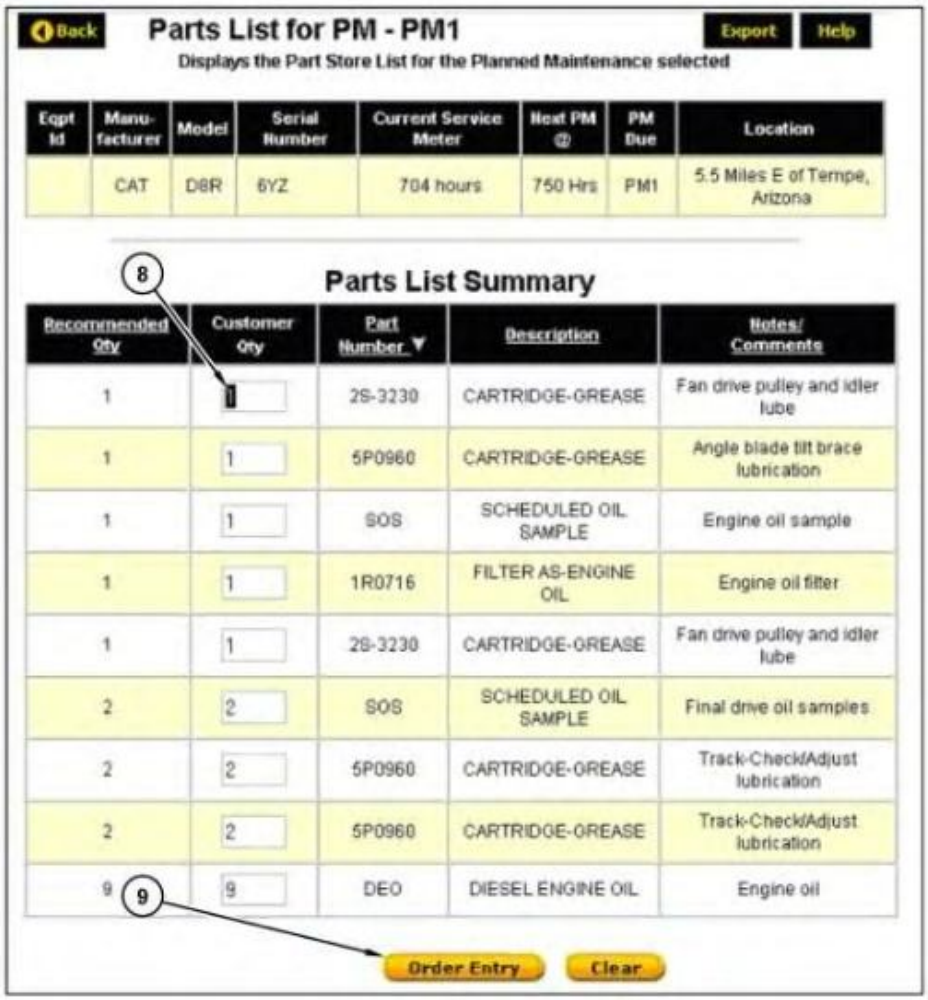


Illustration 7 g01716418

Parts List for PM

(8) "Customer Qty" text fields

(9) "Order Entry" button

In order to view the "Parts List Summary", select the "View Part List" button (7) from the "PM Checklist" screen. Refer to Illustration 5. The "Parts List for PM" screen will be displayed. Refer to Illustration 7.

In order to order the parts through the PartStore system, click the "Order Entry" button (9) . The quantities for the parts in the "Customer Qty" text fields (8) can be edited before placing an order.

"View Planner"

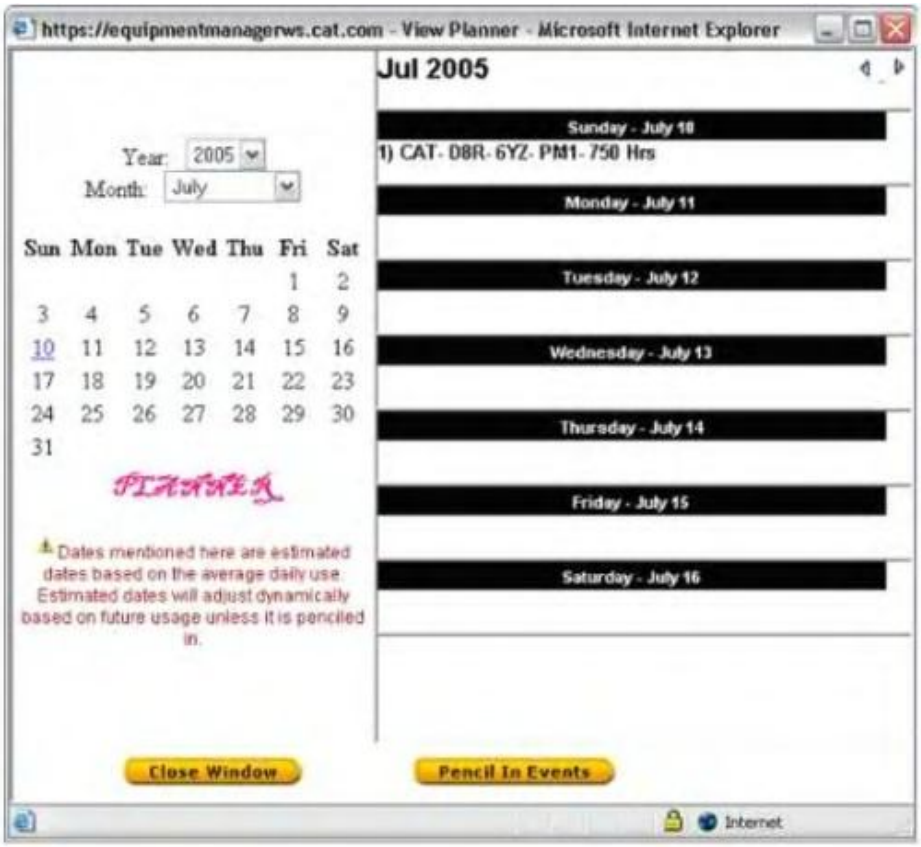


Illustration 8 g01716419

"Planner"

Maintenance Watch schedules the procedures for the PM in the "Planner" from EquipmentManager. The "View Planner" screen displays the date that is estimated for the next PM. This approximation of the dates that are chosen for the repairs is based on the average daily usage of the equipment. The dates adjust dynamically depending on the future usage unless the repair is manually changed by the "Pencil In Event".

In order to view the "View Planner" page, use the following procedure:

1. Select the check box (1) that is next to the equipment from the list on the "Planned Maintenance" screen. Refer to Illustration 1.

2. Click the "View Planner" button. Refer to Illustration 1. The "Planner" window will appear.

The "Planner" displays the items of information for the PM, with the first PM that is due at the beginning for the equipment that has been selected. To view the other PM due dates for this equipment, use the options that are in the calendar to search by a date, a month, or a year. To view the days between the PM due dates for a piece of equipment, you can use the "Back" and "Next" arrows that are located in the upper right-hand corner of the window.

"Pencil In Events"

In order to change the date of the next PM on the "Planner", use the following procedure:

1. From the "Planner" window, click the "Pencil In Events" button. The "Pencil In Events" screen will be displayed.



Illustration 9 g01716420

"Pencil In PM Events" screen

(10) "Pencil In Date" field

(11) "Save" button

2. Click the icon of a calendar next to the "Pencil In Date" field (10) and select a date from the popup window.
3. Click the "Save" button (11) .

Note: Once a "Pencil In Date" has been performed for the PM, the system will no longer adjust the date for the PM dynamically. Once that PM is complete the subsequent schedules for the PM revert to dynamic scheduling again.

Request Quote

A useful feature of Maintenance Watch is the ability to request a note for a PM directly from EquipmentManager. EquipmentManager will send an e-mail to the Dealer Administrator of the web site for your dealer. In order to request a quote, use the following procedure:

1. In order to request a note for a piece of machine, select the check box (1) for the equipment from the list on the "Planned Maintenance" screen. Refer to Illustration 1.
2. Click the "Request Quote" button. Refer to Illustration 1. The "Quotation Details" window will appear.

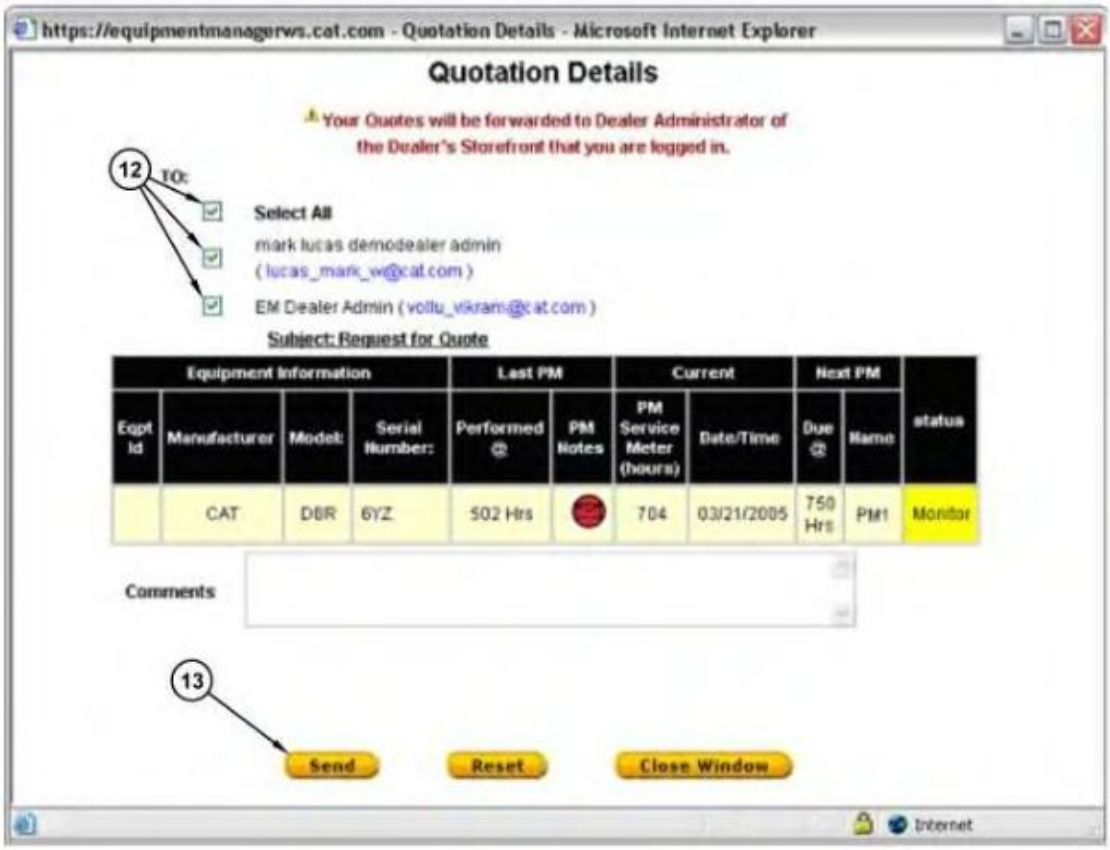


Illustration 10 g01716421

Requesting a PM Quote

(12) Check boxes

(13) "Send" button

3. In order to send a request to multiple Dealer Administrators, select the check boxes (12) next to any of the Dealer Administrator.
4. In order to send a comment to the selected Dealer Administrator, enter the comments in the "Comments" text field.
5. Click the "Send" button (13) . The "Mail Successfully Delivered" screen will be displayed.



Illustration 11 g01716422

"Message Delivered Successfully" screen

6. Click the "OK" button. Refer to Illustration 11.

"Mark PM Completed"

Once you have used the "PM Checklist" to complete a PM, mark the PM as completed so that the PM will no longer appear as an event in EquipmentManager. If you do not mark a PM as completed, the note will appear as PM that has been missed.

In order to mark a PM as completed, use the following procedure:

1. From the "Planned Maintenance" screen, select the check box (1) next to the equipment of the PM that is to be marked as a note completed. Refer to Illustration 1.
2. Click the "Mark PM Complete" button. Refer to Illustration 1. The "Mark Planned Maintenance (PM) Completed" window will appear.



Illustration 12 g01393310

"Mark Planned Maintenance (PM) Completed" screen

3. If the PM was missed, select the check box in the "Not Performed" column.
4. Enter the SMU of the equipment at the time the PM was performed in the "@ Service Meter" text field.
5. Click the icon of a calendar next to the "Date" field and select a date from the popup window.
6. Enter notes in the "Notes/Comments" text field.

   Note: "Notes/Comments" entered at the time a PM is marked as completed, append to the checklists for the next "PM Due". If the last "PM Due" is marked missed, the offset will revert to the defined fixed schedule.

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Major Repair

SMCS - 7600; 7606



Illustration 1 g01738816

"Major Repair" screen

(1) Check box

(2) "View" drop-down menu

In addition to a planned maintenance, a Maintenance Watch subscription gives you the ability to schedule and track major repairs. On the "Event Summary" screen, select the check box (1) next to the equipment you wish to view major repairs and then select "Major Repair" from the "View" drop-down menu (2) . The "Major Repair" screen will be displayed. Refer to Illusrtation 1.

"Repair and Maintenance History"

Using Maintenance Watch, you can view a record of all previous major repairs that were performed on the equipment and entered through EquipmentManager.

In order view the major repair history, use the following procedure:

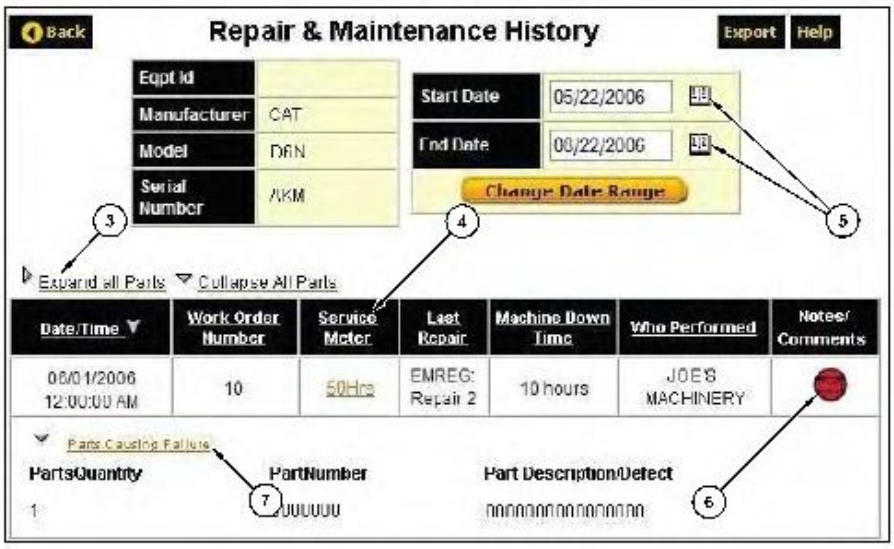


Illustration 2 g01738817

"Repair & Maintenance History" screen

(3) "Expand All Parts" link/icon

(4) "Service Meters" column

(5) Calendar icon

(6) Icon of and envelope

(7) "Parts Causing Failure" link/icon

1. On the "Major Repair" screen, in the "Service Meters" column (4) , click the value in the field. Refer to Illustration 2. The "Repair & Maintenance History" screen will be displayed.
2. Click the calendar icon (5) next to the "Start Date" and "End Date" fields and select a date to indicate a time period for the PM history.
3. In order view the parts causing failure for the major repair, click either the "Expand All Parts" link/icon (3) or the "Parts Causing Failure" link/icon (7) .
4. In order view the comments, click the icon of and envelope (6) in the "Notes/Comments" column.

Request Quote

You can request a quote for the next major repair directly from EquipmentManager. EquipmentManager will send an e-mail to the Dealer Administrator of the Dealer's Web site that you are logged in.

In order request a quote, use the following procedure:

1. From the "Major Repair" screen, select the equipment for which you wish to request a quote.
2. Click the "Request Quote" button. The "Quotation Details" screen will be displayed.

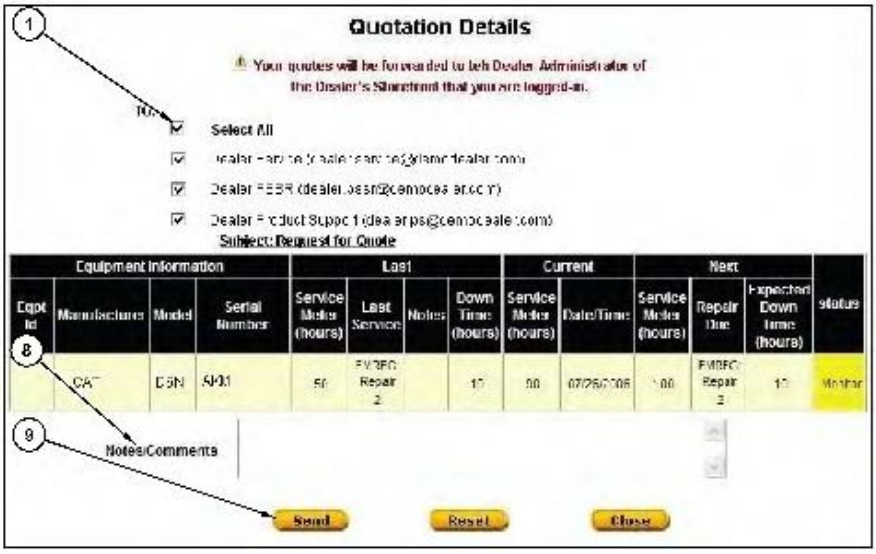


Illustration 3 g01738818

"Quotation Details" screen for requesting a quote

(1) Check box

(8) "Notes/Comments" text field

(9) "Send" button

3. Select the check box (1) next to the dealership personnel to whom you want to send the request.
4. In the "Notes/Comments" text field (8) , enter the comments you wish to send to the recipients.
5. Click the "Send" button (9) . The "Mail Successfully Delivered" screen will be displayed.



Illustration 4 g01738819

"Mail Successfully Delivered " message for a MR quote

6. Click the "OK" button. The details about the machine and the service event are included in the e-mail message.

View Planner

EquipmentManager places major repairs in the EquipmentManager planner. The planner displays the date that the repair should be performed if all conditions remain the same. The dates that are chosen for the repairs are estimated based on the average daily usage of the equipment. The dates adjust dynamically based on usage, unless the repair is manually penciled in.

1. From the "Major Repair" screen, select the check box next to the equipment for which you wish to view the planner. Refer to Illustration 1.

2. Click the "View Planner" button. Refer to Illustration 5. The "View Planner" window appears.

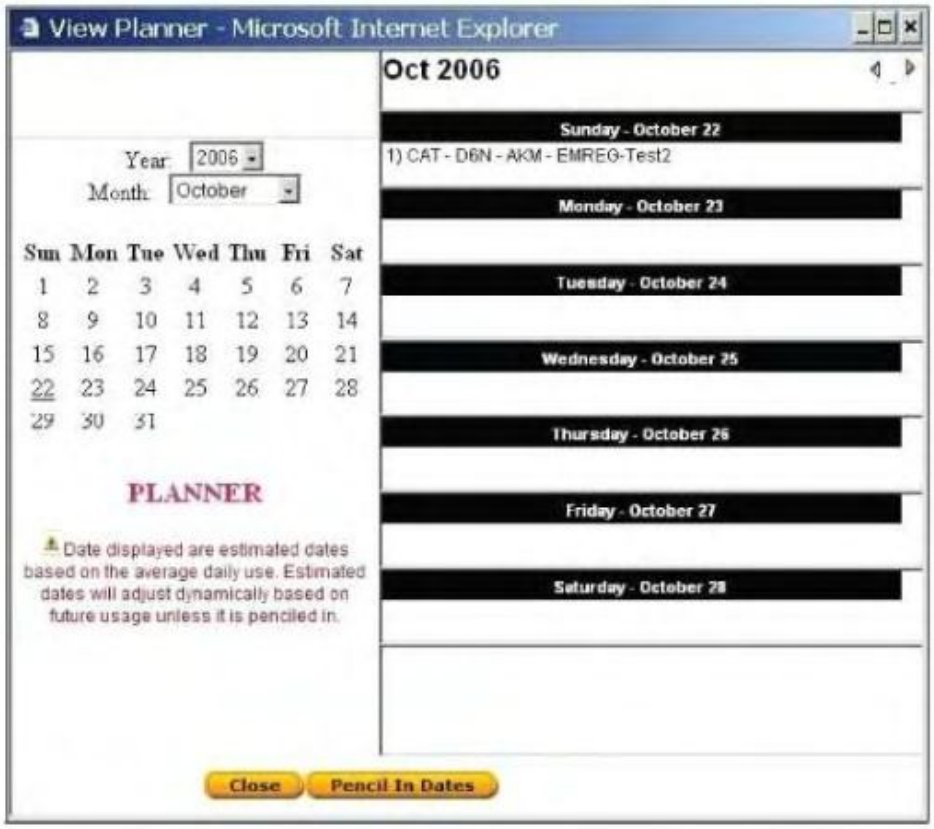


Illustration 5 g01392145

"View Planner" window

3. In order view other major repair due dates for this equipment, you can use the calendar's options to search by date, month, or year.

4. In order view days between equipment major repair due dates, you can use the back and next arrows in the upper-right corner of the window.

Pencil In Dates

If you wish to change the date of the next major repair on the planner, use the following procedure:

1. From the "Planner" window, click the "Pencil In Date" button. The "Pencil In Date" screen will be displayed.

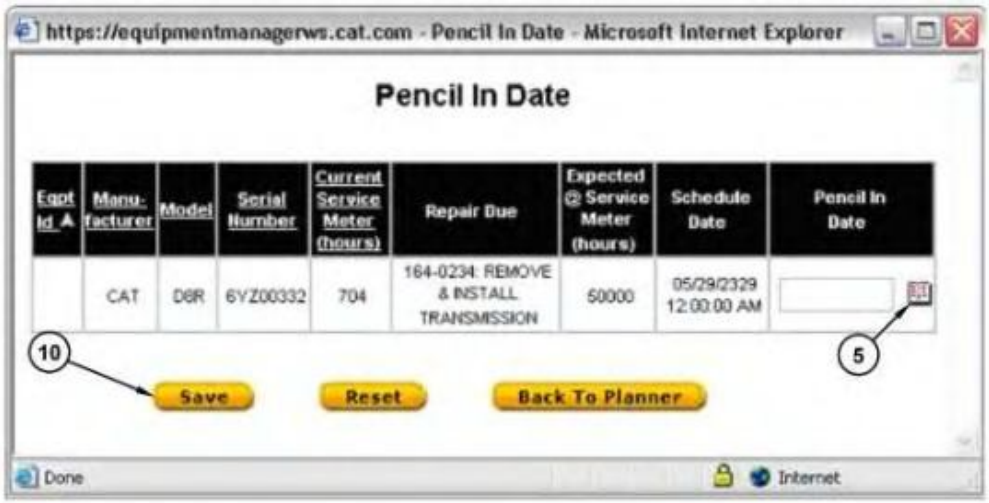


Illustration 6 g01738820

"Pencil In Date" screen for a major repair

(10) "Save" button

(5) Calendar icon

2. Click the calendar icon (5) next to the "Pencil In Date" field and select a date from the popup window.
3. Click the "Save" button (10) .

Note: Once you pencil in a major repair date, the system no longer dynamically adjusts that major repairs date. Once that major repair is complete, the subsequent major repairs revert back to dynamic scheduling.

Mark Repair Complete

Once you have completed a major repair, you need to mark the repair completed.

In order mark a major repair completed, use the following procedure:

1. From the "Major Repair" screen, select the check box next to the equipment with the repair you wish to mark completed. Refer to Illustration 7.
2. Click the "Mark Repair Complete" button. Refer to Illustration 7. The "Mark Repair Complete" screen appears.

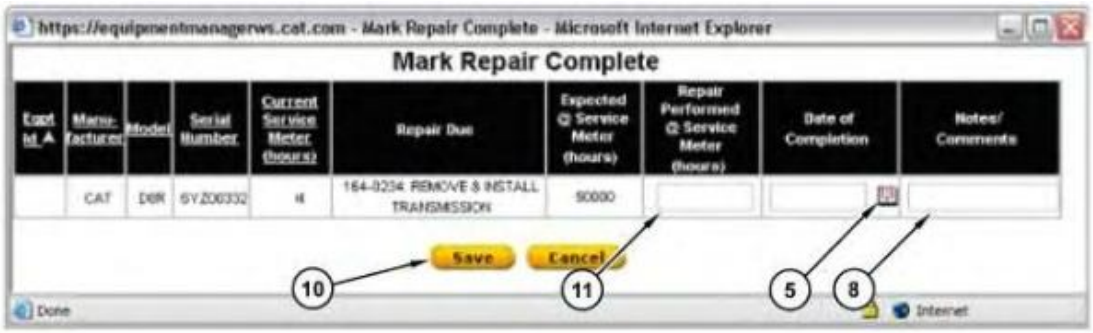


Illustration 7 g01738821

"Mark Repair Complete" screen

(10) "Save" button

(11) "Repair Performed @ Service Meter (hours)" text field

(5) Calendar icon

(8) "Notes/Comments" text field

3. Enter the SMU of the equipment at the time the repair was performed in the "Repair Performed @ Service Meter (hours)" text field (11) .
4. Click the calendar icon (5) next to the "Date of completion" field and select a date from the popup window.
5. Enter notes in the "Notes/Comments" text field (8) .
6. Click the "Save" button (10) .

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Systems Operation
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i02951552

Health Watch

SMCS - 7600; 7606

Overview

A subscription to Health Watch offers the following features:

- Displays the fuel results, fuel level history, fuel used history and refueling history.
- Identifies the onboard logged events and diagnostic codes and retains the events and codes in EquipmentManager machine history.
- Relays available troubleshooting procedures, enabled by SIS Web subscription.

By using these features you can quickly and easily monitor your entire fleet. You can detect trends which will help to improve fleet owning and operating costs.

Note: Diagnostic Codes are frequently referred to as Fault Codes or Event Codes.

Note: Health Watch information is dependent upon the machine model, year of production and Product Link model installed. Machines produced with electronic engines and transmissions equipped with Product Link model PL321SR normally can provide this information.

S·O·S Service Manager (S·O·S)

S·O·S alerts for fluid analysis may be provided in EquipmentManager if your dealership uses S·O·S Service Manager software in the dealership laboratory. S·O·S alerts will be displayed in the Exception Dashboard in the "Event Summary" display.

The S·O·S Service Manager is a software program that is available through your dealers web site. To view S·O·S details or reports for a sample, use the tool for viewing the S·O·S application on the web. Also, you may contact your Caterpillar dealer S·O·S services laboratory for your results. The report from the S·O·S services laboratory may be obtained from a fax or from e-mail. A paper copy of the report can be mailed as well.

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Fuel Results

SMCS - 7600; 7606

The EquipmentManager software is able to collect data regarding the fuel consumption of your equipment. This data includes the following: fuel level, fuel usage and the history for refueling.

Note: The results that are displayed using "Fuel Results" are not results that are measured. The information that is viewed on the "Fuel Results" screen is calculated information. The calculations are based on the performance maps of the machine. The performance maps define specific performance characteristics of the machine. These characteristics determine the calculated fuel usage at different loading conditions. The result is the cumulative fuel consumption.

In order to view the fuel information for a specific machine, use the following procedure:

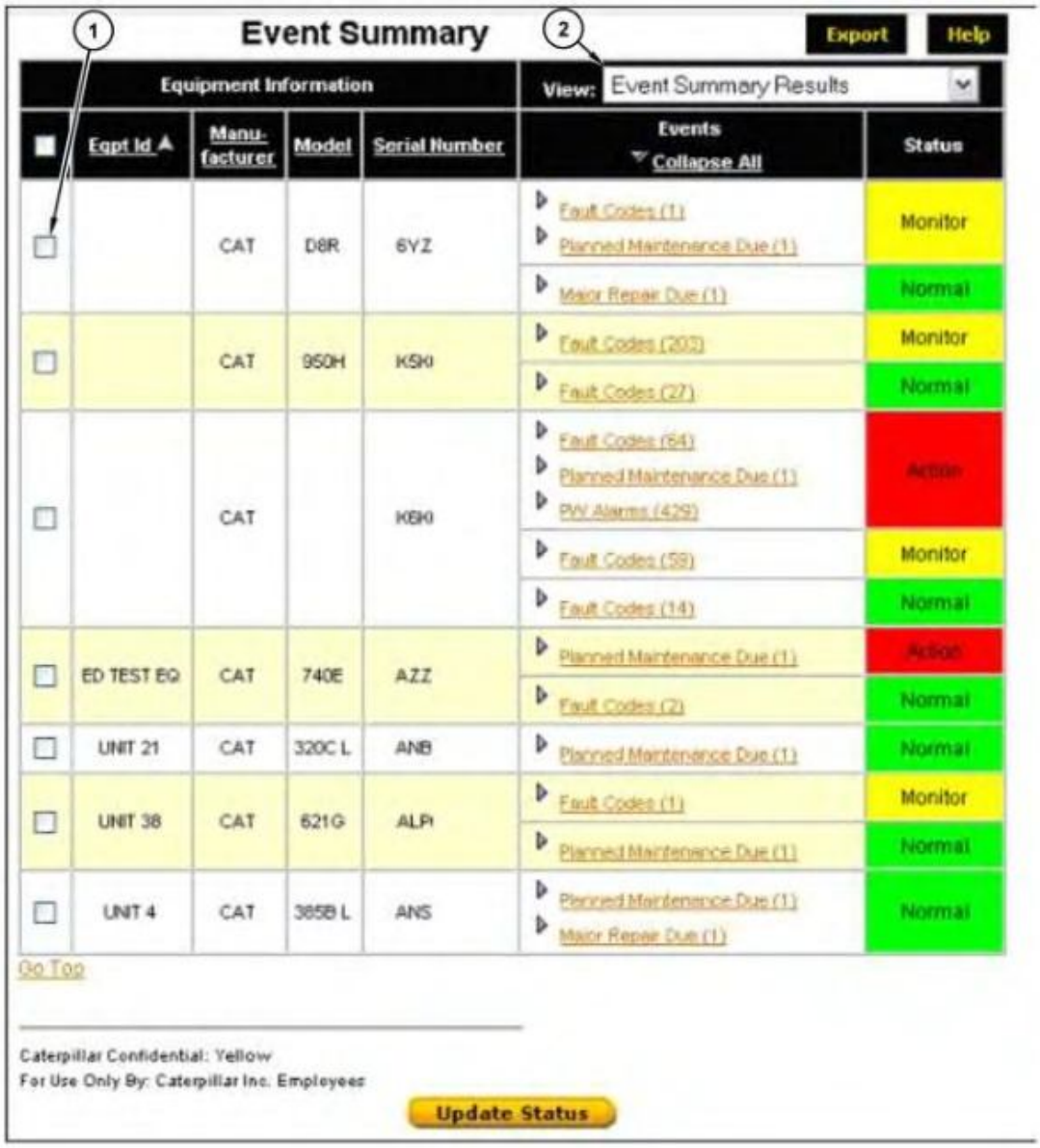


Illustration 1 g01739893

"Event Summary" screen

(1) Check box

(2) "View" drop-down menu

1. Navigate to the "Event Summary" screen. Refer to Illustration 1.
2. Search for the specific machine in the "Equipment Information" column.
3. Click in the check box (1) to the left of the machine in order to select the machine.

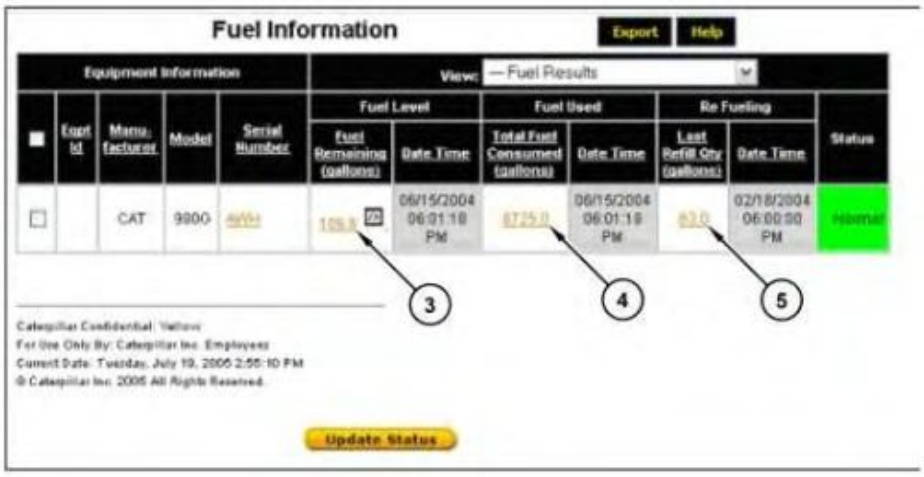


Illustration 2 g01739913

"Fuel Information" screen

4. Select "Fuel Results" from the "View" drop-down menu (2) .

   The "Fuel Information" screen will appear. Refer to Illustration 2. This screen will display the information for the selected machine.

   Click link (3) in order to view the "Fuel Level History" screen. Refer to ""Fuel Level History"". Click link (4) in order to view the "Fuel Used History" screen. Refer to ""Fuel Used History"". Click link (5) in order to view the "Refuel History" screen. Refer to ""Refuel History"".

"Fuel Level History"

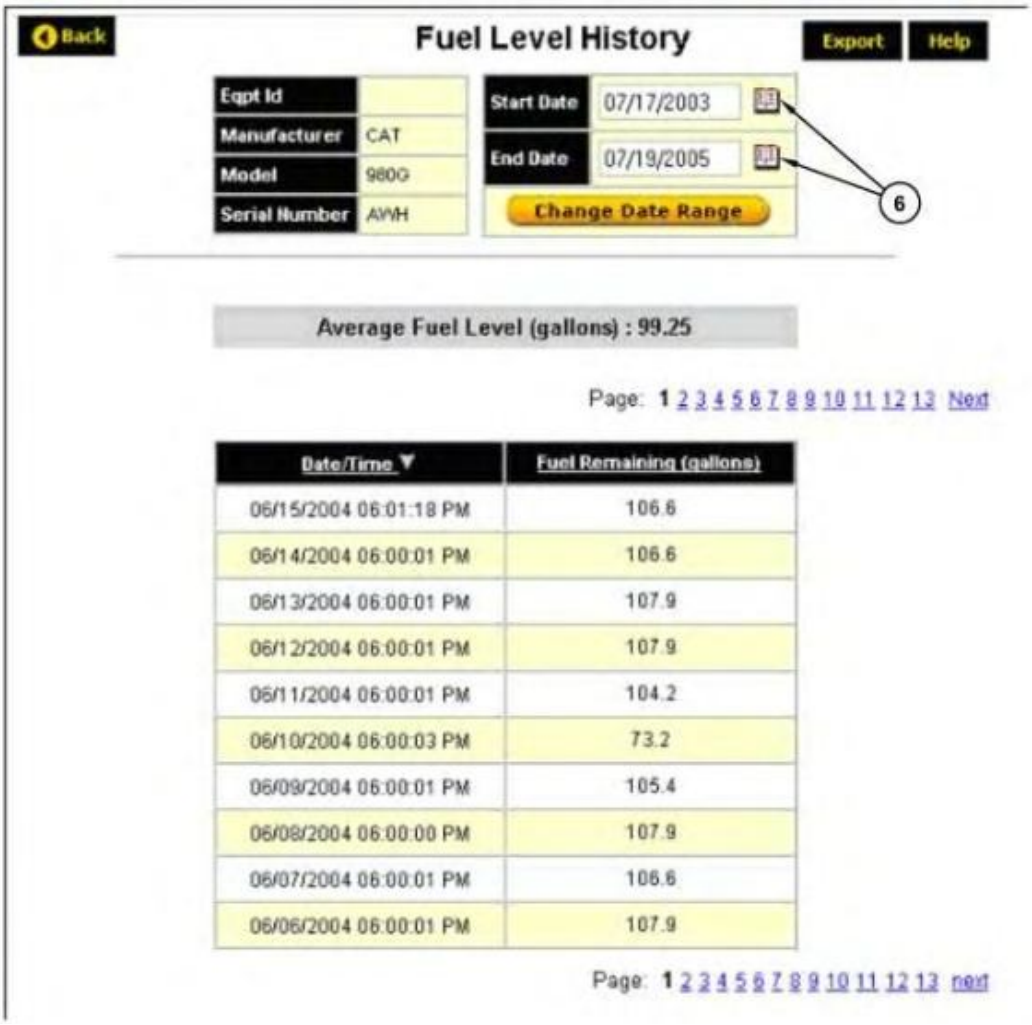


Illustration 3 g01739914

"Fuel Level History" screen

(6) Icon of the calendar

In order to view the "Fuel Level History" screen, use the following procedure:

1. From the "Fuel Information" screen, click on the number in the "Fuel Remaining (gallons)" column. The "Fuel Level History" screen is displayed. Refer to Illustration 3.
2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.
3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.
4. Click "Change Date Range". The information on the "Fuel Level History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

Graph of the Fuel Level

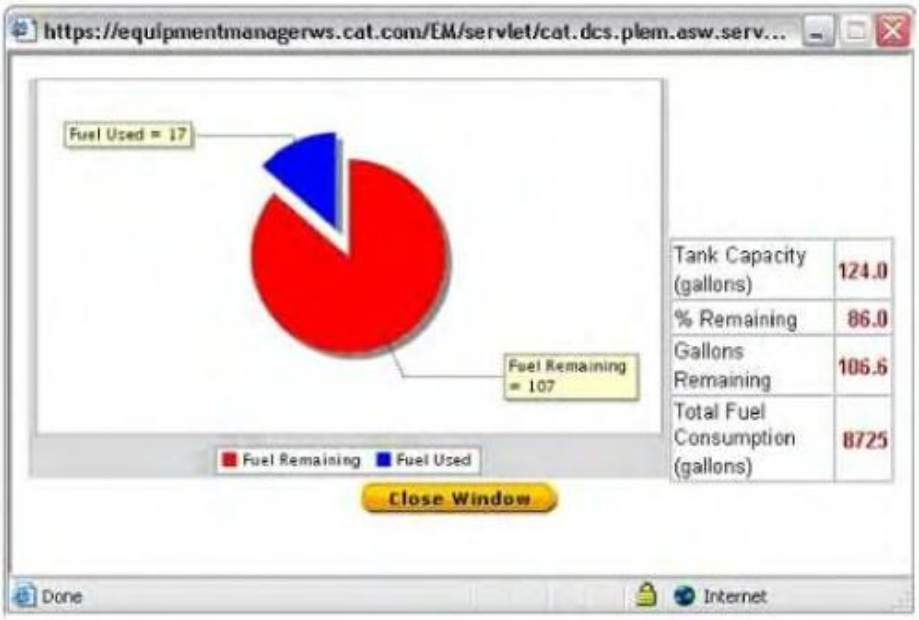


Illustration 4 g01253297

Graph of the existing fuel level

In order to view a graph of the existing fuel level of a machine, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the "Fuel Remaining (gallons)" column.
2. Find the row which displays the information for your specific machine.
3. Click on the icon of a machine in the "Fuel Remaining" column. A graph will appear in a popup window. Refer to Illustration 4. This graph will display information for the selected machine.
4. Click the "Close Window" button or click the "X" in the upper right corner in order to return to the "Fuel Information" screen.

"Fuel Used History"

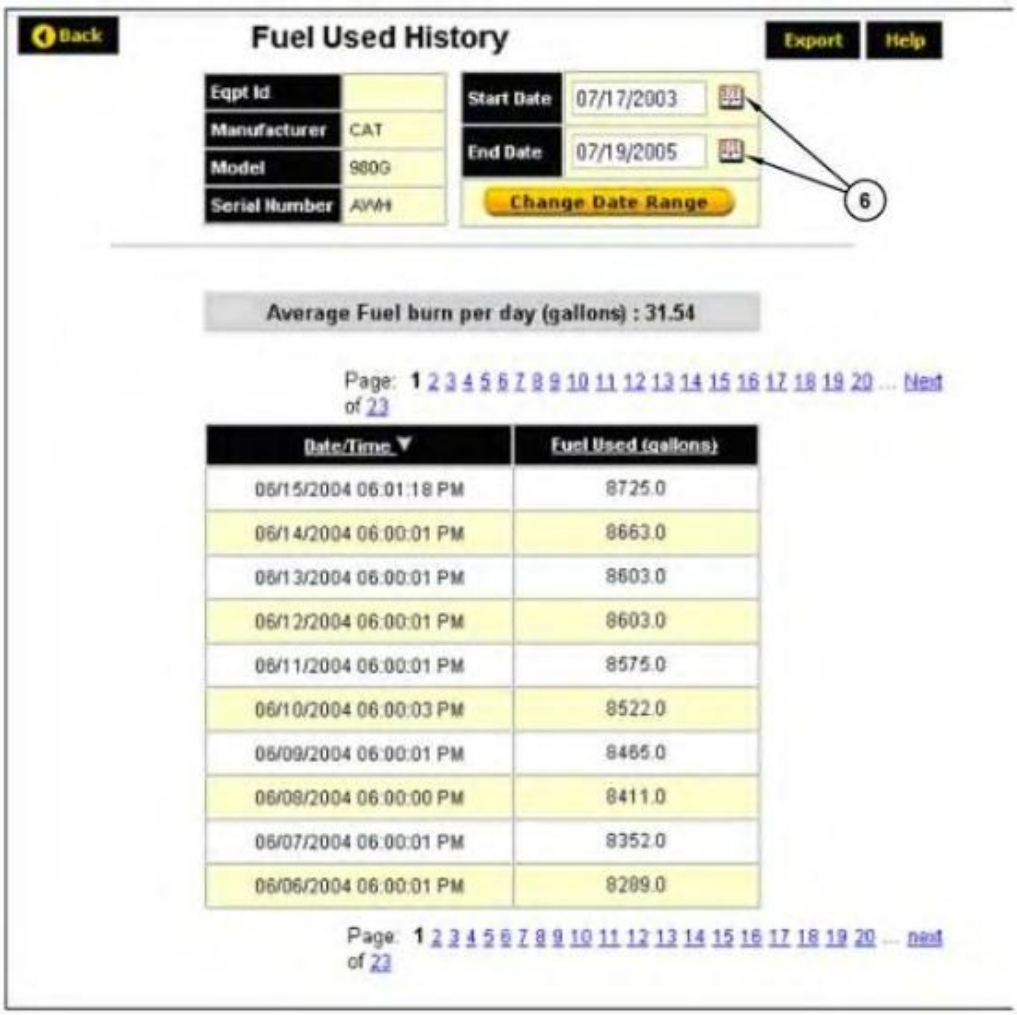


Illustration 5 g01739915

"Fuel Used History" screen

(6) Icon of the calendar

The "Fuel Used History" screen displays the history of fuel usage for a specific machine. Refer to Illustration 5. This amount of fuel usage is calculated by the engine Electronic Control Module (ECM).

In order to view the "Fuel Used History" screen, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the row with the information about your machine. Locate the "Total Fuel Consumed (gallons)" column. Click the number in the "Total Fuel Consumed (gallons)" column for your machine. The "Fuel Used History" screen will appear.

   Note: The results that are displayed using "Fuel Results" are not results that are measured. The information that is viewed on the "Fuel Results" screen is calculated information. The calculations are based on the performance maps of the machine. The performance maps define specific performance characteristics of the machine. These characteristics determine the calculated fuel usage at different loading conditions. The result is the cumulative fuel consumption.

2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.

3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.

4. Click "Change Date Range". The information on the "Fuel Used History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

"Refuel History"

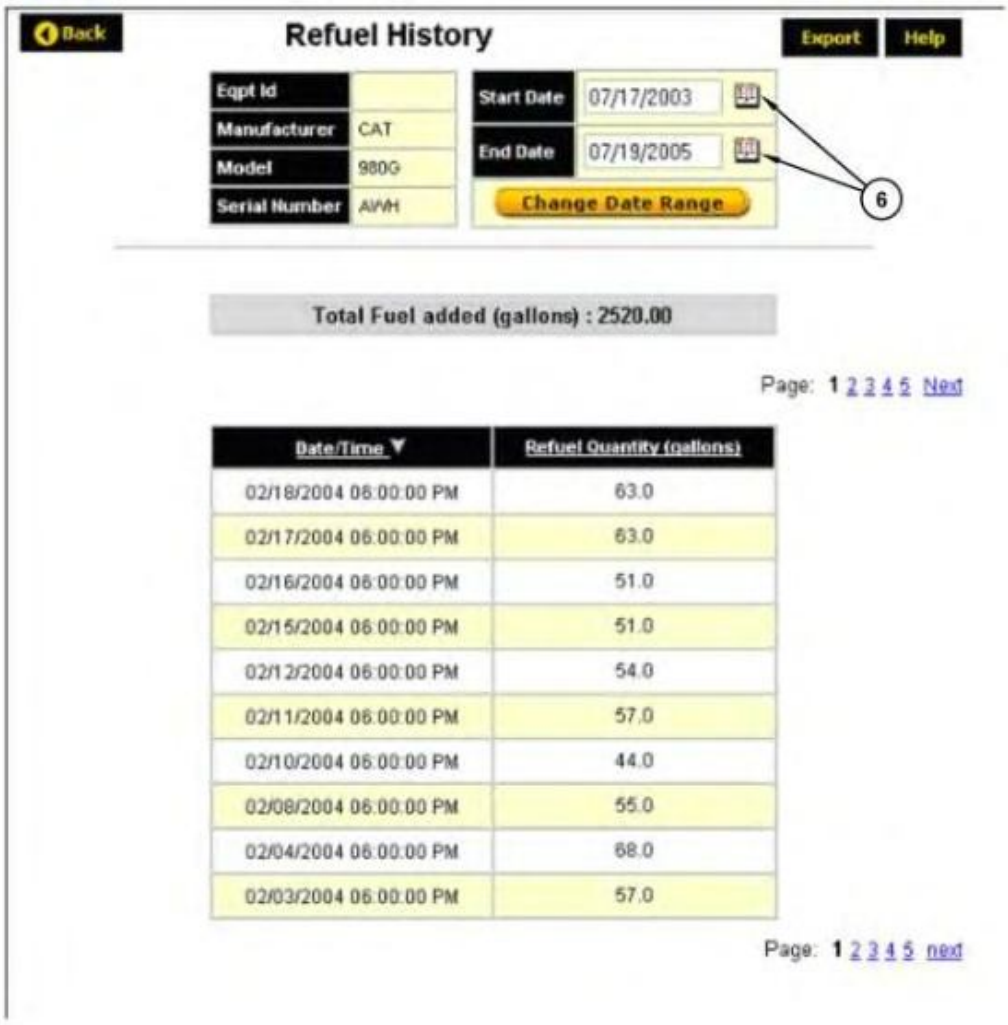


Illustration 6 g01739916

"Refuel History" screen

(6) Icon of the calendar

The "Refuel History" screen displays the history of refueling for a specific machine. Refer to Illustration 6.

In order to view the "Refuel History" screen, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the row with the information about your machine. Locate the "Last Refill Qty. (gallons)" column. Click the number in the "Last Refill Qty. (gallons)" column for your machine. The "Refuel History" screen will appear.

   Note: The information about refueling is not provided by Product Link. This is a manual function in the "Administration" menu.

2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.
3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.
4. Click "Change Date Range". The information on the "Refuel History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

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i03367182

Fault Codes

SMCS - 7600; 7606

Diagnostic codes are frequently referred to as fault codes or event codes. The fault codes that are provided by the EquipmentManager software provide valuable information. This information can be used to make decisions concerning the maintenance of your machine. Use the "Search Equipment" button in order to access the fault codes for your . The "Search Equipment" button is located on the EquipmentManager home screen. Select the check box (1) for the equipment from the "Equipment Summary" screen. Then, select "Fault Codes" from the "View" drop-down menu.

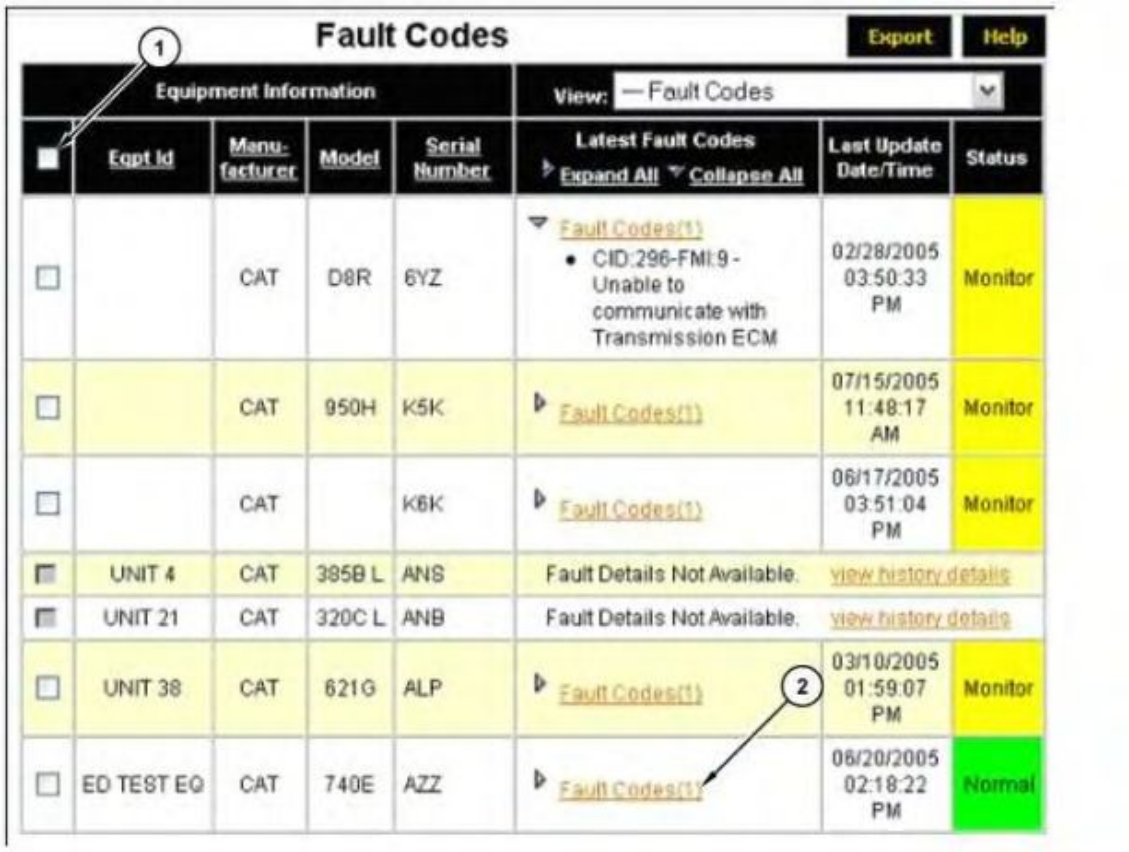


Illustration 1 g01737838

"Fault Codes" screen

(1) Check box

(2) "Fault Codes" link

View "Fault Code History" (Event code and Diagnostic Code)

By using Health Watch, you can view a record of all previous fault codes that were recorded through EquipmentManager software.

In order to view the "Fault Code History" screen, use the following procedure:

1. From the "Fault Codes" screen, click the "Fault Codes" link (2) or the "view history details" link in the "Latest Fault Codes" column. The "Fault Code History" screen will be displayed.

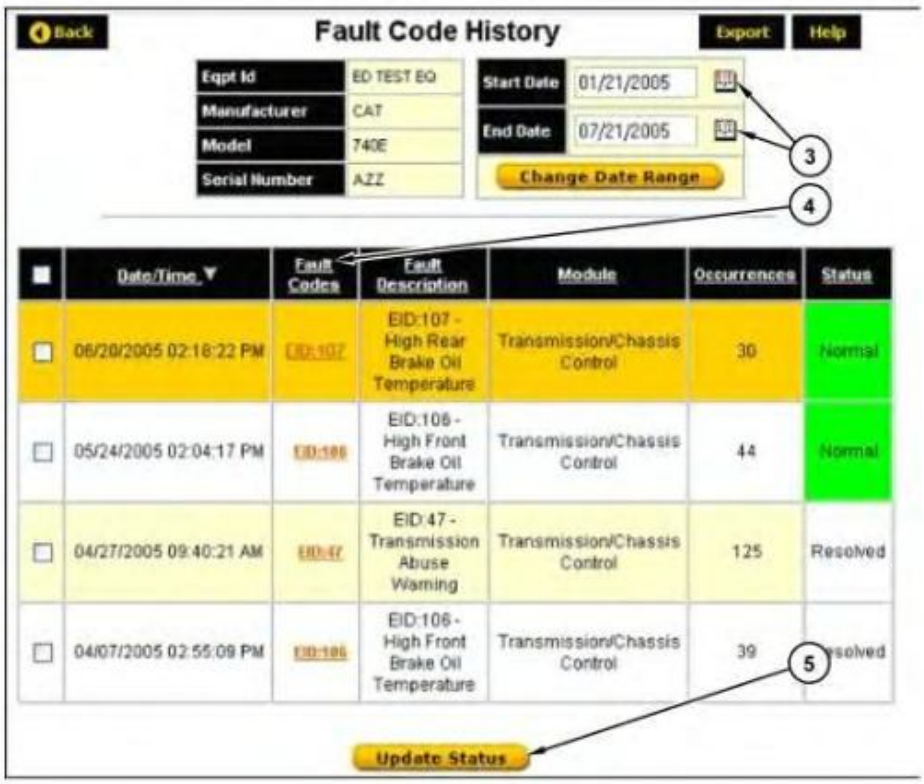


Illustration 2 g01737839

"Fault Code History"

(3) "Start Date" field and "End Date" field

(4) "Fault Codes" column

(5) "Update Status" button

2. Click on the icon for the calendar next to the "Start Date" field and "End Date" field (3) . Select a date in order to indicate a time period for the history of the fault code.

3. Click the "Change Date Range" button. The "Fault Code History" table will be updated to using the new date range.

   Note: The history of the fault code that is viewed in the EquipmentManager software will display all faults that are reported by Product Link. A machine Electronic Control Module (ECM) will automatically erase a diagnostic code after 100 hours of operation if the diagnostic code does not reappear within that period of time. If the machine ECM erases a diagnostic code automatically, the history of the fault code that is displayed by the EquipmentManager software may not match the history that is displayed by Caterpillar Electronic Technician software.

"Service Information for Fault Codes (SIS Web)"

In order to view detailed information about a particular code, EquipmentManager software interfaces with Service Information System (SIS). The link to SIS will provide troubleshooting procedures in order to resolve fault codes. For this link to work, a valid subscription to SIS is required.

In order to obtain service information for specific fault codes, complete the following precedure:

1. On the "Fault Code History " screen, locate the "Fault Codes" column (4) . Click on the fault code in order to view the service information for the fault code. The "Service Information for Fault Codes" screen will now display the information for your specific fault code. The troubleshooting procedure for the selected fault code will appear if there is a proper link in SIS.



Illustration 3 g01253373

"Service Information for Fault Codes" troubleshooting

2. The "Service Information for Fault Codes" screen for troubleshooting will display fault codes in the left column. Click on the hyperlink that applies to your fault code. The "Service Information for Fault Codes" will appear. This screen will display information about your fault code.

3. View the information in the "Information Types" and "Sections" columns. Click on the links that apply to your fault code. Click the "Close" button in order to return to the "Fault Code History" screen.



Illustration 4 g01253376

"Service Information for Fault Codes" information

"Update Status" for the Fault Code

EquipmentManager software enables you to update the status of a fault code. If the status of a fault code is updated to "Resolved", the fault code will no longer appear in the "Event Summary". The "Event Summary" screen is located on the home page. The home page may also be referred to as the Exception Dashboard.

In order to update the status of a fault code, use the following procedure:

1. View the "Fault Code" screen, or the "Fault Code History" screen. Click in the check box (1) that is next to the fault code in order to update the fault code. Then, click the "Update Status" button (5) . The "Update Status" window will appear.

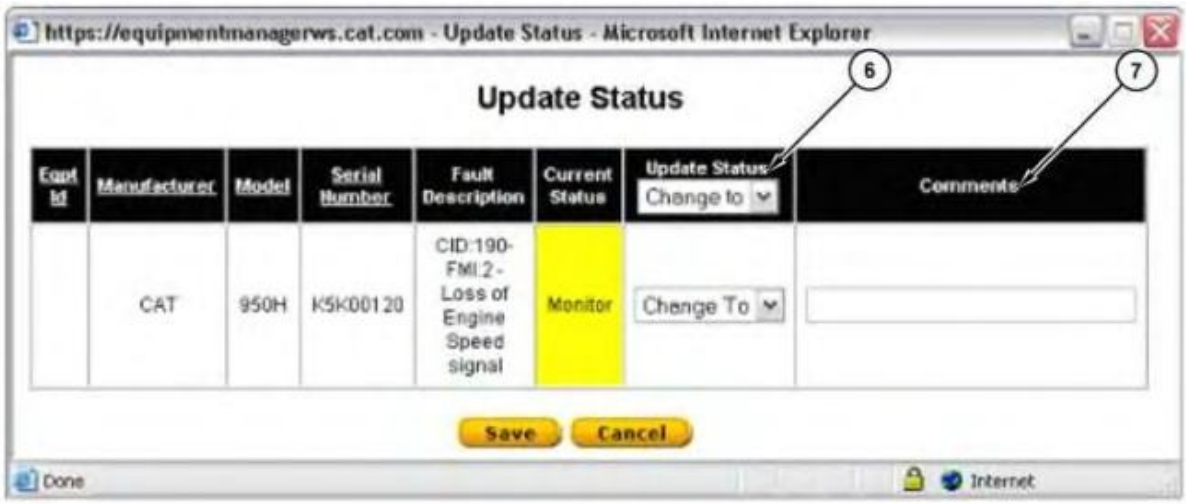


Illustration 5 g01737840

Fault code "Update Status"

(6) "Update Status" field

(7) "Comments" field

2. In the "Update Status" field (6) , select a new status. The following table displays the different possible selections for "Update Status":

Table 1

Status	Color	Importance
Action	RED	Highest
Monitor	YELLOW	Medium
Normal	GREEN	Lowest
Resolved	--	--

3. In the "Comments" field (7) , type your comments.
4. Click "Save". The status of the fault code is now updated.

Note: Once the status of an event is changed to "Resolved", the event will no longer be displayed in the "Exception Dashboard".

S·O·S Service Manager Software

S·O·S alerts for fluid analysis may be provided in EquipmentManager if your dealership uses S·O·S Service Manager software in the dealership's laboratory. S·O·S alerts will be displayed in the Exception Dashboard in the "Event Summary" display.

The S·O·S Service Manager tool is a software program that is available through your dealer's web site. In order to view S·O·S details or reports for a sample, use the tool for viewing the S·O·S application on the web. Also, you may contact your Caterpillar dealer's S·O·S laboratory for your results. The report from the S·O·S laboratory may be obtained from a fax or from e-mail. A paper copy of the report can be mailed as well.

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Systems Operation
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i03347780

Reports

SMCS - 7600; 7606

Overview

EquipmentManager can also assists you in managing your equipment by generating reports can be saved or printed. The following types of reports are available:

- Product Usage
- Product Monitoring
- Operating and Maintenance Manual (OMM) (no PDF format, viewed on-line)
- Equipment Usage (no PDF format, viewed on-line and exported to save or to print)
- Active Fleet Report

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Product Usage

SMCS - 7600; 7606

"Product Usage Report"

The "Product Usage Report" provides information on the "Product Usage" and "Fuel Usage". The "Product Usage" report may be displayed for a period of time that can span for multiple months and that can include the current day. So, the period for reviewing the history of the report can be selected to the preference of the user.

In order to generate a "Product Usage Report", use the following procedure:



Illustration 1 g01727293

"Product Usage Report" screen

(1) Radio button

(2) "View" drop-down menu

(3) "View Reports" button

1. Search for equipment and view the results on the "Event Summary" screen. In the "View" drop-down menu (2), select "Product Usage Report". The "Product Usage Report" screen will appear.

2. Select the radio button (1) that corresponds with the equipment in order to generate a report for the equipment.

3. Select "View Reports" (3). The "Product Usage" report appears as an Microsoft^{R} Excel file in a new window. You can save the report locally and you can print the report. Also, you can send an e-mail of the report.

   Note: The "Product Usage Report" is the calculated comparison of the percentage of operational hours and the total available hours. Total available hours are calculated as 24 hours times the number of days in the range of the date. In order to adjust the total available hours to represent planned hours of operation, type the daily hours in "Daily Product Usage Hours" field before generating the report.

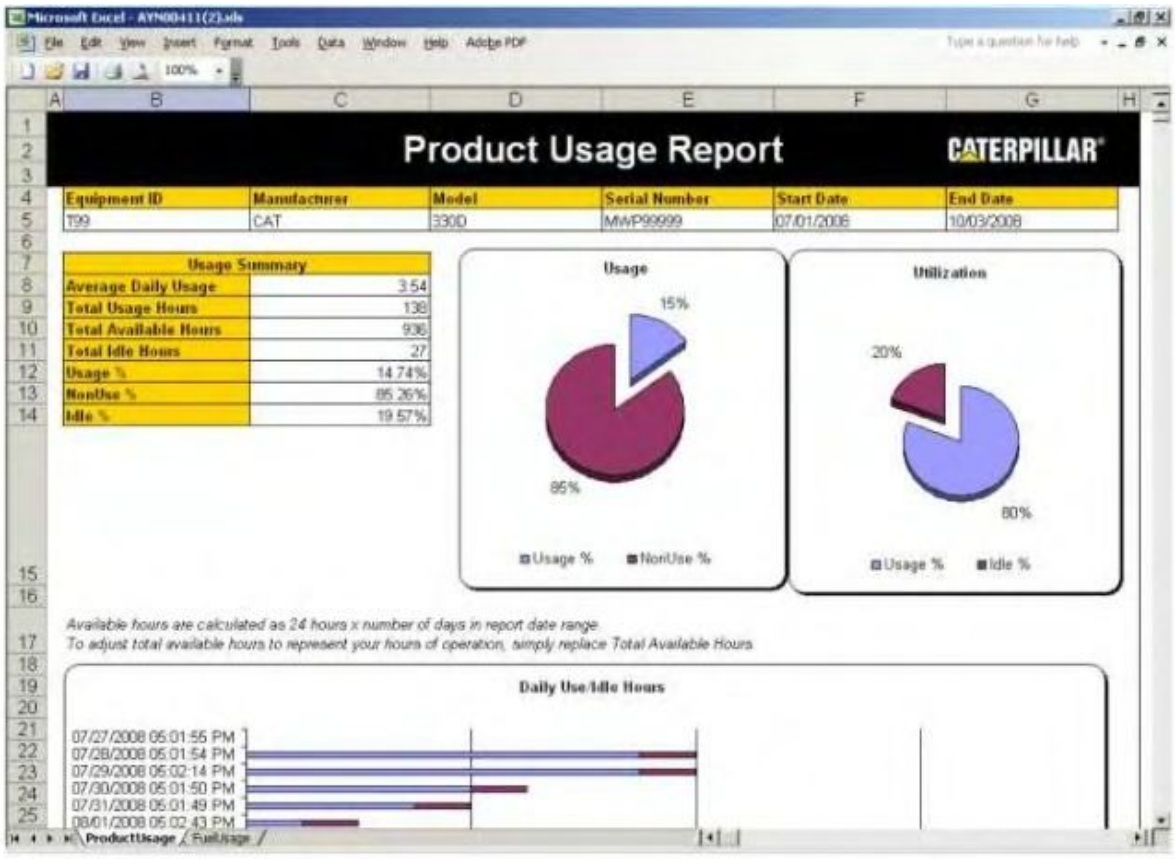
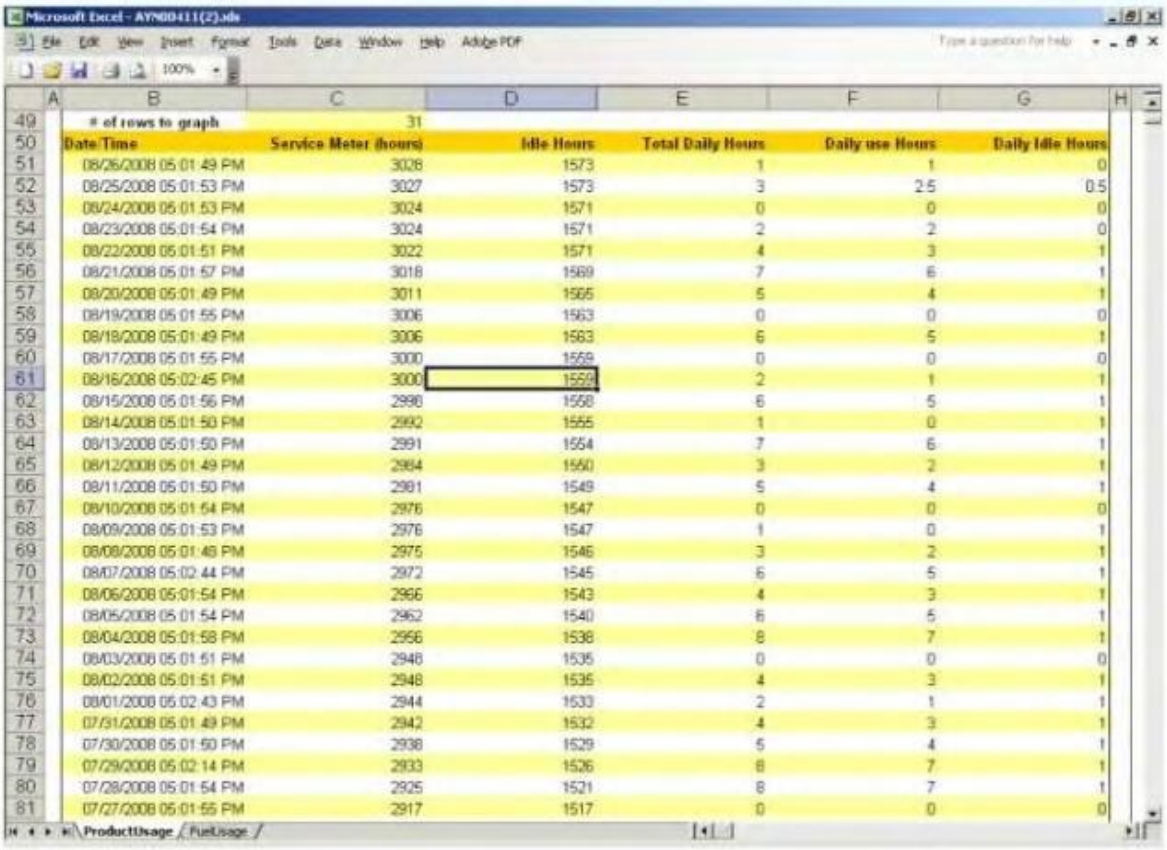


Illustration 2 g01727294

Table 1

"Product Usage Report"	

Field	Description
Header	
"Equipment ID"	The id of the equipment
"Manufacture"	The manufacturer of the equipment
"Model"	The model of the equipment
"Serial Number"	The serial number of the equipment
"Start Date"	The start date for the range of data
"End Date"	The end date for the range of data
"Usage Summary"	
"Average Daily Usage"	The average of daily hours for the dates that are within the range of the defined date
"Total Usage Hours"	The total hours for the dates that are within the range of the defined date
"Total Available Hours"	The total hours of available work for the machine that are within the range of the defined date
"Usage %"	The percentage of the operational time for the equipment as compared to the total available hours
"NonUse %"	The percentage of time the equipment was not in operation as compared to the total usage hours
"Idle %"	The percentage of time the equipment was in operation but engine speed was lower than 1150 rpm
"Usage" pie chart	A pie chart that displays the "Usage %" and the "NonUse %"
"Utilization" pie chart	The Utilization of the machine during hours of operation displayed in a pie chart with "Usage %" indicating the percentage of time the machine operated at an engine speed greater than 1150 rpm and "Idle %" indicating the percentage of time the machine operated at an engine speed lower than 1150 rpm
"Daily Use/Idle Hours" bar chart	A bar chart that displays the daily used hours and idle hours with the Y-axis representing the date and time and with the X-axis representing the number of hours of operation for the machine



	A	B	C	D	E	F	G	H
49		# of rows to graph	31					
50		Date/Time	Service Meter (hours)	Idle Hours	Total Daily Hours	Daily use Hours	Daily Idle Hours	
51		08/26/2008 05:01:49 PM	3028	1573	1	1	0	
52		08/25/2008 05:01:53 PM	3027	1573	3	2.5	0.5	
53		08/24/2008 05:01:53 PM	3024	1571	0	0	0	
54		08/23/2008 05:01:54 PM	3024	1571	2	2	0	
55		08/22/2008 05:01:51 PM	3022	1571	4	3	1	
56		08/21/2008 05:01:57 PM	3018	1569	7	6	1	
57		08/20/2008 05:01:49 PM	3011	1565	5	4	1	
58		08/19/2008 05:01:55 PM	3006	1563	0	0	0	
59		08/18/2008 05:01:49 PM	3006	1563	6	5	1	
60		08/17/2008 05:01:55 PM	3000	1559	0	0	0	
61		08/16/2008 05:02:45 PM	3000	1559	2	1	1	
62		08/15/2008 05:01:56 PM	2998	1558	6	5	1	
63		08/14/2008 05:01:50 PM	2992	1555	1	0	1	
64		08/13/2008 05:01:50 PM	2991	1554	7	6	1	
65		08/12/2008 05:01:49 PM	2984	1550	3	2	1	
66		08/11/2008 05:01:50 PM	2981	1549	5	4	1	
67		08/10/2008 05:01:54 PM	2976	1547	0	0	0	
68		08/09/2008 05:01:53 PM	2976	1547	1	0	1	
69		08/08/2008 05:01:48 PM	2975	1546	3	2	1	
70		08/07/2008 05:02:44 PM	2972	1545	6	5	1	
71		08/06/2008 05:01:54 PM	2966	1543	4	3	1	
72		08/05/2008 05:01:54 PM	2962	1540	6	5	1	
73		08/04/2008 05:01:58 PM	2956	1538	8	7	1	
74		08/03/2008 05:01:51 PM	2948	1535	0	0	0	
75		08/02/2008 05:01:51 PM	2948	1535	4	3	1	
76		08/01/2008 05:02:43 PM	2944	1533	2	1	1	
77		07/31/2008 05:01:49 PM	2942	1532	4	3	1	
78		07/30/2008 05:01:50 PM	2938	1529	5	4	1	
79		07/29/2008 05:02:14 PM	2933	1526	8	7	1	
80		07/28/2008 05:01:54 PM	2925	1521	8	7	1	
81		07/27/2008 05:01:55 PM	2917	1517	0	0	0	

Illustration 3 g01727295

Table 2

"Product Usage Report"	
Field	**Description**
Table	
"# of rows to graph"	The number of rows to display in the "Daily Use/Idle Hours" bar chart
"Date/Time"	The date and time of the Service Meter Hours and Idle Hours as reported by the Product Link Module (PLM)
"Service Meter (hours)"	The "Service Meter (hours)" that are reported by the PLM
"Idle Hours"	The "Idle Hours" that are reported by the PLM
"Total Daily Hours"	The number of operational hours of the equipment from the report from the previous day
"Daily use Hours"	The number of operational hours of the equipment at a higher rpm than 1150 rpm
"Daily Idle Hours"	The number of operational hours of the equipment at 1150 rpm or below 1150 rpm

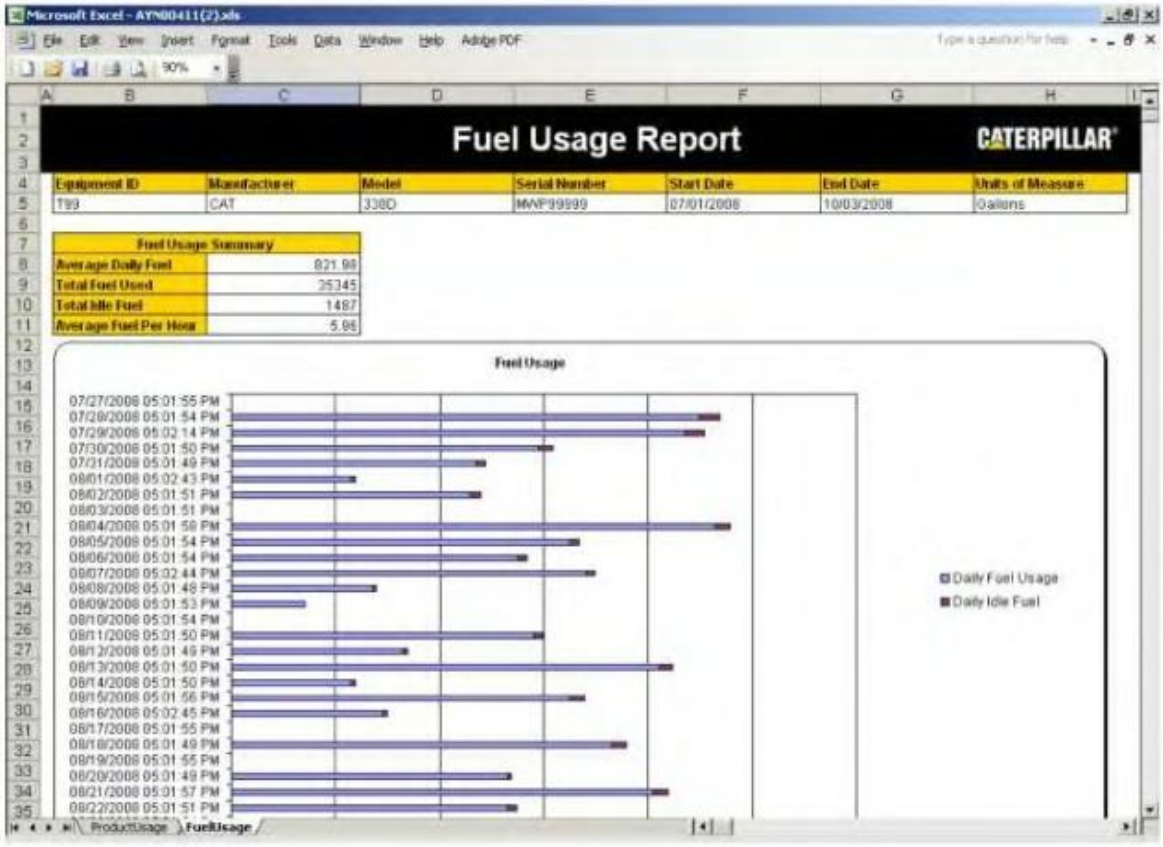


Illustration 4 g01727296

In order to access "Fuel Details", click the "FuelUsage" tab on the bottom of the Microsoft Excel file.

Table 3

"Product Usage Report"	
Field	**Description**
Header	
"Equipment ID"	The id of the equipment
"Manufacture"	The manufacturer of the equipment
"Model"	The model of the equipment
"Serial Number"	The serial number of the equipment
"Start Date"	The start date for the range of data
"End Date"	The end date for the range of data
"Units of Measure"	The units (liters, gallons) of measurement that are defined by the preferences of the user
"Fuel Usage Summary"	
"Average Daily Fuel"	The daily average of fuel that is burned for the dates that are within the range of the defined date
"Total Fuel Used"	The total volume of fuel that is burned for the dates that are within the range of the defined date

"Total Idle Fuel"	The total volume of fuel that is burned at idle for the dates that are within the range of the defined date
"Average Fuel Per Hour"	The comparison of the percentage of operational hours and the total available hours
"Fuel Usage" bar chart	A bar chart that displays the fuel that is burned daily were the X-axis represents the volume of fuel burned. displayed in the units of measurement preferred by the user

Note: "Service Meter (hours)", "Idle Hours", Fuel and Idle Fuel used for this report are values received during the scheduled updates. The time of the day for these scheduled reports is defined by the "First Report Time" value and the value can be viewed in the "General Registry". The schedule report time can be changed over the air. Refer to theSystems Operation, "Manage Hardware" for more information.

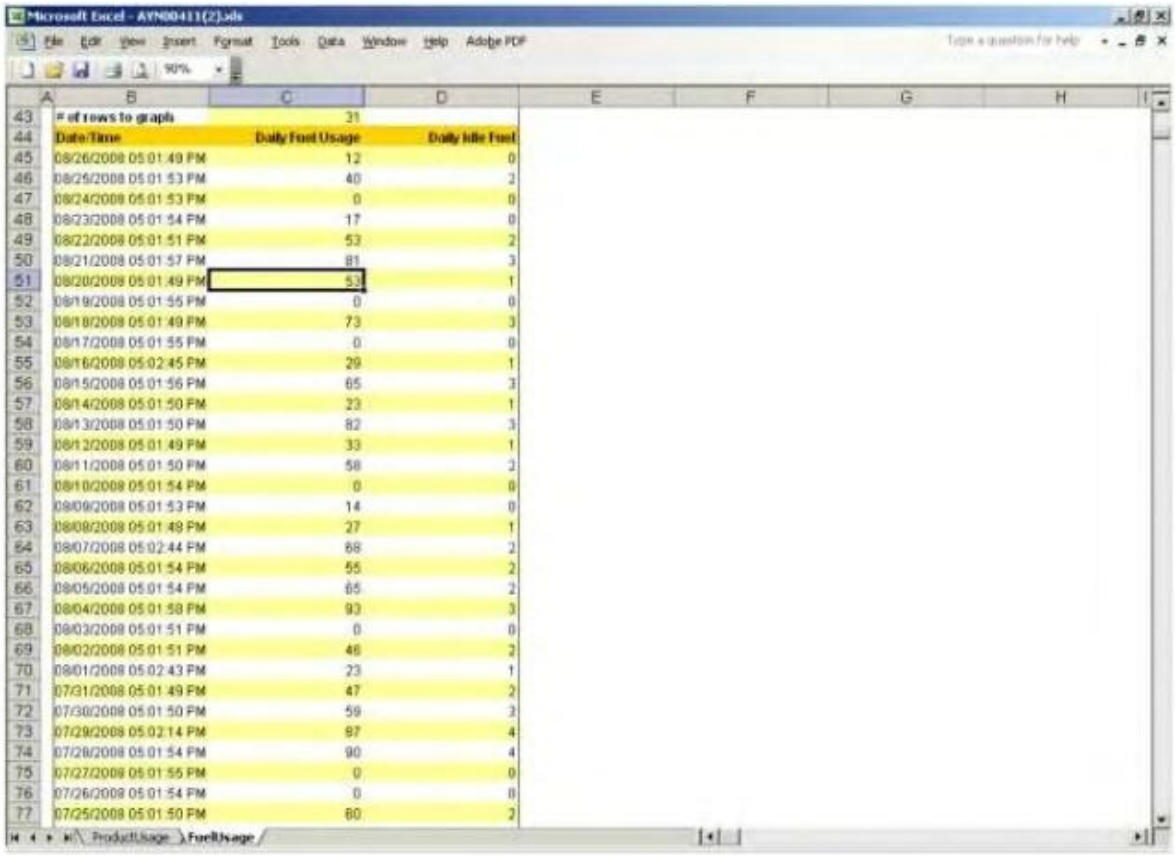


Illustration 5 g01727535

Table 4

"Product Usage Report"	
Field	**Description**
Table	
"# of rows to graph"	The number of rows to display in the "Daily Use/Idle Hours" bar chart
"Date/Time"	The date and time of the "Service Meter (hours)" and "Idle Hours" as reported by the PLM

"Daily Fuel Usage"	Displaying the volume of fuel consumed by the equipment from the report from the previous day in the units of measurment preferred by the user
"Daily Idle Fuel"	The volume of fuel consumed during idle operation report from the previous day. Displayed in the user preference for units of measure

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i03366743

Product Monitoring

SMCS - 7600; 7606

Product Monitoring Report

This report provides a listing of hours, location, cumulative fuel burned and diagnostic codes sent by the Product Link Module (PLM). The " Product Monitoring Report" may be displayed for a period of time that spans multiple months and can include the current day. So, the report history period can be selected to the user preference for period of review.

In order to generate a" Product Monitoring Report", use the following procedure:

1. Search for equipment and view the results on the "Event Summary" screen. In the "View " box, select "Product Monitoring Report". The "Product Monitoring Report" screen appears.

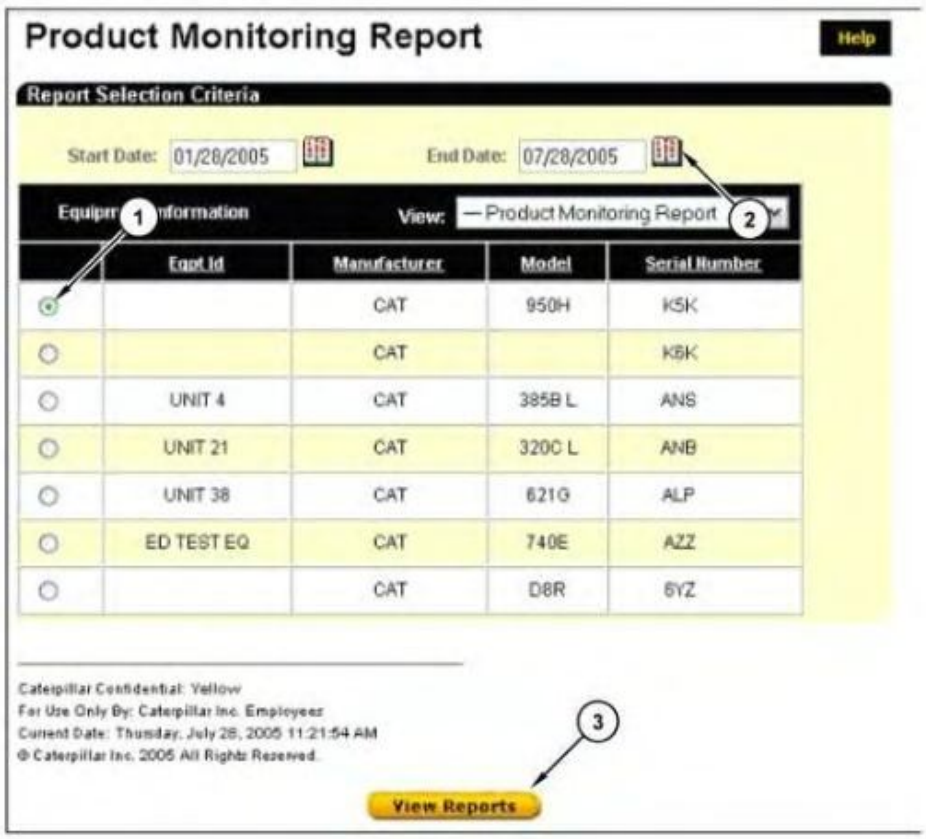


Illustration 1 g01737833

Product Monitoring Report

(1) Radio button

(2) "Start Date" and the "End Date"

(3) "View Reports" button

2. Select the "Start Date" and the "End Date" (2) that corresponds with the period for the "Product Monitoring Report". Refer to Illustration 1.
3. Select the radio button (1) that corresponds with the equipment for which you wish to generate a "Product Monitoring Report".
4. Click the "View Reports" button (3) . The "Product Monitoring Peport" appears as a PDF file in a new window. You can save the report locally, print the report, and e-mail the report.

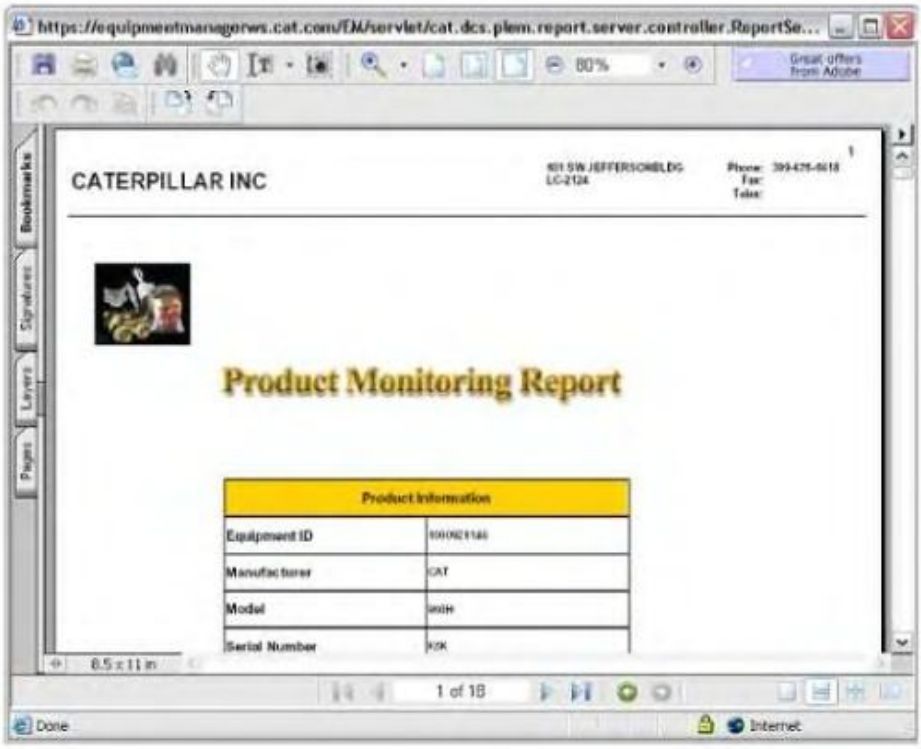


Illustration 2 g01254175

"Product Monitoring Report" PDF

Product Monitoring Report Cover Page



Illustration 3 g01254184

"Product Monitoring Report" cover page

The following table lists the fields that are found on the "Product Monitoring Report" cover page. Refer to Illustration 3.

Table 1

Field	Field Description
Equipment ID	The Equipment ID of the machine for which the report is being generated.
Manufacturer	The Manufacturer of the machine for which the report is being generated.
Model	The Model of the machine for which the report is being generated.
Serial Number	The Serial Number of the machine for which the report is being generated.
Principal Dealer	The name of the Principal Dealer of the machine for which the report is being generated.

Type	The type of report that you are viewing. In this case the type is "Product Usage Report".
Report for the Month Of	The month and year of the data that is being displayed in this report in the form MON-YYYY.
Report Generated Date	The date that the report was generated in the form DD-MON-YYYY.

"Product Monitoring Report" and Details

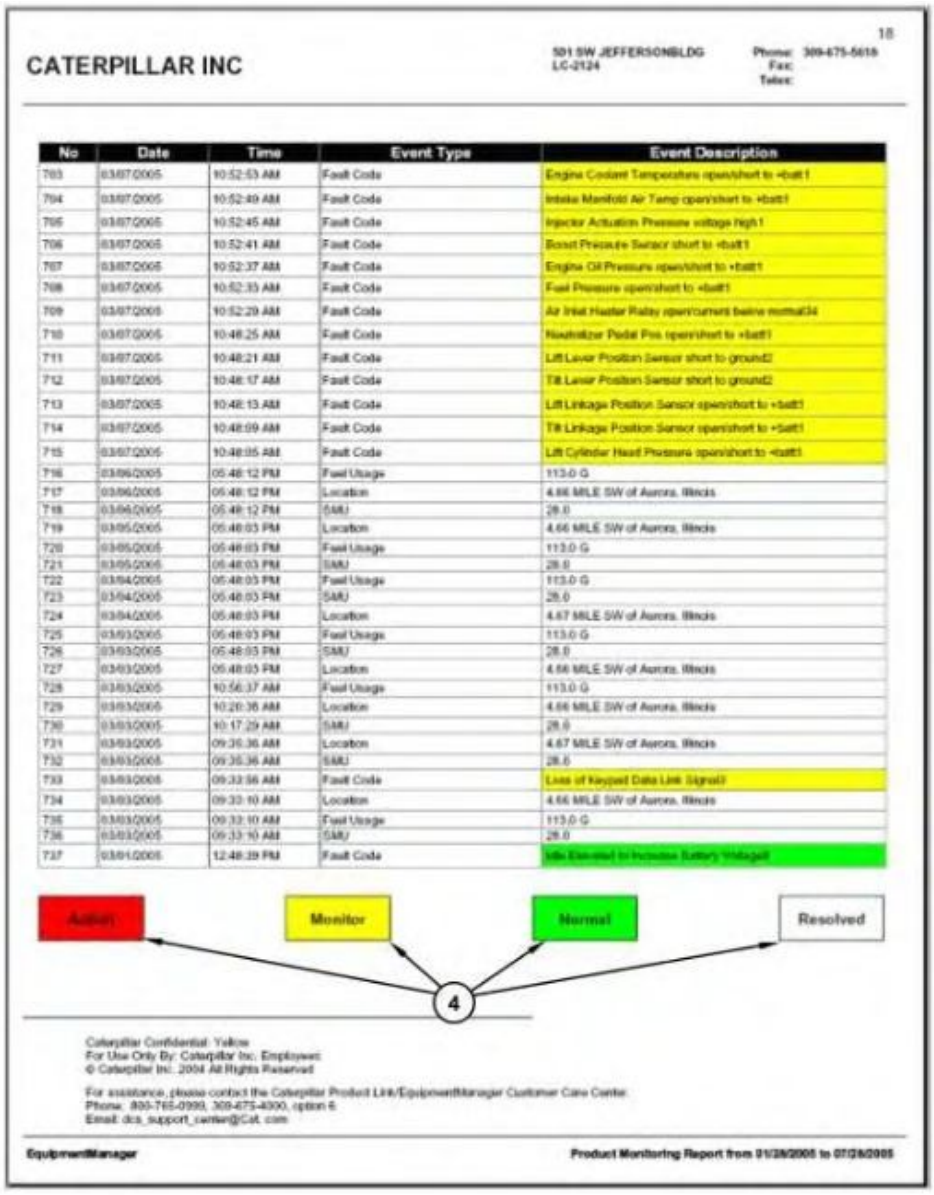


Illustration 4 g01737834

"Product Monitoring Report" details

(4) Event status

After the cover page, the "Product Monitoring Report" displays a table that lists all the events reported by the PLM for the selected time period. Table 2 lists the fieldsthat are in this table. Refer to Illustration 4.

Table 2

Field	Description
No	The events are numbered sequentially and this number is displayed in the "No" column.
Date	The date the event was recorded in MM/DD/YYYY format.
Time	The time the event was recorded in Hr:Min:Sec AM/PM format.
Event Type	The type of event that was recorded. Possible values include: Fault Code, SMU, Fuel Usage, etc.
Event Description	A description of the event. This field is color coded by the event status (4) : "Normal", "Monitor", "Action", and "Resolved".

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Systems Operation
EquipmentManager Dealer Administrator Manual
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i03366262

Operation and Maintenance Manual

SMCS - 7600; 7606

Operation and Maintenance Manual Report

The Operation and Maintenance Manual (O & MM) report provides a link to the Service Information System (SIS) Web site. You can access O & MM information for a specific Caterpillar machine through EquipmentManager. In order to use this feature, you must have access to the SIS Web site.

In order to view an O & MM report, use the following procedure.

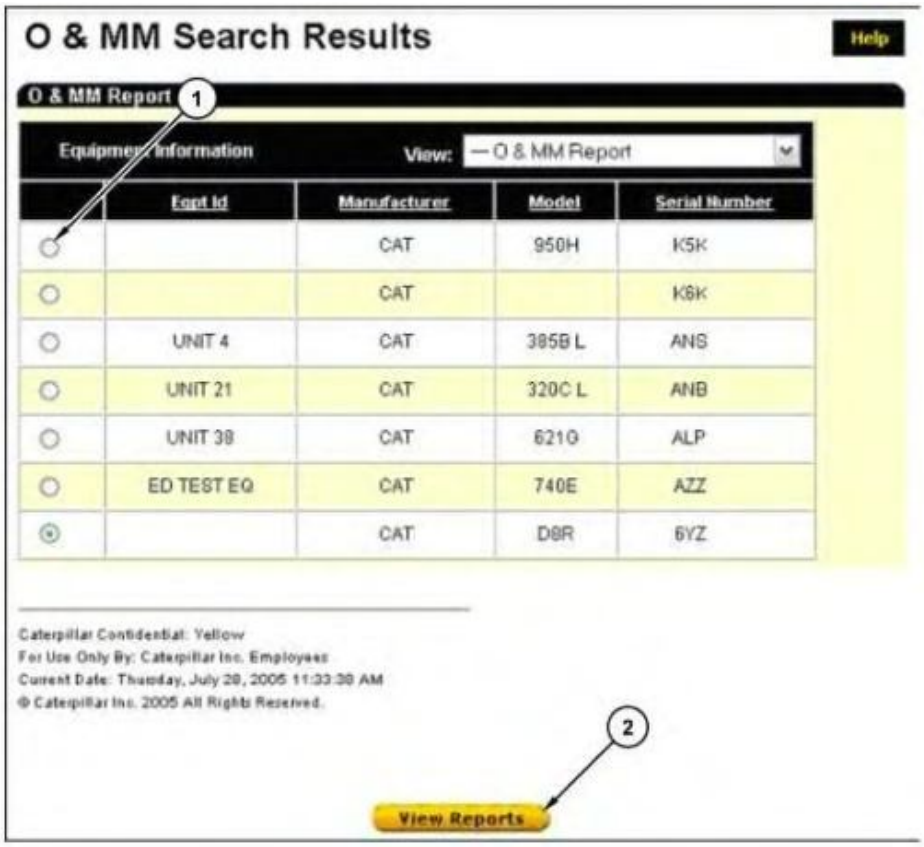


Illustration 1 g01737813

"O & MM Search Results" screen

(1) Radio button

(2) "View Reports" button

1. Search for equipment and view the results on the Event Summary screen. In the "View" box, select "O & MM Report". The "O & MM Search Results" screen appears. Select the radio button (1) for the equipment for which you wish to generate an O & MM report.



Illustration 2 g01254304

Selecting an O & MM for configuration from SIS Web

2. Click "View Reports" button (2) . The Service Information System (SIS) Web site appears in a new window. If there is more than one O & MM available for the machine, a message for selcting a configuration will appear. Refer to Illustration 2.

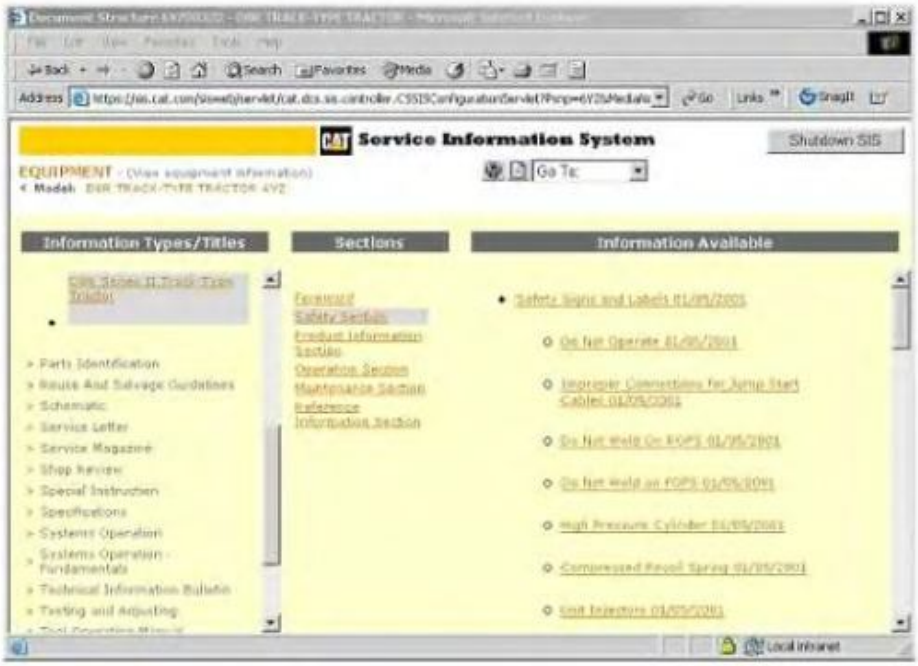


Illustration 3 g01254309

SIS Web – O & MM

3. Click the hyperlink for one of the listed O & MM configurations. A web page displays the manual for the selected configuration. Refer to Illustration 3.

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Equipment Usage

SMCS - 7600; 7606

The Equipment Usage report will calculate the usage of selected machines in hours for a selected period of days, weeks, months, or years. This report also displays the last location reported during the selected period.

To view a summary of the Equipment Usage on a machine, use the following procedure.

1. From the "Event Summary" screen, select the checkbox next to the equipment for which you wish to view equipment usage.
2. From the "View" drop down menu, select "Equipment Usage Summary". The "Equipment Usage Summary" screen is displayed.

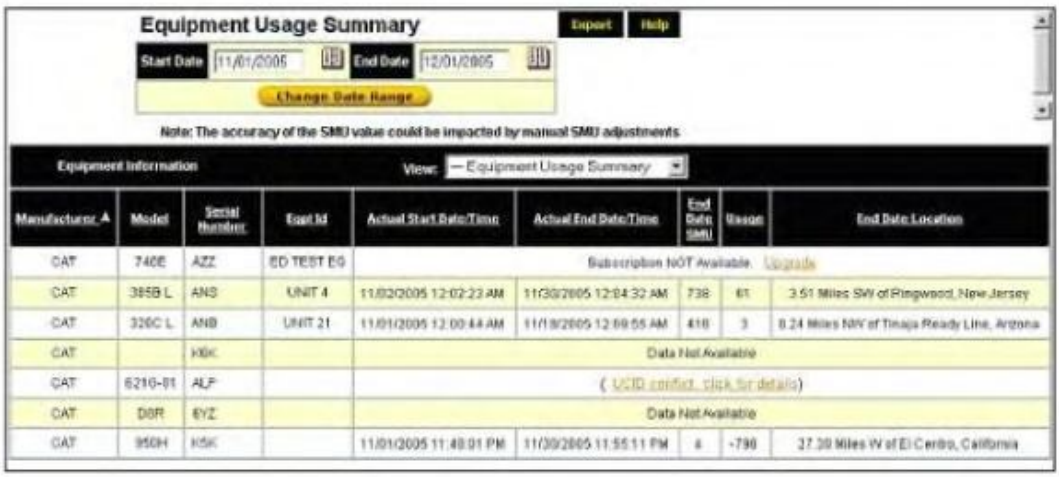


Illustration 1 g01254631

Equipment Usage Summary Screen

3. To change the date of the summary, click the calendar icons next to the "Start Date" and/or "End Date" fields and select a date from the pop up calendar, then click "Change Date Range". A new Equipment Usage Summary is displayed.

Note: The accuracy of the SMU value could be impacted by manual SMU adjustments.

Exports

The Export function enables you to export your current view to multiple file formats. The data can then be sorted, filtered, charted, manipulated, and shared with others.

In order to export data to an Excel spreadsheet, perform the following steps:

1. On the "Equipment Usage Summary" screen, click Export. The "Export" window appears.



Illustration 2 g01393488

Export Window

Note: You can export data to other file formats. Lotus 1, 2, 3 works similarly to Excel. Tab Delimited Text enables easy import into other applications like Access.

2. Select "MS Excel Spreadsheet", and then click "OK".

   The "File Download" dialog box appears.

3. Click "Save" to save the file as a spreadsheet on your hard drive, where you can manipulate the file using standard Excel spreadsheet functions such as "Average and Chart", or share the file electronically.

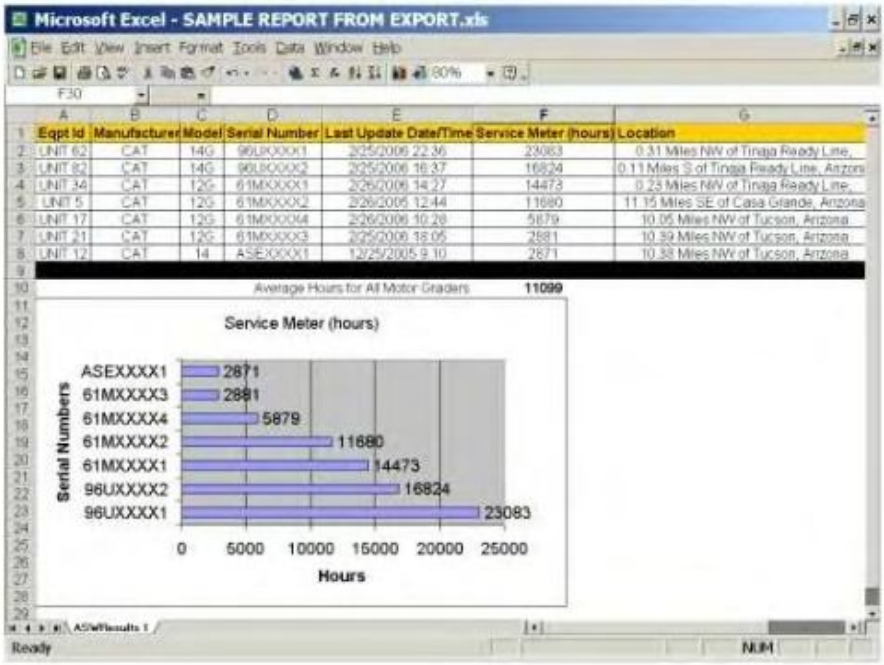


Illustration 3 g01393494

Note: You can export to the Maintenance Control System (MCS) (location and SMU page export only). This export creates a fixed width .txt file that can be imported into the MCS.

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EquipmentManager Dealer Administrator Manual
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i03348523

Active Fleet

SMCS - 7600; 7606

This report provides information of the customer and the equipment, the details from the last report, and Product Link details. This report can be run at the Universal Customer ID (UCID) level or the dealership level. While feature level search results are limited to the 999 equipment, this report has no limit and can be generated to aid in audits, maintenance, and administration of the customer or dealers Product Link population.

In order to generate the "Active Fleet Report", refer to the following procedure:

1. From either the "Reports" section of the "Administration" screen or the "View" drop-down menu, select "Active Fleet Report". The "Active Fleet Report" screen will be displayed.



Illustration 1 g01724615

"Active Fleet Report" screen

2. Select a customer from the "UCID" drop-down menu in order to create a report for the customer or allow "All Dealer Machines" to remain selected in the "UCID" drop-down menu in order to generate the report for all equipment and customers for your dealership. Select "Export". Refer to Illustration 1.



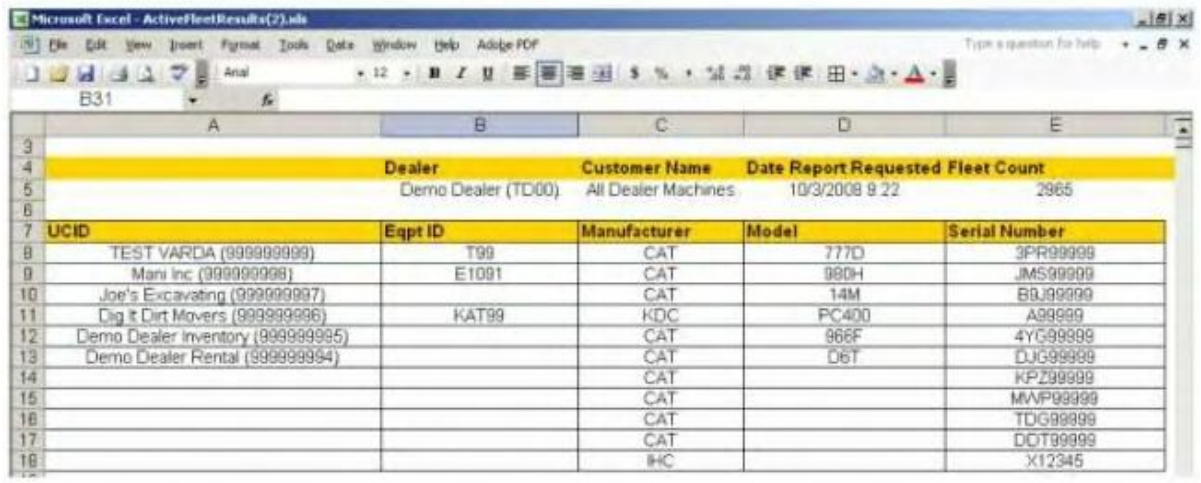
Illustration 2 g01724813

"Export" screen

3. Select "MS Excel Spreadsheet", and then click "OK". The "File Download" dialog box will appear.

   Note: You can export data to other formats for a file. "Lotus 1, 2, 3 SpreadSheet" works similarly to Mircosoft[R] Excel. "Tab Delimited Text" enables files to be imported easily into other applications. Refer to Illustration 2.

4. Click "Save" in order to save the file as a spreadsheet on your hard drive. This will enable you to manipulate the file by using the standard functions in the Mircosoft Excel spreadsheet such as "Average and Chart", or you can share the file electronically.



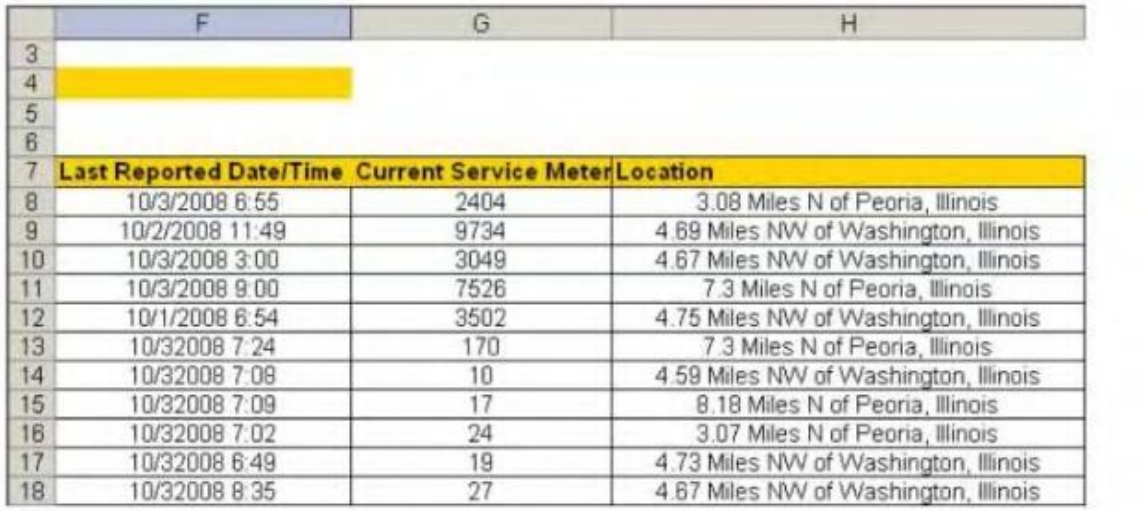
	A	B	C	D	E
3					
4		Dealer	Customer Name	Date Report Requested	Fleet Count
5		Demo Dealer (TD00)	All Dealer Machines	10/3/2008 9:22	2965
6					
7	UCID	Eqpt ID	Manufacturer	Model	Serial Number
8	TEST VARDA (999999999)	T99	CAT	777D	3PR99999
9	Mani Inc (999999998)	E1091	CAT	980H	JMS99999
10	Joe's Excavating (999999997)		CAT	14M	BGJ99999
11	Dig It Dirt Movers (999999996)	KAT99	KDC	PC400	A99999
12	Demo Dealer Inventory (999999995)		CAT	966F	4YG99999
13	Demo Dealer Rental (999999994)		CAT	D6T	DJG99999
14			CAT		KPZ99999
15			CAT		MWP99999
16			CAT		TDG99999
17			CAT		DDT99999
18			IHC		X12345

Illustration 3 g01727033

"Active Fleet Report"

Table 1

"Active Fleet Report"	
Field	**Description**
Header	
"Dealer"	The name of the dealer and dealer code for the generated report
"Customer Name"	The name of the customer for generated report
"Date Report Requested"	The date and time of the generated report which is displayed in the preferred format of the user
"Fleet Count"	The number of machines in the respective fleet
Customer Information and Equipment Information	
"UCID"	Customer name and "UCID"
"Equipment ID"	The id of the equipment
"Manufacture"	The manufacturer of the equipment
"Model"	The model of the equipment
"Serial Number"	The serial number of the equipment



	F	G	H
3			
4			
5			
6			
7	Last Reported Date/Time	Current Service Meter	Location
8	10/3/2008 6:55	2404	3.08 Miles N of Peoria, Illinois
9	10/2/2008 11:49	9734	4.69 Miles NW of Washington, Illinois
10	10/3/2008 3:00	3049	4.67 Miles NW of Washington, Illinois
11	10/3/2008 9:00	7526	7.3 Miles N of Peoria, Illinois
12	10/1/2008 6:54	3502	4.75 Miles NW of Washington, Illinois
13	10/32008 7:24	170	7.3 Miles N of Peoria, Illinois
14	10/32008 7:08	10	4.59 Miles NW of Washington, Illinois
15	10/32008 7:09	17	8.18 Miles N of Peoria, Illinois
16	10/32008 7:02	24	3.07 Miles N of Peoria, Illinois
17	10/32008 6:49	19	4.73 Miles NW of Washington, Illinois
18	10/32008 8:35	27	4.67 Miles NW of Washington, Illinois

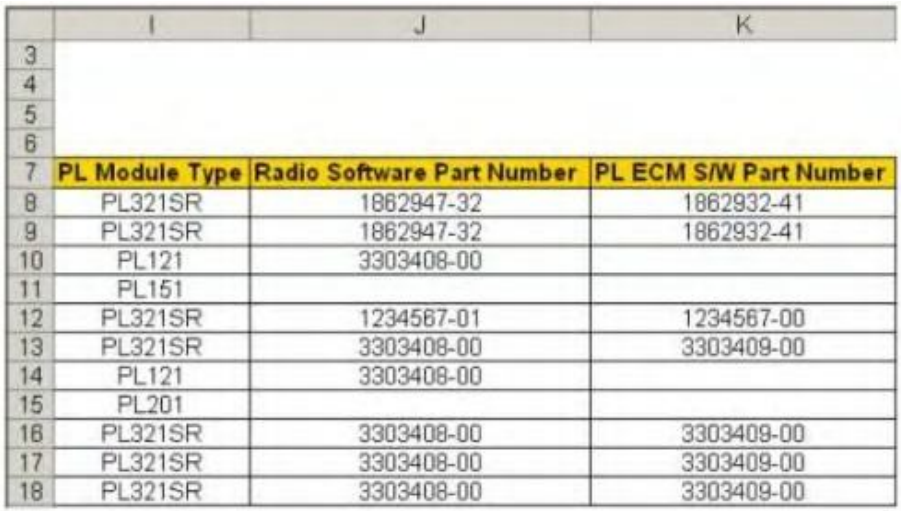
Illustration 4 g01727046

"Last Reported" information of the "Active Fleet Report"

Table 2

"Active Fleet Report"	
Field	**Description**
"Last Reported" Information	
"Last Reported Date/Time"	The date and time of the last report on service meter or location which is displayed in the preferred format of the user
	The last report for the service meter units

"Current Service Meter"	
"Location"	The last report for location which is displayed in preferred format for the user



	I	J	K
3			
4			
5			
6			
7	PL Module Type	Radio Software Part Number	PL ECM S/W Part Number
8	PL321SR	1862947-32	1862932-41
9	PL321SR	1862947-32	1862932-41
10	PL121	3303408-00	
11	PL151		
12	PL321SR	1234567-01	1234567-00
13	PL321SR	3303408-00	3303409-00
14	PL121	3303408-00	
15	PL201		
16	PL321SR	3303408-00	3303409-00
17	PL321SR	3303408-00	3303409-00
18	PL321SR	3303408-00	3303409-00

Illustration 5 g01727048

Product Link information of the "Active Fleet Report"

Table 3

"Active Fleet Report"	
Field	**Description**
Product Link Information	
"PL Module Type"	The type of Product Link Module
"Radio Software Part Number"	The part number of the onboard Product Link Radio software (PL121)
"PL ECM S/W Part Number"	The part number of the onboard Product Link ECM software (PL300)

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i03319401

General Information

SMCS - 7600; 7606

Use of this Manual

EquipmentManager provides valuable information that allows remote monitoring of either a single machine or a fleet of machines. Customers can perform the following tasks if the customer can provide the location of the machine, Service Meter Unit (SMU), and information about the health of the machine:

- Manage the location and the basic usage of engines and machines.
- Schedule maintenance that is planned and schedule major repairs.
- Manage fault codes or diagnostic codes.
- Detect problems before problems cause a major component failure.
- Increase the availability and the productivity for the machines by avoiding unexpected downtime for repairs.
- Identify the need for training in order to improve the efficiency of the operator.

EquipmentManager is part of Dealer Web site and works with other applications such as PartStore and EquipmentManager. EquipmentManager enables customers to remotely manage fleets. The customer is alerted to only those machines that need immediate attention.

The "EquipmentManager Dealer Administrator Manual" includes the following information:

- Setting up Product Link Modules (PLM)
- Registering PLM
- Setting up and maintaining the accounts of the customer
- Customizing EquipmentManager for optimum use
- Managing EquipmentManager functions

This manual also provides suggestions for using the features of EquipmentManager.

Assumptions

The "EquipmentManager Dealer Administrator Manual" assumes that the user is a Dealer Administrator. The"EquipmentManager Dealer Administrator Manual" also assumes the following:

- The user is familiar with Dealer Web site and related applications.
- The user is able to access the dealership's Dealer Web site.
- The user is familiar with using and entering information in forms that are found in web sites, performing searches on the web, and submitting information via the web.

Terms and Definitions

Table 1 defines common acronyms and terms that are used throughout this manual.

Table 1

Term or Acronym	Definition
Dealer Web site	Dealer Web site is an application on the internet that is used to access EquipmentManager.
ECM	Electronic Control Module
I/O	Input/Output
PLM	Product Link Module This on board hardware communicates with any ECM that is on the machine. Additionally, the hardware sends information to the satellites and from the satellites.
PM	Preventive Maintenance
SMU	Service Meter Units
S·O·S	Scheduled Oil Sampling This is a program that analyzes samples of fluid. This program is designed to be an easy way to monitor the impact of maintenance programs, applications, and operational factors on machine health.
UCID	Universal Customer ID
CWS	Corporate Web Security

Related Documentation

ReferenceRefer to the following documents for additional EquipmentManager information and related applications.

- Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121SR/321SR"
- Special Instruction, REHS2365, "Product Link PL121SR and PL300 Installation Guide"
- Systems Operation, KENR6303, "EquipmentManager User Manual"

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Getting Started

SMCS - 7600; 7606

Overview

The following provides an overview of EquipmentManager. This overview instructs you on the steps that are necessary to begin using EquipmentManager in order to manage the life cycle of your equipment and the equipment of your customers.

There are five steps:

1. Enable EquipmentManager.
2. Verify the records for the machine and the ownership of the machine.
3. Manage the users.
4. Install Product Link Modules.
5. Set up the subscriptions.

Some of the steps that are outlined in this section may be completed in a different order. Following the steps in the order that is suggested here is recommended strongly by the Caterpillar Dealer Solution Network (DSN).

Note: Use your web browser to select your preferred language.

Note: Caterpillar does not recommend using software to block popup software while EquipmentManager is active.

EquipmentManager and the Product Link System

EquipmentManager is an upgrade of a previous application that was known as Product Link Web. Many of the features of EquipmentManager are similar to this application.

EquipmentManager is an application that is used on the Internet. This application allows you to better manage the maintenance, health, and utilization of your machines. EquipmentManager uses a combination of Product Link hardware, satellites, wireless technology, a Caterpillar database, and a Caterpillar server in order to manage the machines.

Illustration 1 illustrates the EquipmentManager and the Product Link System.

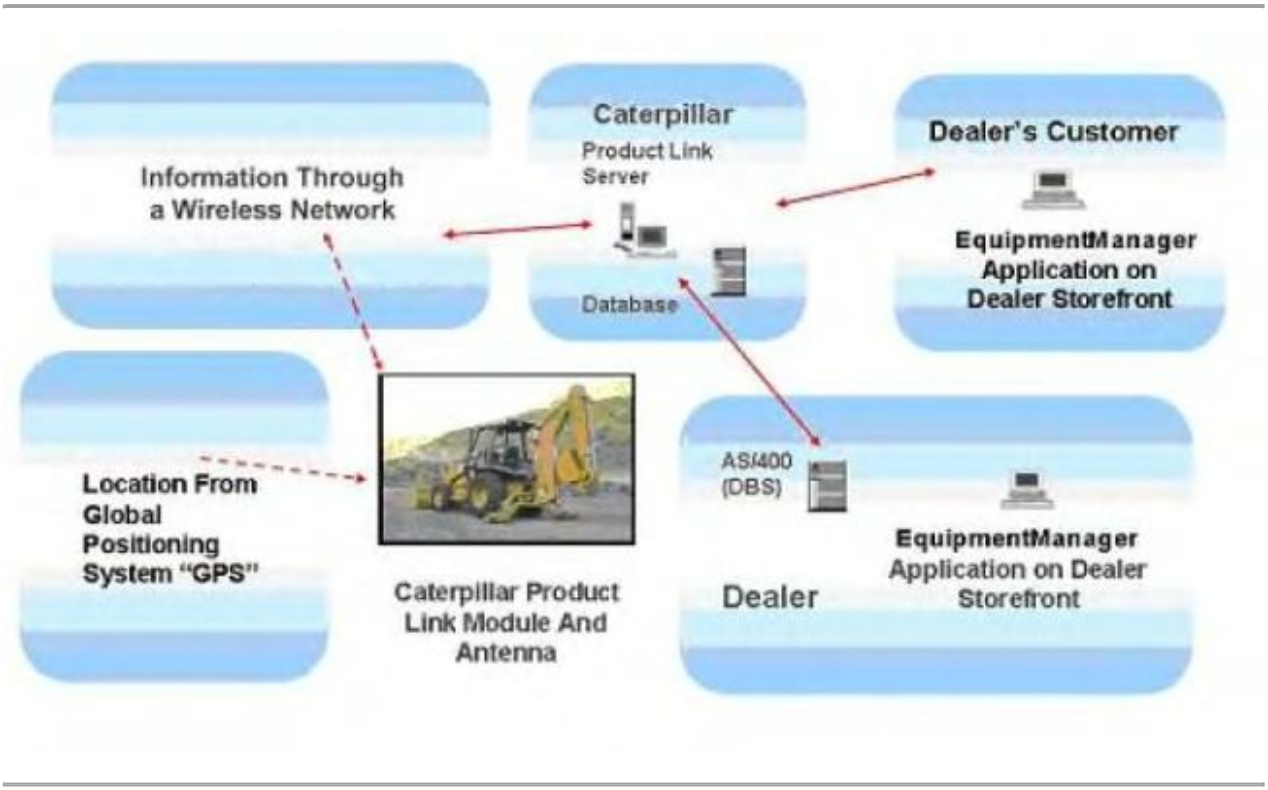


Illustration 1 g01243520

EquipmentManager and Product Link System

Each piece of machinery is equipped with Product Link hardware. Each machine can be managed by using EquipmentManager. Information is sent to the machine and information is received from the machine via a Product Link Module (PLM) through a wireless network.

Note: For more information about the available PLMs and installation of the PLMs, refer to Systems Operation, "Install Product Link Modules".

The location of the machine is determined by using a Global Positioning System (GPS). Wireless networks send the information that is received from the PLMs to a central database for Product Link that is provided by Caterpillar. This information can then be viewed with EquipmentManager.

If you are using the Caterpillar Dealer Business System you will have the option of receiving daily updates from Product Link Service Meter Units (SMU). EquipmentManager can store these updates in your DBS database.

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i03368383

Verify Machine Records and Ownership

SMCS - 7600; 7606

Verify Machines in Equipment Data

Verify that the machines exist in Equipment Data before you install Product Link Modules (PLM) on machines. After you install PLM, configure PLM and register PLM in order to communicate with the EquipmentManager application. If the machines do not already exist in Equipment Data (ED), you must add the machines.

Note: Equipment Data allows customers to manage the customer's equipment across dealerships. Equipment Data provides a central equipment database for use in Caterpillar developed applications. Equipment Data is delivered through CaterpillarDealer Web sites.

The following features are included in Equipment Data:

- Automatic updates of the Equipment Data equipment record from the Dealer's Business System (DBS)
- Updates that are sent to the DBS/DBSi when changes are made in the Equipment Data
- Equipment grouping functionality

The PartStore System and EquipmentManager users will often have access to Equipment Data. Caterpillar recommends that the Dealer Administrator for EquipmentManager is provided with access to the Equipment Data application.

If you do not have access to the Equipment Data application in order to add machines, contact your Technical communicator.

Note: Refer to Caterpillar Equipment Data Dealer Manual Release 2.0 for complete instructions on the Equipment Data Application.

UCID Conflict Management

Once you have verified that the necessary machines exist in Equipment Data, you must then resolve any ownership conflicts that may exist on that machine. Ownership conflicts arise when a

single serial number within Equipment Data has been associated with two or more Universal Customer ID's (UCID). Within EquipmentManager, detailed information about a single serial number is not displayed if the ownership data for that equipment has a UCID conflict.

In order to resolve an ownership conflict by consolidating UCID's, contact your Technical Communicator.

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i03319640

Manage Users

SMCS - 7600; 7606

Set Up New Users

There are four different types of user roles that are available in EquipmentManager. The tables below list the four types of roles. Under each of the roles the permissions that are available for that role are listed.

Table 1

Customer User Permissions	
Features	Administration
Hours and Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Assign Groups (to user level)
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	**Event Tracking**
Planned Maintenance	None
Request quote	**Upload Data**
View Planner	Repair History
Enter PM Notes	Refueling History
Mark PM Complete	**Manage Exiting User**

View Checklists	Limited to Customer User Level
View Parts lists	**Time and Geo. Fence Descriptions**
Major Repair	Inclusive / Exclusive Descriptions
Request Quote	Time Based Descriptions
View Planner	**Manage Planned Maintenance**
Mark Repair Complete	Customize PM Intervals
View History Details	Edit PM Check List
Fuel Information	Customize PM Schedule
View Fuel Level History	General
View Fuel Level Graph	Search
View Fuel History	Export
View Status History	Preferences
Update Fuel Level Status	Equipment Details
Fault Codes	Registration Details
View Fault Code History	Optional Permissions
Update Fault Code Status	Order Parts [(1)]
View Status History	OTA Configuration
View Troubleshooting Procedures [(2)]	Send Commands
Reports	Address Book
View Product Usage Report	Event Reactions
View Product Monitoring Report	
View OM&M	
View Equipment Usage Summary	

[(1)] Contingent on Partstore access

[(2)] Contingent on SIS access

Table 2

Customer Administrator Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments

Time & Geo Fence	Manage Hardware
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	Over the Air Commands
Planned Maintenance	Send Commands
Request quote	**Event Tracking**
View Planner	Address Book
Enter PM Notes	Event Reactions
Mark PM Complete	**Upload Data**
View Checklists	Repair History
View Parts lists	Refueling History
Order Parts [1]	**Manage Exiting User**
Major Repair	Customer User or Admin Level
Request Quote	**Time and Geo. Fence Descriptions**
View Planner	Inclusive / Exclusive Descriptions
Mark Repair Complete	Time Based Descriptions
View History Details	**Manage Planned Maintenance**
Fuel Information	Customize PM Intervals
View Fuel Level History	Edit PM Check List
View Fuel Level Graph	Customize PM Schedule
View Fuel History	General
View Status History	Search
Update Fuel Level Status	Export
Fault Codes	Preferences
View Fault Code History	Equipment Details
Update Fault Code Status	Registration Details
View Status History	Manage Subscriptions
View Troubleshooting Procedures [2]	
Reports	
View Product Usage Report	
View Product Monitoring Report	
View OM&M [2]	

View Equipment Usage Summary	

(1) Contingent on Partstore access

(2) Contingent on SIS access

Table 3

Dealer User Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	**Event Tracking**
Planned Maintenance	None
Request quote	**Upload Data**
View Planner	Repair History
Enter PM Notes	Refueling History
Mark PM Complete	**Manage Exiting User**
View Checklists	Limited to Dealer User or Customer User or Admin Level
View Parts lists	**Time and Geo. Fence Descriptions**
Major Repair	Inclusive / Exclusive Descriptions
Request Quote	Time Based Descriptions
View Planner	**Manage Planned Maintenance**
Mark Repair Complete	Customize PM Intervals
View History Details	Edit PM Check List
Fuel Information	Customize PM Schedule
View Fuel Level History	General
View Fuel Level Graph	Search
View Fuel History	Export

View Status History	Preferences
Update Fuel Level Status	Equipment Details
Fault Codes	Registration Details
View Fault Code History	Optional Permissions
Update Fault Code Status	Order Parts [1]
View Status History	OTA Configuration
View Troubleshooting Procedures [2]	Send Commands
Reports	Address Book
View Product Usage Report	Event Reactions
View Product Monitoring Report	
View OM&M [2]	
View Equipment Usage Summary	

[1] Contingent on Partstore access

[2] Contingent on SIS access

Table 4

Dealer Administrator Permissions	
Features	Administration
Hours & Location	**Groups**
Map	Create Groups
Start/Stop Times	Modify Groups
View SMU history	Delete Groups
View Location History	Assign Groups (to user level)
View Status History	Delete Group Assignments
Time & Geo Fence	**Manage Hardware**
Update Status	View General Registry
Setup Fence	View Digital Registry
Enable/Disable	View Transmission Registry
View Alarm History	Product Link Module Search
View Status History	Over the Air Commands
Planned Maintenance	Send Commands
Request quote	**Event Tracking**
View Planner	Address Book
Enter PM Notes	Event Reactions
Mark PM Complete	**Upload Data**

View Checklists	Repair History
View Parts lists	Refueling History
Order Parts [1]	**Manage Exiting User**
Major Repair	Dealer User or Admin Level
Request Quote	Customer User or Admin Level
View Planner	**Time and Geo. Fence Descriptions**
Mark Repair Complete	Inclusive / Exclusive Descriptions
View History Details	Time Based Descriptions
Fuel Information	**Manage Planned Maintenance**
View Fuel Level History	Customize PM Intervals
View Fuel Level Graph	Edit PM Check List
View Fuel History	Customize PM Schedule
View Status History	General
Update Fuel Level Status	Search
Fault Codes	Export
View Fault Code History	Preferences
Update Fault Code Status	Equipment Details
View Status History	Registration Details
View Troubleshooting Procedures [2]	Manage Subscriptions
Reports	
View Product Usage Report	
View Product Monitoring Report	
View OM&M [2]	
View Equipment Usage Summary	

[1] Contingent on Partstore access

[2] Contingent on SIS access

A user role may only be given to another user by a user that is equal or higher than the user that is being assigned. For example, a Dealer Administrator may create another Dealer Administrator, but a dealer user cannot create a "Dealer Administrator".

Use the following procedure in order to create a new user:



Illustration 1 g01698693

The Dealer Web site with the "Applications" drop-down menu

(1) "Applications" drop-down menu

1. Log in to your Dealer Web site. The home screen of Dealer Web site appears.

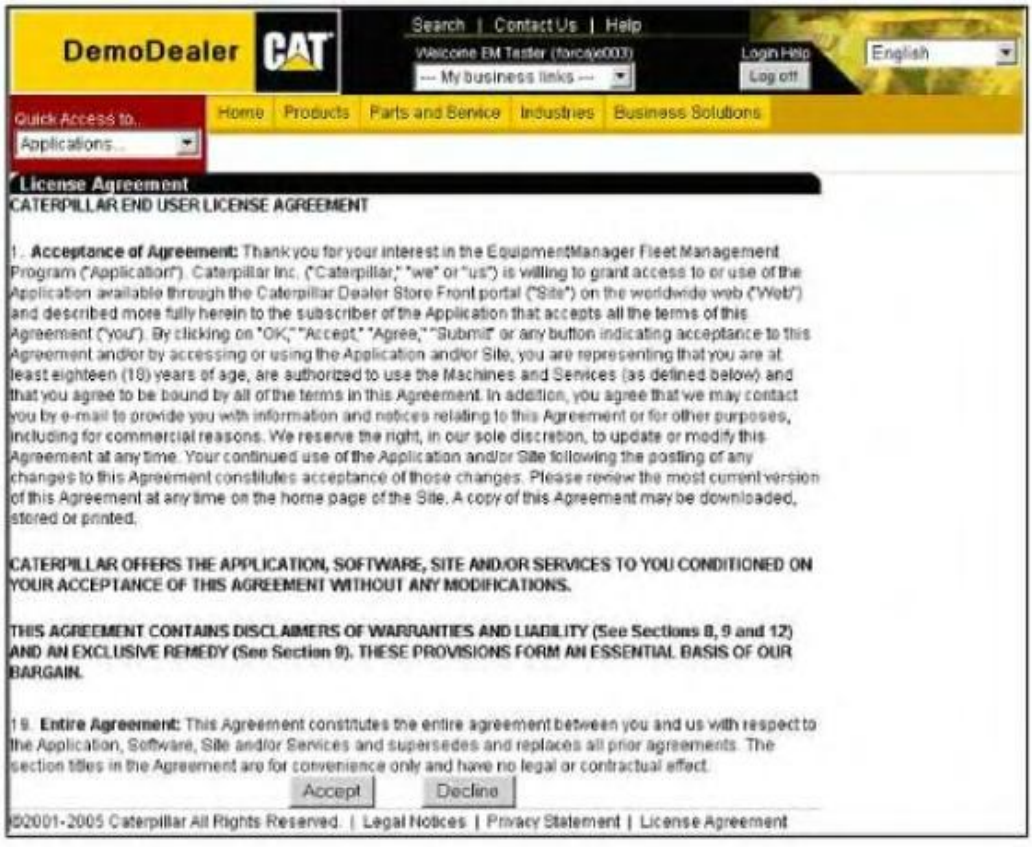


Illustration 2 g01244205

"End User License Agreement"

Note: If this is your first time to log in to EquipmentManager, then an "End User License Agreement" (EULA) appears. Refer to Illustration 2. Scroll to the bottom of the EULA and click "Accept". The screen for setting the user preferences will appear. Refer to Systems Operation, "Preferences".

2. Select "EquipmentManager" from the "Applications" drop-down menu (1) . Refer to Illustration 2. The home page of EquipmentManager will appear.



Illustration 3 g01698734

EquipmentManager home page

(2) "Administration" tab

3. From the left navigation, click the "Administration" tab (2) . The "Administration" screen will be displayed.



Illustration 4 g01698776

"Administration" screen

(3) "View" drop-down menu

(4) "Manage User"

(5) "Setup a New User" link

4. Select "Set Up New User" (5) under "Manage User" (4) . The "Setup a New User" screen will be displayed.

   Note: "View" drop-down menu (3) contains same links that appear on the "Administration" page.



Illustration 5 g01698833

"Setup a New User" screen

(6) "Enter a:" field

5. In the "Enter a:" field (6) , enter a last name or login ID.
6. Click on the "Display Accounts" button.



Illustration 6 g01699073

"Display accounts" on the "Setup a New User" screen

(7) "Login Id" of a user

7. Select the "Login Id" of a user (7) to setup from the list of users that appear below the "Display Accounts" button. The "User Permission" screen will be displayed.

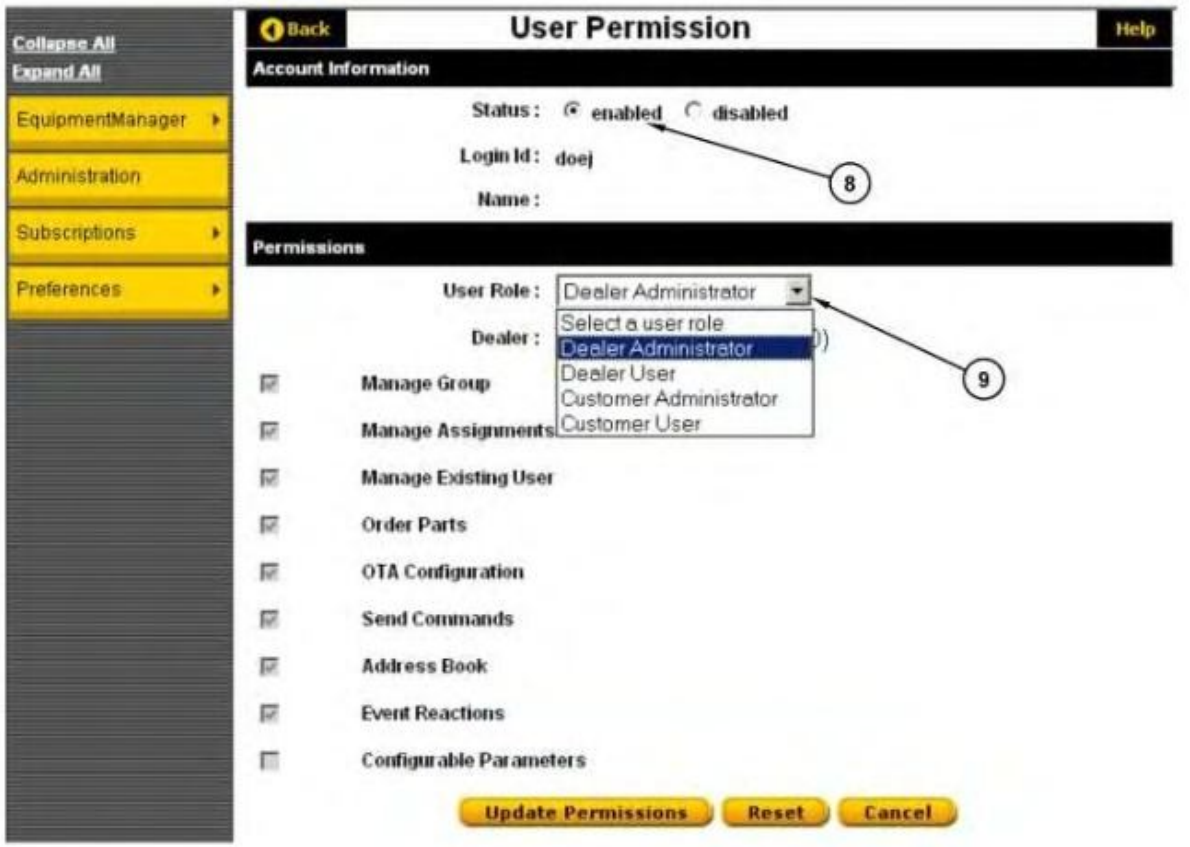


Illustration 7 g01699701

"User Permissions" screen

(8) "Enable" radio button

(9) "User Role" drop-down menu

8. Select the "enabled" radio button (8) next to "Status" in the "Account Information" section. Select the check box next to the permissions in order to apply the change.

9. In the "Permissions" section, select a user role for the user from the "User Role" drop-down menu (9) .

   Note: If you selected "Dealer Administrator" or "Customer Administrator", all of the check boxes next to the available permissions that can be granted to these two users will be selected because an administrator is automatically given all permissions. You will not be able to unselect particular permissions. If you selected "Dealer User" or "Customer User", the check boxes next to "Manage Group" and "Manage Assignments" will be selected and unavailable. The remaining check boxes will be available for selection.

10. Click the "Update Permissions" button. The "Do you want to proceed with the assignments?" dialog box will be displayed.



Illustration 8 g01244272

Proceed with the "Assignments" dialog box.

11. Click on "OK". The "Confirmation – User Permission" screen will be displayed.



Illustration 9 g01699776

"Confirmation: User Permissions" screen

(10) "The user permission(s) have been successfullu updated" message

(11) Check boxes

12. The "The user permission(s) have been successfullu updated" message (10) will appear. Also, green check marks in the check boxes (11) will appear in order to indicate that the user was given that specific authorization. Select "OK". The "Setup a New User" screen will be displayed.



Illustration 10 g01699797

"Setup a New User" with a "No results found for the search" message

(12) "No results found for the search" message

The last name or login id that was entered in Step 5 will appear again in the "Enter a:" field. Below the "Display Accounts" button, a message will appear that reads "No results found for the search" (12) . This is because the user that you added no longer appears in the list of users that are not registered with the EquipmentManager application. Your newly created user now appears in the list of existing users.

Manage Existing Users

In addition to adding new users, as a Dealer Administrator you may edit the user roles and permissions of existing users.

In order to manage an existing user, use the following procedure.

1. From the "Administration" screen or the "View" drop-down menu, select "Manage Existing User". The "Manage Existing User" screen will be displayed.

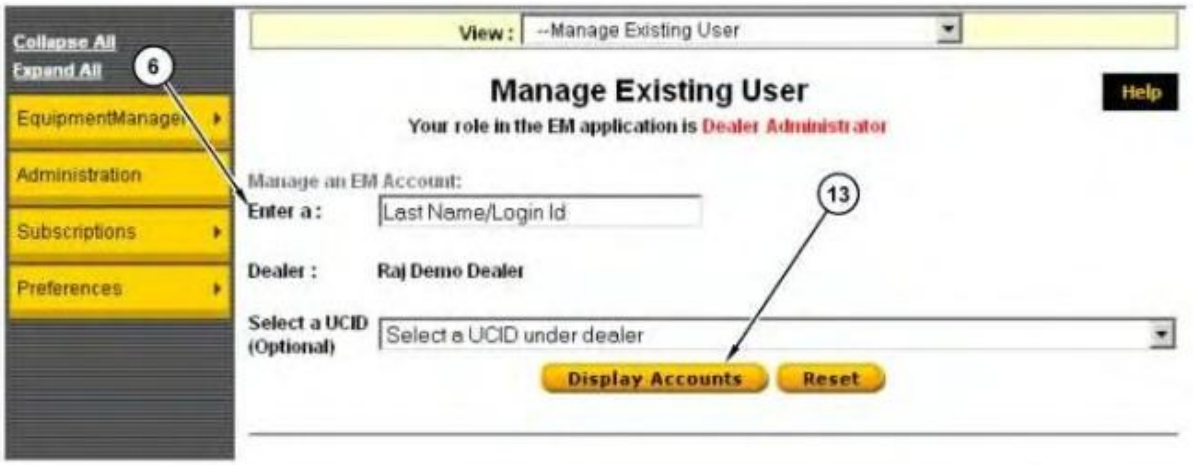


Illustration 11 g01699875

"Manage Existing User" screen

(6) "Enter a:" field

(13) "Display Accounts" button

2. Enter a last name or login id in the "Enter a:" field (6) . Select the "Display Accounts" button (13) .

   The system searches for the last name or login id among the list of registered EquipmentManager users. The system will display a list of all the available matches.



Illustration 12 g01700273

Manage Existing Users : User List

(7) "Login Id" of a user

3. Click on the login id of a user (7) you wish to edit. The "User Permission" screen will be displayed.

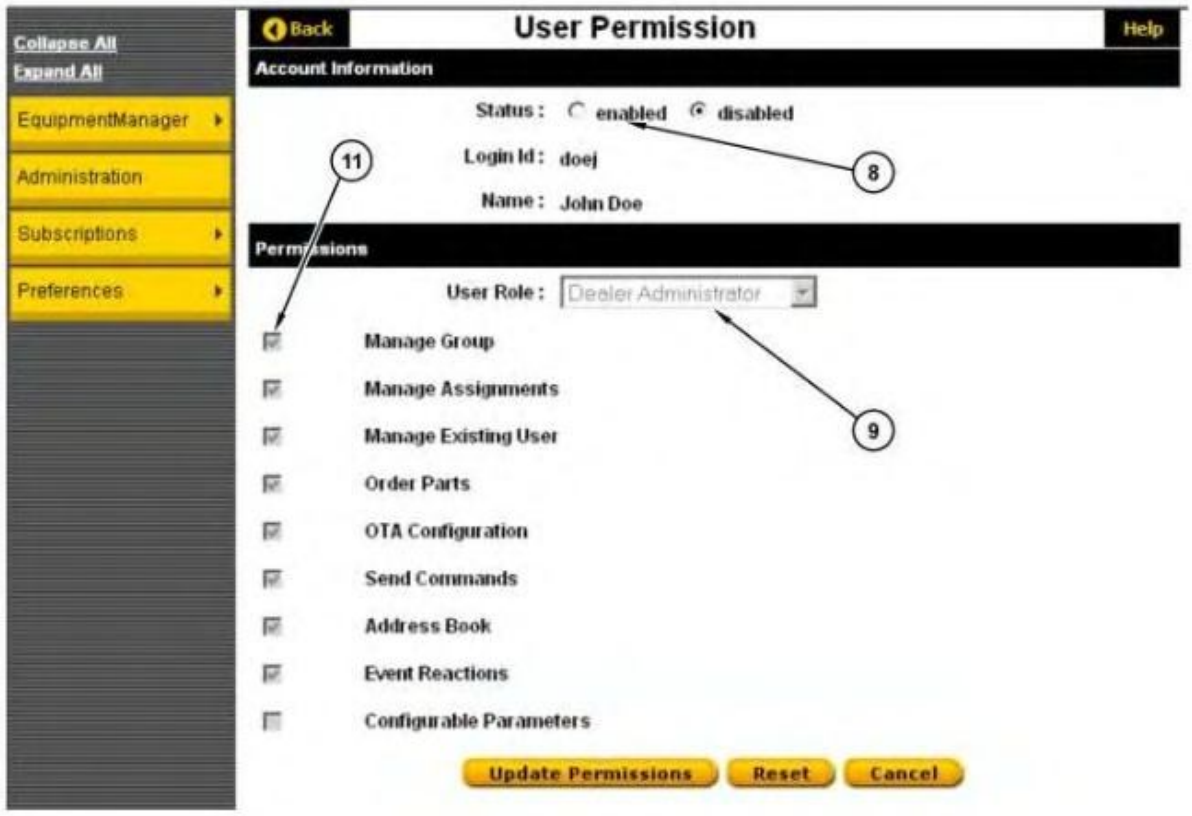


Illustration 13 g01698675

Existing "User Permission" screen

(8) Enable radio button

(9) "User Role" drop-down menu

(11) Check boxes

4. Update the "User Role" in the "Status" by clicking one of the buttons highlighted in Ilustration 13.
   a. Select the enable radio button (8) .
   b. Select a different role from the "User Role" drop-down menu (9) .
   c. Update permissions by selecting or clearing the available check boxes (11) next to the permissions.
5. When you have finished making your changes, click the "Update Permissions" button at the bottom. The "Confirmation – User Permission" screen will be displayed.



Illustration 14 g01700354

"Confirmation: User Permissions" screen

(10) Confirmation message

(11) Check boxes

6. Click on "OK". You have successfully updated the existing user and will be returned to the "Manage Existing User" screen.

   Note: Check marks in the check boxes (11) indicate permissions that are granted to the user. Permissions that display the letter "X" over the check mark indicate that these permissions are not granted to the user.

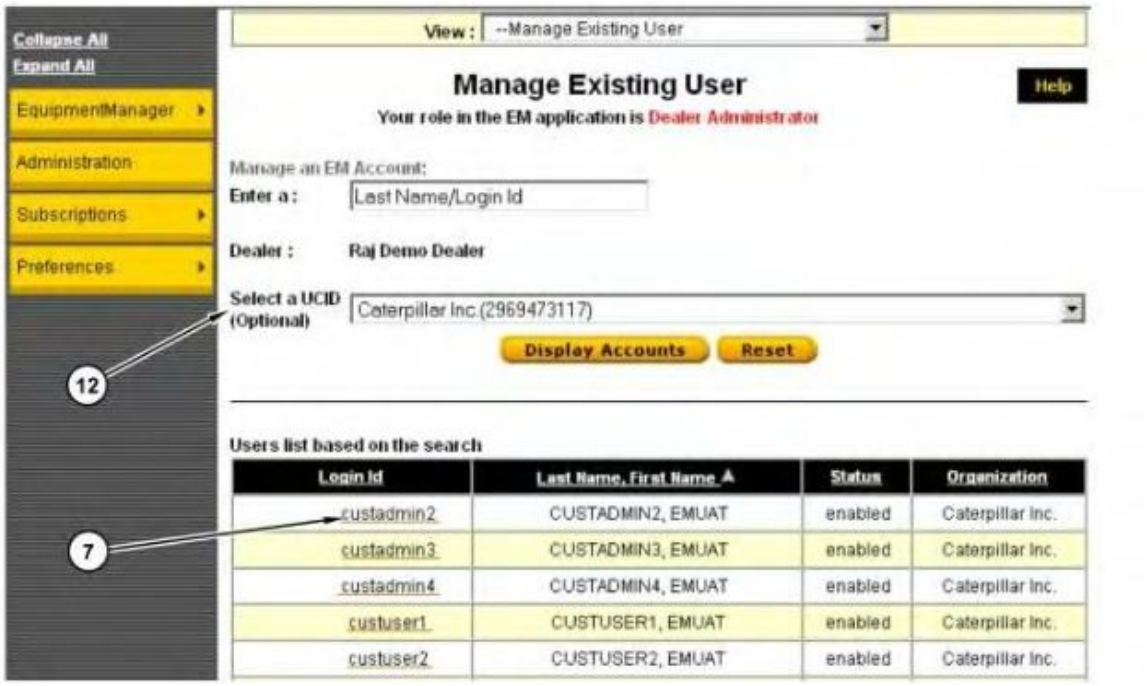


Illustration 15 g01700398

Manage Existing User : List by UCID

(7) "Login Id" of a user

(12) "Select a UCID (Optional)" drop-down menu

An existing user can be search for from the "Manage Existing User" screen. Select a UCID from the "Select a UCID (optional)" menu (12) . EquipmentManager will return a list of users associated with that UCID.

Click the login id of a user (7) for editing. Repeat steps 2 through 5.

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i02941638

Product Link Installation

SMCS - 7600; 7606

Modules

The Product Link Modules are the systems onboard hardware components. These components allow data to be transmitted over a secure Caterpillar wireless network. Data is sent to machines and data is received from machines. The Product Link hardware consists of: antenna, data module and interconnecting wire harness. The antenna consists of two separate components. One component is for receiving location information from the Global Positioning satellite (GPS) system. The second component is for receiving and transmitting signals from and to a wireless network. The second component also has a taller whip antenna.

The GPS signal provides data about the location of the machine. This data is sent to the Product Link data module from the GPS antenna. The signal is processed by the Product Link data module. After the signal is processed, it is transmitted to the wireless network through the whip antenna.

The Service Meter Unit (SMU) is data captured from the "R" terminal on the alternator. The SMU represents the number of hours that the engine has run. Some data drift from meters in the cab or SMU accumulation on other modules is possible. Product Link PL321 systems conform to onboard SYNC clock strategies. This strategy will synchronize the SMU with the designated master Electronic Control Module (ECM).

Date and time stamps are captured onboard with Product Link using Greenwich Mean Time (GMT). The SMU data will be displayed according to users preference for the time zone. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121/321" for details.

Product Link Module Types

The table shows the Product Link Modules that are available.

Table 1

Module	Capabilities	Watch Coverage
PL121SR		Asset Watch

	Hours Location Time & Geographic Fencing	
PL321SR	Hours Location Time and Geographic Fencing I/O Switch Channels Events and Diagnostic codes	Asset Watch Health Watch



Illustration 1 g01244806

PL121SR



Illustration 2 g01244807

PL321SR

Installation

Once you have purchased a Product Link Module, you must install the module on the machine. A comprehensive Installation Guide comes with your Product Link Module. Refer to Special Instruction, REHS2365, "An Installation Guide for the Product Link PL121SR and for the PL300".

Note: The instructions that are mentioned above are for installing the PL121SR and PL300. The PL321SR is the combination of the PL121SR Radio and PL300 ECM.

Configure and Register

Product Link modules are configured and registered by using Caterpillar Electronic Technician (CAT ET). After installing the Product Link module on the machine, a laptop computer with Cat ET software is connected to the module. The Dealer technician uses Cat ET to set up the module for that specific machine. Included with each Product Link is a Special Instructions that explain the product installation and product registration procedures.

For additional information on configuration and registration of your Product Link Module, refer to Systems Operation Troubleshooting, Testing and Adjusting:, RENR7911, "Product Link 121/321".

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i03322229

Administration

SMCS - 7600; 7606

You can customize EquipmentManager in the "Administration" section of EquipmentManager in order to enable the most effective use of the tool, productive use of the tool, and efficient use of the tool. While the "Preferences" primarily affect the way information is displayed in EquipmentManager, the "Administration" functions are where you will group equipment, set up and assign event reactions, manage the registry parameters of the Product Link Modules (PLM), upload repair and refueling history, set up fences, manage planned maintenance, and so on. These functions, once configured, should not need to be changed on a daily basis.



Illustration 1 g01700556

"Administration" screen

(1) "Administration" link

To reach the "Administration" screen, click on the "Administration" link (1) in the left navigation.

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i03361360

Manage Equipment Groups

SMCS - 7600; 7606

Introduction

Being able to create predetermined groupings of equipment is particularly useful when managing large numbers of equipment through EquipmentManager. These groups that you create will allow you to work more efficiently because you can quickly select one of your predefined groups upon which to perform any of the asset watch, maintenance watch or health watch tasks rather than entering individual serial numbers or performing advanced searches each time.

Equipment Groups

Equipment groups can be created. Existing equipment groups can be modified or deleted.

Create Equipment Group

Use the following procedure in order to create an equipment group:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Group". The "Equipment Search" screen will be displayed.



Illustration 1 g01729973

"Create Equipment Group" - "Equipment Search"

(1) "Display Equipment" button

2. Enter your search criteria in the "Equipment Search" fields and click the "Display Equipment" button (1) . The "Create Equipment Group" screen will be displayed. The results of the search will be displayed in the "Equipment List" section of this screen.

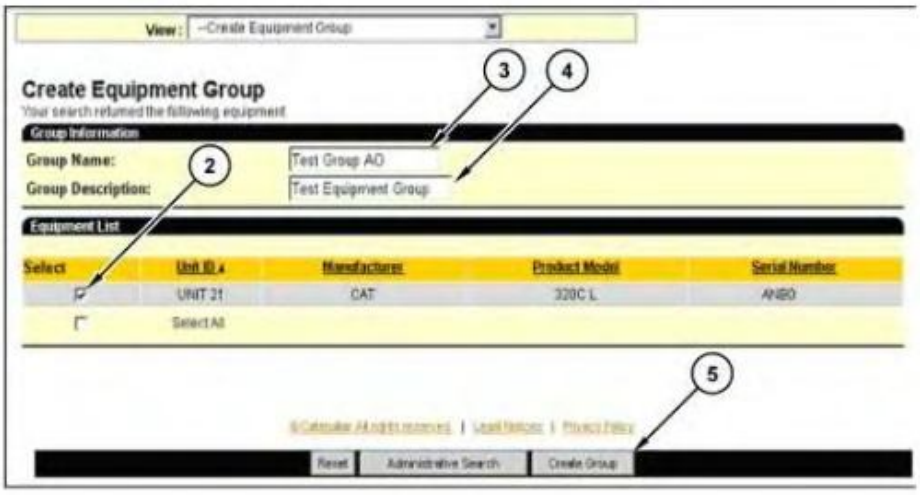


Illustration 2 g01730034

"Create Equipment Group" - "Group Information" and "Equipment List"

(2) Check box

(3) "Group Name" field

(4) "Group Description" field

(5) "Create Group" button

3. In the "Group Information" section, enter a name for the new equipment group in the "Group Name" field (3) .
4. In the "Group Information" section, enter a description of the new equipment group in the "Group Description" field (4) .
5. In the "Equipment List" section, select the check box (2) next to each piece of equipment that you wish to add to the new equipment group.



Illustration 3 g01270513

"Create Equipment Group Confirmation" screen

6. Click the "Create Group" button (5) at the bottom. The selected equipment is added to the new group and the "Create Equipment Group Confirmation" screen will be displayed.

Modify Equipment Group

Once you have created an equipment group, you may decide to add or remove equipment from the group or change the name and/or description of the group.

In order to modify an existing equipment group, use the following procedure:

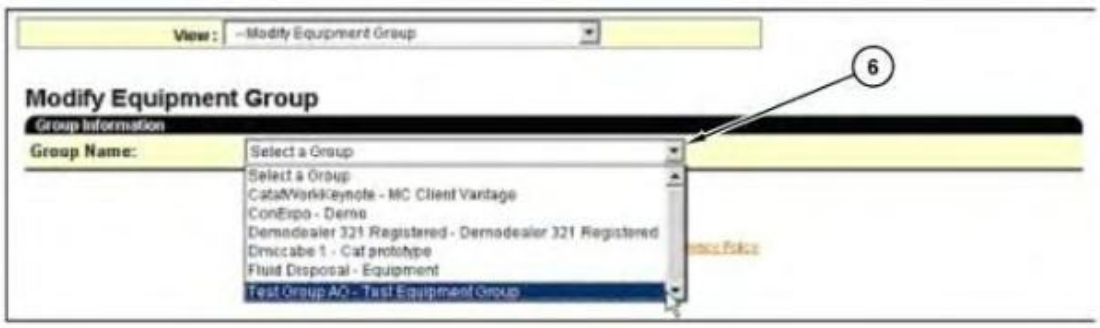


Illustration 4 g01730035

"Modify Equipment Group"

(6) "Group Name" drop-down menu

1. From either the "Equipment Groups" drop-down menu section of the "Administration" screen or the "View" drop-down menu, select "Modify Equipment Group". The "Modify Equipment Group" screen will be displayed.
2. Select the name of the group from the "Group Name" drop-down menu (6) in order to modify the group. The "Group Information" and "Equipment List" sections appear on the "Modify Equipment Group" screen for the selected equipment group.

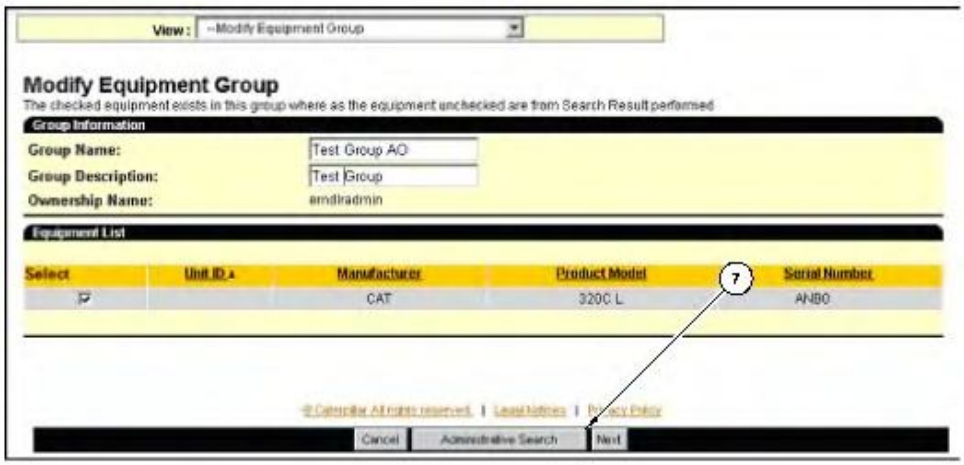


Illustration 5 g01730037

"Modify Equipment Group" - "Group Information" and "Equipment List"

(7) "Administrative Search" button

3. If you wish to add equipment to the equipment group, click on the "Administrative Search" button (7) , or else skip to Step 5. The "Equipment Search" screen will be displayed.

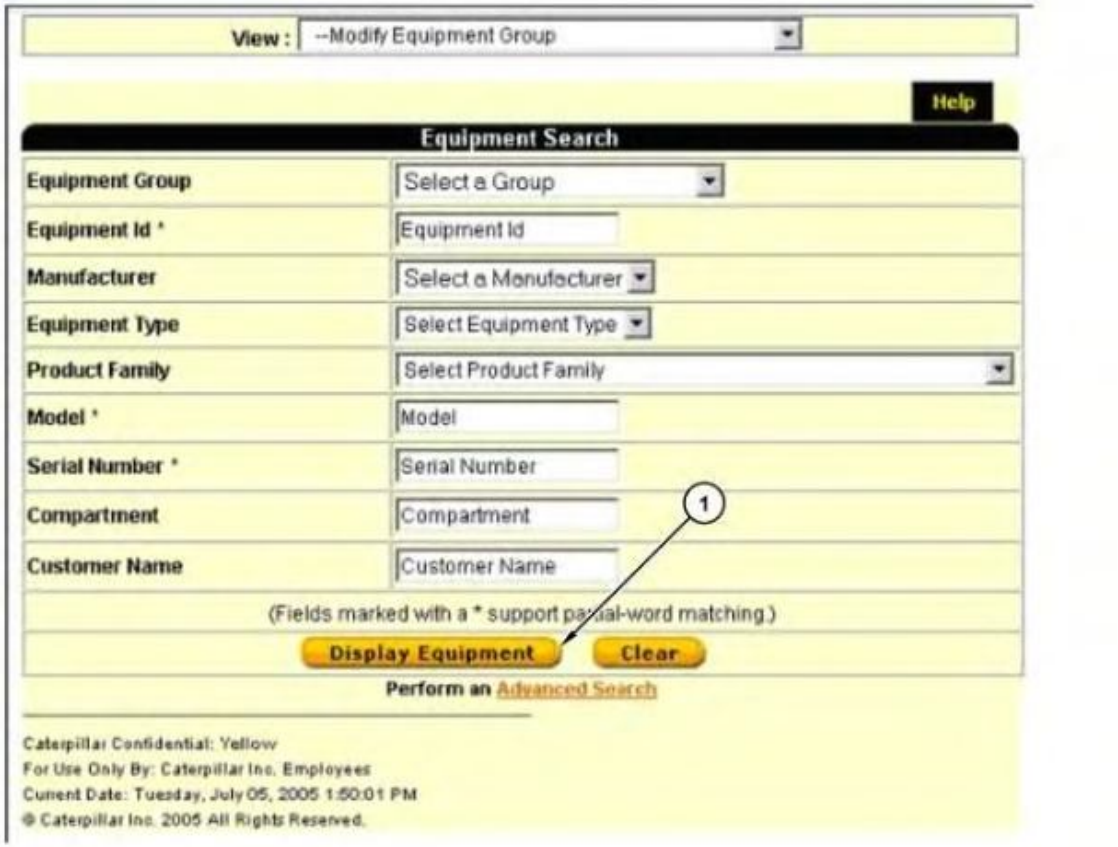


Illustration 6 g01730039

"Equipment Search"

(1) "Display Equipment" button

4. Enter your search criteria in the search fields and click the "Display Equipment" button (1) . The "Modify Equipment Group" screen will be displayed with the equipment in the existing group. The equipment list is also displayed in the "Equipment List" section of the screen.

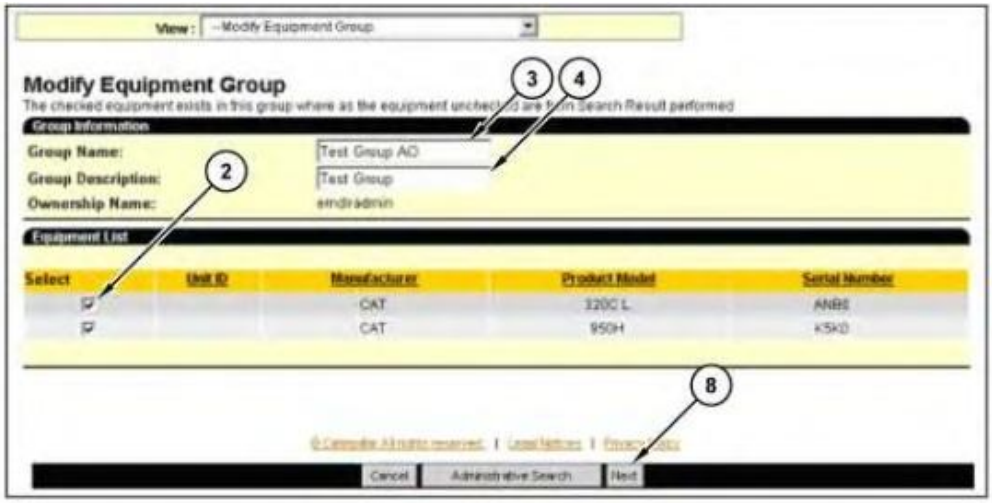


Illustration 7 g01730042

Updating" Equipment List"

(2) Check box

(3) "Group Name" field

(4) "Group Description" field

(8) "Next" button

5. In the "Group Information" section, edit the name in the "Group Name" field (3) .
6. In the "Group Information" section, edit the description in the "Group Description" field (4) .
7. In the "Equipment List", select the check box (2) for the equipment you want to add to the group. Clear the check box for the equipment that you want to remove from the group.



Illustration 8 g01270517

"Modify Equipment Group Detail"

8. Click the "Next" button (8) . The "Modify Equipment Group Detail" screen will be displayed.

Delete Equipment Group

Just as you may create and modify groupings of equipment, you may also delete equipment groups completely.

In order to delete an equipment group, use the following procedure:

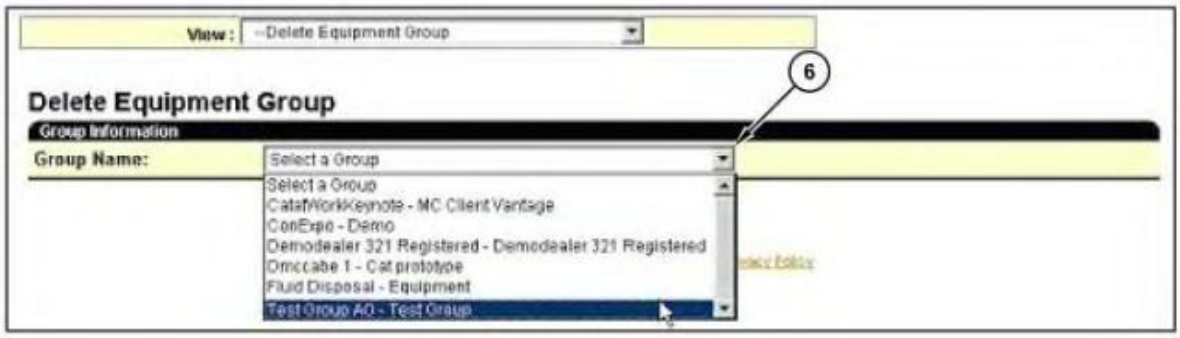


Illustration 9 g01730044

"Delete Equipment Group" screen

(6) "Group Name" drop-down menu

1. Either from the "Equipment Groups" section of the "Administration" screen or from the "View" drop -down menu, select "Delete Equipment Group". The "Delete Equipment Group" screen will be displayed.
2. Select the name of the equipment group you wish to delete from the "Group Name" drop-down menu (6) . The "Delete Equipment Group" screen is displayed with the details of the equipment group that you selected.

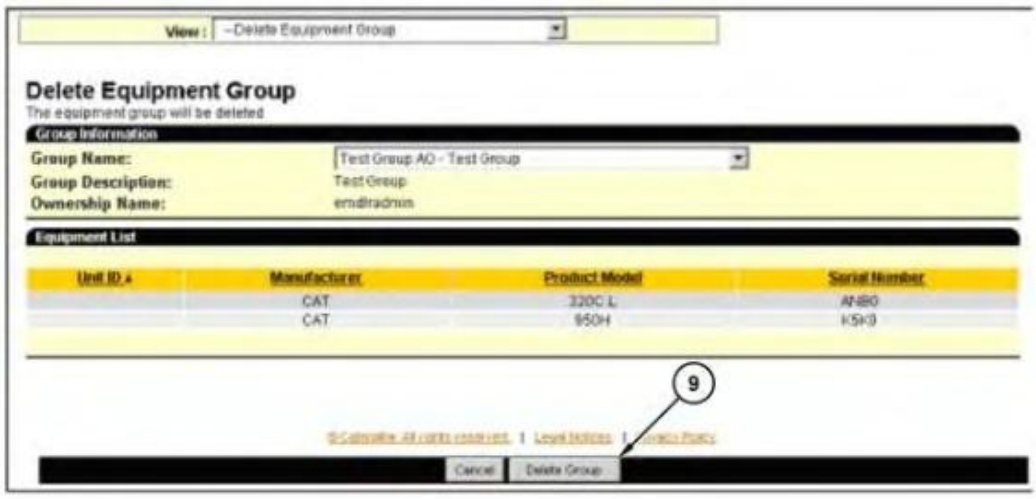


Illustration 10 g01730046

"Delete Equipment Group" details

(9) "Delete Group" button

3. Click the "Delete Group" button (9) . A window will appear with a "Delete" confirmation message.



Illustration 11 g01246611

"Delete" confirmation message

4. Click "OK". The equipment group is deleted.

Equipment Subgroups

In addition to creating groupings of equipment, you can use these equipment groups to create subgroups. Equipment subgroups are subsets of existing equipment groups that are given a name and description, and then saved. For example, a dealer could create an equipment group of all the equipment. The Dealer could then create a subgroup that contains all of the equipment from multiple locations.

Similar to equipment groups, equipment subgroups can be selected on the EquipmentManager search screens in order to save time entering search criteria into the search and advanced search fields. The procedures to create, modify, and delete an equipment subgroup are similar to those you performed when you created, modified, and deleted an equipment group

Create Equipment Subgroup

In order to create an equipment sub group, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Create Equipment Sub Group". The "Create Equipment Subgroup" screen will be displayed.



Illustration 12 g01730048

"Create Equipment Subgroup" screen

(6) "Group Name" drop-down menu

2. Select the name of the equipment group from which you wish to create a subgroup from the "Group Name" drop-down menu (6) . The "Create Equipment Subgroup" screen is displayed with the "Subgroup Information" section and the "Equipment List".

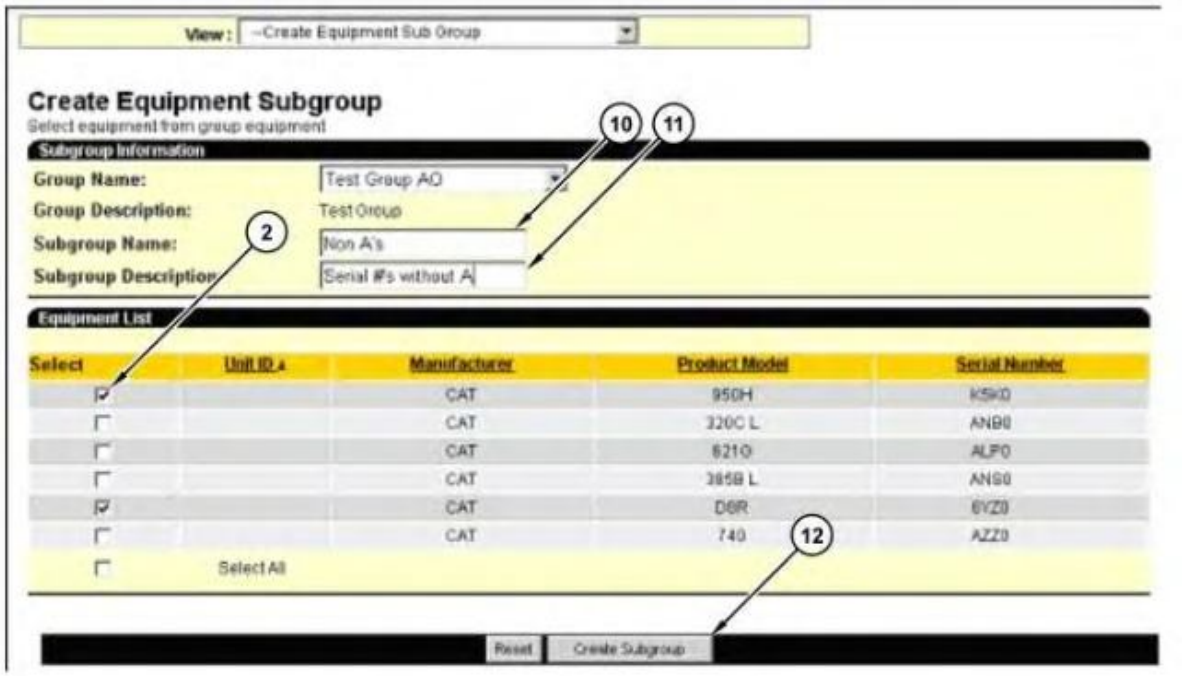


Illustration 13 g01730049

"Create Equipment Subgroup" screen

(2) Check box

(10) "Subgroup Name" field

(11) "Subgroup Description" field

(12) "Create Subgroup" button

3. In the "Subgroup Information" section, enter a name for the new subgroup in the "Subgroup Name" field (10) .

4. In the "Subgroup Information" section, enter a description for the new subgroup in the "Subgroup Description" field (11) .

5. In the "Equipment List" section, select the check box (2) next to each piece of equipment in the group that you wish to be added to the new subgroup.

6. Click the "Create Subgroup" button (12) . The "Create Equipment Subgroup Confirmation" screen will be displayed.

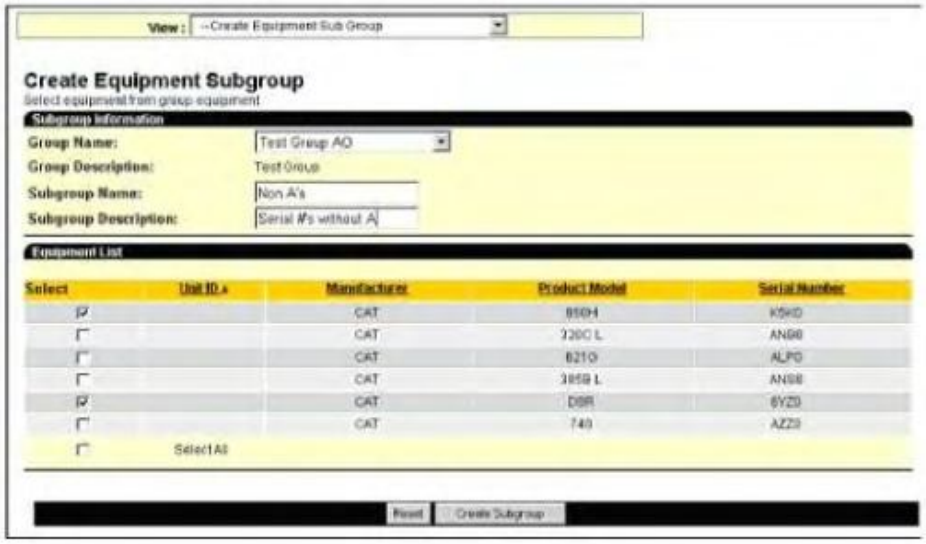


Illustration 14 g01270520

"Create Equipment Subgroup" confirmation

7. Click the "Done" button. The new subgroup has been created.

Modify Equipment Subgroup

You have the ability to change the name and/or the description of an equipment subgroup as well as add or remove pieces of equipment from the subgroup.

In order to modify an equipment subgroup, use the following procedure:

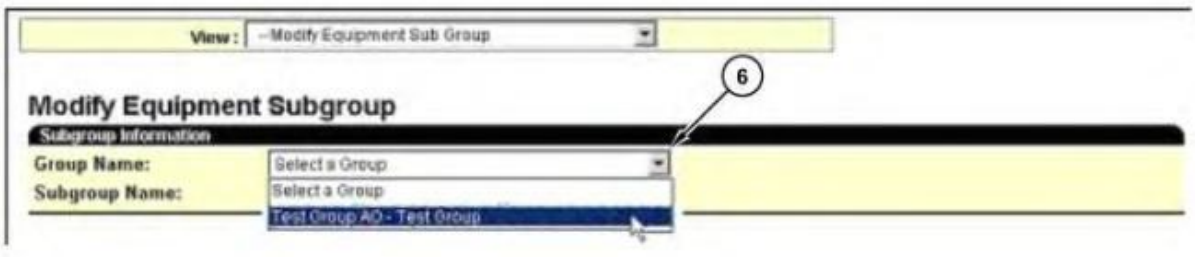


Illustration 15 g01730050

"Modify Equipment Subgroup"

(6) "Group Name" drop-down menu

1. From either the "Equipment Groups" section of the "Administration" screen, or from the "View" drop-down menu, select "Modify Equipment Sub Group". The "Modify Equipment Sub Group" screen will be displayed.

2. Select the name of the group for the subgroup that you wish to modify from the "Group Name" drop-down menu (6) . The subgroups that pertain to the selected group will be populated in the "Subgroup Name" drop-down menu.

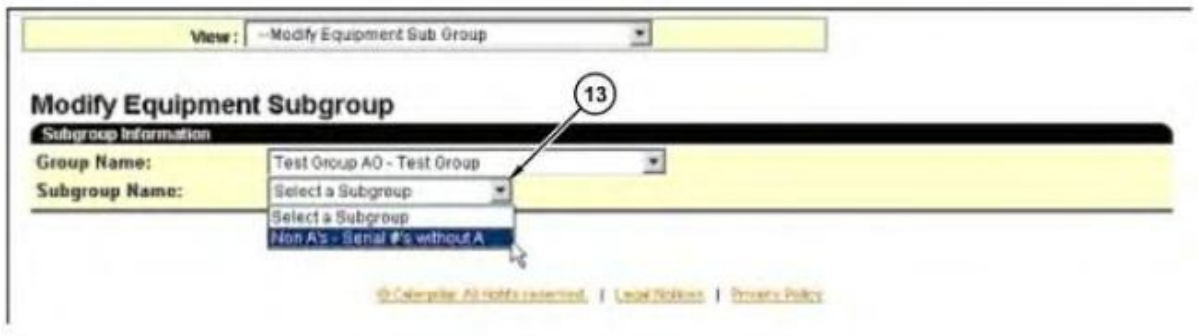


Illustration 16 g01730052

"Modify Equipment Subgroup"

(13) "Subgroup Name" drop-down menu

3. Select the name of the subgroup you wish to modify from the "Subgroup Name" drop-down menu (13) . The "Modify Equipment Subgroup" screen will be displayed with the "Subgroup Information" and "Equipment List" sections.

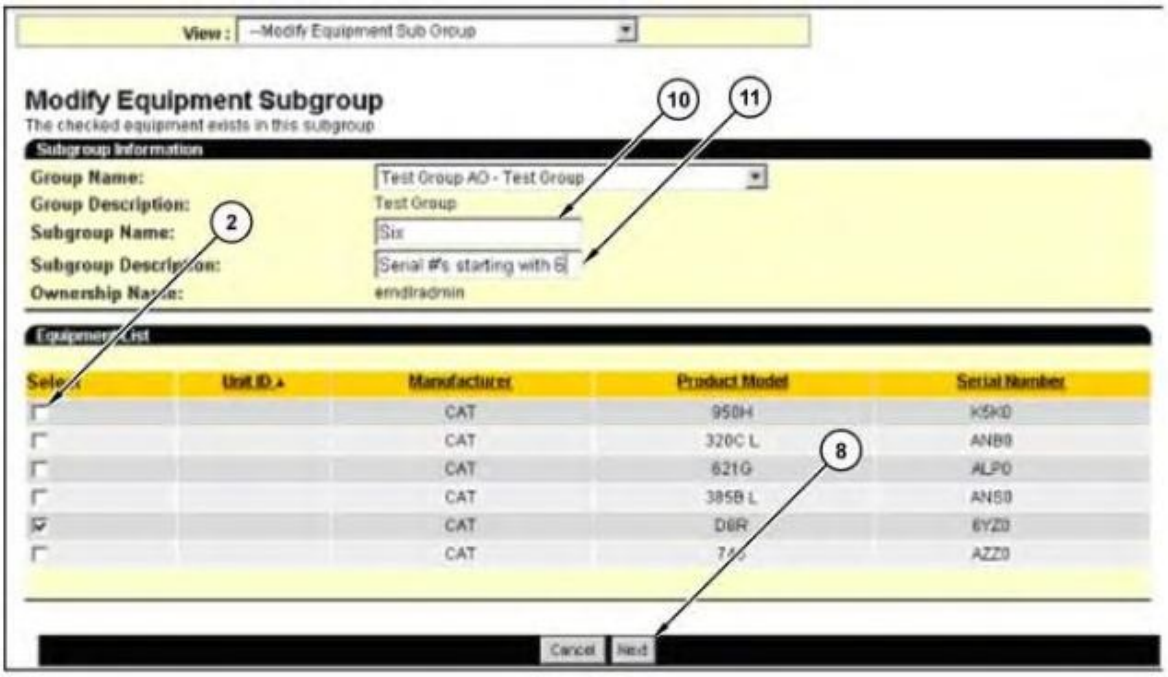


Illustration 17 g01730053

Editing "Subgroup Information" and "Equipment List"

(2) Check box

(10) "Subgroup Name" field

(11) "Subgroup Description" field

(8) "Next" button

4. In the "Subgroup Information" section, edit the name in the "Subgroup Name" field (10) .
5. In the "Subgroup Information" section, edit the description in the "Subgroup Description" field (11) .
6. In the "Equipment List" section, select the check box (2) for the equipment you want to add to the subgroup. Clear the check box for the equipment that you want to remove from the subgroup.
7. Click the "Next" button (8) . The subgroup is modified and the "Modify Equipment Subgroup Detail" screen will be displayed.



Illustration 18 g01270523

"Modify Equipment Subgroup Detail"

Delete Equipment Subgroup

In order to delete an equipment subgroup, use the following procedure:

1. From either the "Equipment Groups" section of the "Administration" screen or the "View" drop-down menu, select "Delete Equipment Sub Group". The "Delete Equipment Subgroup" screen will be displayed.

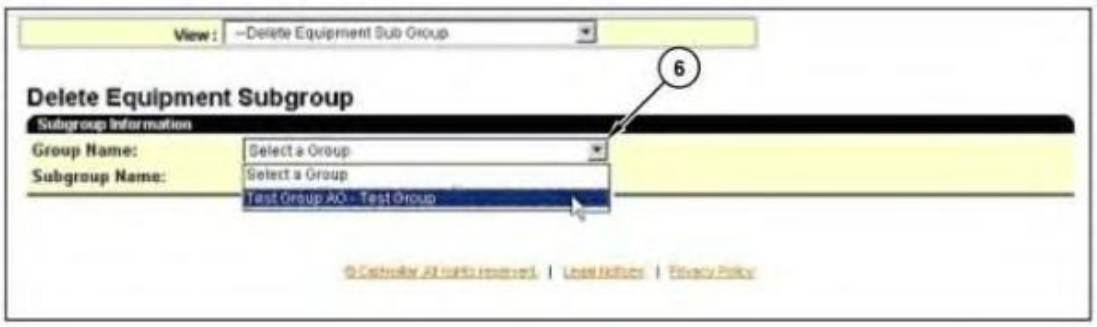


Illustration 19 g01730054

"Delete Equipment Subgroup"

(6) "Group Name" drop-down menu

2. Select the name of the group for the subgroup you wish to delete from the "Group Name" drop-down menu (6) . The "Subgroup Name" drop-down menu is populated with all the subgroup names that match the selected group.

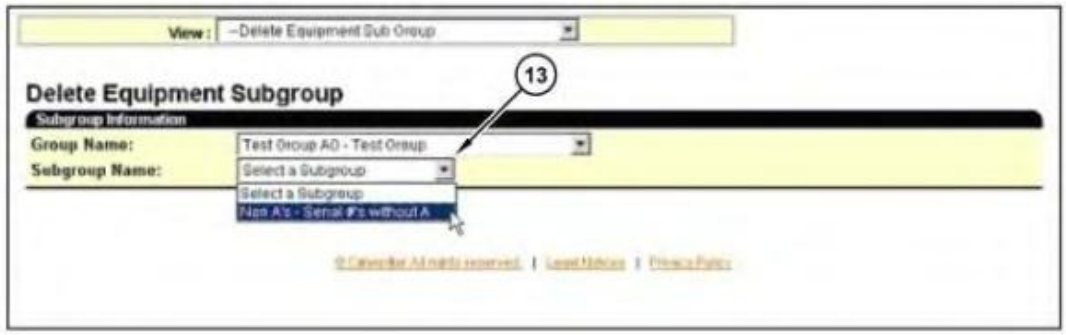


Illustration 20 g01730055

"Delete Equipment Subgroup"

(13) "Subgroup Name" drop-down menu

3. Select the name of the subgroup you want to delete from the "Subgroup Name" drop-down menu (13) . The "Delete Equipment Subgroup Details" screen will be displayed.

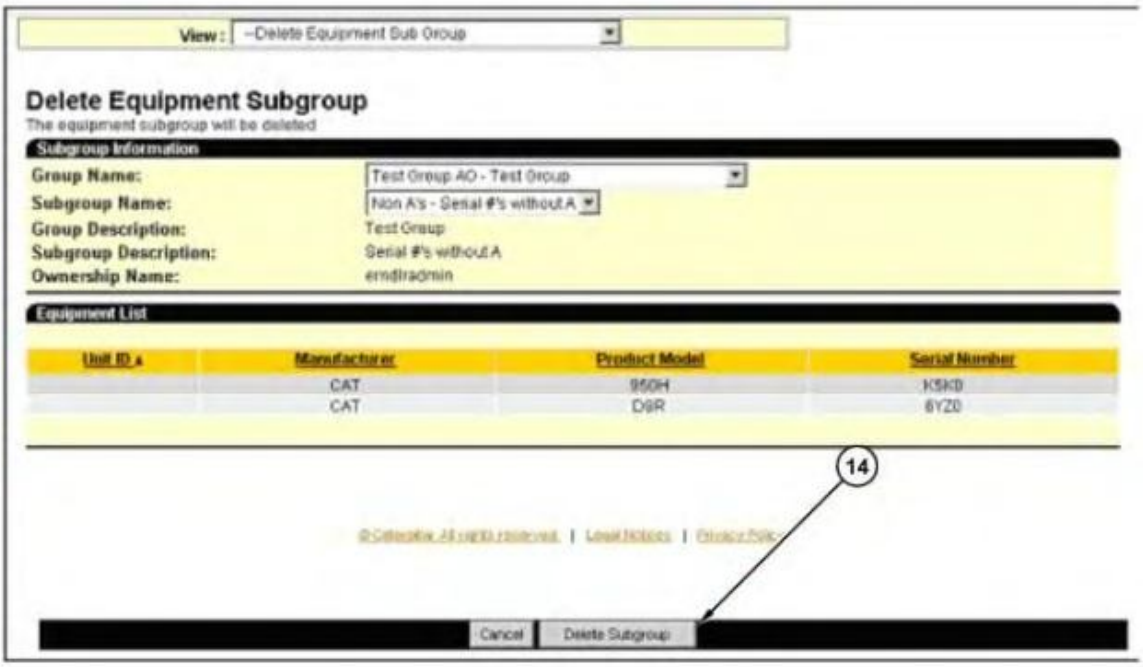


Illustration 21 g01730057

"Delete Equipment Subgroup" details

(14) "Delete Subgroup" button

4. Click the "Delete Subgroup" button (14) . A window will appear with a "Delete" confirmation message.



Illustration 22 g01246657

"Delete" confirmation message

5. Click "OK". The equipment subgroup is deleted.

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Systems Operation
EquipmentManager User Guide
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Manage Hardware

SMCS - 7600; 7606

Introduction

The technician registers the Product Link Modules (PLM) when the modules are installed on a piece of equipment for the first time. The technician then sets the parameters of the configuration that can be viewed and can be changed by using the "Over the Air Configuration" feature from EquipmentManager. Caterpillar recommends providing these parameters to the technician before the installation process begins.

The "Administration" screens of EquipmentManager display the details for the registry of your equipment in the following categories:

- "General Registry"
- "Digital Registry"
- " "Transmission Registry""
- "Send Commands"
- ""Product Link Module Status Report""

"General Registry"



Illustration 1 g01396363

"General Registry" screen

Once one or more of the equipment has been selected and the "General Registry" has been selected from either "View" drop-down menu or the"Administration" screen the "General Registry" screen will appear. Refer to Illustration 1.

Table 1 lists the fields that appear on the "General Registry" screen.

Table 1

The fields on the "General Registry" Screen		
Field	**Description**	**Sample Values**
"Eqpt ID"	This is the ID of the equipment that has the installed PLM.	UNIT 4
"Manufacturer"	This is the manufacturer of the equipment.	CAT
"Model"	This is the name of the model of the equipment.	D8R
"Serial Number"	This is the serial number of the equipment. The "Serial Number" is a link. Clicking the link takes you to the "Equipment Registration Detail" screen.	6YZ#####
"Last Reg/Admin Date & Time"	This is the date and time that the last registration or administration message was received.	07/15/2002 02:43:16 AM
"Status"	This indicates that the PLM has been installed and registered. If PLM is not registered, the "Subscriptions not available. Contact Administrator" message will appear across remaining fields.	Registered
"First Report Time"	This indicates the first time for each day the PLM reports.	06:19 AM
"Report Type"	This is the indicates the type of report that is sent from PLM. Choices are "Position", "SMU", or both. Position reports contain information about the location of the equipment. "SMU" reports contain the data about the Service Meter Units that are used.	Position SMU
"Frequency"		(0-4)/Day

	This indicates the number of reports for each day that are sent by the PLM.	
"Global Gram"	"Global Grams" are used in areas of the world that have no ground stations. If the machine will operate in areas that have no ground stations, select "Enabled". Otherwise, leave the parameter set to the default of "Disabled". If you have any questions about "Global Gram", contact your Technical Communicator.	Enabled Disabled
"PLM ID"	This is the ID number of the Product Link Module.	DQ0000######Q1
"Module Type"	This is the type of the PLM.	PL201 PL321
"Data Link Type"	This field describes the type of data link that is used. Most Product Link Modules use the CDL or the Cat Data Link (CDL).	CDL SAE 1708 SAE 1939
"Block Data Transfer"	"Block Data Transfer" is a technology that is used to pull large blocks of data from a machine. "Block Data Transfer" exists for future use. Leave this parameter set to "Disabled".	Disabled Enabled
"Software Revision"	This is the version of the software for Product Link that is onboard at the time of last registration message.	1.6 2.1

From the "General Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to ""Over the Air Configuration"" for more details.

"Equipment Details"

The "Equipment Details" screen provides all the details about the selected equipment.

In order to view the "Equipment Details" of a machine, select the serial number for the equipment from the "Serial Number" column on the "General Registry" screen. The "Equipment Details" screen will be displayed.



Illustration 2 g01390762

"Equipment Details" screen

Click the "Back" button in order to return to the "General Registry" screen. Table 2 describes the fields that are found on the "Equipment Details" screen.

Table 2

"Equipment Details" Screen		
Field	**Description**	**Sample Value**
Customer Information		
"Universal Customer ID:"	UCID Name – UCID Number	Acme Aggregate 1234567890
"Customer Account Number"	Customer Name – Dealer Customer Number	Acme SW Quarry

		1234567
"Customer Address"	Street, City, State, Zip	100 Any Street Any Town, USA
	Dealer Information	
"Last Dealer Update"	Primary Dealer Name Date of last Equipment Record Maintenance	Demo Dealer 9/27/2006
"Other Assigned Dealer"	Other Dealers associated with selected equipment	Other Dealer Name
	Dealer Specific Equipment Information	
"Equipment ID"	The ID of the equipment upon which the PLM is installed	UNIT 4
"Location/Jobsite"	Equipment's assigned location or jobsite	Southeast Quarry
"Purchase Date"	Equipment Purchase Date for current owner	1-Sep-02
"Ownership Status"	Current ownership status of the equipment	Owned Leased Rented
	Equipment Details – Product Link/EquipmentManager Information	
"PLM ID"	The "ID" number of the Product Link Module. The "PLM ID" is a link. Clicking the link will display the "Equipment Registration Detail" screen.	DQ0000012345
"Module Type"	The type of PLM	PL201 PL321
"Global Gram"	Global Grams are used in geographical areas that have no ground stations. If the machine will operate in areas without ground stations, select "Enabled". Otherwise, leave the parameter set to the default Disabled. If you have questions about "Global Gram", contact your Marketing Company.	Enabled Disabled
"Dealer"	Dealer through which the subscriptions are purchased	Dealer Name
"Status"	Indicates that the PLM has been installed and has been registered.	Registered Deregistered
"Subscription Level"	The table shows the subscriptions that are active and for whom they are purchased. Includes link to "Edit Subscriptions"	AW, MW, HW
	Equipment Information	
"Serial Number"	The serial number of the equipment	6YZ#####
"Manufacturer"	The manufacturer of the equipment	CATERPILLAR, INC.
"Product Industry"	Industry in which the selected equipment is primarily used	Quarry + Aggregates

"Product Use"	Describes for what the equipment is used	Sand & Gravel
"Application"	Describes the machine application	Light Medium Heavy
"Meter Indicator"	Unit of measure for equipment usage meter	Hours Miles Kilometers
"Related Serial Number(s)"	Vehicle Identification Number if the equipment is an engine, or related serial numbers and descriptions if machine. Related serial numbers may be the engine, transmission, etc. Four related serial numbers can be listed	2BR#####, Engine 1YS##### Transmission Attachment
"Equipment Type"	Describes the type for the selected equipment	Engine/Power System Machine
"Product Model"	The model name of the equipment	D8R
"Model Year"	The year of the equipment was manufactured	2001
"Meter Reading Date"	Date of last meter reading update	27-Sep-06
"Meter Reading"	Last service meter reading value	214
"Arrangement Number"	Equipment arrangement or configuration number	157-0818
Equipment Groups		
"Equipment Groups"	Names of group(s) in which selected equipment is included	Sample Group
"Group Owner"	Login ID of the group owner	smithxx

"Equipment Registration Details"

The "Equipment Registration Detail" screen provides details about the current configuration of the onboard PLM.

In order to view the details of the registration, click the "PLM ID" of a machine in the "PLM ID" column on the "General Registry" screen. The "Equipment Registration Detail" screen will be displayed.

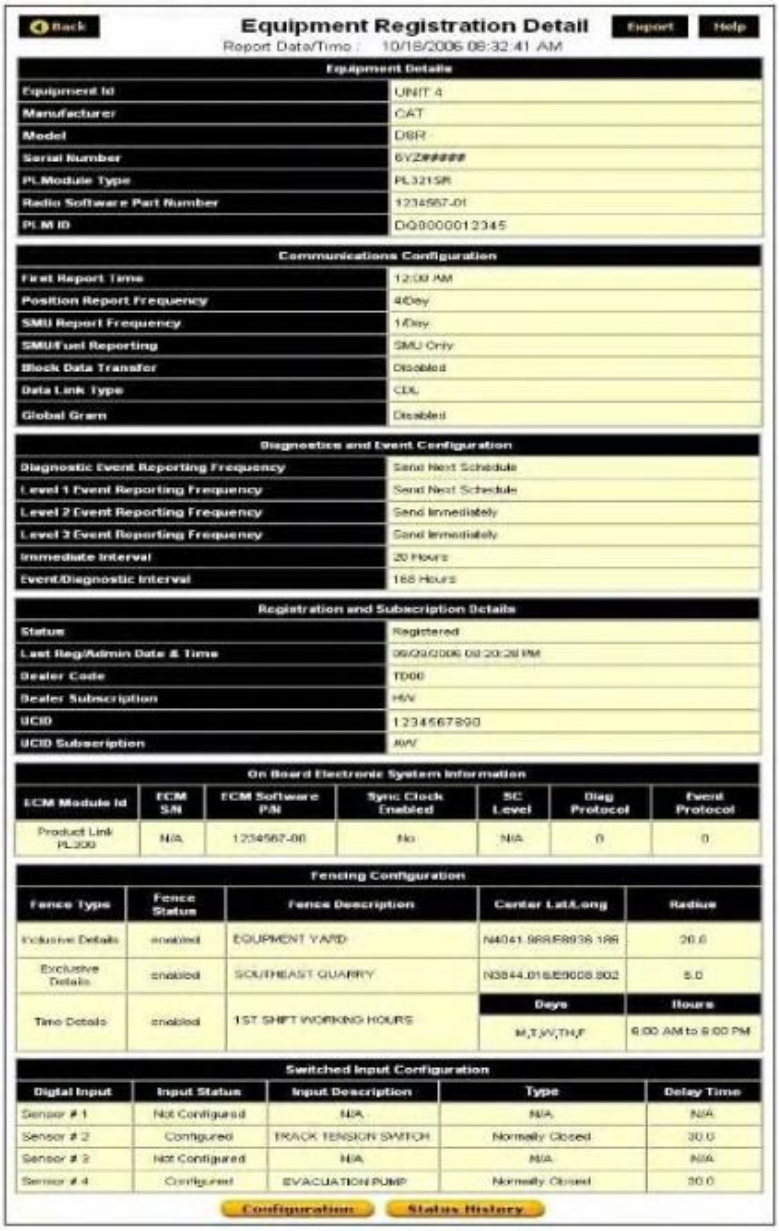


Illustration 3 g01390775

"Equipment Registration Details" screen

Table 3 describes the fields that are found on the "Equipment Registration Detail" screen. Click the "Back" button in order to return to the "General Registry" screen.

Table 3

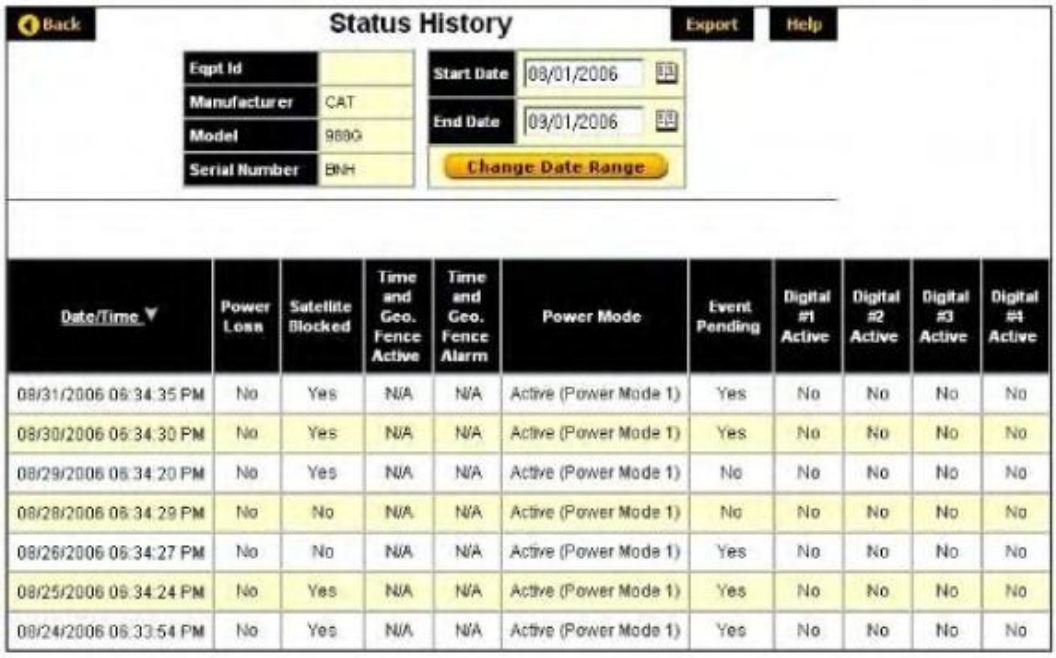
"Equipment Registration Detail" Screen		
Field	**Description**	**Sample Value**
Equipment Details		
"Equipment Id"	The ID of the equipment upon which the PLM is installed	UNIT 4
"Manufacturer"	The Manufacturer of the equipment	CAT

"Model"	The model name of the equipment	D8R
"Serial Number"	The serial number of the equipment. The serial number is a link. Clicking the link will display the Equipment Detail screen.	6YZ#####
"PLModule Type"	The type of Product Link Module	PL201 PL321
"Radio Software Part Number"	On-board Product Link software part number.	1234567-01
"PLM ID"	The ID number of the Product Link Module	DQ000012345
	Communications Configuration	
"First Report Time"	Indicates the first time each day the PLM reports.	12:00 AM
"Position Report Frequency"	Frequency of which location is reported	4/Day
"SMU Report Frequency"	Frequency of which service meter units are reported	1/Day
"SMU/Fuel Reporting"	Defines whether the SMU or Fuel consumption report is sent as part of the daily standard message.	Fuel Only SMU Only Alternate SMU/Fuel
"Block Data Transfer"	A technology that is used to pull large blocks of data from a machine. Block Data Transfer exists for future use. Leave this parameter set to Disabled.	Disabled Enabled
"Data Link Type"	The type of data link that is used. Most PLMsuse Caterpillar Data Link (CDL).	CDL SAE 1708 SAE 1939
"Global Gram"	"Global Grams" are used in geographical areas that have no ground stations. If the machine will operate in areas without ground stations, select "Enabled". Otherwise, leave the parameter set to the default "Disabled". If you have questions about "Global Gram", contact your Technical Communicator.	Enabled Disabled
	"Diagnostics and Event Configuration"	
"Diagnostic Event Reporting Frequency"	Defines when to send messages from the Product Link system when a diagnostic event is reported from other ECMs on the machine.	Immediate: sends a message when an event occurs.
"Level 1 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 1 event is reported from other ECMs on the machine.	Next: queues messages about events and sends the messages in a batch based on the next scheduled interval that is calculated from the report start time.

"Level 2 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 2 event is reported from other ECMs on the machine.	Never: Never log messages or send messages about the events.
"Level 3 Event Reporting Frequency"	Defines when to send messages from the Product Link system when a level 3 event is reported from other ECMs on the machine.	
"Event/Diagnostic Interval"	Determines when the Product Link will report a recurrence of an event or a diagnostic code, measured in units of machine operating hours. All events and diagnostics are recorded and may be viewed with the Electronic Technician.	Minimum value: 4 hours
"Immediate Interval"	The default value of 20 hours means that an event or diagnostic update message will not be present for a specific event or diagnostic update until the machine has operated for 20 hours after the last transmitted occurrence of that event or diagnostic update. At the next event or diagnostic occurrence after the time period elapses, another message will be sent.	Default value: 20 hours
"Event/Diagnostic Interval"	Sets the time period before an event or diagnostic message update is sent, measured in units of real time or clock hours. This time period is calculated from the Report Start Time.	Minimum value: 24 hours
"Event/Diagnostic Interval"	The default value of 168 hours or 1 week is only valid if the event or diagnostic report intervals are set to Next.	Default value: 168 hours or 1 week
	Registration and Subscription Details	
"Status"	This indicates that the PLM has been installed and registered. If PLM is not registered, the "Subscriptions not available. Contact Administrator" message will appear across remaining fields.	Registered Deregistered
"Last Reg/Admin Date & Time"	The Date and Time of the last time of registration of the PLM	##########
"Dealer Code"	Defines the Dealer code for which subscriptions are purchased	TD00
"Dealer Subscription"	Defines which subscriptions are owned at Dealer Level	AW, MW, HW
"UCID"	Defines the Universal Customer ID for which subscriptions are purchased	1234567890
"UCID Subscription"	Defines which subscriptions are owned at customer level	AW, MW, HW
	On Board Electronic System Information	
"ECM Module ID"	Lists all Electronic Control Modules detected on the data link of the machine.	Engine, Transmission, Product Link PL300
"ECM S/N"	Indicates serial numbers for all Electronic Control Modules detected on the data link of the machine.	XXX12345

"ECM Software P/N"	Indicates the software part number for all Electronic Control modules detected on the data link of the machine.	1234567-00
"Sync Clock Enabled"	Indicates Sync Clock enabled on each Electronic Control Module detected on the data link of the machine.	Yes, No
"SC Level"	Indicated the Sync Clock Level for each Electronic Control Module that is Sync Clock Enabled	Slave, Master
"Diag Protocol"	Displays the diagnostic protocol for each Electronic Control Module	0
"Event Protocol"	Displays the event protocol for each Electronic Control Module	0
Fencing Configuration		
"Fence Type"	Lists all Geographic and Time Fence Types	Inclusive, Exclusive, Time
"Fence Status"	Indicates fence type is enabled or disabled	enabled, disabled
"Fence Description"	Displays user defined fence descriptions	Equipment Yard, Working Hours
"Center Lat/Long"	Indicates the latitude and longitude center point for configured fence	N1234.0000/ E1234.0000
"Radius"	Indicates the radius of configured fence	20.0, 5.0
"Days"	Indicates working days of configured fence	M,T,W,TH,F,
"Hours"	Indicates start time and end time of configured fence	6:00 AM to 6:00 PM
Switched Input Configuration		
"Digital Input"	Sensor identification	Sensor #1
"Input Status"	Defines whether the Digital Input Sensor is configured.	Configured, Not Configured
"Input Description"	Describes the condition that the switch is monitoring.	Track Tension Switch Maximum of 24 characters
"Type"	Defines whether a switch is attached. If the switch is attached, the defines the state of the switch contacts under normal operating conditions.	Not Configured Normally Closed Normally Open
"Delay Time"	Defines the delay time before an alarm condition is recorded. If the normal condition of the switch is open and the delay time is set to the default time of 30.0 sec, an alarm condition will be sent when the switch is closed for 30.0 sec.	30.0 sec (default) 0.1 sec - 1200 sec

"Status History"



Date/Time	Power Loss	Satellite Blocked	Time and Geo. Fence Active	Time and Geo. Fence Alarm	Power Mode	Event Pending	Digital #1 Active	Digital #2 Active	Digital #3 Active	Digital #4 Active
08/31/2006 06:34:35 PM	No	Yes	N/A	N/A	Active (Power Mode 1)	Yes	No	No	No	No
08/30/2006 06:34:30 PM	No	Yes	N/A	N/A	Active (Power Mode 1)	Yes	No	No	No	No
08/29/2006 06:34:20 PM	No	Yes	N/A	N/A	Active (Power Mode 1)	No	No	No	No	No
08/28/2006 06:34:29 PM	No	No	N/A	N/A	Active (Power Mode 1)	No	No	No	No	No
08/26/2006 06:34:27 PM	No	No	N/A	N/A	Active (Power Mode 1)	Yes	No	No	No	No
08/25/2006 06:34:24 PM	No	Yes	N/A	N/A	Active (Power Mode 1)	Yes	No	No	No	No
08/24/2006 06:33:54 PM	No	Yes	N/A	N/A	Active (Power Mode 1)	Yes	No	No	No	No

Illustration 4 g01390790

"Status History" screen

The "Status History" is a record of all the status reports that are sent by the PLM. The status report contains information about the status of the actual PLM.

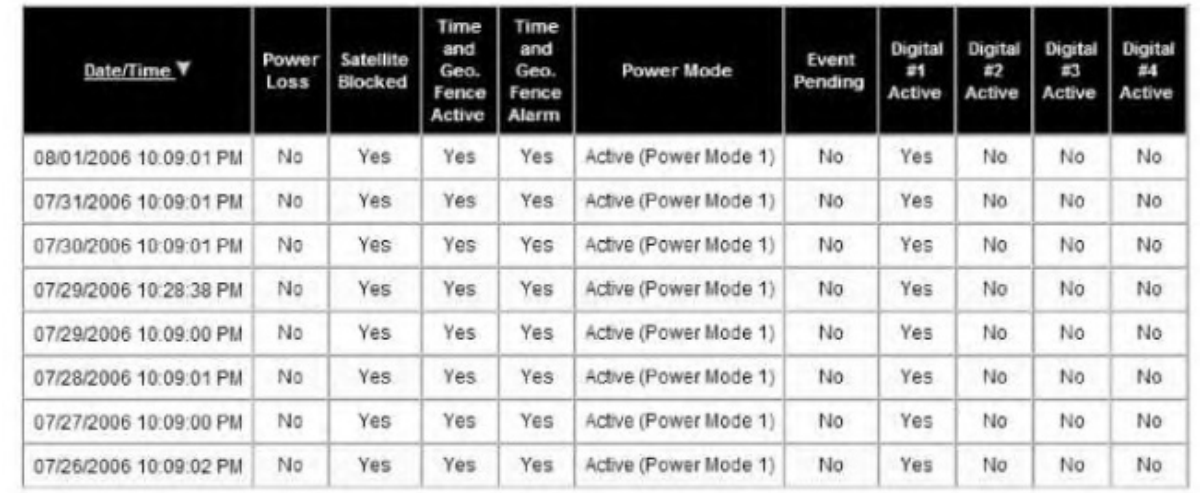
In order to view the "Status History" of a PLM, click the "Status History" button that is on the "Equipment Registration Detail" screen.



Illustration 5 g01390794

Top of the "Status History" screen

In order to change the range of the date to reflect an appropriate time period for the status history, click the "Calendar" icon next to the "Start Date" and "End Date" boxes, respectively. Then, select a desired date from the applicable calendar.



Date/Time ▼	Power Loss	Satellite Blocked	Time and Geo. Fence Active	Time and Geo. Fence Alarm	Power Mode	Event Pending	Digital #1 Active	Digital #2 Active	Digital #3 Active	Digital #4 Active
08/01/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/31/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/30/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/29/2006 10:28:38 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/29/2006 10:09:00 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/28/2006 10:09:01 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/27/2006 10:09:00 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No
07/26/2006 10:09:02 PM	No	Yes	Yes	Yes	Active (Power Mode 1)	No	Yes	No	No	No

Illustration 6 g01390795

Bottom of the "Status History" screen

When you are done, click the "Change Date Range" button. The "Status History" table will again load the date in order to reflect the updated range of the date. Click the "Back" button in order to return to the "Equipment Registration Detail" screen.

Note: The "Change Date Range" function works similarly in many views or screens throughout the application.

Table 4 describes fields that are found on the "Status History" screen. Click the "Back" button in order to return to the "General Registry" screen.

Table 4

"Status History" Screen		
Field	**Description**	**Values**
"Date/Time"	Displays the date and time of the status report. If the PLM is set to send status once per day, these values should be approximately one day apart each time.	
"Power Loss" (Low Voltage)	Indicates that the PLM experienced a loss of power or low voltage sometime between this status report and the last status report.	Yes, No
"Satellite Blocked"	Indicates that the PLM was blocked from the satellite sometime between this status report and the last status report.	Yes, No
"PW Active"	Indicates that "Time and Geographic Fencing" is active.	Yes, No, N/A
"PW Alarms"		

	Indicates that a "PW Alarm" has occurred sometime between this status report and the last.	Yes, No, N/A
"Power Mode"	Indicates the "Power Mode" of the PLM. Power mode has the following "Status" levels: Active (1) – The machine has operated in the last 48 hours. Sleep (2) – The machine has not operated for greater than 48 hours but less than one week. The PLM will wake up every six hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters. Hibernate (3) – The machine has not operated for more than one week. The PLM will wake up every 24 hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Active (1) Sleep (2) Hibernate (3)
"Event Pending"	Indicates that an event was recorded and will be sent (PL321 system only).	Yes, No
"Digital # Active"	Indicates that the digital switch is active (PL321 system only).	Yes, No

"Digital Registry"

The Product Link system uses up to four digital switches in order to monitor the equipment status. By installing switches and configuring the state during normal operating conditions, which are open or closed, you can be alerted when this normal state has changed.



Illustration 7 g01247670

"Digital Registry" screen

When some equipment has been selected and the " Digital Registry" from the "View" drop-down menu has been selected, the "Digital Registry" screen will appear. Notice that the fields in the "Equipment Information" section of this screen are the same fields that are on the "General Registry" screen. Table 5 describes the information that is found on the "Digital Registry" screen.

Table 5

"Digital Registry" Screen		

Field	Description	Sample Values
"Type"	Defines whether a switch is attached. If the switch is attached, defines the state of the switch contacts under normal operating conditions.	Not Configured Normally Closed Normally Open
"Delay"	Defines the delay time before an alarm condition is recorded. If the normal condition of the switch is open and the delay time is set to the default time of 30.0 sec, an alarm condition will be sent when the switch is closed for 30.0 sec.	30.0 sec (default) 0.1 sec - 1200 sec
"Description"	Field used to describe the condition that the switch is monitoring.	Track Tension Switch Maximum of 24 characters.
"Monitoring Condition"	Defines the monitoring condition for the digital input. When will the switch be monitored?	All Conditions (default) Key Off/Engine Off Key On/Engine Off Key On/Engine On

On the "Digital Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to the "Over the Air Configuration" topic for more details.

"Transmission Registry"

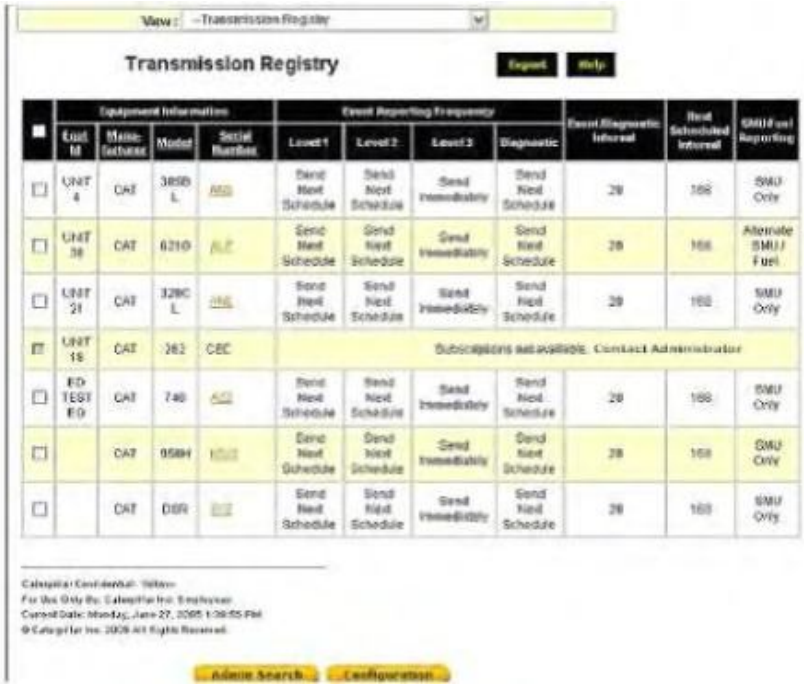


Illustration 8 g01247675

"Transmission Registry" screen

The "Transmission Registry" screen will display the parameters for the registration that have been set for determining the types of information that are transmitted from the PLM and the frequency that the information is transmitted. Notice that the fields in the "Equipment Information" section of the screen are the same fields that are on the "General Registry" screen and "Digital Registry" screen. Table 6 describes the information that is found on the "Transmission Registry" screen.

Table 6

"Transmission Registry" Screen		
Field	**Description**	**Sample Values**
"Event Reporting" "Frequency: Level 1"	Defines when to send messages from the Product Link system when a level 1 event is reported from other ECMs on the machine.	Immediate: sends a message when an event occurs. Next: queues messages about events and sends the messages in a batch based on the next scheduled interval that is calculated from the report start time. Never: never log messages or send messages about the events.
"Event Reporting" "Frequency: Level 2"	Defines when to send messages from the Product Link system when a level 2 event is reported from other ECMs on the machine.	
"Event Reporting" "Frequency: Level 3"	Defines when to send messages from the Product Link system when a level 3 event is reported from other ECMs on the machine.	
"Event Reporting" "Frequency: Diagnostic"	Defines when to send messages from the Product Link system when a diagnostic event is	

	reported from other ECMs on the machine.	
"Event/Diagnostic Interval"	Determines when the Product Link will report a recurrence of an event or a diagnostic code, measured in units of machine operating hours. All events and diagnostics are recorded and may be viewed with the Electronic Technician.	Minimum value is 4 hours. The default is 20 hours, meaning that an event or diagnostic update message will not be present for a specific event or diagnostic update until the machine has operated for 20 hours after the last transmitted occurrence of that event or diagnostic update. At the next event or diagnostic occurrence after the time period elapses, another message will be sent.
"Next Scheduled Interval"	Sets the time period before an event or diagnostic message update is sent, measured in units of real time or clock hours. This time period is calculated from the "Report Start Time".	Minimum value is 24 hours. Default value is 168 hours or 1 week. This value is only valid if the event or diagnostic report intervals are set to "Next".
"SMU/Fuel Reporting"	Defines whether the SMU or Fuel consumption report is sent as part of the daily standard message.	Fuel Only SMU Only Alternate SMU/Fuel

From the "Transmission Registry" screen, you can select the check box next to a piece of equipment. Then, click the "Configuration" button. The "Over the Air Configuration" screen will appear. On this screen, you can edit the "General Registry" parameters, the "Digital Registry" parameters, and the "Transmission Registry" parameters. Refer to ""Over the Air Configuration"".

"Over the Air Configuration"

You can use EquipmentManager over the air in order to change the configurable parameters for the registration of the PLM. This screen can be reached from the following screens by selecting the "Configuration button" that appears on each screen:

- "General Registry"
- "Equipment Registration Detail"
- "Digital Registry"
- "Transmission Registry"

Refer to the following procedure in order to configure parameters for the registration over the air from the "Equipment Registration Detail" screen:

1. In order for the "Over The Air Configuration" screen to appear , select the "Configuration" on the "Equipment Registration Detail" screen. The "Over The Air Configuration" screen will appear.

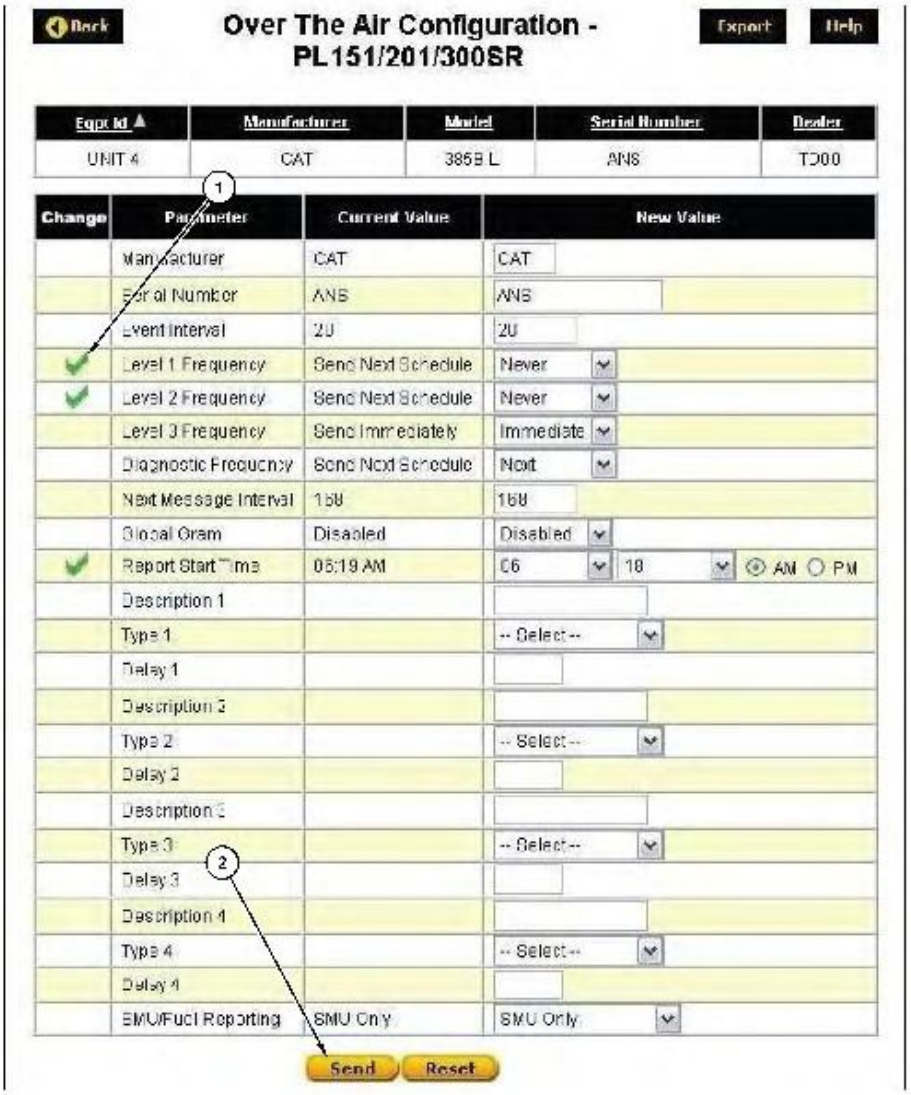


Illustration 9 g01721395

"Over the Air Configuration" screen

(1) Green check mark

(2) "Send" button

2. Change the desired parameters of the configuration by either typing new values into the text fields or selecting new values from the drop-down menus that appear in the "New Value" column of the table.

   A green check mark (1) will appear in the "Change" column next to any parameter that has been changed.

   ReferenceRefer to Systems Operation, "General Registry", Systems Operation, "Digital Registry", and Systems Operation, "Transmission Registry" for more information about the parameters and values.

   Note: Machine "Start Time" and "Stop Time" are supported by PL321 systems with the current software version. This configuration can only be set by using the "Over the Air Configuration" feature. When the "Start Time" and "Stop Time" feature is available, the "Start Time" and the "Stop Time" parameters will appear and the parameters can be set to "On" or "Off".

Note: In some cases, the parameter name on the "Over the Air Configuration" screen is different from the parameter name that appears on the "Transmission Registry" screen.

The following list shows the parameter name on the "Over the Air Configuration" screen and the equivalent parameter name on the "Transmission Registry" screen:

- Event Internal = Event/Diagnostic Interval Next Message
- Interval = Next Scheduled Interval

3. Click the "Send" button (2) . A popup window for a confirmation will appear.



Illustration 10 g01721396

Successful message for sending of the configuration parameters

4. Click the "OK" button. The parameters are updated and the "Configuration Parameters Sent Successfully" screen will be displayed.

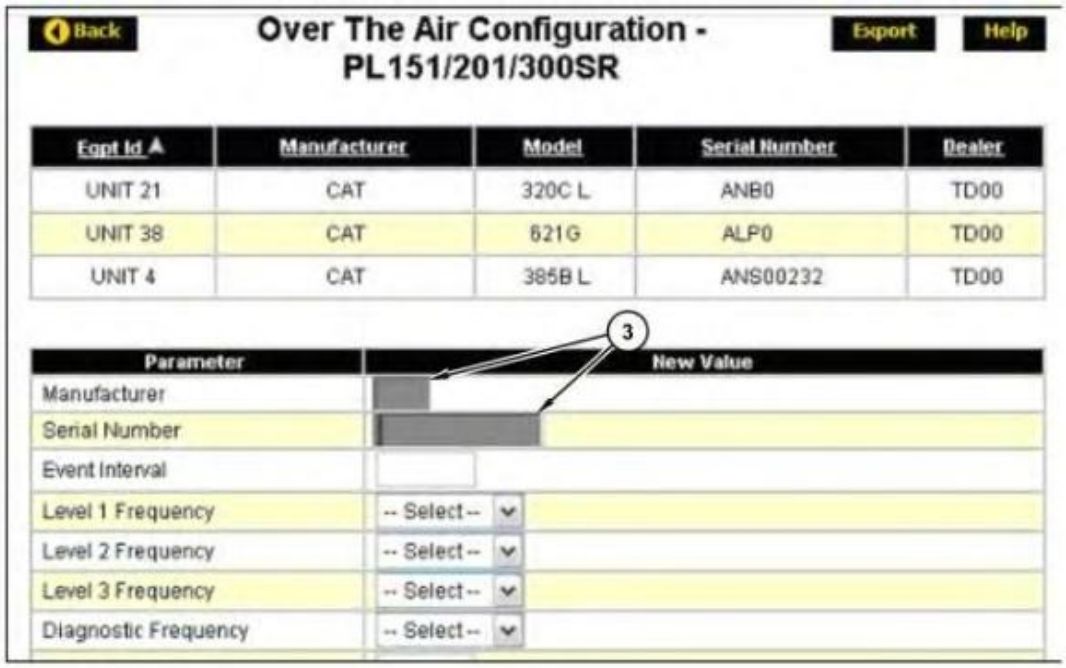


Illustration 11 g01721397

The "Over the Air Configuration" screen due to selecting multiple equipment

(3) "Manufacturer" parameter and "Serial Number" parameter

Note: If you select more than one piece of equipment for configuration at the same time, you must set all the parameters to the same value. Only the "Manufacturer" parameter and "Serial Number" parameter (3) can be set separately. These fields can not be edited on the "Over The Air Configuration" screen if multiple machines have been selected.

"Send Commands"

The "Send Commands" feature enables you to force the PLM to immediately send messages rather than waiting for the next interval of transmission. This could be useful if you needed to know information such as the immediate location or SMU of the machine. "Send Commands" is also where you can register and deregister the PLM for purposes of moving the module from one machine to another.

In order to send commands, use the following procedure:

1. From the "Administration" screen or the "View" drop-down menu, select "Send Commands". The "Equipment Search" screen will appear.

2. Select the criteria of your search and/or type the criteria of your search. Then click "Display Equipment". The "Send Commands" screen will appear and the screen will display the results of the search.

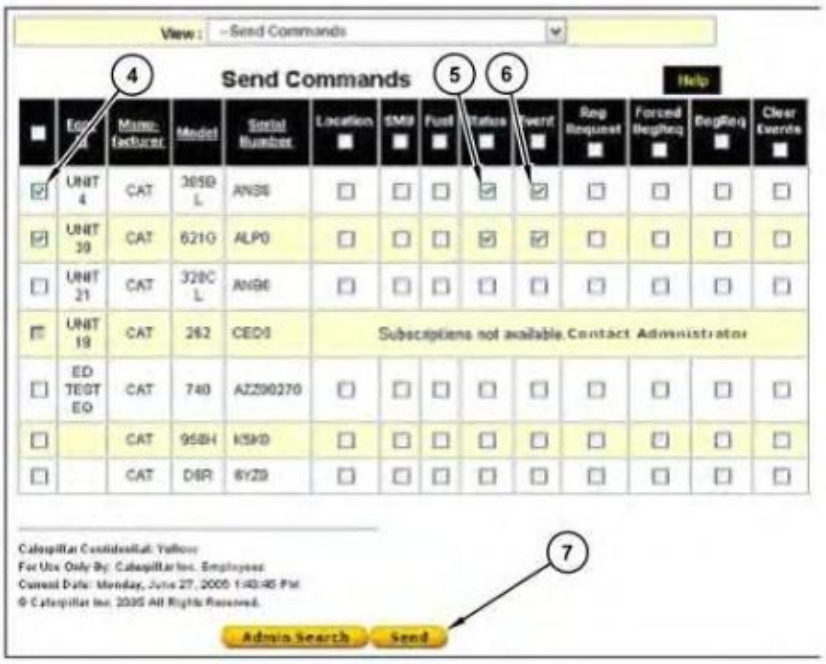


Illustration 12 g01721398

"Send Commands"

(4) Check boxes

(5) "Status" check box

(6) "Event" check box

(7) "Send" button

3. In order to send commands, select the check box that corresponds to the machine from the most left column. In the remaining columns, select the check box that corresponds to the type of command.

   Note: Selecting the check box (4) in the first column of the "Send Commands" table automatically selects the "Status" check box (5) and "Event" check box (6) for that selected item. Because the "Status" command returns reports about "Location", "SMU" and "Fuel", there is no reason to send any of these three commands if "Status" is selected.

   Table 7 describes the type of commands that can be sent.

Table 7

"Send Commands" Options

Subscriptions			Command	Description
Asset Watch	**Maint. Watch**	**Health Watch**		
X			Location	Sends report with location information of machine.
X			SMU	Sends report with information about current Service Meter Units.
		X	Fuel	

				Sends report with information about fuel consumption.
X			Status	Sends report with information about Location, SMU, and Fuel.
	X		Event	Sends report with Level 1, 2 and 3 event messages that have been collected from ECMs on machine since last transmission.
X	X	X	Reg Request	Request that a new registration message be sent.
X	X	X	Forced DegReg	The "Forced Deregistration" is useful if you know that a module has been removed without being de-registered from the old machine. The "Forced Deregistration" will remove the registration from EquipmentManager.
X	X	X	DegReg	Use the "Deregistration" command when you are removing a PLM from a machine. (1)
X	X	X	Clear Events	Send this command in order to clear all of the event messages that have been logged and are waiting until the next transmission interval to be sent.

(1) Deregistering the PLM does not affect the billing status. You must deactivate billing separately.

4. Click the "Send" button (7) . The "Send Commands" confirmation message will be displayed.

   Note: The configuration message is sent over the air via a satellite to the onboard PLM. The PLM will return a status message when the command has been successfully received at the module. This two-way communication will take a few minutes. Communication can be completed assuming that the machine is running or the master switch is open.



Illustration 13 g01721399

"Send Commands" confirmation message

5. Click "OK". The "Send Commands" page will display a successful message.



Illustration 14 g01721401

"Send Commands" with a successful message

6. Click"OK".

"Product Link Module Status Report"

The "PLM Status Report" will display the "Product Link Module Details". In order to display these details perform the following procedure:



Illustration 15 g01458356

"Product Link Module Details" screens

1. Select "Product Link Module Statue Report" from the "Administration" menu.
2. Enter the "Product Link Module ID" in the "Search" field.
3. Click "Display Details"

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Systems Operation
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i03369021

Manage Event Tracking

SMCS - 7600; 7606

There are many events that EquipmentManager reports that may be time sensitive, such as "Time and Geo Fence Alarms" and some "Fault Codes". EquipmentManager enables you to configure these event alerts to be sent to an e-mail account or text messaging device. This enables immediate notification of these events so the events can be addressed in a timely manner.

By establishing an "Address Book" and telling EquipmentManager the specific events to track ("Reactions"), you can be sure that the correct person is notified when certain alarms, planned maintenance, diagnostic, events, and levels occur.

Address Book

Before you can assign reactions to individuals, you must enter the individual in the EquipmentManager "Address Book".

Add an Address

In order to add a person to the address book, use the following procedure:



Illustration 1 g01248267

"Add Address" screen

1. On the "Administration" screen, in the "View" box, select "Address Book". The "Address Book" screen will appear.
2. In the "Description" box, type a description of the address. In the "Address" box, type a valid e-mail address.
3. Click "Add Address". The address appears in the upper area of the screen.

Edit an Address

In order to edit an existing address, use the following procedure:



Illustration 2 g01739413

The "Address Book" screen while editing an address

(1) Pencil and paper icon

1. From the "Address Book" screen, click the pencil and paper icon (1) next to the address to be edited. The "Edit Address" section is displayed at the bottom of the screen.
2. Edit the description in the "Description" field.
3. Edit the address in the "Address" field.
4. Click the "Save" button. The updated address appears in the list of addresses at the top of the screen.

Delete an Address

In order to delete an existing address from the address book, use the following procedure:

1. From the "Address Book" screen, select the check box next to the address you wish to delete.
2. Click the "Delete Addresses" button. The "Delete Address" confirmation window will appear.



Illustration 3 g01248269

Address Book - Delete Address

3. Click "OK".

   If there are currently no "Event Reactions" that are ready to be sent to the address that is selected, the "Confirm Deletion of Targets" screen is displayed with a corresponding message.

   If there are "Event Reactions" that are ready to be sent to the address that is selected, the "Confirm Deletion of Targets" screen contains a table that lists these reactions.

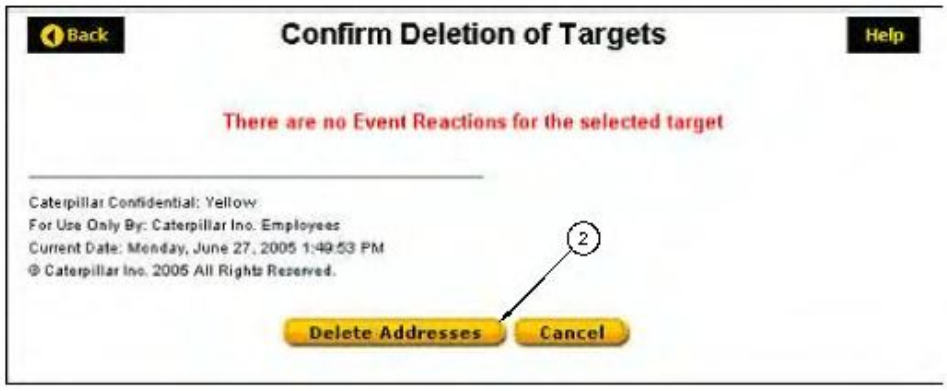


Illustration 4 g01739414

Confirm message for deleting address without "Event Reactions"

(2) "Delete Addresses"



Illustration 5 g01739415

Confirm message for deleting address with "Event Reactions"

(2) "Delete Addresses"

4. Click "Delete Addresses" (2) . The address is deleted from the address book.

"Reactions"

Once you have addresses in the EquipmentManager "Address Book", you can configure EquipmentManager to send e-mail messages to those addresses when alarms, events, diagnostics, planned maintenance notifications, and warnings are received.

Note: Event reactions that are delivered to email are provided in English only.

Add or Edit "Event Reactions"

In order to add or edit an "Event Reactions", perform the following procedure:

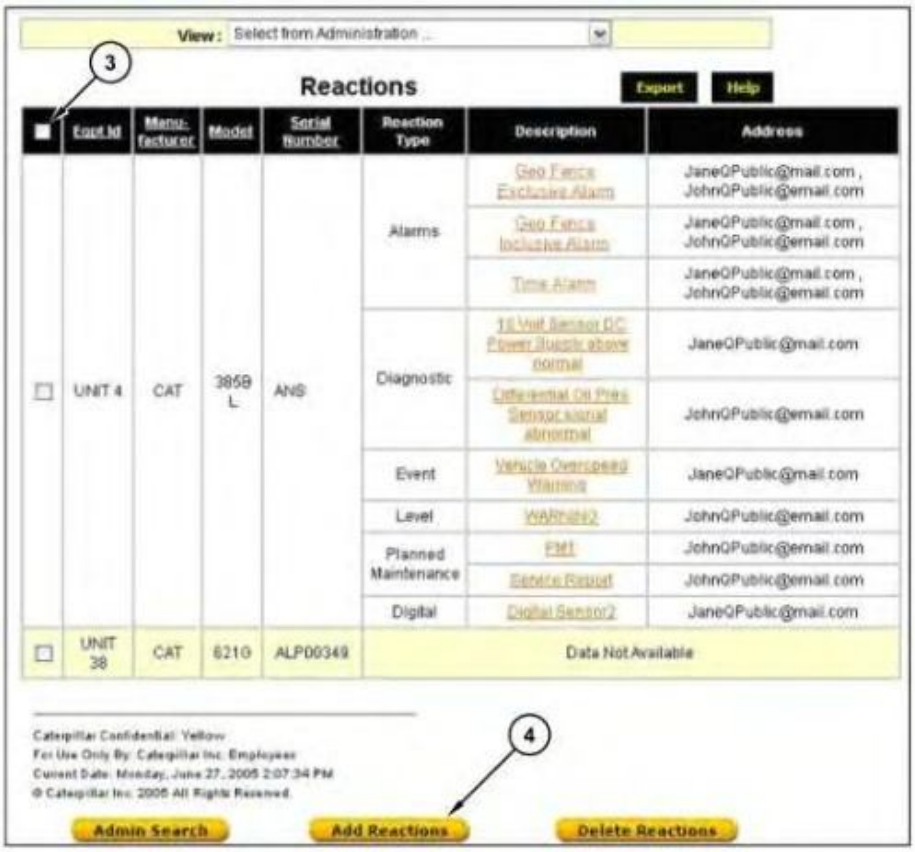


Illustration 6 g01739416

"Reactions" screen

(3) check box

(4) "Add Reactions" button

1. From the "Administration" screen or the "View" drop-down menu, select "Reactions".

   If you have equipment that is already selected, the "Reactions" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to Step 2.

2. Select the check box (3) of the machine that you want to add or edit reactions.

3. Click the "Add Reactions" button (4) . The "Add/Edit Reactions" screen will be displayed.



Illustration 7 g01739417

"Add/Edit Reactions" screen

(5) "Reaction Types" drop-down menu

4. From the "Reaction Types" drop-down menu (5) , select a reaction type. The left of the "Description" list box is populated with the available reactions for the type that is selected.
5. Select the events that are to be tracked from the left "Description" list box.
6. Click the "Add" button. The event is moved from the left "Description" list box to the right box.
7. If there are events that are to be removed from the reaction, select the events in the right list box.
8. Click the "Remove" button. The event is moved from the right list box to the left list box.
9. From the "Addresses" list box, select the address you wish an email message to be sent to when the selected events occurs.
10. Click the "Add" button. The address is moved from the "Addresses" list box to the "Add New Addresses" list box.
11. If there are addresses that are to be removed from the reaction, select the addresses from the "Add New Addresses" list box.
12. Click the "Remove" button. The address is moved from the "Add New Addresses" list box to the "Addresses" list box.
13. Click the "Save Reactions" button. The reaction is saved.

Alarm Reaction Types

The Alarm "Reaction Types" menu is used for defining the parameters for Time and Geo Fence alarm notification.

In order to receive notification of a fence violation you must select the type of violation you wish to alarm. Select one of the following types of fence violation alarms:

- "Geo. Fence Exclusive Alarm"
- "Geo. Fence Inclusive Alarm"
- "Time Alarm"

In order to receive notification of fence configuration failure you must select one of the following fence configuaration alarms:

- "Geo. Fence Inclusive Initialization Failure"
- "Time and Geo. Fence Application Not Enabled"
- "Time and Geo. Fence Invalid Command Length"
- "Time and Geo. Fence Invalid Configuration Alarm"
- "Time and Geo. Fence Invalid End Time"
- "Time and Geo. Fence Invalid Location Flag"
- "Time and Geo. Fence Invalid Start Time"
- "Time and Geo. Fence Password Failure"

In order to receive notification when equipment returns to inclusive boundary select "Geo. Fence Inclusive Return Alert".

Note: AID: 0 is not supported.

Level "Reaction Types"

One of the "Reaction Types" that can be added or edited is the "Level" reaction type. The the "Add/Edit Reactions" screen has the following "Reaction Types" levels:"Derate", "Severe", "Unknown Severity" and "Warning".

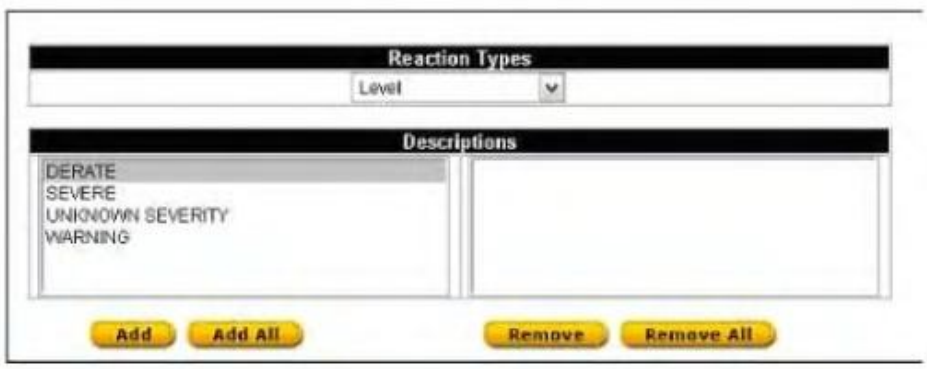


Illustration 8 g01248874

"Reaction Type" with levels

The "Level" reaction types correspond to the Electronic Technician (ET) defined diagnostic severity levels. Note that the "Add/Edit Reactions" screen is the only place that these levels are given alternate names. On the "Transmission Registry", these levels are still referred to by the Electronic Technician names. The following table lists the "Event Reactions" term and the corresponding ET diagnostic severity level.

Table 1

Corresponding "ET Diagnostic" Severity Level for "Reactions"	
"Reaction Type" Level	**"ET Diagnostic" Severity Level**
Derate	Level 2
Severe	Level 3
Unknown Severity	Level 0 No Level
Warning	Level 1

"Delete Reactions"

In order to delete an "Event Reactions", use the following procedure:

1. From the "Reactions" screen , select the check box next to the machine(s) with the reactions you wish to delete.
2. Click the "Delete Reactions" button. The "Delete Reactions" screen will be displayed in a new window.

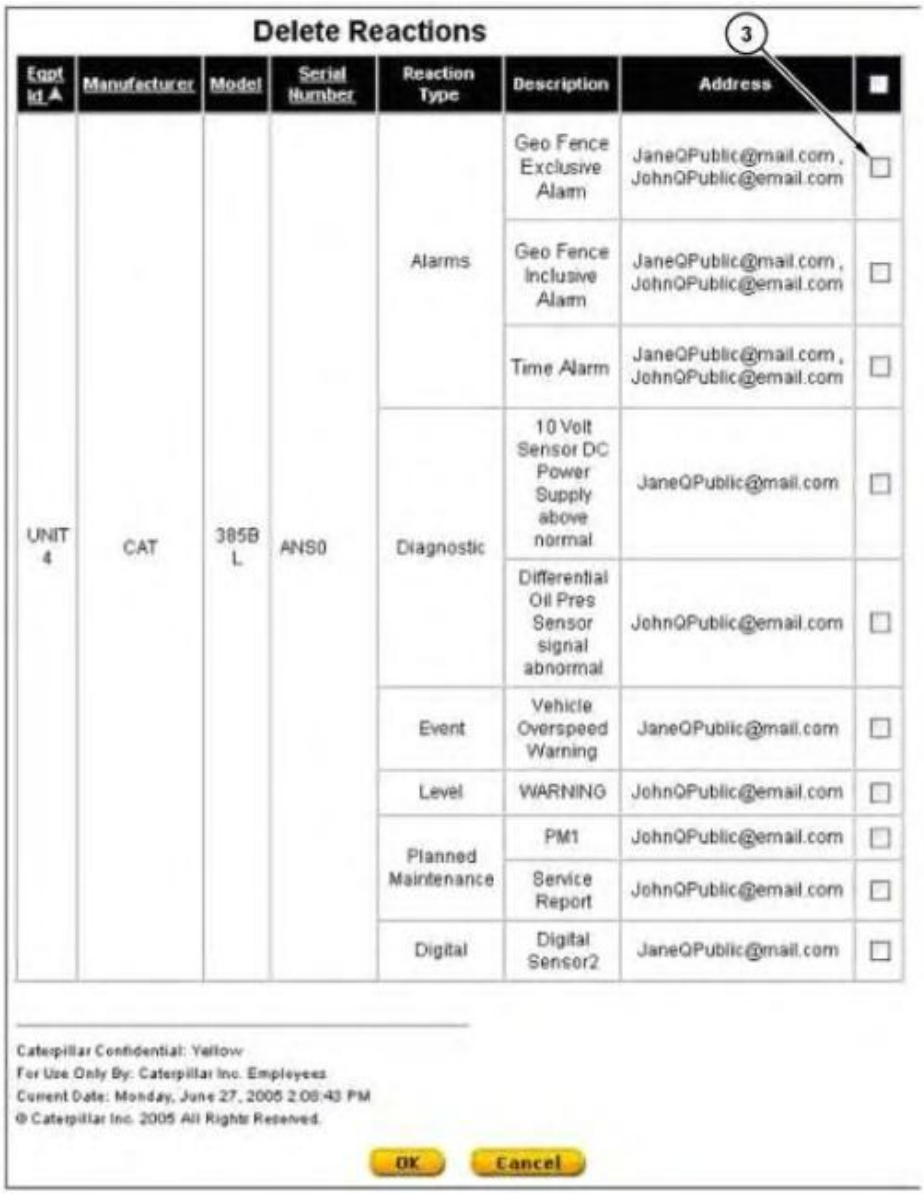


Illustration 9 g01739418

"Delete Reactions"

(5) Check box

3. Select the check box (5) in the far right column that corresponds with the reaction you wish to delete.
4. Click the "OK" button. The reaction is deleted.

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i03365020

Upload Data

SMCS - 7600; 7606

The Caterpillar EquipmentManager database only begins storing information about a machine when the Product Link Module (PLM) has been installed and registered, subscriptions have been purchased and the PLM has begun submitting reports.

"Repair History"

There are two methods for uploading the repair history for a machine. The first method is by entering the information about each individual service by using a form. Refer to "Upload "Repair History" Using Form". The second method is by uploading a file that contains information about one or more services that were performed on one or more machines. Refer to "Upload "Repair History" by Importing From a File". Both of these methods are available on the "Repair History Upload" screen.

Upload "Repair History" Using Form

In order to upload the repair history by using the form, use the following procedure:

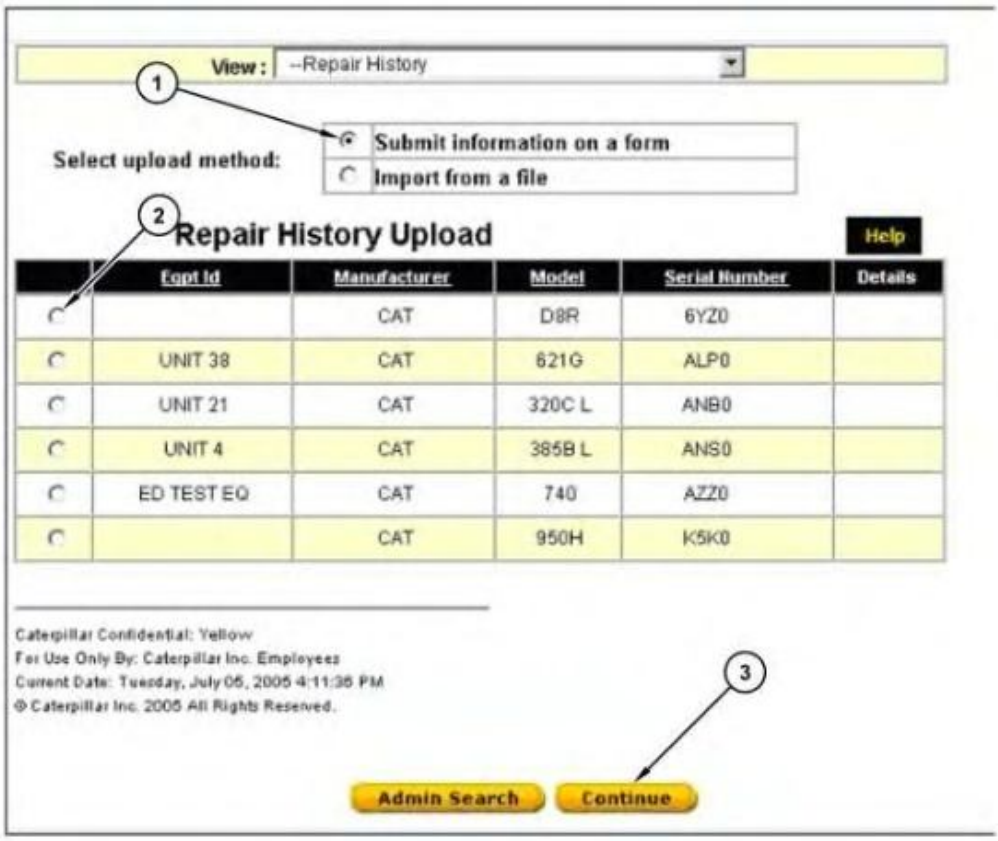


Illustration 1 g01740013

"Repair History Upload" screenusing a form

(1) "Submit information on a form" radio button

(2) Radio button

(3) Continue

1. From either the "Administration" screen or the "View" menu, select "Repair History".

   If equipment has already been selected, the "Repair History Upload" screen is displayed.

   If you have not already selected equipment, the "Equipment Search" screen is displayed. Perform your search, and then click the "Display Equipment" button. The "Repair History Upload" screen will appear.

2. Select the "Submit information on a form" radio button (1) if "Submit information on a form" is not already selected.

3. Select the radio button (2) that is next to the desired machine in order to upload the repair history.

4. Click the "Continue" button (3) .

   The "Report Service" screen will be displayed.



Illustration 2 g01249465

"Report Service" screen

5. In the "Service Report Common Info" section, select the appropriate checkbox for the service that was performed.

   If you selected "Dealer", a dropdown appears below the radio buttons. Select the name of the "Dealer" that serviced the equipment and proceed to Step 7.

   If you selected "Others", a text field appears below the radio buttons. Type the name of the person or entity that serviced the equipment and proceed to Step 7.

6. Enter the work order number in the "Work Order" text field.

7. Enter the segment number in the "Segment" text field.

8. Enter the date that the service was performed by clicking the calendar icon that is next to the "Repair Date" field. Select the date from the popup calendar.

9. Enter the Service Meter Units in the "Service Meter" text field. If the units were measured in hours, select the "H" radio button. If the units were measured in miles, select the "M" radio button. If the units were measured in kilometers, select the "KM" radio button.

10. Enter a description of the repair in the "Repair Description" text field.

11. Enter the time in hours that the machine was unavailable while being serviced in the "Downtime Labor" text field.

12. Enter Information about faulty parts in the "Part Causing Failure" table including the part name, manufacturer, quantity, defect code, and group number.

    Click the "Add Part" button in order to create a new row in the table for additional parts. Select the checkbox that is next to a part. Click the "Delete Part" button in order to remove the part from the list.

13. Click the "Save" button. The repair history is uploaded.

Upload "Repair History" by Importing From a File

In order to import the repair history from a file, use the following procedur:

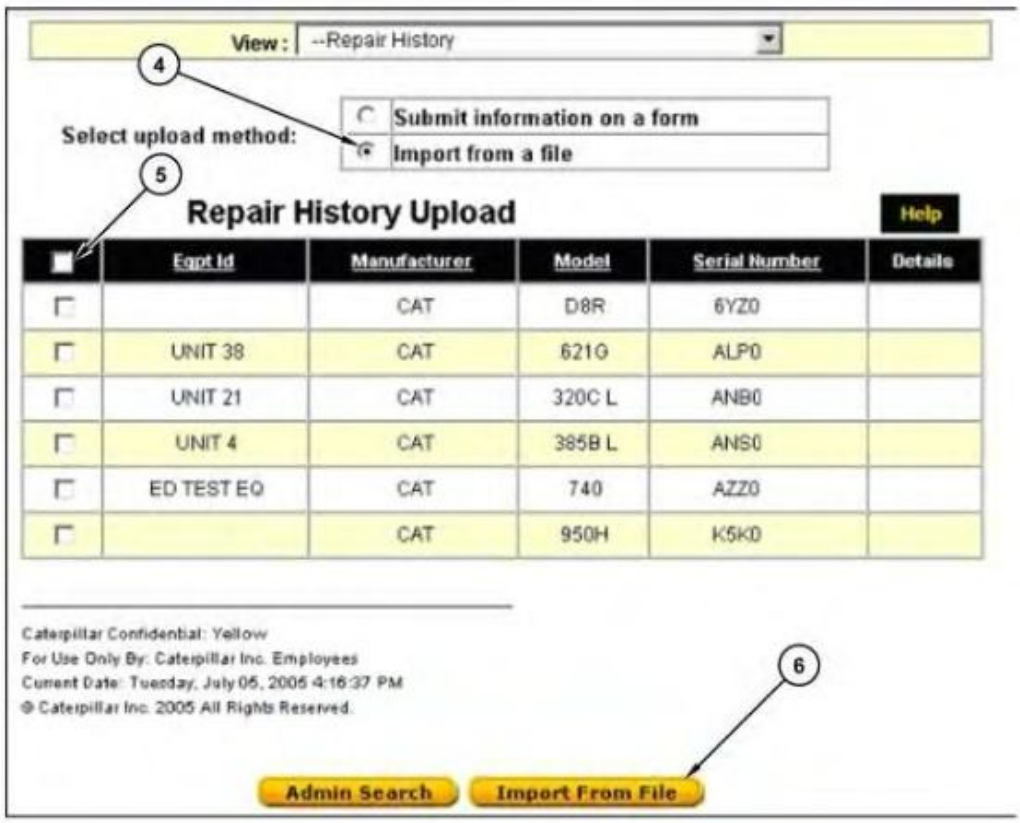


Illustration 3 g01740014

"Repair History Upload" screen by importing from a file

(4) "Import from a file" radio button

(5) Check box

(6) "Import From File" button

1. From the "Repair History Upload" screen, select the "Import from a file" radio button (4) .
2. Select the check box (5) next to the pieces of equipment to which you wish to upload repair history.
3. Click the "Import From File" button (6) . The "Import From File" screen is displayed in a new window.



Illustration 4 g01249475

"Import From File" screen browsing for a file

4. Click the "Browse" button. Navigate to the file that contains the repair history to be added. Click the "Open" button. The name of the file that was selected appears in the "File" text field.
5. Click "OK". The repair history is uploaded.

Preparing a Repair History Upload File



Illustration 5 g01249480

Sample of a Microsoft® Excel file using "Repair History Upload"

In order for a "Repair History Upload" file to be successfully uploaded, the file must contain the correct fields and files. Also, the files must be formatted in a specific way. Illustration 5 is an example of a spreadsheet that was used to create an upload file.

In order to create a "Repair History Upload" file, use the following procedure:

1. Open a new Microsoft® Excel spreadsheet.

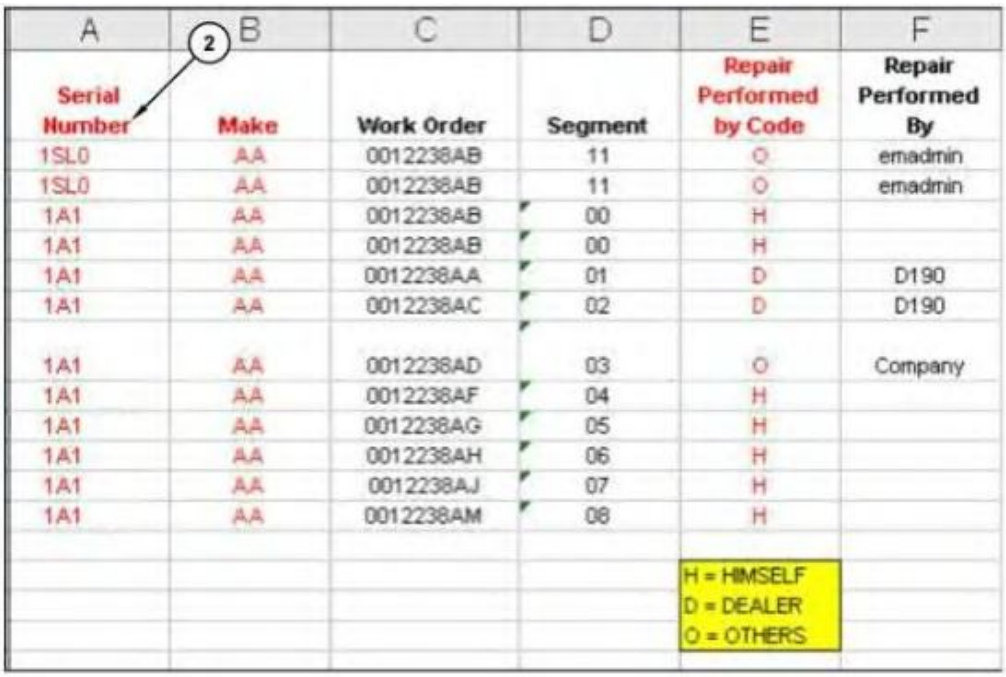


Illustration 6 g01740015

"Repair History Upload" Microsoft Excel - Columns A through F

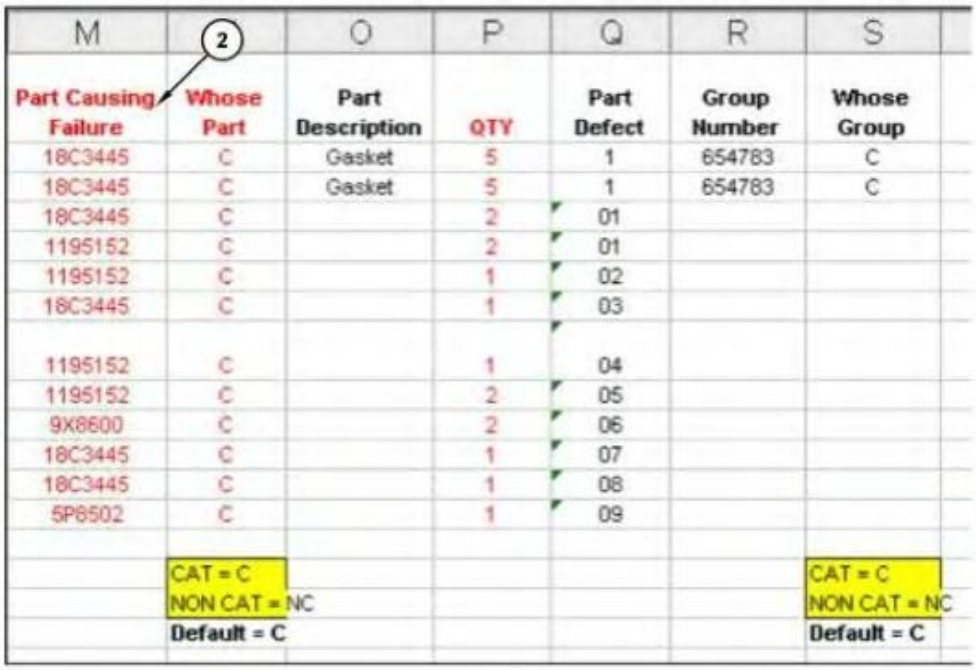
(6) Column headers



Illustration 7 g01740808

"Repair History Upload" Microsoft Excel - Columns G through L

(6) Column headers



M	(2)	O	P	Q	R	S
Part Causing Failure	Whose Part	Part Description	QTY	Part Defect	Group Number	Whose Group
18C3445	C	Gasket	5	1	654783	C
18C3445	C	Gasket	5	1	654783	C
18C3445	C		2	01		
1195152	C		2	01		
1195152	C		1	02		
18C3445	C		1	03		
1195152	C		1	04		
1195152	C		2	05		
9X8600	C		2	06		
18C3445	C		1	07		
18C3445	C		1	08		
5P8502	C		1	09		
	CAT = C NON CAT = NC Default = C					CAT = C NON CAT = NC Default = C

Illustration 8 g01740016

"Repair History Upload" Microsoft Excel - Columns M through S

(6) Column headers

2. Enter the repairs in the spreadsheet one repair per row. Refer to Illustrations 6 through 8 as examples of the columns and values that should appear in the spreadsheet. Items that are displayed in red indicate mandatory items.
3. Once you have finished entering data, delete the column headers (6) .
4. Go to "File", "Save As" and pick "CSV (Comma Delimited)" and save the file.

"Refueling History"

For "Repair History", information can be submitted as a form or an upload from a file. However, there is only one method to upload the refueling history.

Import Refueling History from File

In order to import refueling history from a file, use the following procedure:

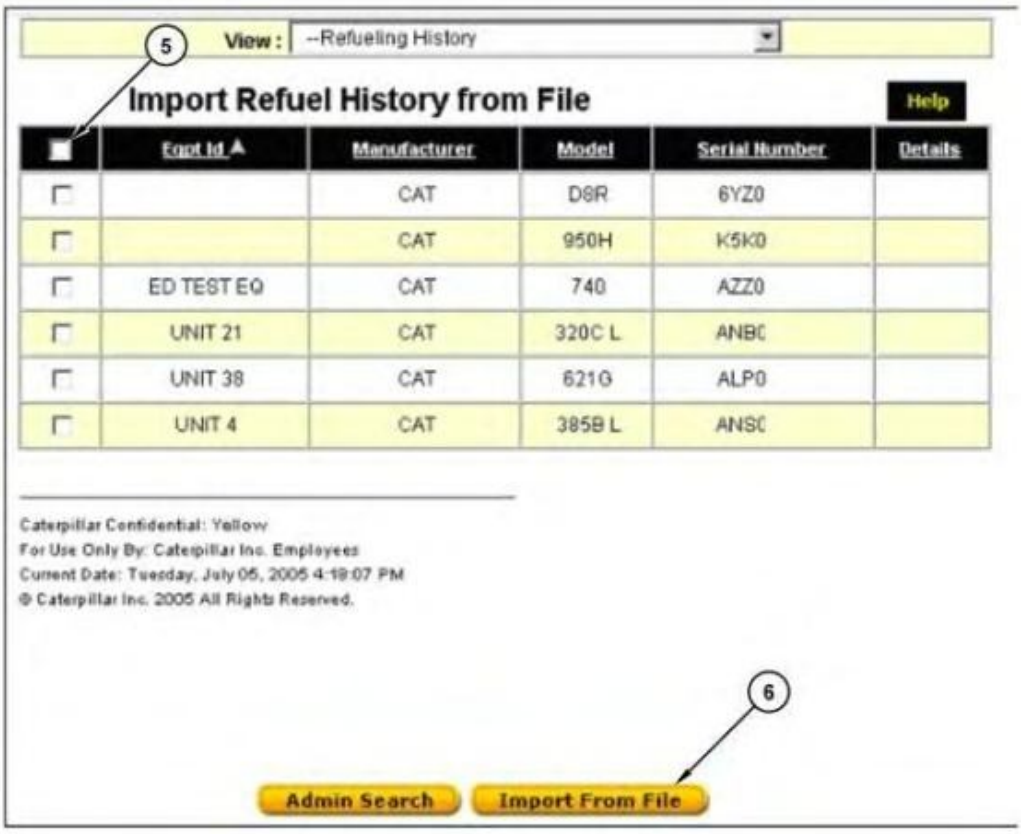


Illustration 9 g01740017

"Import Refuel History from File" screen

(5) Check box

(6) "Import From File" button

1. From either the "Administration" screen or the "View" menu, select "Refueling History".

   If equipment has already been selected, the "Import Refuel History from File" screen is displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

2. Select the check box () next to the pieces of equipment to which you wish to upload refueling history.

3. Click the "Import from File" button () . The "Import from File" screen opens in a new window.

4. Click the "Browse" button. Navigate to the file that contains the refueling history that is to be added. Click the "Open" button. The name of the file that was selected will appear in the "File" text field.

5. Click "OK". The refueling history is uploaded.

Preparing a Refueling History Upload File

In order for a "Refuel History Upload" file to be successfully uploaded, use the following procedure:

1. Open a new Microsoft Excel spreadsheet.

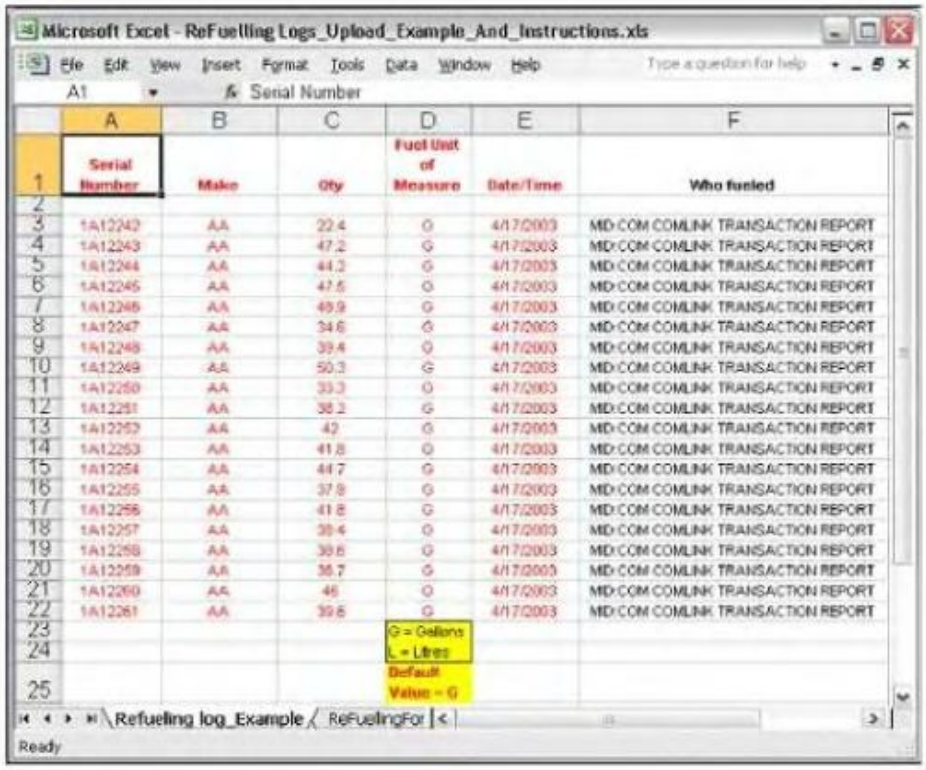


Illustration 10 g01249493

Sample of a Microsoft Excel file using "Refuel History" with headings

2. Enter the refuelings in the spreadsheet one refueling per row. Refer to Illustration 10 as an example of the columns and values that should appear in the spreadsheet. Items that are displayed in red indicate mandatory items.
3. After you have finished entering data, delete the column headers.
4. Go to "File", "Save As" and pick "CVS (Comma Delimited)" and save the file.

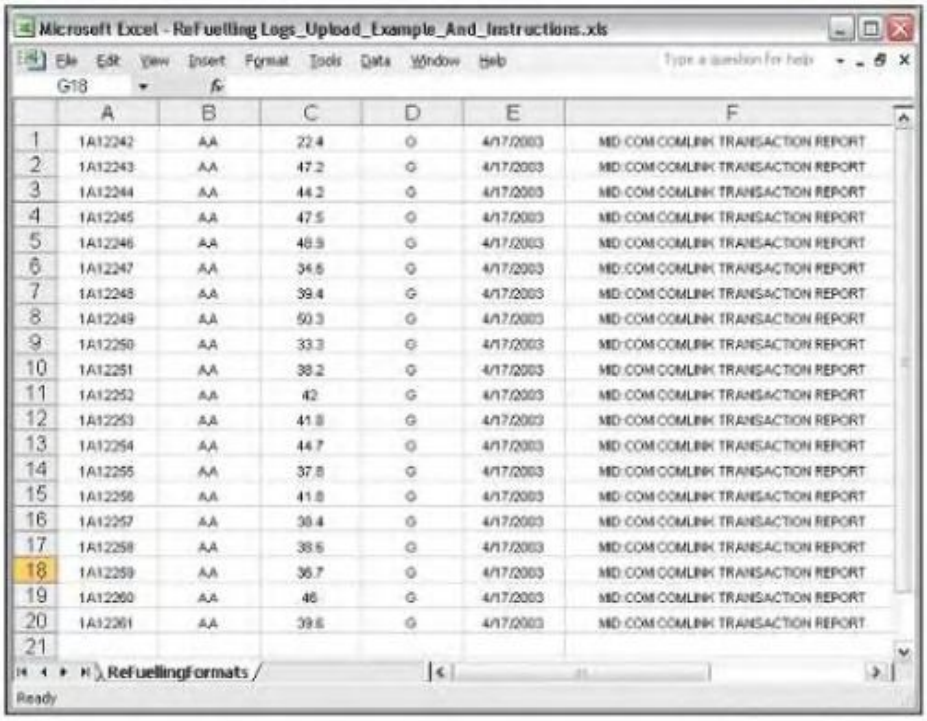


Illustration 11 g01249521

Sample or a Microsoft Excel file using "Refuel History" without headings

Illustration 11 shows the final file without the headers.



Illustration 12 g01249494

".cvs" alert message

If you attempt to upload a file that is not of the ".csv " file type, you will get the message displayed in Illustration 12.

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Systems Operation
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i03365163

Manage Major Repair Tracking

SMCS - 7600; 7606

Track Major Repairs

EquipmentManager can track major repairs in the same way that EquipmentManager can track planned maintenance schedules. You must configure EquipmentManager to track major repairs through the Administration screens.

In order to add or remove the tracking of major repairs, use the following procedure:

1. From either the "Administration" screen or the "View" dropdown, select "Track Major Repairs".

   If equipment has already been selected, the "Track Major Repairs Results" screen is displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

2. Select the radio button next to the pieces of equipment for which major repairs are to be tracked.

3. Click the "Track Major Repairs" button. The "Track Major Repairs" screen will be displayed.

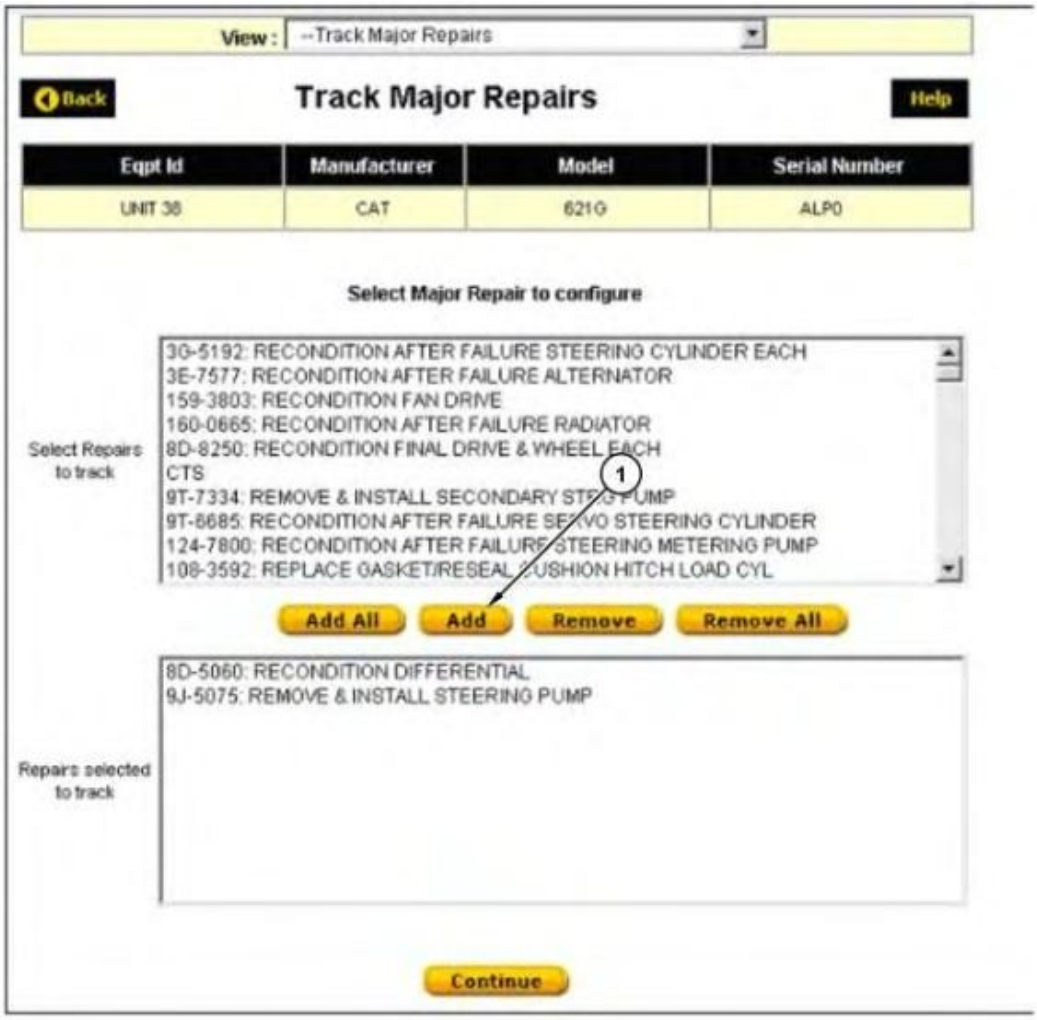


Illustration 1 g01737054

"Track Major Repairs"

(1) "Add" button

4. From the "Select Repairs to track" list box, select all major repairs you wish to add to the repair tracking.

   Note: Multiple repairs can be selected by holding down the "Ctrl" key and clicking on the items you wish to select.

5. Click the "Add" button (1). The repair is moved from the "Select Repairs to track" list box to the "Repairs selected to track" list box.

6. From the "Repairs selected to track" list box, select all repairs you wish to remove from the repair tracking.

7. Click the "Remove" button. The repair is moved from the "Repairs selected to track" list box to the "Select Repairs to track" list box.

8. Click the "Continue" button.

   The "Configure Repair Tracking intervals" screen will be displayed.

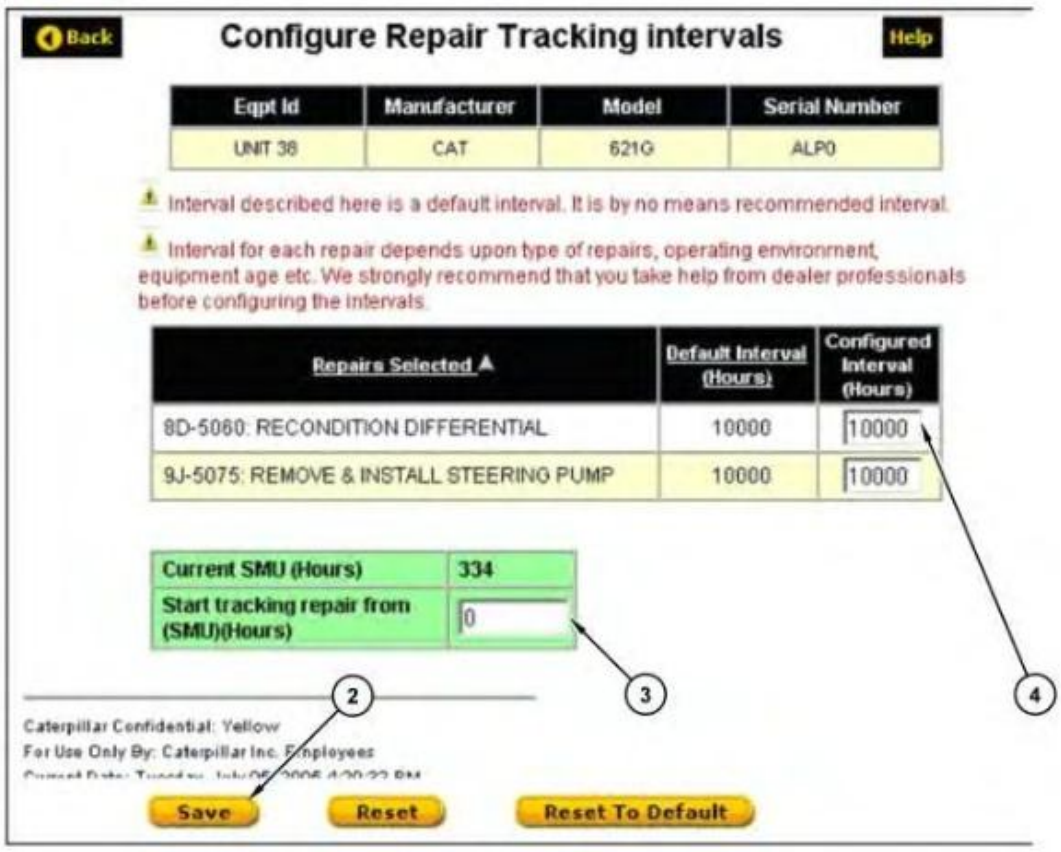


Illustration 2 g01737055

"Configure Repair Tracking intervals" screen

(2) "Save" button

(3) "Start tracking repair from" text field

(4) "Configured Interval" text field

9. In the "Configured Interval" text field (4), enter the number of hours that represents the interval for each repair.
10. In the "Start tracking repair from" text field (3), enter the SMU hours you wish the repair to begin being tracked.
11. Click the "Save" button (2). The "Confirmation – Configure Repair Tracking Intervals" screen will be displayed.



Illustration 3 g01737056

"Confirmation – Configure Repair Tracking Intervals" screen

12. Click "OK". The major repair tracking is saved.

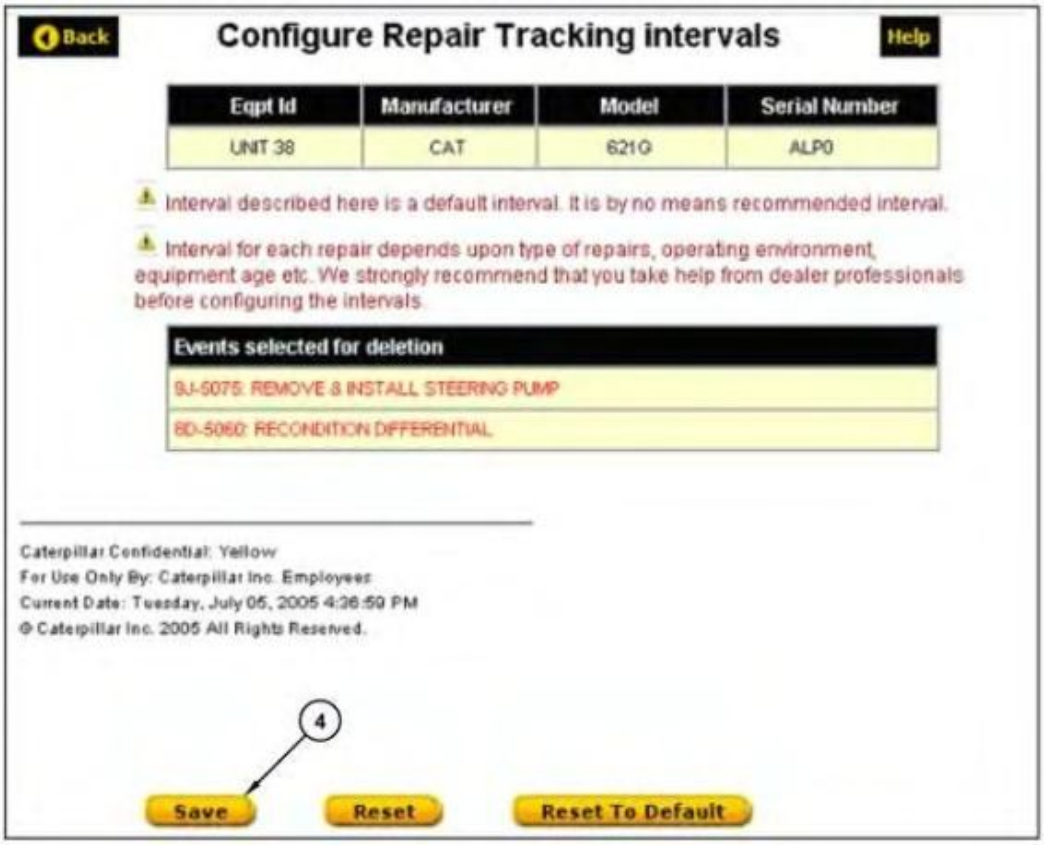


Illustration 4 g01737057

"Configure Repair Tracking intervals" screen if repairs have been deleted from "Track Major Repair" details

(2) "Save" button

If you removed any events or major repairs, clicking the "Save" button (2) will result in Illustration 4.

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i03365722

Manage Time Fence and Geographic Fence

SMCS - 7600; 7606

Geographic Fences and Time Fences

During normal working conditions, machines can move in and out of yards. Machines can also move to different job sites. A machine will not normally travel beyond a designated work area. The EquipmentManager software will record the location of a machine as history, unless the machine travels beyond the normal work area.

The EquipmentManager software uses the following features in order to track the machines:

Inclusive Geographic Fencing and Exclusive Geographic Fencing - The ability to be alerted when one of your machines is either inside or outside of a particular geographical area

Time Fencing - The ability to be alerted when one of your machines is operating either outside or inside of a designated time of the day

In the "Administration" section of EquipmentManager you use Asset Watch in order to set up the fences that can be applied to individual machines or to groups of machines. Refer to the Systems Operation, "Time Fence and Geographic Fence" for detailed descriptions.

Inclusive and Exclusive Descriptions

Inclusive and exclusive descriptions are descriptions of the geographical areas that make up the geographic fences. You can create as many descriptions as desired. Creating and storing these descriptions in advance, so that you can apply them to your equipment when needed, will save you time.

When creating the descriptions, inclusive and exclusive are the same. When assigning a machine to a geographic fence, you must choose whether the fence is inclusive or exclusive.

Note: The information in the Systems Operation, "Time Fence and Geographic Fence" describes some practical scenarios where previously created geographic and time fences can be assigned to machines. In this module, you will focus on creating these descriptions.

Add Descriptions

In order to add descriptions by using a map, use the following procedure:

1. In the "View" box, select "Inclusive/Exclusive Descriptions". The "Inclusive/Exclusive Descriptions" screen will appear.



Illustration 1 g01397246

2. Click "Map Lat/Long". The "Internet Map" screen will appear.

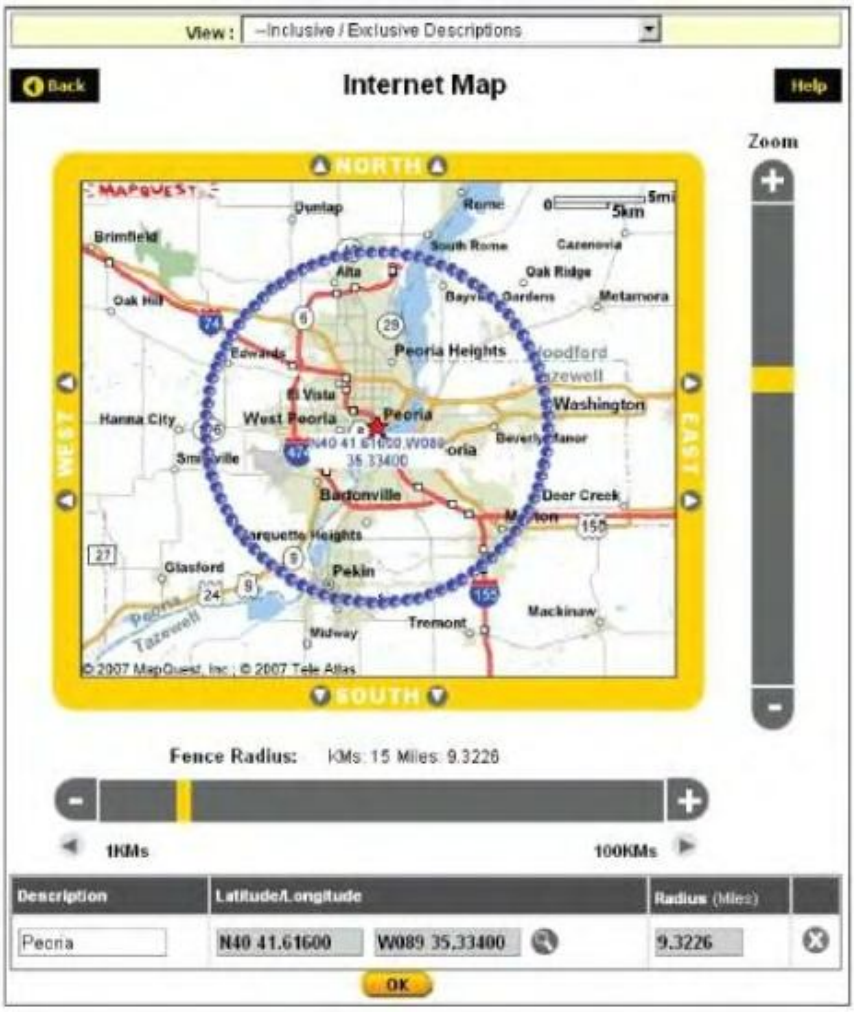


Illustration 2 g01397249

3. In the "Description" box, type a description for the new fence.
4. Define the center of a geographic fence by using one of the following methods:
   - In the "Latitude/Longitude" boxes, type the desired values.
   - Click a point on the map. In order to help establish the desired location, you can use the zoom in button and zoom out button to the right of the map. You can also use the "North", "South", "East", and "West" buttons on the borders of the map.
   - Select the icon of a magnifying glass. This enables you to enter a street address, city, state, and/or zip code.

   Note: The options for entering a street address, city, state, and/or zip code are only available in North America.
5. Configure the radius of the fence by dragging the "Fence Radius" slider to the appropriate location.

   Note: The fence radius values will display in whole kilometers. If your units of measure preference is miles, the fence will be configured in kilometers, converted to miles, and then displayed in miles.
6. Click "OK". The "Inclusive/Exclusive Descriptions" screen displays the new values in the "Add New Description" section.
7. Click "Add Location". A confirmation message will appear.



Illustration 3 g01397252



Illustration 4 g01737653

"Inclusive/Exclusive Descriptions" screen with the added location

(1) Pencil and paper icon

8. Click "OK". The location is added to the list of descriptions at the top of the "Inclusive/Exclusive Descriptions" screen. Refer to Illustration 4.

Edit "Inclusive/Exclusive Descriptions"

In order to edit an inclusive/exclusive description on the "Inclusive/Exclusive Descriptions" screen, click the pencil and paper icon (1) to the right of the description that you want to edit. Refer to Illustration 4. The "Edit Description" section appears. Use the procedure described earlier for changing the parameters using the map. When the changes have been made, click "Save".

Delete "Inclusive/Exclusive Descriptions"

In order to delete an inclusive/exclusive description, use the following procedure:



Illustration 5 g01397261

"Inclusive/Exclusive Descriptions" screen for deleting

1. On the "Inclusive/Exclusive Descriptions" screen, select the check box for the description that you want to delete.
2. Click "Delete Location Descriptions". A confirmation window will appear.



Illustration 6 g01397267

3. Click "OK". The description is deleted.

Time Based Descriptions

In order to create a "Time Based Description", use the following procedure:

1. From either the "Administration" screen or the "View" drop down menu, select "Time Based Descriptions". The "Time Based Descriptions" screen will be displayed.

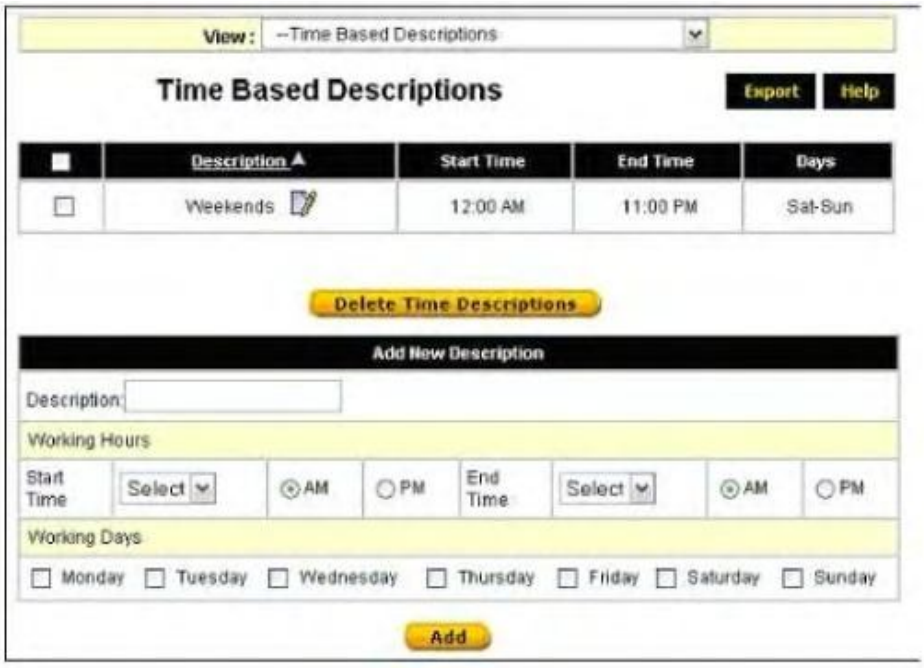


Illustration 7 g01249897

"Time Based Descriptions" with "Add New Description"

2. In the "Add New Description" section, enter a description of the new time fence in the "Description" text field.
3. In the "Working Hours" section, select an hour from the "Start Time" drop down menu.
4. Select the radio button next to the "Start Time" "AM" or "PM".



Illustration 8 g01249898

"End Time greater than Start Time" alert message

5. Repeat Steps 3 and 4 for the End Time.

   Note: If you enter an "End Time" that is less than the S"tart Time" the window in Illustration 8 will appear.

6. In the "Working Days" section, select the checkbox next to the days of the week to which you want the fence to apply.

7. Click the "Add" button. The new description is added to the list at the top of the screen.

Edit a Time Based Description

In order to edit a time based description, use the following procedure:

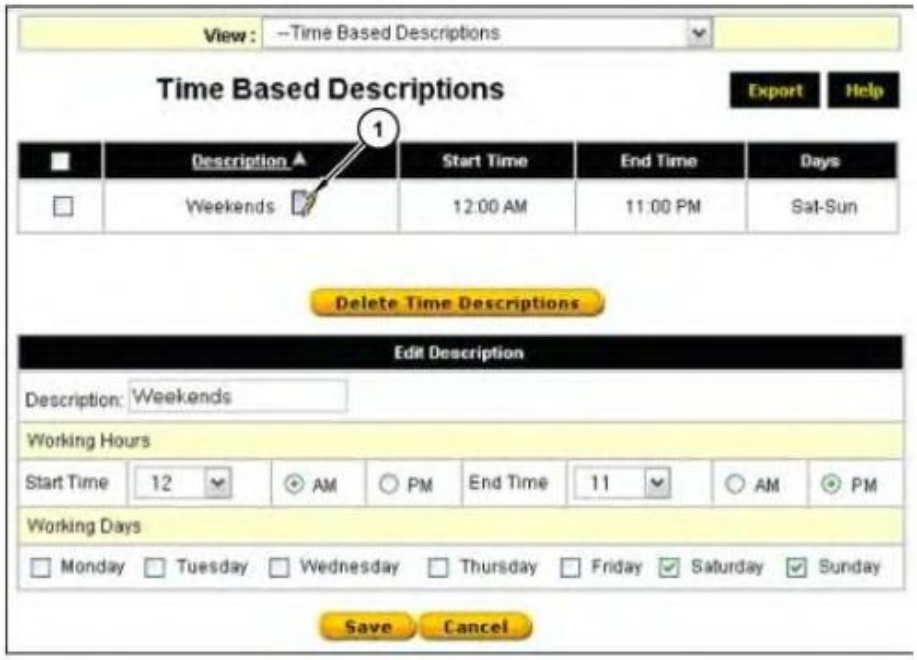


Illustration 9 g01737654

Editing "Time Based Description"

(1) Pencil and paper icon

1. From the "Time Based Descriptions" screen, click the pencil and paper icon (1) next to the description you wish to edit. The "Edit Description" section will be displayed.

2. In the "Edit Description" section, edit the description of the time fence in the "Description" field.

3. Edit the "Start Time" and "End Time" hours and "AM" or "PM".

4. Edit the selected "Working Days".

5. Click the "Save" button. A confirmation window will appear.



Illustration 10 g01249903

Confirmation message for editing "Time Based Description"

6. Click "OK". The updated description appears in the list at the top of the screen.

Delete a Time Based Description

In order to delete a time based description, use the following procedure:

1. From the "Time Based Descriptions" screen, select the checkbox next to the description you wish to delete. Refer to Illustration 10.
2. Click the "Delete Location Descriptions" button. Refer to Illustration 10. A confirmation window will appear.



Illustration 11 g01249904

3. Click "OK". The description is deleted.

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i03359362

Manage Planned Maintenance

SMCS - 7600; 7606

One of the ways that EquipmentManager helps you manage your equipment is by organizing the often complex task of managing planned maintenance for your equipment. Through the administration section of EquipmentManager, you can customize the intervals at which planned maintenance is performed, edit the checklists that are used to guide the planned maintenance, and customize the scheduling of the planned maintenance for individual or groups of equipment.

Customize PM Intervals

For each piece of equipment you are managing, default planned maintenance intervals exist. These default intervals are defined in the Operation Maintenance Manual specific to each Caterpillar models. Default intervals are applied to a manufactures models other than Caterpillar. The intervals indicate the Service Meter Unit (SMU) that when reached by the machine, should trigger a planned maintenance. You have the option of setting these intervals to values other than the defaults.

In order to customize PM Intervals, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Customize PM Intervals".

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

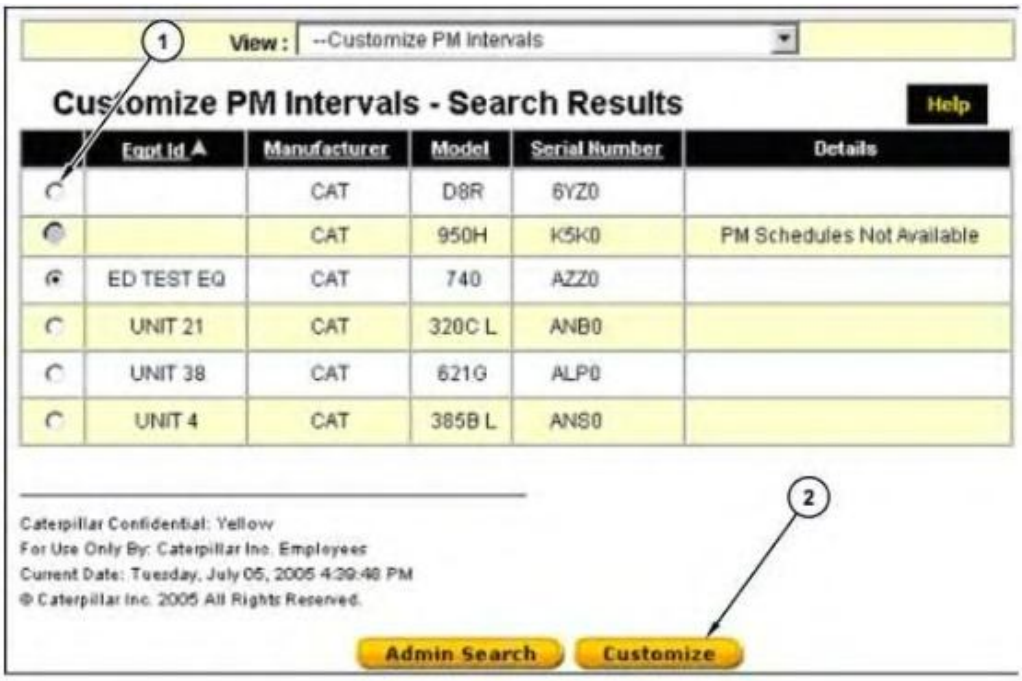


Illustration 1 g01732833

"Customize PM Intervals - Select Results" screen

(1) Radio buttons

(2) "Customize" button

2. Select the radio button (1) next to the piece of equipment in order to customize the "PM Interval" for the equipment.



Illustration 2 g01250076

Warning for trusting the applet

3. Click the "Customize" button (2) . A warning for trusting the applet will appear. Refer to Illustration 2.

4. Click "Yes". The "Customize PM Intervals" screen will be displayed.

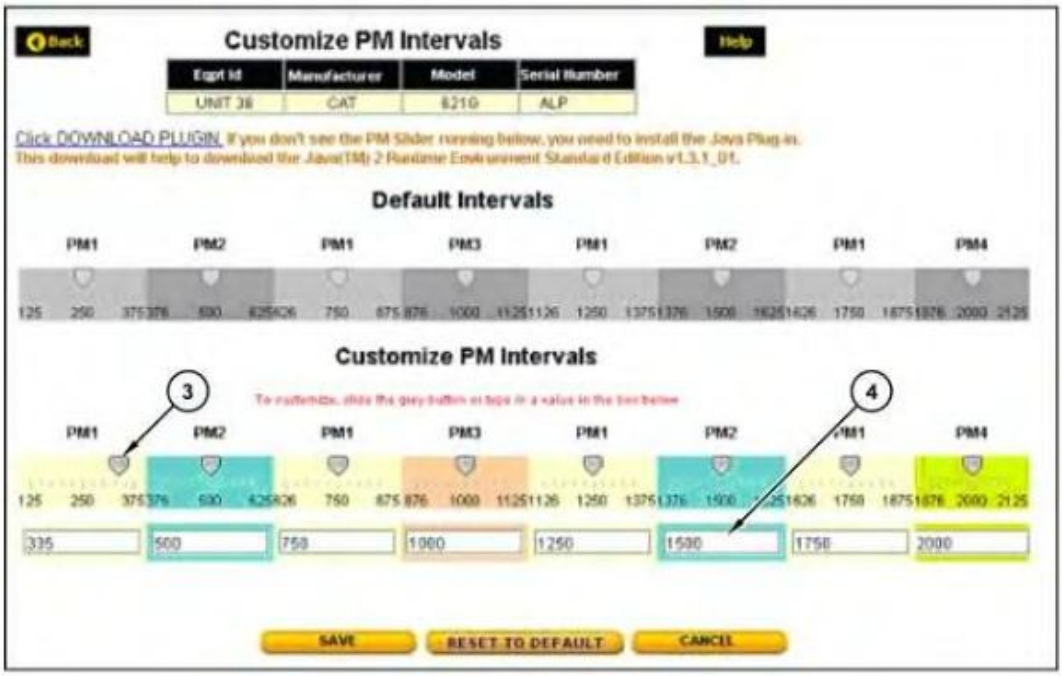


Illustration 3 g01732834

"Customize PM Intervals"

(3) Gray slider

(4) Text field

5. In order to change the " PM Interval", drag the gray slider (3) to the desired value (measured in SMUs) or edit the value in the text field (4) that appears below the PM.



Illustration 4 g01250081

The "Successful" message for "Customize PM Intervals"

6. Click the "Save" button. A successful message will be displayed. Refer to Illustration 4.
7. Click "OK". The PM Intervals have been customized.



Illustration 5 g01250119

"Reset All PM Intervals" confirmation message

If you choose to click the "Reset to Default" button on the "Customize PM Intervals" screen, the window as shown in Illustration 5 will appear.



Illustration 6 g01250121

No "PM Interval" changes message

If you click the "Save" button on the "Customize PM Intervals" screen and have not changed from the defaults, the window as shown in Illustration 6 will appear.

Edit PM Check List

The PM Checklist is a description of the steps that should be taken when performing a planned maintenance. The steps can include everything from checking fluid levels to replacing parts. Through EquipmentManager you can edit these checklists to add, edit, or remove steps.

Note: Complete checklists that are applied for Caterpillar models and serial numbers from model year 2000 or newer. Generic checklists that are applied for Caterpillar models and serial numbers older than 2000 as well as other manufacture models.

"Edit PM Check List"

In order to edit a step in a check list, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Edit PM Check List".

   If you have equipment already selected, the "Edit PM Check List - Search Results" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

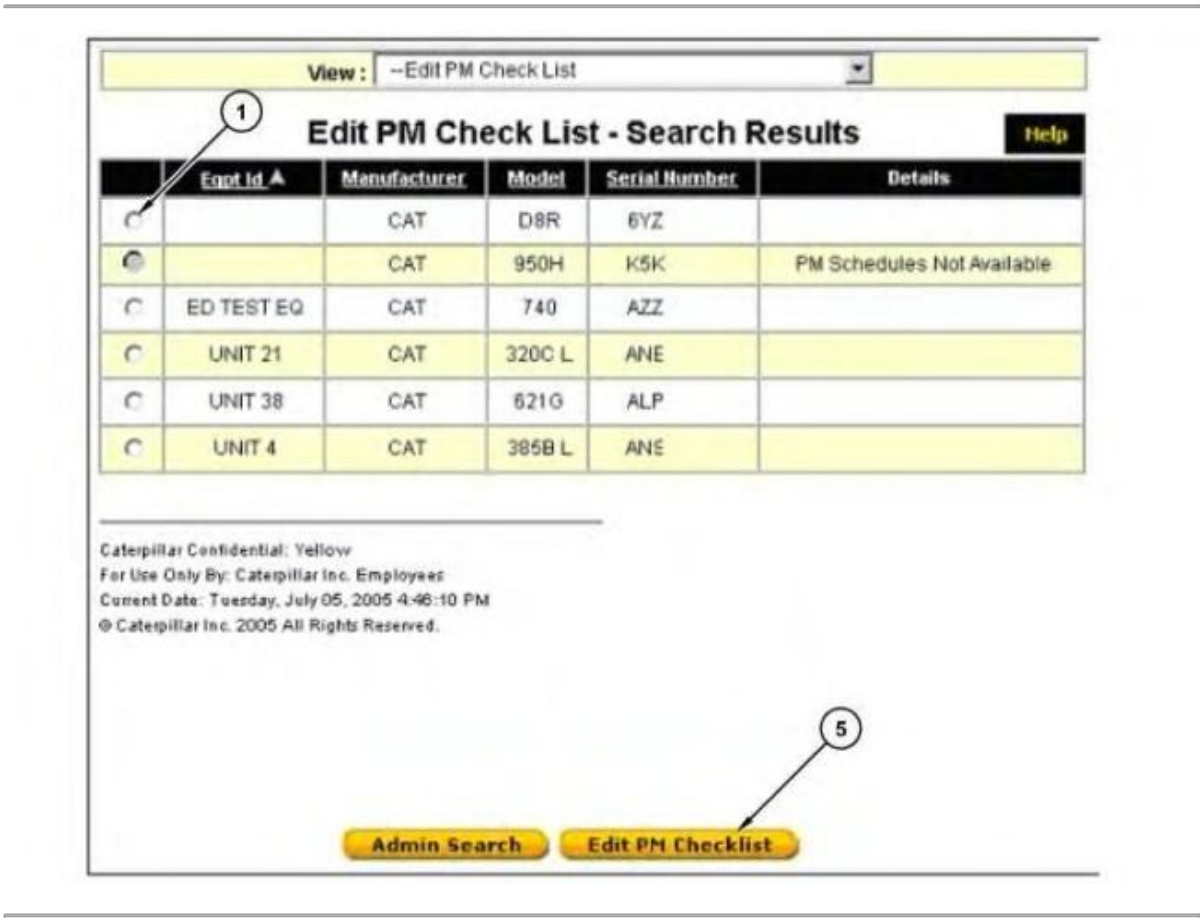


Illustration 7 g01732835

"Edit PM Checklist - Select Results" screen

(1) Radio button

(5) "Edit PM Checklist" button

2. Select the radio button (1) next to the piece of equipment for which you wish to edit a PM Checklist.
3. Click the "Edit PM Checklist" button (5) . The "Edit PM Check List" screen will be displayed.

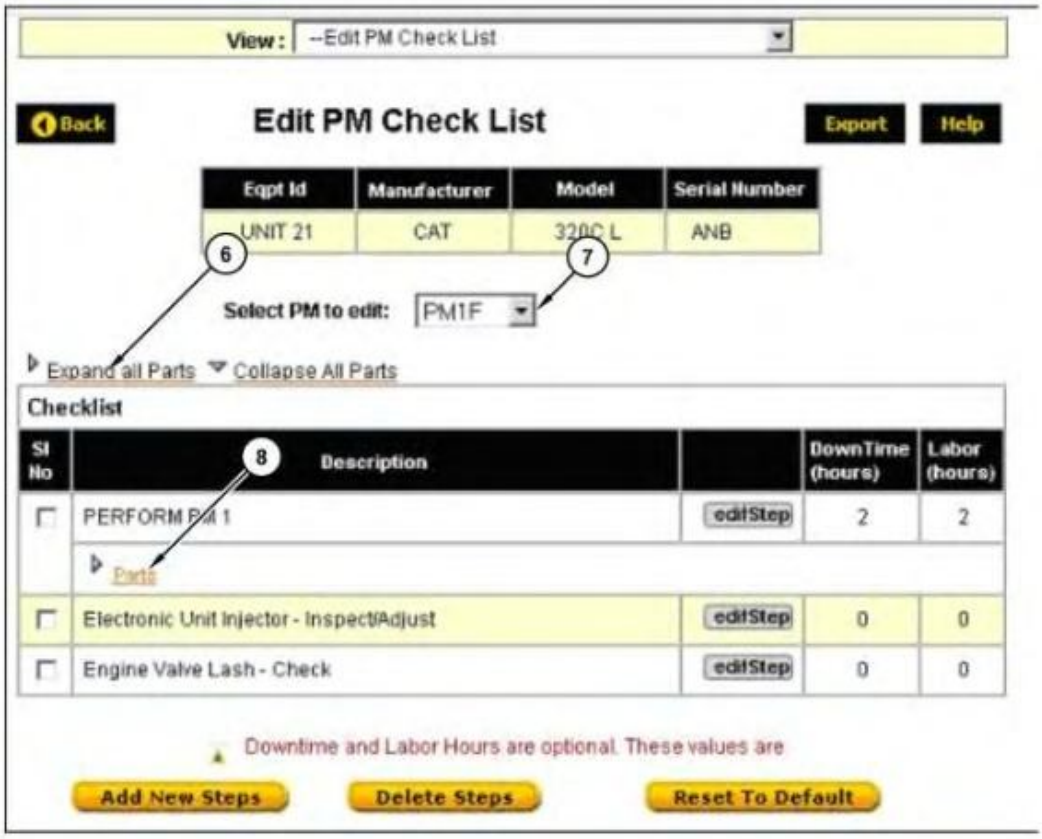


Illustration 8 g01732836

"Edit PM Check List" screen with the "Parts" collapsed

(6) "Expand all Parts" link

(7) "Select PM to edit" drop-down menu

(8) "Parts" link

4. Select the planned maintenance you wish to edit from the "Select PM to edit" drop-down menu (7) .
5. In order to view the parts associated with a step, click the blue triangle icon or the "Parts" link (8) . In order to view all parts in the checklist click the blue triangle icon or the "Expand all Parts" link (6) . The expanded checklist will be displayed.

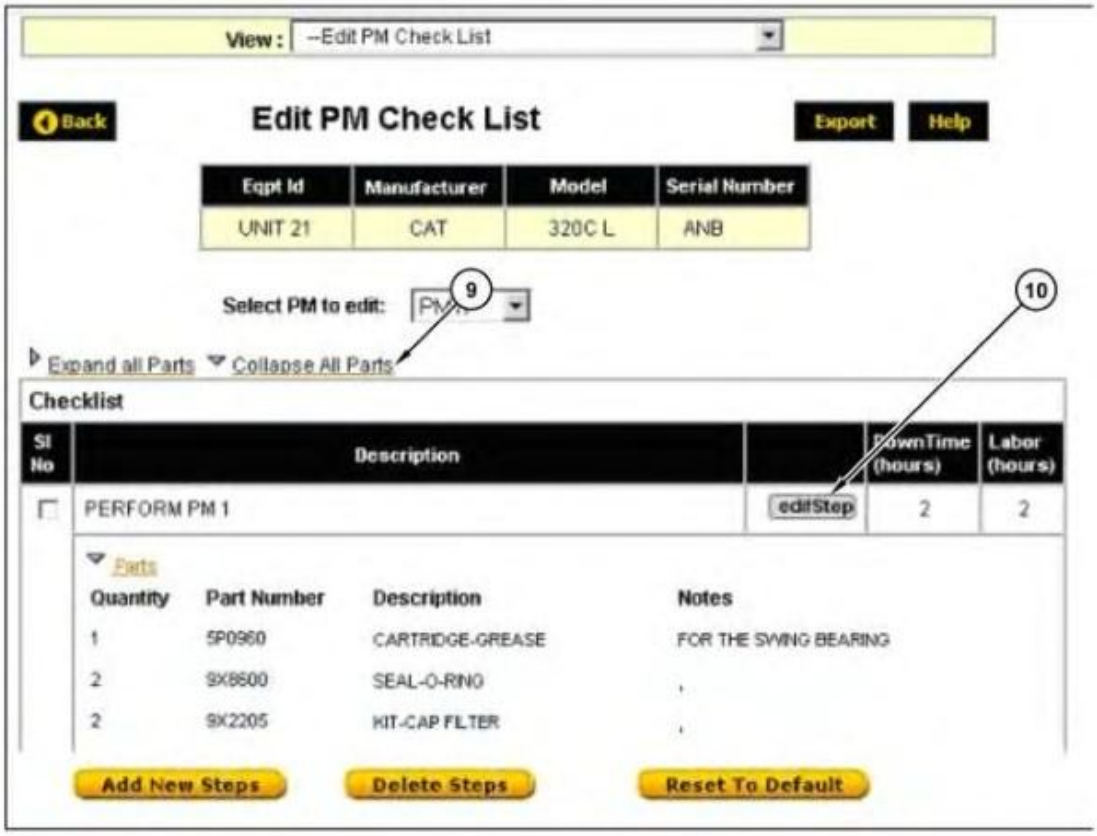


Illustration 9 g01732837

"Edit PM Check List" screen with the "Parts" expanded

(9) " Collapse all Parts"

(10) "editStep" button

6. Click the "editStep" button (10) next to the step that you wish to edit. The "Edit Step" window will be displayed.

   Note: In order to collapse all the parts in the checklist click the blue triangle icon or the " Collapse all Parts" link (9) .



Illustration 10 g01732838

"Edit Step" window

(11) "Description" field

(12) "Additional Parts" button

7. Edit the description of the step in the "Description" field (11) .
8. Edit the number of hours in the "Down Time" text field.
9. Edit the number of hours in the "Labor" text field.
10. If you wish to add a part to the step, click the "Additional Parts" button (12) . A row with part fields will appear below the step description.



Illustration 11 g01250140

"Edit Step" window with additional parts options

11. Enter a quantity in the "Quantity" text field.



Illustration 12 g01250143

"Enter Part Quantity" alert message

Note: If you fail to enter a part quantity, the message in Illustration 12 will appear

12. Enter a part number in the "Part Number" field.
13. Select either the "Solid" or "Fluid" radio button.
14. Enter a description of the part in the "Description" text field.
15. Enter notes in the "Notes" text field.
16. Repeat Steps 9 through 14 until you have added all the desired parts.
17. If you wish to remove a part from the step, select the check box next to the part you wish to delete.
18. Click the blue "Delete Parts" button.
19. Repeat Steps 17 and 18 until you have removed all desired parts.
20. Click the "Save" button. The edited checklist step is saved.

Add New Step to Checklist

In order to add a new step to a checklist, use the following procedure:

1. From the "Edit PM Checklist" screen, click the "Add New Steps" button. Refer to Figure 8. The "Add New Steps" window will be displayed.

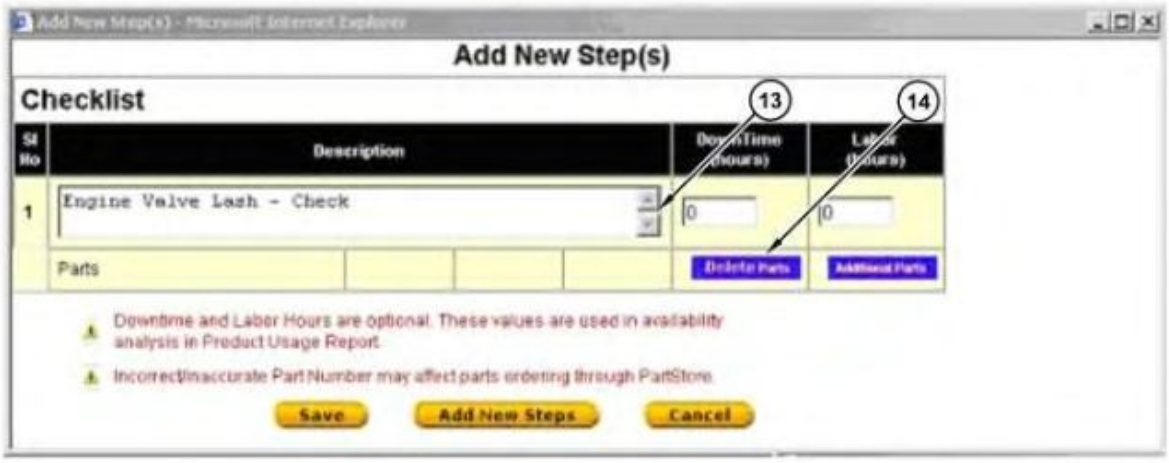


Illustration 13 g01732839

"Add New Step(s)" screen

(13) "Add New Steps" button

(14) "Delete Parts" button

2. Complete the fields on the "Add New Steps" screen. The fields are the same as the fields that are in the "Edit Step" window.
3. If you wish to add more than one step, click the "Add New Steps" button (13) and repeat Step 2.

Note: If you need to delete parts, click the blue "Delete Parts" button (14) .



Illustration 14 g01732840

Attaching a new step to a PM

(15) Check box

(16) "Save" button

4. Once you have added all desired steps and parts, click the "Save" button (16) . The "Higher PM details" window will be displayed.
5. The new steps you added will be added to the planned maintenance that you selected from the drop-down menu, but you can also add these steps to other PMs. Select the check box (15) next to all of the PMs to which you wish to add the new steps.
6. Click the "Save" button. The new steps are added to the planned maintenance.



Illustration 15 g01250153

Confirmation message for no additional PM's being attached

Note: If you did not select any additional PMs to add the step to, the confirmation window in Illustration 15 will appear. Click the "OK" button.

"Customize PM Schedule"

You can customize the interval at which planned maintenances are scheduled. PM schedule intervals can be hour based or date based. You can also apply an offset to the schedule if desired (default is no offset applied). Each interval and its description follows:

"Hour based" - Interval schedule based on hour (SMU) accumulation of the equipment.

"Date based" - Interval schedule based on calendar days.

"Offset" - Next scheduled service calculated from previous service details. If offset is not applied (default), the schedule will ignore previous service details and adhere to fixed" PM Intervals".

Configuring Equipment for Hour Based PM Scheduling

In order to configure equipment for hour based PM scheduling, use the following procedure:

1. From either the "Administration" screen or the "View" drop-down menu, select "Customize PM Schedule".

   If you have equipment already selected, the "Customize PM Schedule - Select Equipment" screen will be displayed.

   If you have not already selected equipment, complete the "Equipment Search" fields and click "Display Equipment" before proceeding to the next step.

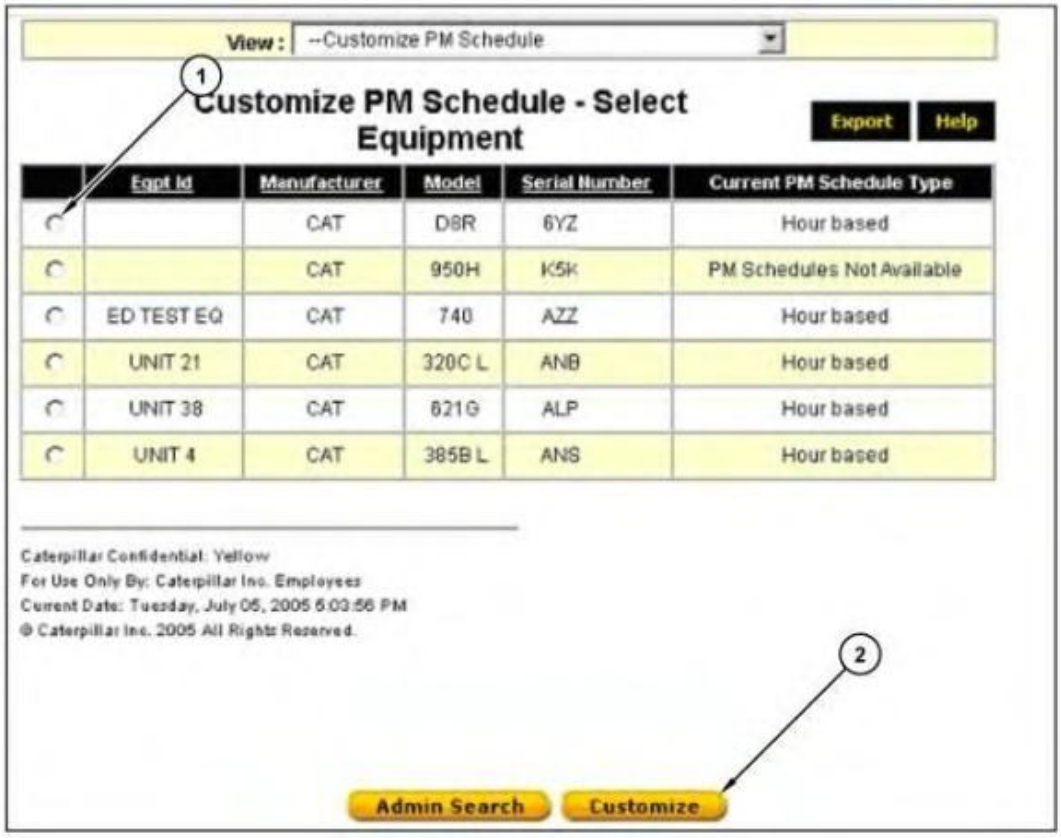


Illustration 16 g01732841

"Customize PM Schedule - Select Equipment"

(1) Radio buttons

(2) "Customize" button

2. Select the radio button (1) next to the piece of equipment you wish to configure for hour based scheduling.
3. Click the "Customize" button (2) . The "Customize PM Schedule" screen will be displayed.

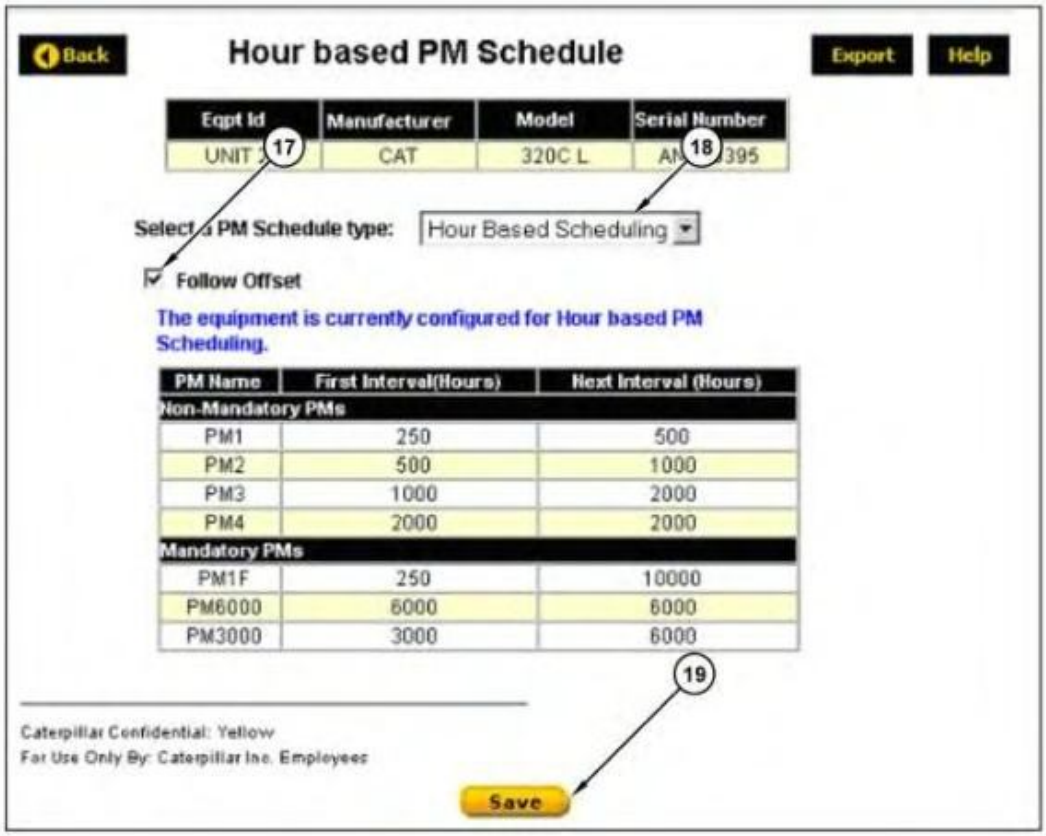


Illustration 17 g01732842

"Hour Based PM Scheduling"

(17) "Follow Offset" check box

(18) "Select a PM Schedule type" drop-down menu

(19) "Save" button

4. If not already selected, select "Hour Based Scheduling" from the "Select a PM Schedule type" drop-down menu (18) .
5. In order for the PM Schedule to follow offset, select the "Follow Offset" check box (17) .

Note: If you select Follow Offset, the next planned maintenance will be scheduled at the interval starting from when the last planned maintenance was performed. For example, if a planned maintenance is scheduled for every 500 SMUs and the first PM is performed after 600 SMUs, the next PM will be scheduled for 1100 SMUs rather than 1000.

If you do not select Follow Offset, the next planned maintenance will be scheduled at a fixed interval. For example, if the PM is scheduled for every 500 SMUs and the first PM is performed after 600 SMUs, the next PM will still be scheduled for 1000 SMUs.

6. Click the "Save" button (19) . The "Hour based PM Schedule Success" screen will be displayed.



Illustration 18 g01732843

"Hour based PM Schedule" configuration successful message

(20) "OK" button

7. Click the "OK" button. The equipment has been configured for hour based PM scheduling.

Configuring Equipment for Date Based PM Scheduling

Date based PM schedules are available for equipment that do not apply to an hour based schedule. One example would be a standby generator set. In order to configure equipment for date based PM Scheduling, use the following procedure:

1. From the "Customize PM Schedule - Select Equipment" screen, select the radio button next to the piece of equipment you wish to configure for date based PM scheduling. Refer to Figure 16.
2. Click the "Customize" button. Refer to Figure 16. The "Customize PM Schedule" screen will be displayed.

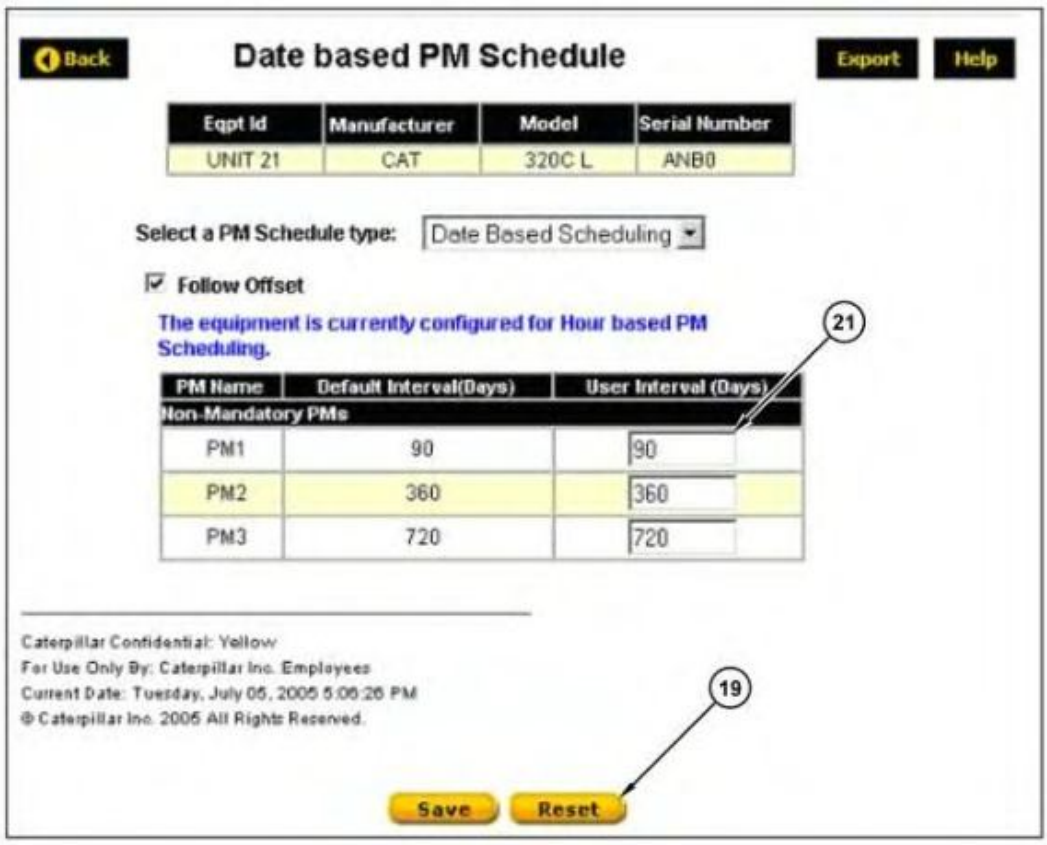


Illustration 19 g01732844

Customizing the "Date based PM Schedule"

(21) "User Interval" text fields

(19) "Save" button

3. If not already selected, select "Date Based Scheduling" from the "Select a PM Schedule type:" drop-down menu.
4. Select whether or not you wish the "PM Schedule" to follow offset or not by selecting or deselecting the "Follow Offset" check box.
5. If you want the scheduling interval to be different than the default interval, enter the number of days in the "User Interval" text fields (21) .

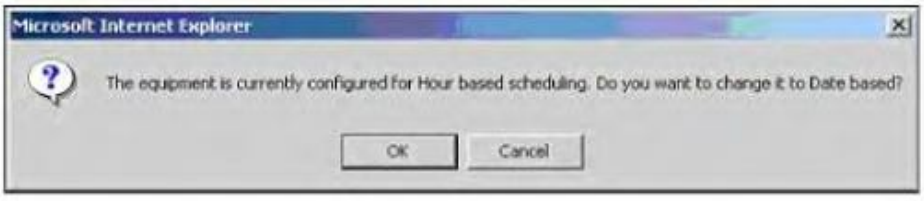


Illustration 20 g01250175

Confirmation message for change "PM Schedule" from hour based to date based

6. Click the "Save" button (19) . If you changed the scheduling type from hour based to date based, the "Date based" confirmation message will appear. If not, skip to Step 8.
7. Click "OK". The "Date based PM Schedule Success" screen will be displayed.



Illustration 21 g01732845

"Date based PM Schedule" configuration successful message

(20) "OK" button

8. Click "OK". The equipment has been successfully configured for date based PM scheduling.

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Media Number -KENR6303-08 **Publication Date -01/05/2010** **Date Updated -18/05/2010**

i03332823

Preferences

SMCS - 7600; 7606

Overview

Each person that uses EquipmentManager to manage equipment may use EquipmentManager in slightly different ways. For this reason, each EquipmentManager user can set the preferences in order to utilize the application more efficiently and effectively. This provides individual levels of customization of the application that will fulfill individual process needs.

"Set Your Preferences"

Complete the following procedure, in order to set your preferences for the first time or change your preferences:

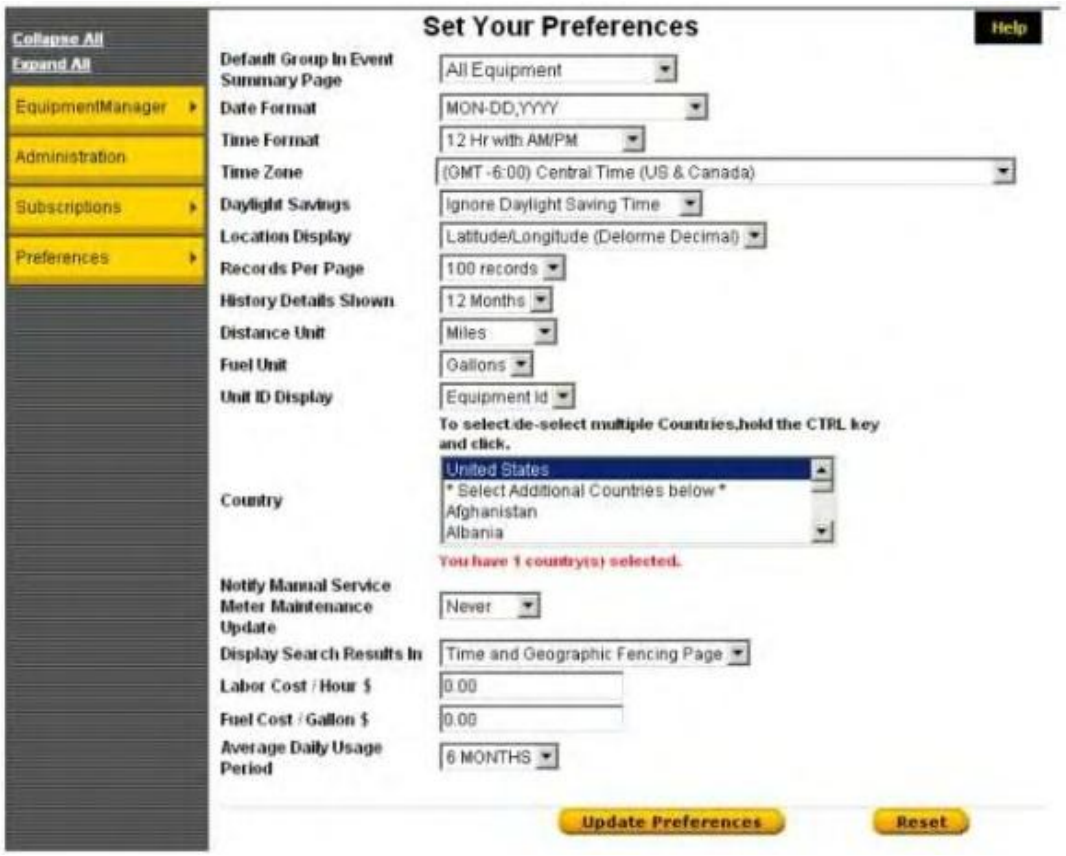


Illustration 1 g01710637

"Set Your Preferences" screen

1. From the left navigation, click the "Preferences" tab. The "Set Your Preferences" screen will be displayed.
2. Set the preferences or edit the preferences by changing values in the drop-down menus, input boxes, and list boxes that appear next to the names of the preference.
3. Click "Update Preferences". The "Confirmation – Set Your Preferences" screen will be displayed.



Illustration 2 g01710636

"Confirmation - Set Your Preferences" screen

4. Click the "OK" button at the very bottom of the screen. Your preferences will be saved and the "Set Your Preferences" screen will be displayed.

Available Preference Values

The following table lists the available values for each of the preferences that appear on the "Set Your Preferences" screen.

Table 1

Name of Preference	Available Values
"Default Group In Event Summary Page"	"All Equipment" (Equipment Groups you created) (Equipment Groups you have been assigned)
"Date Format"	"MM/DD/YYYY " "DD/MM/YYYY" "DD-MON-YY" "DD-MON-YYYY" "MON-DD,YYYY"
"Time Format"	"12 Hr Format" "24 Hour (Military Time)" "12 Hr with AM/PM"
"Time Zone"	(A list of all time zones appears in the drop-down menu)
"Daylight Savings"	"Observe Daylight Savings Time" "Ignore Daylight Savings Time"
"Location Display"	"Nearest City" "Latitude/Longitude (Deg/Min/Sec)" "Latitude/Longitude (Delorme Decimal)"
"Records Per Page"	"10 records" "20 records" "50 records" "100 records"
"History Details Shown"	"3 Months" "6 Months" "9 Months" "1 Year" "2 Years" "3 Years" "5 Years"
"Distance Unit"	"Miles" "Kilometers"
"Fuel Unit"	"Gallons" "Liters"
"Unit ID Display"	"Unit ID" "Equipment ID"
"Country"	(A list of over 240 countries appears in the list box)

"Notify Manual Service Meter Maintenance Update"	"Weekly" "Monthly" "Never" "6 Weeks"
"Display Search Results In"	"Event Summary Results Page" "S· O· S Results Page" "Remote Monitoring Report" "Utilization Monitoring Report" "Planned Maintenance Page" "Fault Code Results Page" "Time and Geographic Fencing Alarms Page" "Location/SMU Page"

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i03323941

Preference Detail

SMCS - 7600; 7606

"Default Group In Event Summary Page"



Illustration 1 g01707378

Setting the preference for the default for "Select a Group"

(1) "Select a Group" drop-down menu

The default preference is "All Equipment" for the "Select a Group" drop-down menu (1). Other options will appear in this drop-down menu only when groups of documents have been created or you have been given access to groups of documents that were created by other users.

If you select a group from the drop-down menu and you update your preferences, from that time forward the value in the "Select a Group" drop-down menu (1) in the "Event Summary" section of the "EquipmentManager Home" screen will default to the group that was selected on the "Set Your Preferences" screen. For example, if the preferences of "DocGrp" was chosen, Illustration 1 is an

example of the "Event Summary" section of the "EquipmentManager Home" screen that will appear after the initial time.

Also, EquipmentManager allows you to manage your equipment by an exception. There are three "Status" levels of events.

Action (red) - The "Action" status indicates an event that is deemed of the highest importance. "Action" events should be given the most attention and "Action" events should be resolved first.

Monitor (yellow) - The "Monitor" status indicates an event that should have attention, but this event does not require immediate resolution.

Normal (green) - The "Normal" status indicates an event that is deemed least important of the actions that require attention or resolution.

"Date Format" and "Time Format" Preferences

The "Date Format" and the "Time Format" that are used to display all dates and times throughout EquipmentManager may be set to your preference.

In the "Time Zone" drop-down menu, the time may be set to the time zone of your dealership, the time zone of the location of your equipment, or any other time zone.

In the "Time Format" drop-down menu, the time may be viewed with the following options: "12 Hr Format", "12 Hr with AM/PM" and "24 Hour (Military Time)".

In the "Daylight Savings" drop-down menu, the daylight savings time may be chosen.

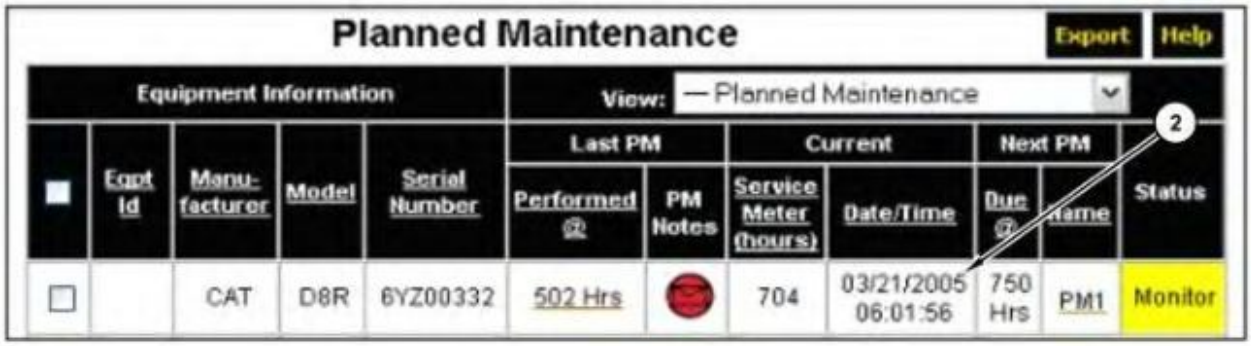


Illustration 2 g01708096

Example of the "Date Format" and the "Time Format"

(2) "Date/Time"

The "Planned Maintenance" screen is an example that displays "Date/Time" (2) within EquipmentManager. Refer to Illustration 2.

"Location Display"

EquipmentManager uses GPS to determine the location (3) of your equipment. On the "Set Your Preferences" screen, you can choose to display the location in any one of the following three formats:

- "Nearest City"

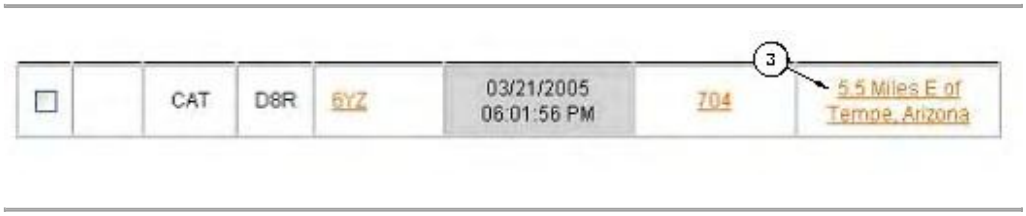


Illustration 3 g01708145

Format for the "Nearest City"

(3) Location

- "Latitude/Longitude (Deg/Min/Sec)"

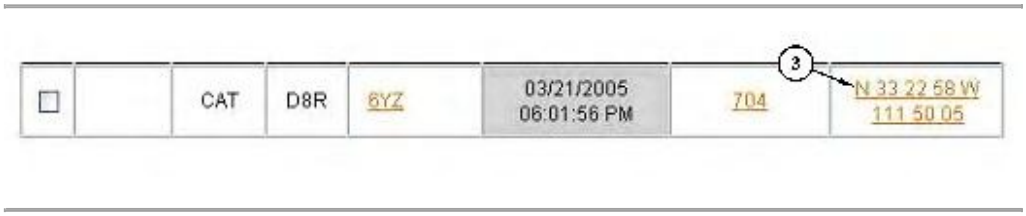


Illustration 4 g01708146

Format for the "Latitude/Longitude (Deg/Min/Sec)"

(3) Location

- "Latitude/Longitude (DeLorme Decimal)"

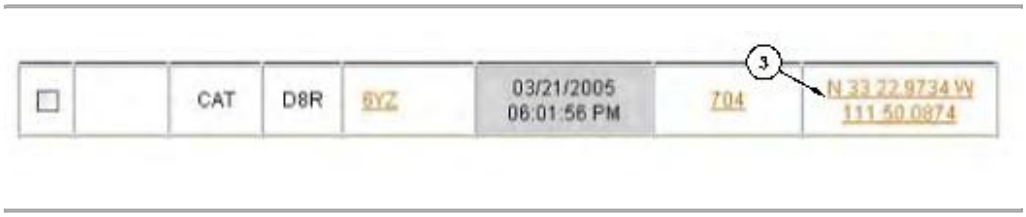


Illustration 5 g01708147

Format for the" Latitude/Longitude (DeLorme Decimal)"

(3) Location

"Records Per Page"

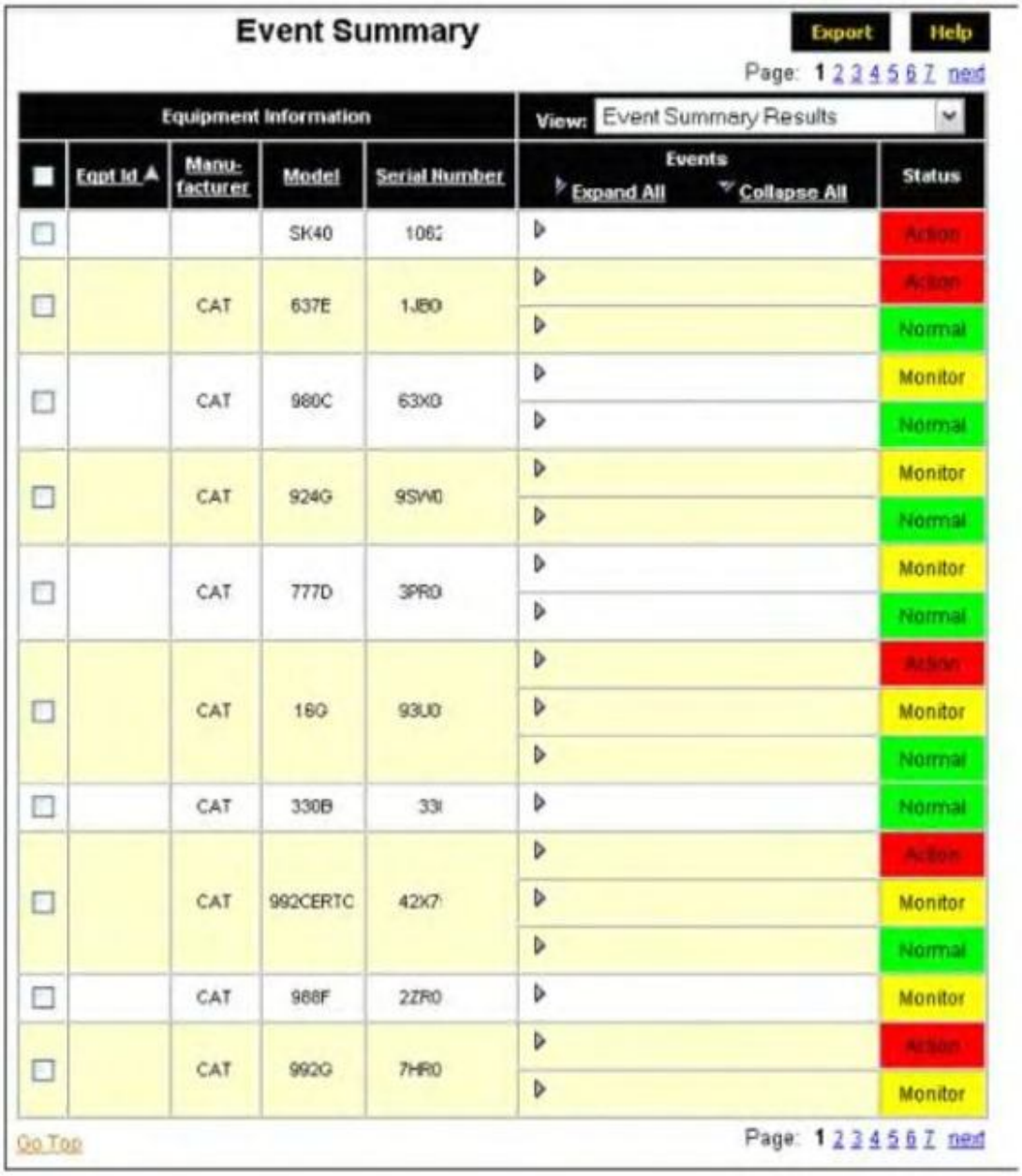


Illustration 6 g01708149

The preference of 10 records for the records per page

The number of records that are displayed per page may be set for the list of information of the equipment that is returned from EquipmentManager. Illustration 6 indicates an "Event Summary" list with 68 machines that have been divided into 10 results per page. If the same list was divided into 50 records per page, there would be only two pages instead of seven pages.

"History Details Shown"



Illustration 7 g01708734

"History Details Shown" preference

(4) "Start Date"

(5) "End Date"

When the page for the "Repair & Maintenance History" of a machine is being viewed, a "Start Date" (4) and an "End Date" (5) may be entered in order to indicate the span of history for viewing. By setting a "History Details Shown" preference, you are setting the default values that will appear in the "Start Date" and "End Date" fields. For example, if you set a "History Details Shown" preference of three months, the "End Date" field will default to the current date and the "Start Date" will default to a date that is exactly three months prior to the current date.

Units

There are two types of preferences for units that can be set:

- "Distance Unit"
- "Fuel Unit"

The first type of preference is the "Distance Unit".

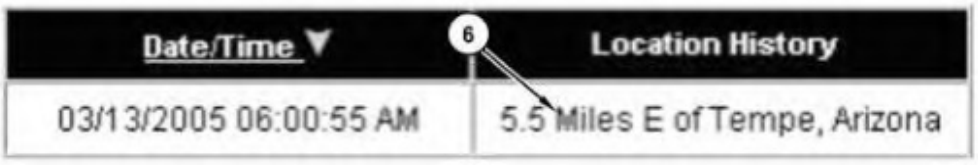


Illustration 8 g01708151

"Distance Unit" preference

(6) "Miles"

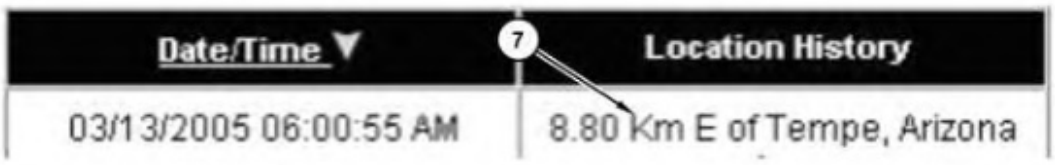


Illustration 9 g01708152

"Distance Unit" preference

(7) "Kilometers"

You may select either "Miles" (6) or "Kilometers" (7) .

The second type of preference that can be set is the "Fuel Unit".

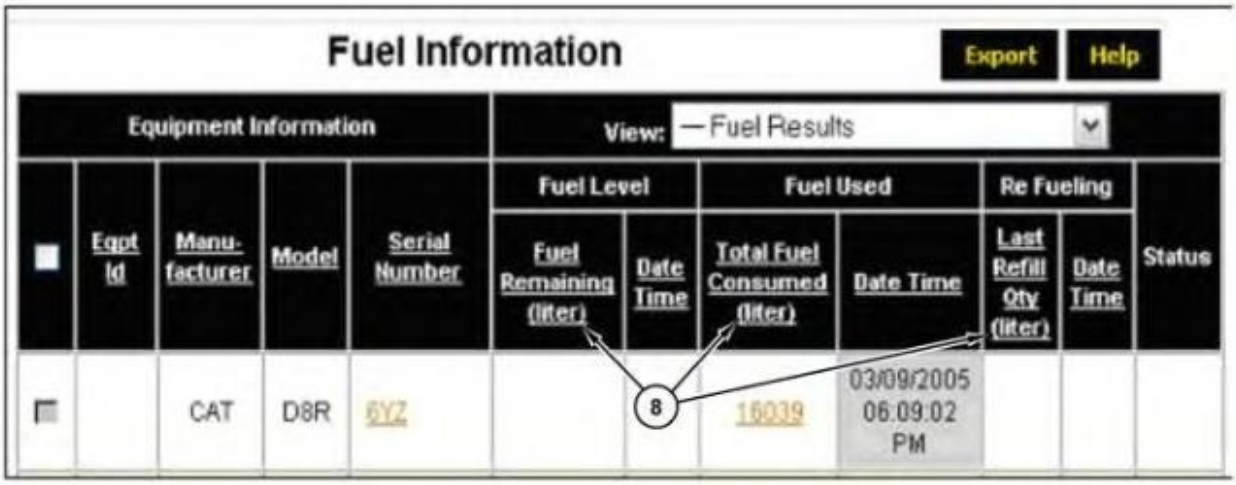


Illustration 10 g01708153

"Fuel Units" preference

(8) Liters

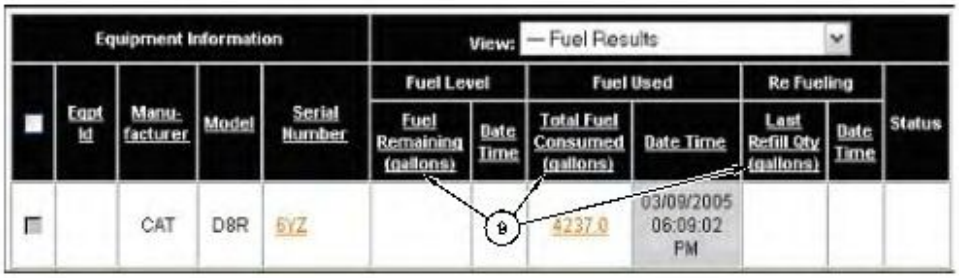


Illustration 11 g01708154

"Fuel Unit" preference

(9) Gallons

You may select either "Liters" (8) or "Gallons" (9) .

Country

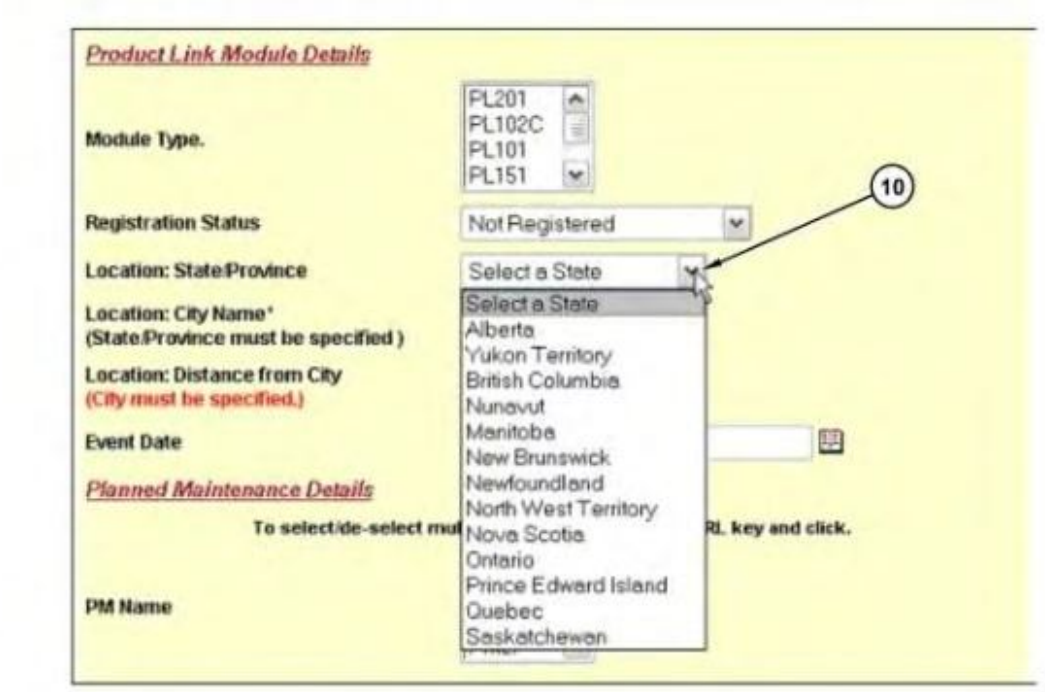


Illustration 12 g01708155

"Product Link Module Details" section of the "Advanced Search" screen

(10) "Location: State/Province" drop-down menu

From the "Set Your Preferences" screen in the "Country" drop-down menu, a country or multiple countries may be selected. The preference for the country or countries will determine the states or provinces that will appear in the "Location: State/Province" drop-down menu (10) on the "Advanced Search" screen. For example, if the preference for a country is set to "Canada", the "Location: State/Province" field will be filled with the Canadian provinces on the "Advanced Search" screen. Refer to Illustration 12.

"Notify Manual Service Meter Maintenance Update"

EquipmentManager can be used to manage "Planned Maintenance" on equipment that does not contain a Product Link Module (PLM). In this case, the dealer or the customer subscribes to Maintenance Watch. With Maintenance Watch and no PLM on the equipment, you must enter the "Service Meter Update" manually. From the "Set Your Preferences" screen in the "Notify Manual Service Meter Maintenance Update" drop-down menu, you may indicate the frequency of notification

from EquipmentManager. This frequency will be used for the entry of data of service meter units for equipment with Maintenance Watch subscriptions. The following values are available: "Weekly", "Monthly", "6 Weeks" and "Never".



Illustration 13 g01708156

The "Planned Maintenance" screen with "Load SMU"

(11) "Load SMU" link

Illustration 13 above displays the "Planned Maintenance" screen for a piece of equipment that has no PLM and a Maintenance Watch subscription. Notice that "Load SMU" link (11) is present in the "Current" column. In order to update the SMU manually, select this link. After clicking this link, the "Manual Maintenance – Service Meter Update" window will be displayed.



Illustration 14 g01708158

"SMU Update" window

(12) Radio buttons

In the "SMU Update" window, the frequency of notification for updating the service meter units can be changed by selecting one of the radio button (12) .

"Display Search Results In"

When you perform a search for EquipmentManager data about a given set of equipment, the display of the results for the search default to the "Event Summary Results Page". By using the "Set Your Preferences" screen, you may change the page of the results from the search that are first displayed. For example, if you use EquipmentManager most often to check the location of your equipment, you can change your "Display Search Results In" preference to "Location/SMU Page". Then, when you perform the next search, the results will be displayed first in "Location/SMU Page".

The following values for the "Display Search Results In" preferences are available:

- "Event Summary Results Page"
- "S·O·S Results Page"
- "Remote Monitoring Report"
- "Utilization Monitoring Report"

- "Planned Maintenance Page"
- "Fault Code Results Page"
- "Time and Geographic Fencing Alarms Page"
- "Location/SMU Page"

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Asset Watch

SMCS - 7600; 7606

Overview

The Asset Watch subscription is used for monitoring and managing the usage and the location of your equipment.

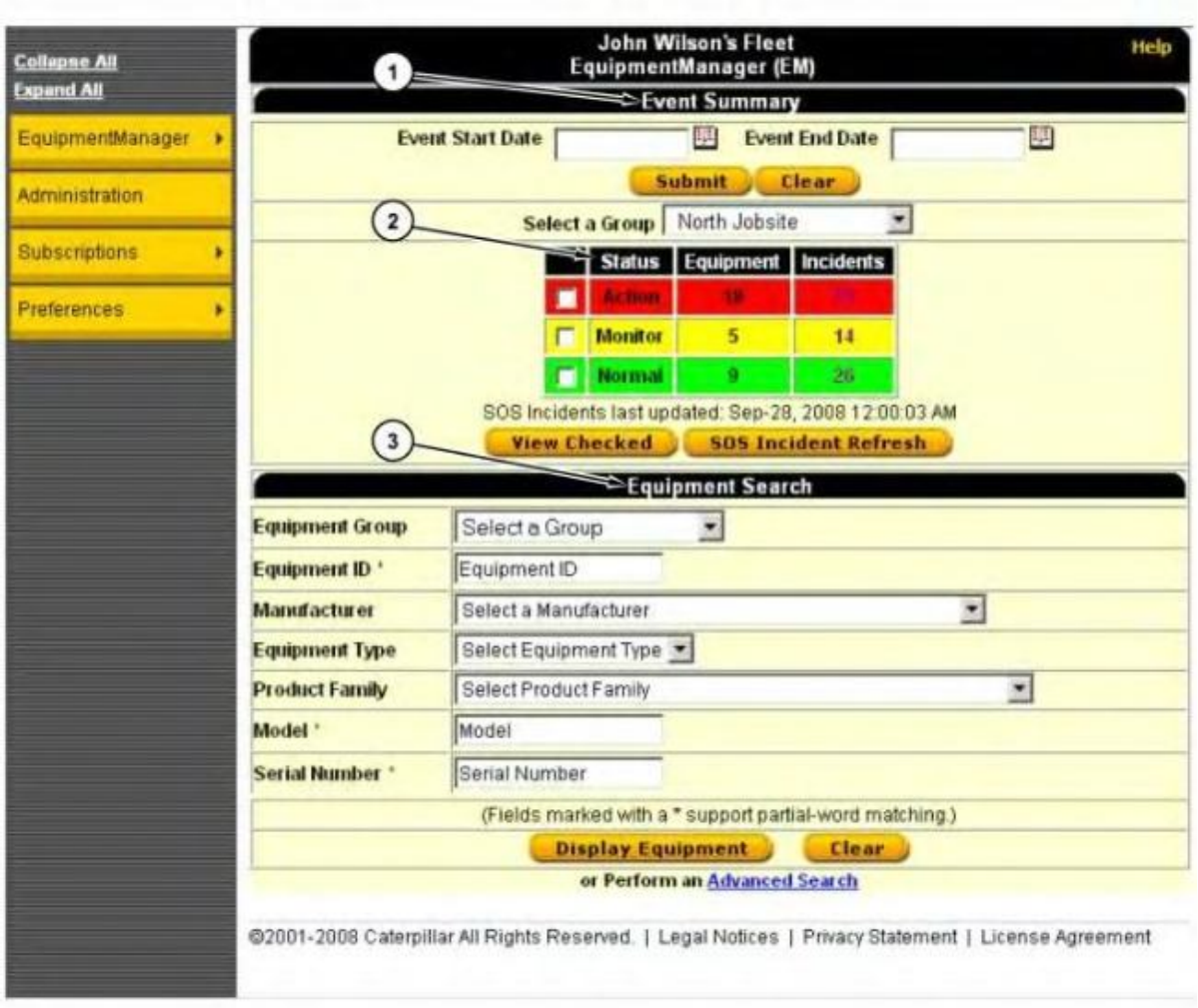


Illustration 1 g01710930

"Exception Dashboard"

(1) "Event Summary" section

(2) "Status" levels

(3) "Equipment Search" section

The default home screen of EquipmentManager is known as the "Exception Dashboard". Refer to Illustration 1. This screen features the following two sections:

- "Event Summary" section (1)
- "Equipment Search" section (3)

"Event Summary"

EquipmentManager allows you to manage your equipment by an exception. There are three "Status" levels (2) of events:

Action (red) - The "Action" status indicates an event that is deemed of the highest importance. "Action" events should be given the most attention and "Action" events should be resolved first.

Monitor (yellow) - The "Monitor" status indicates an event that should have attention, but this event does not require immediate resolution.

Normal (green) - The "Normal" status indicates an event that is deemed of the least importance of the actions that require attention or resolution.

Search Using "Event Summary"

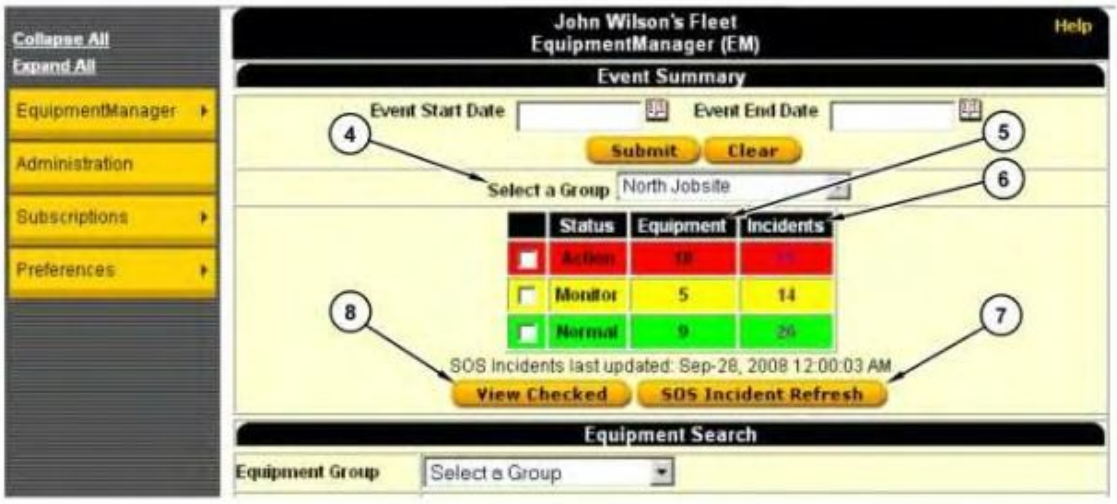


Illustration 2 g01710926

"Event Summary" search with popup text

(4) "Select a Group" drop-down menu

(5) "Equipment" column

(6) "Incidents" column

(7) "S·O·S Incident Refresh" button

(8) "View Checked" button

Perform the following procedure in order to use "Event Summary" section (1) to search for issues and view issues that need to be resolved:

1. Select a group of equipment from the "Select a Group" drop-down menu (4) or select a customer from the "Universal Customer ID" drop-down menu. Once a selection has been made, the "Equipment" column (5) and the "Incidents" column (6) for each "Status" level will be filled with the number of machines and incidents that are outstanding. Refer to Illustration 2.

2. Point to any of the "Incidents" fields for more information of the events that are outstanding and for a count for each level. For example, when you point to the number of incidents in the "Incidents" column (6) , a boxof text will be displayed with a breakdown of the events by category and by quantity.

3. In order to view the detail of the machines with outstanding events, select the check box next to the "Status" level or "Status" levels. Any of the check boxes or all of the check boxes can be selected. Then, click "View Checked" button (8) in order to display results. Results appear on the "Event Summary" screen. Refer to ""Event Summary" Screen" for more information.

   Note: In order to perform a refresh of the S·O·S alerts, press the "S·O·S Incident Refresh" button (7) .

Search Using "Equipment Search"



Illustration 3 g01341562

"Equipment Search"

The lower section of the default EquipmentManager home screen is the "Equipment Search" section (3) . This provides another way to narrow the search of the equipment. This is the same "Equipment Search" form that is used throughout EquipmentManager. Complete at least one of the fields on the form and click "Display Equipment".

"Event Summary" Screen

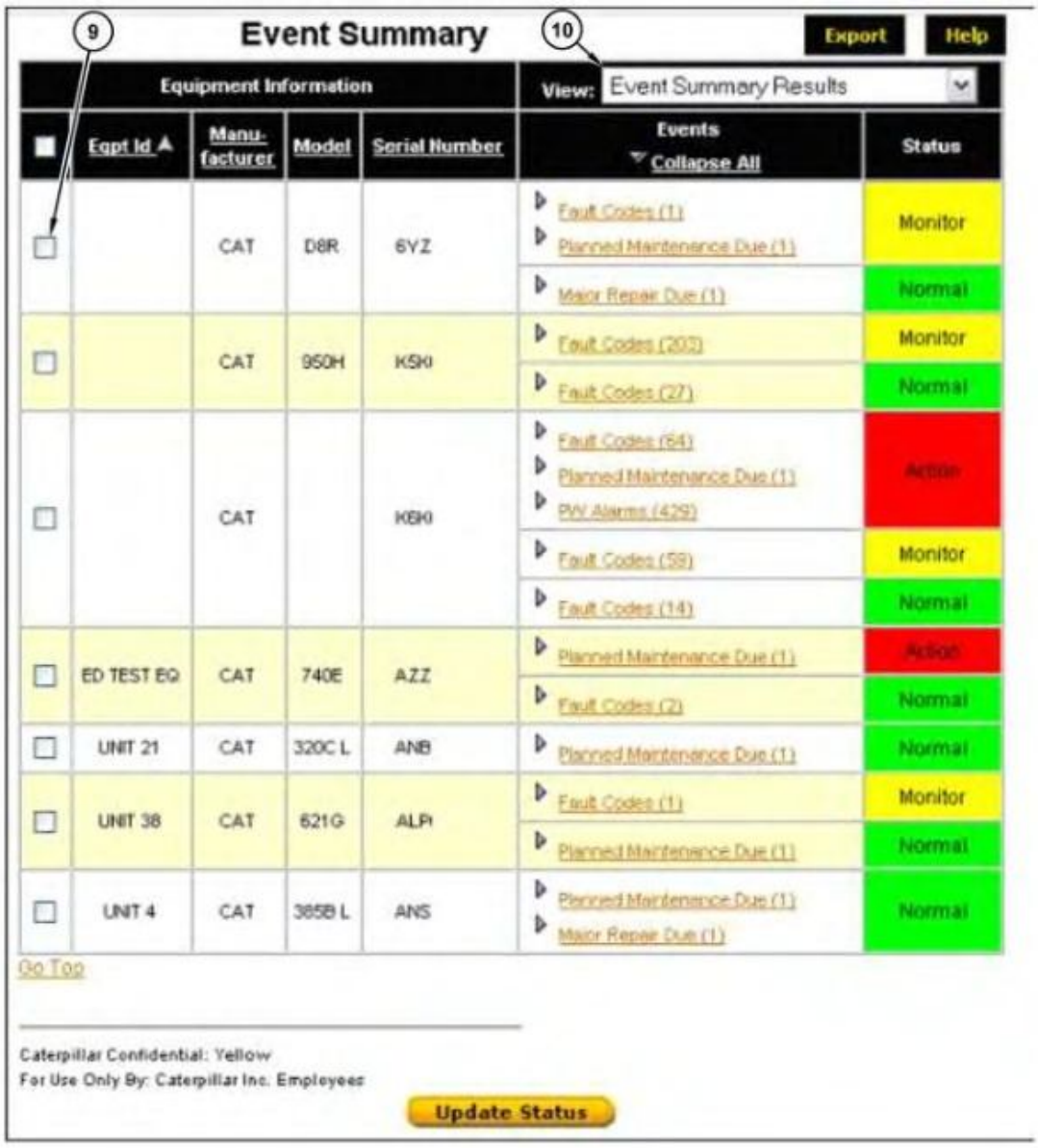


Illustration 4 g01710932

"Event Summary"

(9) Check boxes for the equipment

(10) "View:" drop-down menu

When you perform a search for EquipmentManager data about a given set of equipment, the display of the results default to the "Event Summary" screen. The "Event Summary" table contains the following columns: "Eqpt Id" ("Equipment Id"), "Manufacturer", "Model", "Serial Number", "Events" and "Status".

If a machine has multiple events of the same category, the information can be expanded by clicking the icon that is a blue triangle. This icon will show a brief description of each of the events in that category.

Clicking on the hyperlink of the name of the event will move you to the appropriate detailed screen in EquipmentManager. This screen may be an "Event History" screen, a "Planned Maintenance" screen, a "S·O·S" screen, or another screen.

Select the check box for the equipment (9) in order to update the status. Then, select the "Update Status" button.

Change the view of the results by selecting a option from the "View:" drop-down menu (10) .

Location and Service Meters

On the"Event Summary" screen, select "Location and Service Meters" from the "View" drop-down menu (10) . The "Location and Service Meters" screen will be displayed.

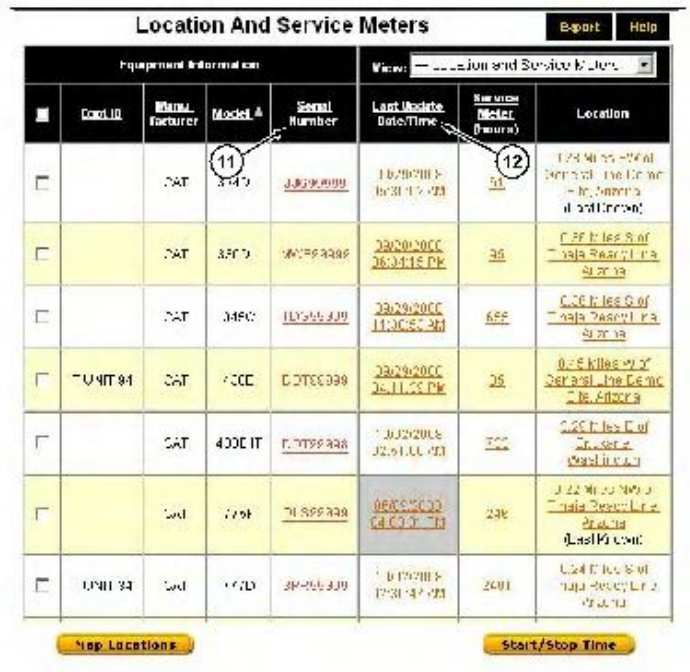


Illustration 5 g01710935

Location and Service Meters

(11) "Serial Number" column

(12) "Last Update Date/Time" column

The links in the "Serial Number" column (11) are linked to the "Equipment Details" screen and the links in the "Last Update Date/Time" column (12) are linked to the "Status History" screen.

"Status History"

The "Status History" is a record of all the status reports that were sent by a Product Link ModulePLM. The "Status" report contains the information about the status of the actual PLM.

To view the "Status History" screen, use the following procedure:

1. From the "Location and Service Meters" screen, click the date of one of the pieces of equipment in the "Last Update Date/Time" column. The "Status History" screen will be displayed.

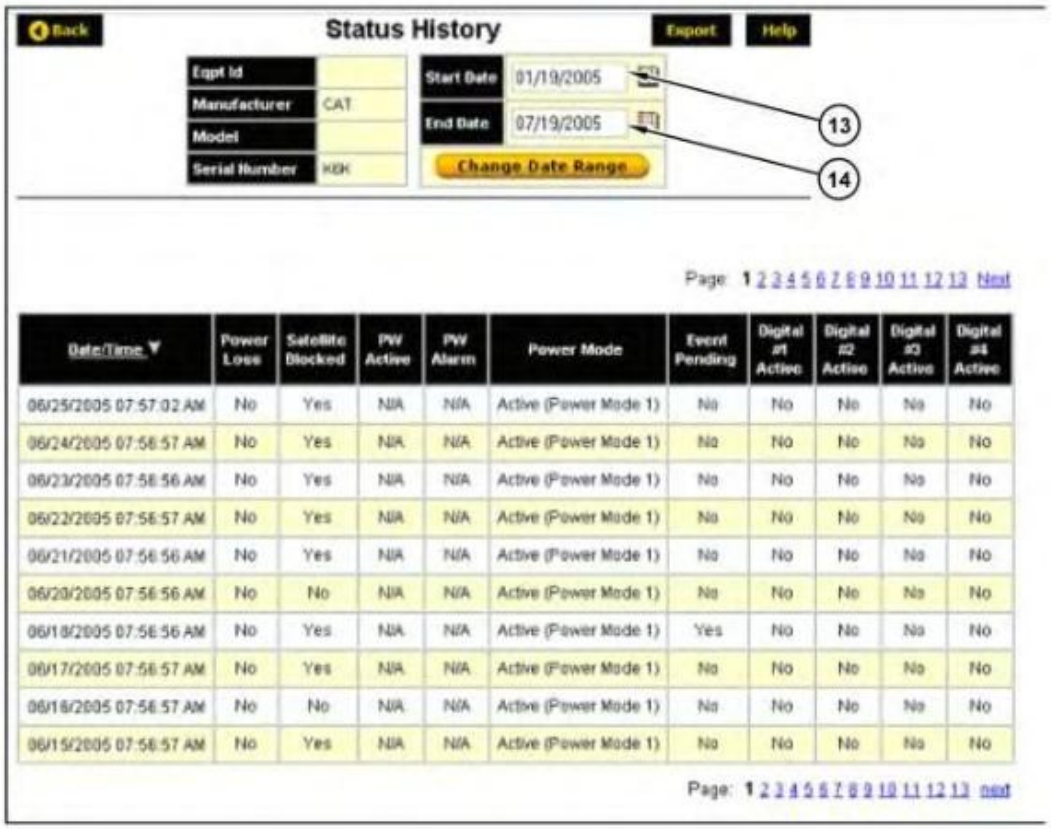


Illustration 6 g01710937

"Status History"

(13) "Start Date" field

(14) "End Date" field

2. The range of the date is set by your preferences. In order to temporarily change the range of the date, click the icon of a calendar that is next to the "Start Date" field (13) and "End Date" field (14) . Then, select a date for indicating a time period for the "Status History".

3. Click the "Change Date Range" button. The "Status History" table will perform a refresh in order to reflect the updated range of the date.

4. Click the "Back" button in order to return to the "Location and Service Meters" screen.

The following table describes the fields that are found on the "Status History" screen.

Table 1

"Status History" screen

Field	Description	Values
"Date/Time"	The date and time of the status report are displayed if the PLM is set to send status once per day. These values should be different by approximately one day for each time.	
"Power Loss" (Low Voltage)	Indicates that the PLM experienced a loss of power or low voltage somewhere between this status report and the last status report.	Yes, No
"Satellite Blocked"	Indicates that the PLM was blocked from the satellite sometime between this status report and the last status report.	Yes, No
"PW Active"	Indicates that "Time and Geographic Fencing" is active.	Yes, No, N/A
"PW Alarms"	Indicates that a "PW Alarm" has occurred sometime between this status report and the last.	Yes, No, N/A
"Power Mode"	Indicates the "Power Mode" of the PLM. Power mode has the following "Status" levels:	
	"Active" (1) – The machine has operated in the last 48 hours.	Active (1)
	"Sleep" (2) – The machine has not operated for greater than 48 hours but less than one week. The PLM will activate every 6 hours in order to send the messages every 6 hours. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Sleep (2)
	"Hibernate" (3) – The machine has not operated for more than one week. The PLM will wake up every 24 hours to send and receive messages. Position messages will only be sent if the unit has changed position by greater than 200 meters.	Hibernate (3)
"Event Pending"	Indicates that an event was recorded and will be sent (PL321 system only).	Yes, No
"Digital # Active"	Indicates that the digital switch is active (PL321 system only).	Yes, No

"Service Meter History"

Use the following procedure in order to view the "Service Meter History":

1. In order to view the "Service Meter History" for a machine, select a service meter reading for a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen.

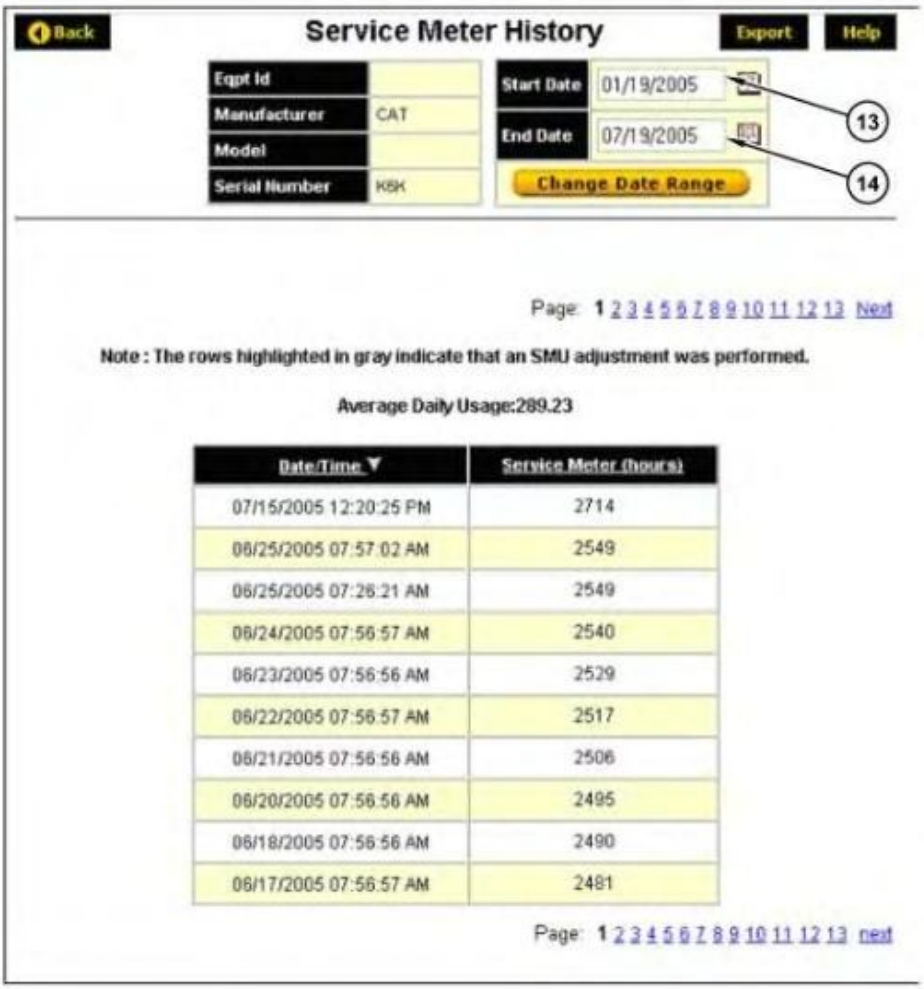


Illustration 7 g01710941

"Service Meter History"

(13) "Start Date" field

(14) "End Date" field

2. Change the range of the date, if necessary. Click "Back" in order to return to the "Location and Service Meters" screen.

"Location History"

Use the following procedure to view the "Location History" of a machine.

1. In order to view the "Location History" for a machine, select the location of a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen.

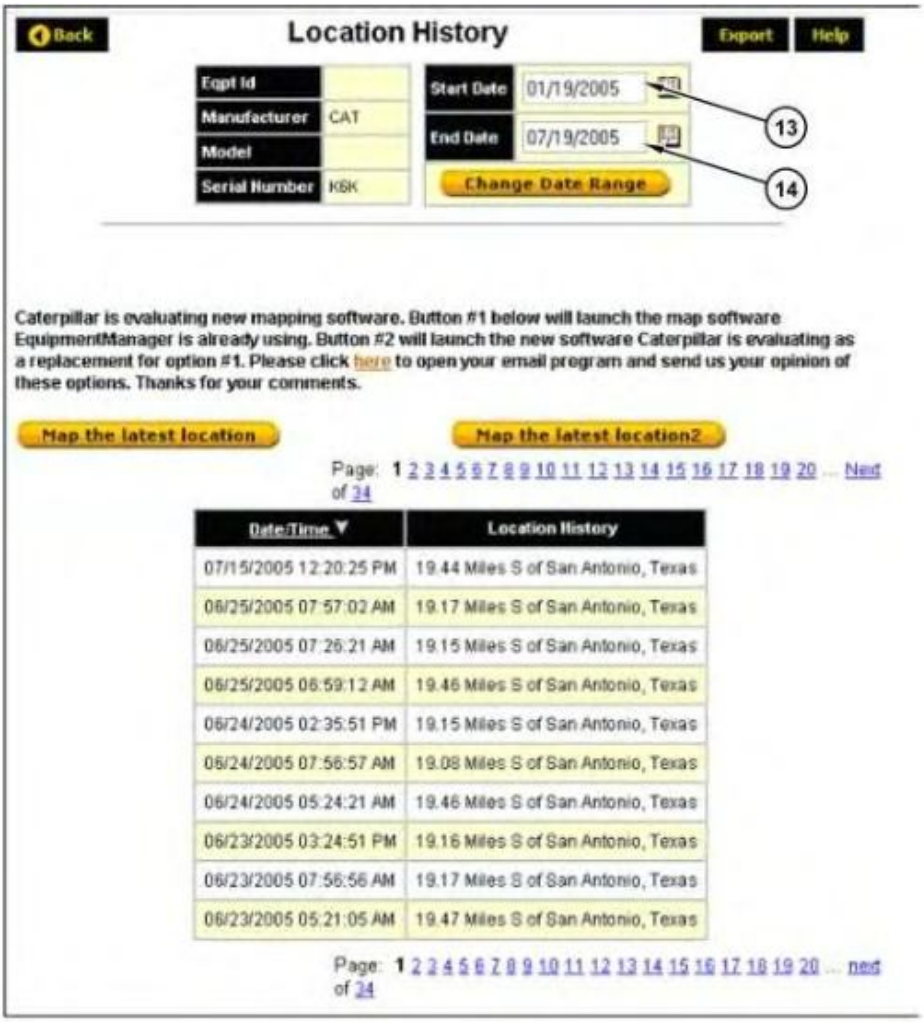


Illustration 8 g01710944

"Location History"

(13) "Start Date" field

(14) "End Date" field

2. The "Location History" screen will appear. Change the range of the date, if necessary. Click "Back" in order to return to the "Location and Service Meter" screen.

"Location Report Frequency"

Product Link is configured to a maximum of four reports of the location per day. The first location report is sent at the Report Start Time. The Position Report Minimum Location Change configuration defines the minimum distance the machine must move since the last report in order for a position report to be sent. If the minimum configured distance has not been met, Product Link will not send a position report. The minimum distance that is permitted is zero meters and the maximum distance is 200 meters. If the parameter is set to zero meters, then the PLM will send a position report 4 times a day regardless of movement. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Manage Hardware", and to Special Instruction, REHS2365, "Product Link PL121SRPL121SR and PL300PL300 Installation Guide".

Last Known Location

If a valid location from the GPS is not obtained in the given time, the last known location will be displayed in EquipmentManager. This "stale" location will be identified with "(Last Known)" in the "Location and Service Meter" view. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Installation Parameters Conifgure" for more information about the GPS Fix Validity Time Duration parameter.

"Map Locations"

There are two options for creating the map of the location of your machine. The machine can be plotted on a map from either the "Location and Service Meters" screen or from the "Location History" screen.

1. In order to view the location of a machine on the map from the "Location and Service Meters" screen that is in the "Equipment Information" section, select the check box next to the machine. Refer to Illustration 5.

2. Click the "Map Locations" button. The "Equipment Location Map" screen will be displayed.



Illustration 9 g01710946

"Equipment Location Map"

(15) Marker for the equipment

3. The location of the machine is plotted on a map with identification of a landmark and a city street. Use the "Zoom In" and "Zoom Out" buttons to change your view of the map. Click near the marker of the equipment (15) that is being viewed in order to center the marker in the window of the map. When you are done, click the "Back" button in the upper left hand corner in order to return to the "Location and Service Meters" screen.

Note: The information of the location will be displayed per user preference. The display for the "Nearest City" will show the location of a machine relative to public landmarks or city centers. The location can also be displayed with the latitude and the longitude. These coordinates can be entered into routing software in order to provide driving directions.

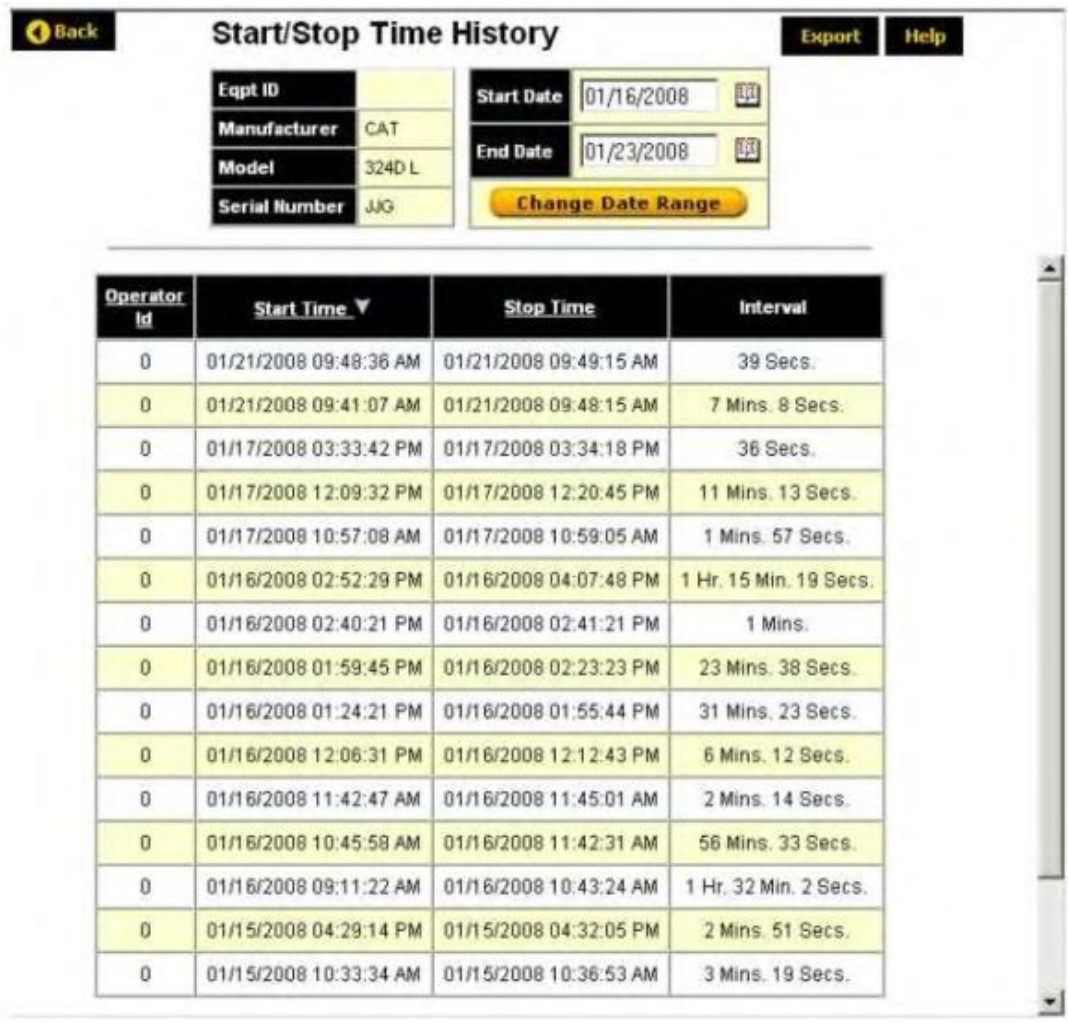
The other way to create the map of the location is from the "Location History" screen.

1. In order to view the "Location History" for a machine, select the location of a machine from the "Service Meter (hours)" column on the "Location and Service Meters" screen. Refer to Illustration 5. The "Location History" screen will be displayed. Refer to Illustration 8.

2. Click the "Map the latest location" button. The "Equipment Location Map" screen will be displayed. Refer to Illustration 9.

Note: Click "Map the latest location" button in order to start the EquipmentManager software for maps that is being used currently. Click "Map the latest location 2" in order to start the new software that is being considered by Caterpillar as a replacement to option 1. Click on the "here" link in order to send your comments to Caterpillar about the mapping software.

"Start/Stop Time History"



Operator Id	Start Time ▼	Stop Time	Interval
0	01/21/2008 09:48:36 AM	01/21/2008 09:49:15 AM	39 Secs.
0	01/21/2008 09:41:07 AM	01/21/2008 09:48:15 AM	7 Mins. 8 Secs.
0	01/17/2008 03:33:42 PM	01/17/2008 03:34:18 PM	36 Secs.
0	01/17/2008 12:09:32 PM	01/17/2008 12:20:45 PM	11 Mins. 13 Secs.
0	01/17/2008 10:57:08 AM	01/17/2008 10:59:05 AM	1 Mins. 57 Secs.
0	01/16/2008 02:52:29 PM	01/16/2008 04:07:48 PM	1 Hr. 15 Min. 19 Secs.
0	01/16/2008 02:40:21 PM	01/16/2008 02:41:21 PM	1 Mins.
0	01/16/2008 01:59:45 PM	01/16/2008 02:23:23 PM	23 Mins. 38 Secs.
0	01/16/2008 01:24:21 PM	01/16/2008 01:55:44 PM	31 Mins. 23 Secs.
0	01/16/2008 12:06:31 PM	01/16/2008 12:12:43 PM	6 Mins. 12 Secs.
0	01/16/2008 11:42:47 AM	01/16/2008 11:45:01 AM	2 Mins. 14 Secs.
0	01/16/2008 10:45:58 AM	01/16/2008 11:42:31 AM	56 Mins. 33 Secs.
0	01/16/2008 09:11:22 AM	01/16/2008 10:43:24 AM	1 Hr. 32 Min. 2 Secs.
0	01/15/2008 04:29:14 PM	01/15/2008 04:32:05 PM	2 Mins. 51 Secs.
0	01/15/2008 10:33:34 AM	01/15/2008 10:36:53 AM	3 Mins. 19 Secs.

Illustration 10 g01458443

"Start/Stop Time History" is available if the PLM is configured to record the history. "Start Time" and "Stop Time" details are available when the equipment "Serial Number" will be displayed in bold print.

1. In order to view the "Start/Stop Time History" screen for a machine, select the check box next to the machine. Refer to Illustration 10.

2. Click the "Start/Stop Time" button. The "Start/Stop Time History" screen will be displayed.

   Note: If Machine Security System is installed, the "Key ID" will be displayed in the "Operator Id" column in EquipmentManager.

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i02943044

Time Fence and Geographic Fence

SMCS - 7600; 7606

Types of Fences

During normal working conditions, machines can move in and out of yards. Machines can also move to different job sites. A machine will not normally travel beyond a designated work area. The EquipmentManager software will record the location of a machine as history, unless the machine travels beyond the normal work area.

The EquipmentManager software uses time fencing and geographic fencing to trigger some action if a machine travels beyond a designated work area. Time fencing and geographic fencing use inclusive geographic functions, exclusive geographic functions, and functions that are based on time.

Inclusive Geographic Fencing

By applying an inclusive geographic fence to your equipment, any movement of the equipment beyond a predetermined geographical boundary can trigger an alarm. The alarm will indicate when a machine moves beyond a predetermined geographical area.

Exclusive Geographic Fencing

By applying an exclusive geographic fence to your equipment, any movement of the equipment within a predetermined geographical boundary can trigger an alarm. The alarm will indicate that the equipment is inside of a predetermined geographical area.

Time Fencing

By applying a time fence to your equipment, any operation of the equipment beyond a predetermined period of time can trigger an alarm. The alarm will indicate that the equipment is operating beyond a predetermined period of time.

"Time and Geographic Fencing" Screen

Access the "Time and Geographic Fencing" Screen

Use the following procedure to access the "Time and Geographic Fencing" configuration screen.

1. Search for equipment and view the results in the "Event Summary" screen.

2. In the "View" box, select "Time and Geographic Fencing". The "Time and Geographic Fencing" screenwill appear.



Illustration 1 g01397849

View "Time and Geo. Fence Alarm History"

To view a history of time fencing and geographic fencing alarms for a machine, use the following procedure:

1. Access the "Time and Geographic Fencing" screen.
2. View the "Latest Time and Geo. Fence Alarms" column. Select one of the following links in order to view the information for that machine:

   "view history details" - This link displays previous alarms that have been resolved. The data from the alarm is now stored for historical reference.

   "Time and Geo Fence Alarms" - This link displays data for a current alarm. This link will also show the status of an alarm that has been resolved if the alarm has not been updated.



Illustration 2 g01397851

3. Click on a link in the "Fence Description" column in order to view details of the configuration of the fence. The map on the screen will include the fence as well as the location of a machine at the time of an alarm.

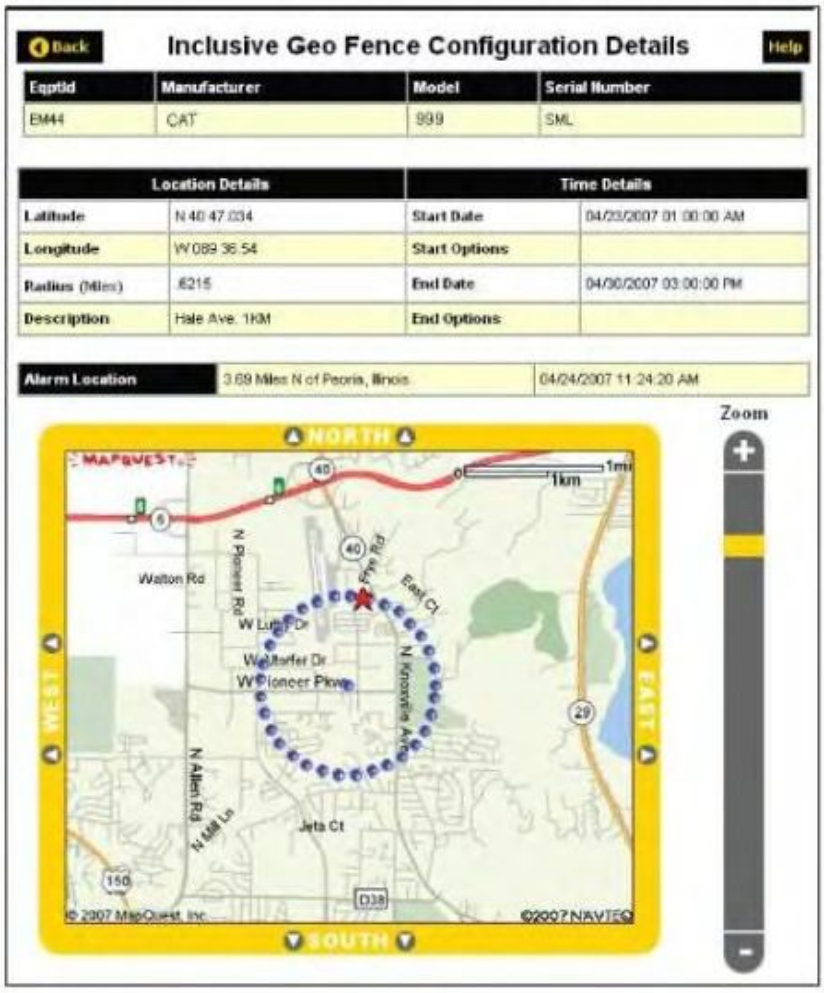


Illustration 3 g01397852

Note: Product Link sends an alarm message immediately when the radius of a fence is violated. However, the speed of a machine may cause the machine to appear closer to the radius of a fence in the map view. For example, a machine traveling at normal road speeds of 40 mph or more may display a fence violation at a location as far as a couple of city blocks from the actual point of the fence violation. After the initial alarm, a subsequent alarm will be sent each day that the equipment remains outside of the radius of the fence. This subsequent message is sent with the first message of each day.

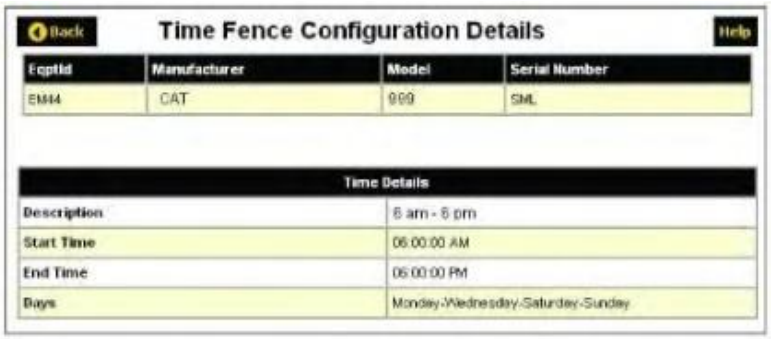


Illustration 4 g01397855

"Update Status"

The EquipmentManager software enables you to update the status of an alarm for time fencing and geographic fencing. If you update the status of the alarm to "Resolved", the status will no longer appear on the "Event Summary "screen. Also, the status will no longer appear on the EquipmentManager home screen. The EquipmentManager home screen is also referred to as the "Exception Dashboard".

To update the status of an alarm in time fencing and geographic fencing, use the following procedure:

1. Navigate to the "Time and Geographic Fencing" screen. Locate the row with the information about your equipment. Click in the box to the left of the equipment.



Illustration 5 g01397856

Note: You can also update the status of an alarm for time fencing and geographic fencing from the "Time and Geo. Fence Alarm History" screen.

2. Click the "Update Status" button at the bottom of your screen. The "Update Status" window will appear. In the "Update Status" menu, select the status for your equipment. Refer to Table 1 for a list of the "Update Status" options.

   Note: "Resolved" will not be displayed on the "Event Summary" screen or on the "Exception Dashboard" screen. However, the details of the alarm are stored in History.

Table 1

"Status"	**"Color"**	**"Importance"**
"Action"	"Red"	"Highest"
"Monitor"	"Yellow"	"Medium"
"Normal"	"Green"	"Lowest"
"Resolved"		



Illustration 6 g01397858

Note: The Status can be changed to any value. A status of "Action", "Monitor", or "Normal" enables the event to remain outstanding. This state will be reflected on the "Exception Dashboard" screen and on the "Event Summary" screen.

3. Click in the box under the "Notes/Comments" column.
4. Type a message in order to describe the reason for the update. The message should describe actions that were taken in order to address the event.
5. Click "Save" in order to update the status of the alarm .

"Setup Fence"

The "Setup Fence" screen allows you to configure the following: inclusive parameters for the fence, exclusive parameters for the fence and parameters for time for the fence. The procedures that follow will demonstrate the features of the "Setup Fence" screen.

Preliminary Steps

1. Navigate to the "Time and Geographic Fencing" screen. Locate your machine from the list of machines. Click in the box in the left hand column next to your machine in order to configure the fence for that machine.
2. Click the "Setup Fence" button. The "Setup Fence " configuration screen will appear. This screen will allow you to add fences for the selected machine. Determine the type of fence required for the application. Follow the procedure for the type of fence selected in order to configure the fence for the machine.

Add Inclusive Geographic Fence

To create an inclusive geographic fence in a map, use the procedure that follows.



Illustration 7 g01397859

1. View the "Inclusive" section of the "Setup Fence" configuration screen. Select the radio button next to the fence that is to be to configured.

   Note: The color on the "Fence Radius" slider coincides with the selected fence.

2. Type a description for the new fence in the "Description" field.

3. Use one of the following methods in order to define the center of a geographic fence:

   - **Click a point on the map.** To help establish the desired location, you can use the "Zoom" tool to the right of the map. You can also use the "North", "South", "East", and "West" buttons. These buttons are located on the borders of the map.

   - **Click on the icon of the magnifying glass.** This method enables you to enter a street address, city, state, and/or zip code. Note that this option is only available in North America.

4. In order to configure the radius of the fence, drag the "Fence Radius" slider to the appropriate location.

   Note: The radius of the fence is displayed in kilometers. If your "Units of Measure" preference is miles, the fence will be configured in kilometers, converted to miles, and then displayed in miles.

"Show/Hide Fence" Button

The radius of the fence will be drawn on the map in order to provide a visual reference for the parameters of the fence. Click the "Show/Hide Fence" button in order to hide a fence. Also click the "Show/Hide Fence" button in order to show a fence. This button is located to the left of the "Description" box.

Load Description Button

You can load an existing fence with the load fence button. This button is located to the right of the "Description" field.

Configure Exclusive Geographic Fence



Illustration 8 g01397861

To configure an exclusive geographic fence with a map, use the following procedure:

1. View the "Exclusive" section of the "Setup Fence" screen. Click the radio button in the exclusive section.

   Note: The color on the indicator for the "Fence Radius" bar will be the same color as the selected fence.

2. Type a description for the new fence in the "Description" field.

3. Use one of the following methods in order to define the center of the geographic fence:
    - **Click a point on the map.** To help establish the desired location, you can use the "Zoom In" and the "Zoom Out " buttons to the right of the map. You can also use the "North", "South", "East", and "West" buttons on the borders of the map.
    - **Click on the icon for the magnifying glass.** This method enables you to enter a street address, city, state, and/or zip code. Note: This option is only available in North America.
4. Configure the radius of the fence. Drag the "Fence Radius" slider to the appropriate location.

    Note: The radius of the fence is displayed in kilometers. If your "Units of Measure" preference is miles, then the fence will be configured in kilometers, converted to miles, and then displayed in miles.
5. You can configure up to five exclusive geographic fences. To add additional fence configurations, click the "Add Fence" button. Repeat the previous steps in order to configure the parameters of each additional fence.

Note: You can also add existing fences with the load description button.

Configure a Time Fence

To configure a time fence, use the following procedure:

1. At the top of the "Setup Fence" screen, click the "Time" tab.
2. In the row for "Days", select the days of the week for which you want the fence to apply.
3. In the "Description" field, enter a description of the time fence.
4. Click "Save".



Illustration 9 g01397864

You can also add existing time fences using the "Load Descriptions" button. For detailed instructions for using this function, refer to Systems Operation, KENR6302, "EquipmentManager User Guide", "Time Fence and Geographic Fence" .

Time and Geographic Fencing Setup Confirmation

To confirm your settings for the time fences, use the following procedure:

1. Click "Save" on the "Time and Geographic Fencing Setup - Edit" screen. A confirmation message appears.



Illustration 10 g01397877

2. Click "OK". The Time and Geo Fence Setup Confirmation screen appears. This screen displays the details of all the fences that you have added. This screen also notifies you that these details will be updated in the database.

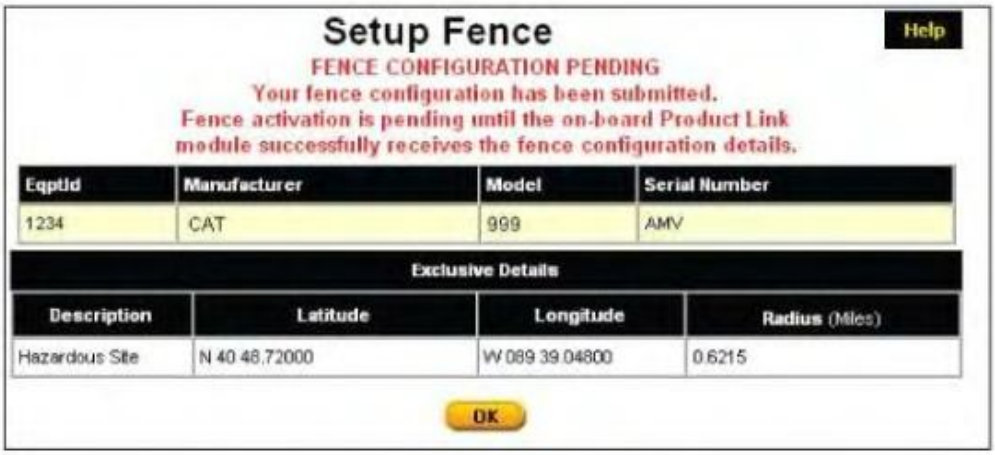


Illustration 11 g01397880

3. Click "OK". The Time and Geo Fence Setup Confirmation screen displays a red success message.

Configuration History

Once a fence is configured with Setup Fence, the fence configuration is sent via satellite to the Product Link module on the machine. The fence state is "Pending" until the onboard configuration completes and a confirmation is received in the EquipmentManager software.

The state of recently configured fences is displayed as an icon in the "Config History" field. The type of icon indicates one of the following states:

Yellow Hour Glass - Pending

Green Check Mark - Successful

Grey Stop Watch - No new activity

The Pending or the Successful icons will be viewable for seven days after the configuration parameters have been sent to the Product Link module. After seven days, the "Successful" status will revert to the grey stop watch icon. If a pending configuration is not confirmed within the seven day time period, then Caterpillar recommends that a new configuration be sent.

To view details of the configuration history, click the icon in the "Config History" column. The Time and Geographic Fencing Configuration History screen appears.

Table 2 lists the descriptions of each of the fields that are in this screen.



Illustration 12 g01397882

Table 2

Field	Description
Request Type	The type of fence that had been configured. Click the link to view configuration details.
Fence Description	The description provided for the fence configured fence.
Configuration Date	The date of the configuration: **Bold Date** – Date the fence was configured in the EquipmentManager software. **Normal Date** – Date Product Link accepted the fence configuration.
State	The state of the configuration request: **Pending** – Yellow hour glass **Successful within the last 7 days** – Green check mark **Successful but older than 7 days** – Grey stop watch

A configuration will remain in the "Pending" state if the machine cannot be reached via satellite. If this condition occurs, ensure that the master switch is closed and that the machine has a clear view to the sky.

If Product Link is not able to receive the message, then the satellite network will continue to try to resend the message for up to one hour. If the message is not received within one hour, then the satellite network will retain the message for five additional days.

The message delivery will be attempted again once Product Link is detected on the network and is sending and receiving messages. After five days, the configuration will no longer be retained and there will be no further attempts to deliver the message to the Product Link module.

Enable and Disable

Once you have configured a machine to use time or geographic fences, remember that those fences are enabled by default. By opening the Enable/Disable screen, you can enable or disable the applied fences.

In order to enable or to disable a time or geographic fence, use the following procedure:

1. Locate the "Equipment Information" section on the **Time and Geographic Fencing** screen.
2. Select the check box that is adjacent to the machine you wish to enable or to disable.
3. Click "Enable/Disable". The "Enable/Disable" screen appears.

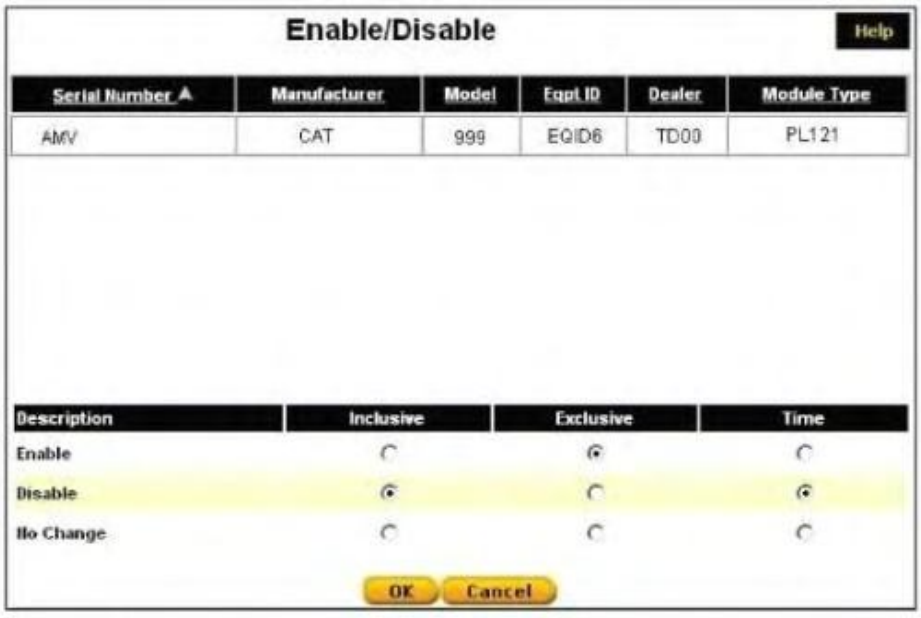


Illustration 13 g01397885

4. Perform the desired action to the Inclusive, Exclusive, or Time fences that are applied to this machine:

   Click on the actions listed below in the appropriate column:

   Enable - This option sends an active fence command to the Product Link module that is on the identified machine.

Disable - This option sends a command to disable an active fence to the Product Link module on the identified machine.

No Change - Select this option if you do not want to send a status change for the chosen fence to the Product Link module on the identified machine.

5. Click "OK" when you have completed all of the appropriate actions. The Enable/Disable Confirmation screen appears. This screen confirms that your changes will be sent to the machine's Product Link module. The changes will be sent as soon as communications with the satellite network can be completed.

   Note: Communication can be completed assuming the machine is running or that the master switch is closed.



Illustration 14 g01397887

6. Click "OK" on the "Enable/Disable Confirmation" screen.

   The Enable/Disable Confirmation screen displays a red success message. This message confirms that the changes will be reflected in the Enable/Disable screen. This screen will list the changes when the confirmation message is returned to the EquipmentManager software from the machine's Product Link module.



Illustration 15 g01397888

Fence Alarm Messages

After the fences have been set, the alarm for the associated fence is triggered. The alarm will occur when the machine crosses the defined fence.

Initial Alarm Message

This message is sent at the time of the fence violation by all supported Product Link modules regardless of the type of module. The supported modules include PL151, PL201, PL121, and PL321.

PL121 only - The EquipmentManager software will not display an alarm on consecutive days (regardless of active status) unless the machine leaves the work site or the machine enters a restricted area again.

PL321 only - If the alarm is still active on consecutive days, the EquipmentManager software will display a new Product Watch Event. The EquipmentManager software will send the appropriate event reaction once with the daily standard message. The EquipmentManager software will send the appropriate event reaction the next time the alarm is activated.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Product Link 121/321", for more information about the PL121 and PL321 alarms.

Subsequent Alarm Message

A subsequent alarm message may be sent while the Product Link module remains in the alarm state.

The following conditions will cause a subsequent alarm message. The type of message that is sent will depend on the type of Product Link module and the version of software that is on the module.

- **Daily** – The alarm message will be included in the Daily Status Message.
- **Accumulative** – If multiple fences are configured, and a fence is in an alarm state, then all fence alarms will be sent with any alarm message.
- **Machine Start** – While the modules remain in an alarm state, subsequent alarm messages are sent each time that a machine is started.

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i02786572

Maintenance Watch

SMCS - 7600; 7606

Overview

Maintenance Watch provides many features that will aid in a proactive maintenance program for your equipment. With a Maintenance Watch subscription, EquipmentManager applies to a machine, the Caterpillar recommended Preventative Maintenance Schedule including intervals, checklists, and part lists. The Maintenance Watch subscription offers the following feature.

- Reports the last PM date and the adherence to the PM schedule
- Builds reference history for use in future repairs
- Schedules the next PM in on-line calendar automatically
- Sends alerts for missed PMs
- Provides PM checklist access
- Contains checklists of predefined PM procedures
- Generates list of parts that are required to complete the PM
- Enables ordering PM parts through the PartStore

Note: Maintenance Watch can be purchased without purchasing Asset Watch.

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Planned Maintenance

SMCS - 7600; 7606

In order to access the "Planned Maintenance" screen, use the following procedure:

1. Search for equipment and view results on the "Event Summary" screen.
2. Select the "Planned Maintenance" option from the "View:" drop-down menu.

   The "Planned Maintenance" screen will then appear.

PM History

By using Maintenance Watch, you can view a record of all previous procedures for the PM that were performed on the equipment and the procedures that were entered through EquipmentManager. In order to view the PM history, use the following procedure:

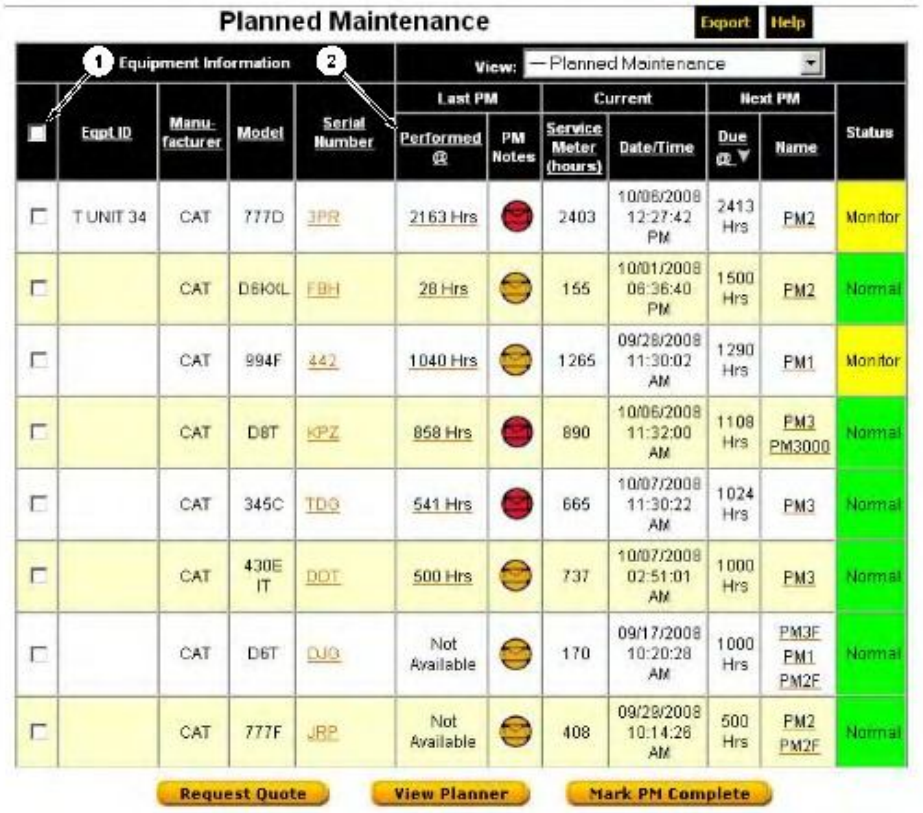


Illustration 1 g01711296

"Planned Maintenance" screen

(1) Check box

(2) "Performed @" column

1. From the "Planned Maintenance" screen, click the number in the "Performed @" column (2) under the "Last PM" column if the number is available.

   The "Planned Maintenance (PM) History" screen will be displayed.

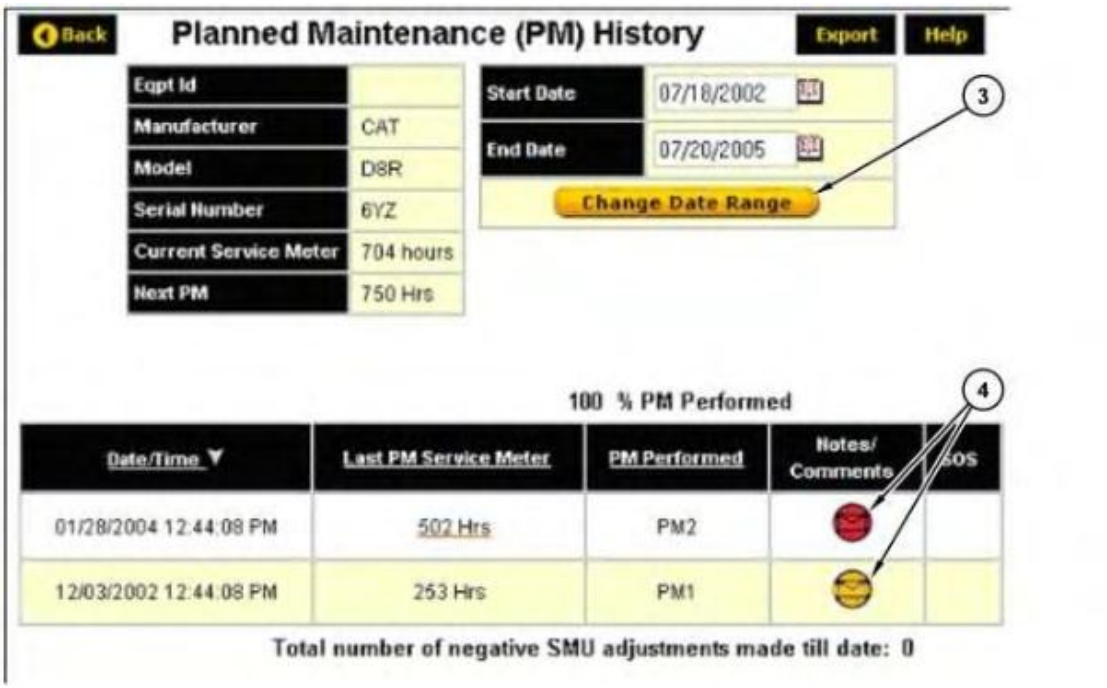


Illustration 2 g01716414

"Planned Maintenance (PM) History"

(3) "Change Date Range" button

(4) Icon of an envelope in a circle

2. Click the icon of a calendar next to the "Start Date" and "End Date" fields. Select a date in order to indicate a time period for the PM history.

3. Click the "Change Date Range" button (3) . The table for the PM history will be loaded again in order to reflect the updated range for the date. The "Change Date Range" function works similarly in many views or screens throughout the application.

"PM Notes"

When a "Planned Maintenance" is completed in EquipmentManager, a field is provided in order to enter notes that pertain to the performed maintenance. On the "Planned Maintenance" screen, the notes for the last "Planned Maintenance" can be viewed.

Use the following procedure in order to view the "PM Notes" and/or update the "PM Notes":

1. From the "Planned Maintenance (PM) History" screen, click the icon of an envelope in a circle (4) that is in the "Notes/Comments" column. The icon will be either red or yellow. Refer to Illustration 2. The "PM Notes" window will appear.



Illustration 3 g01716415

PM Notes

2. If you wish to update the notes, edit notes or add notes in the "PM Notes" text field.
3. Click the "Save" button.

Note: If the icon for the PM note is yellow, the "PM Notes" window does not currently contain notes. If the icon for the PM note is red, the "PM Notes" window contains notes.

Note: The "PM Notes" will attach to the bottom of the checklists for the next "PM Due".

"Past Due" PM

EquipmentManager can be set to send an alert if EquipmentManager schedules a "Planned Maintenance" that is based upon the SMU or the date and that PM passes without being performed. The past due PM details can be accessed from the "Planned Maintenance" screen.

In order to view the procedures for the PM that have been missed, use the following procedure:

1. From the "Planned Maintenance" screen, click "Past Due" in the "Next PM: Due @" column. Refer to Illustration 1. The "Past Due" window will appear.



Illustration 4 g01393298

"Past Due" window

2. In order to close the window, click the "Close Window" button.

PM Checklist

With a Maintenance Watch subscription, a "Planned Maintenance Checklist" can be displayed.

In order to view a PM checklist, use the following procedure:

1. In order to view a PM, click the PM in the "Next PM: Name" column from the "Planned Maintenance" screen. Refer to Illustration 1. The "Planned Maintenance (PM) Checklist" screen will be displayed.

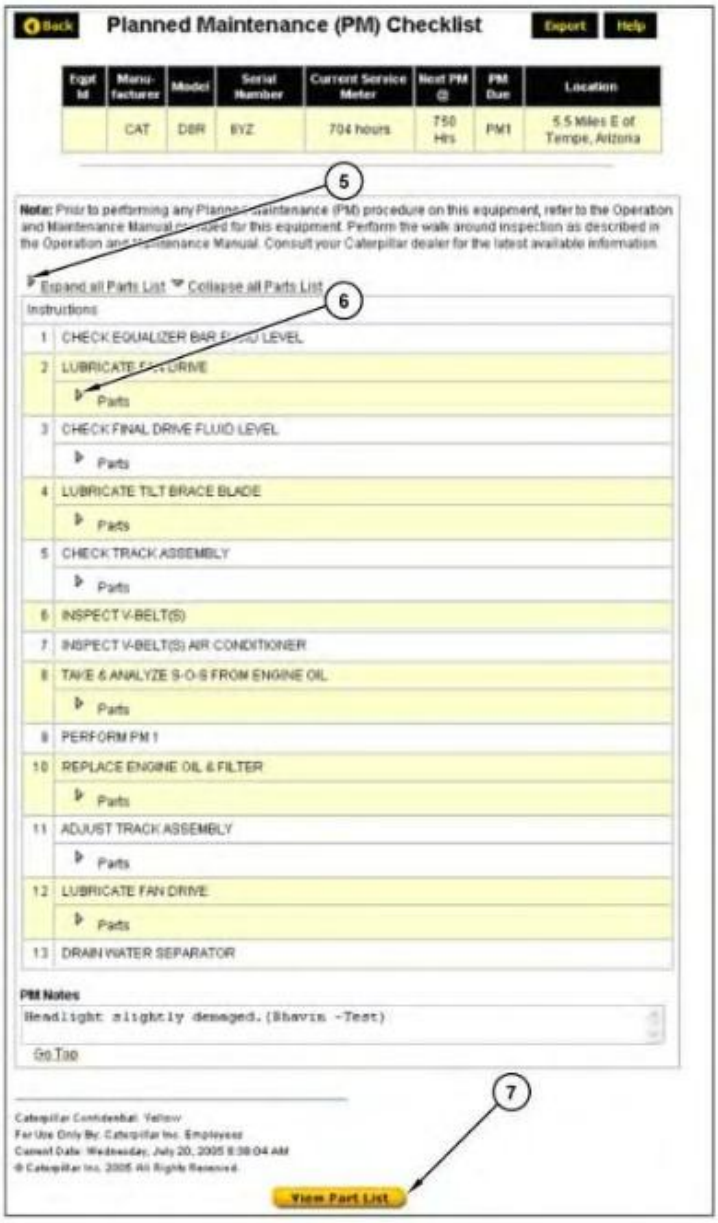


Illustration 5 g01716417

"PM Checklist"

(5) "Expand all Parts List" icon

(6) Icon of a triangle

(7) "View Part List" button

2. In order to view all of the parts list, click the "Expand all Parts List" icon (5) . This action will expand all of the parts lists for all of the steps.



Illustration 6 g01252508

"PM Checklist" with an example of expanded parts

3. To expand the parts list for a single step, click the icon of a triangle (6) below the individual step of that part. The step will expand in order to display the parts that are required to complete the step.

"View Part List"

To assist the technician during a "planned maintenance", a list of all parts that are required for completing the PM can be displayed and exported for printing. In addition, this list of parts can be sent to the PartStore system for ordering.

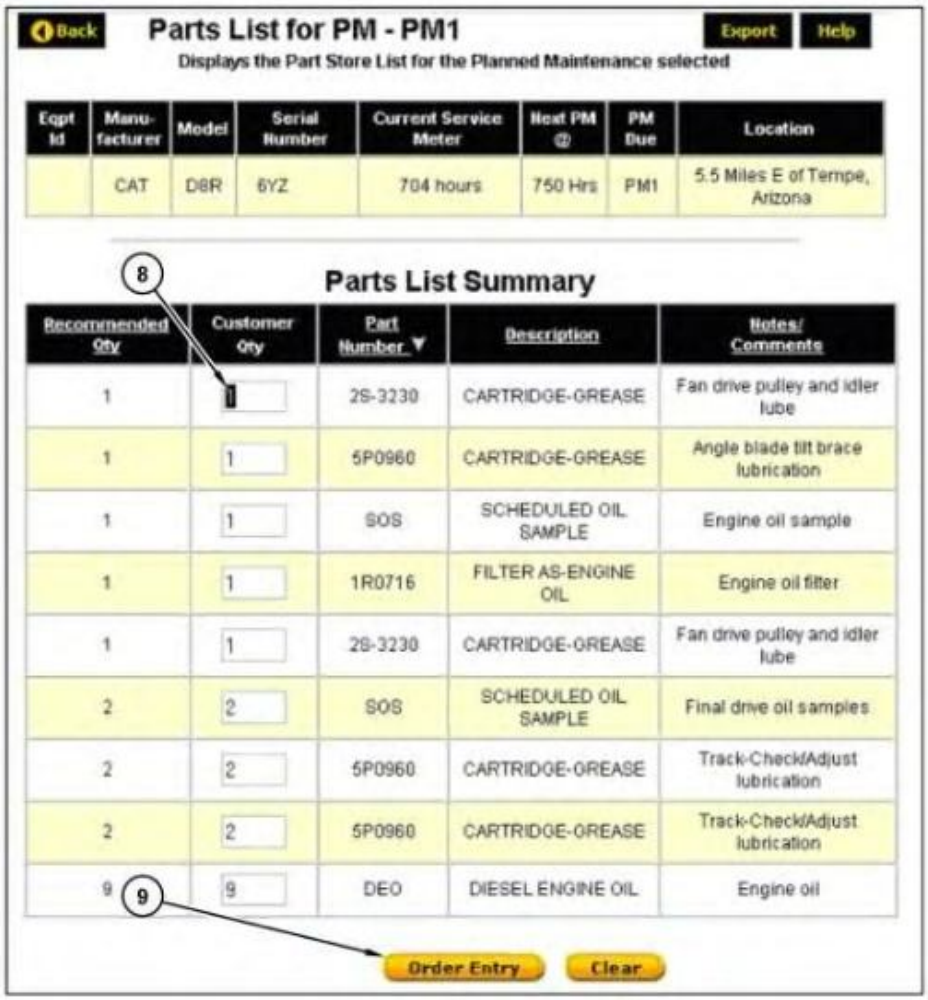


Illustration 7 g01716418

Parts List for PM

(8) "Customer Qty" text fields

(9) "Order Entry" button

In order to view the "Parts List Summary", select the "View Part List" button (7) from the "PM Checklist" screen. Refer to Illustration 5. The "Parts List for PM" screen will be displayed. Refer to Illustration 7.

In order to order the parts through the PartStore system, click the "Order Entry" button (9) . The quantities for the parts in the "Customer Qty" text fields (8) can be edited before placing an order.

"View Planner"

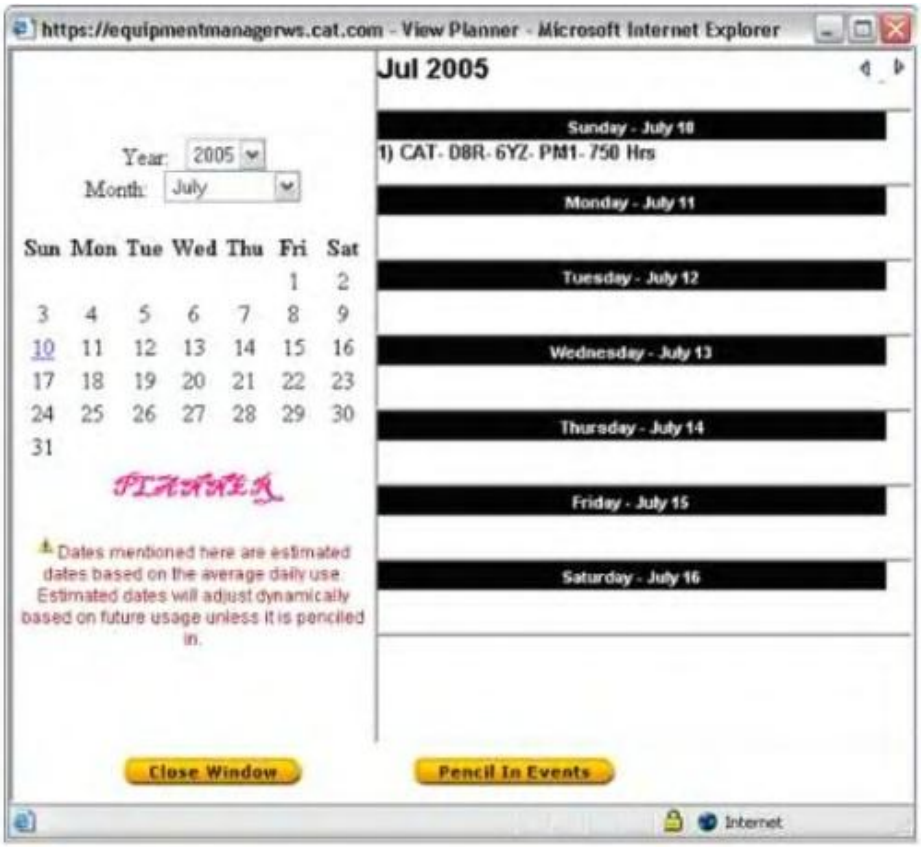


Illustration 8 g01716419

"Planner"

Maintenance Watch schedules the procedures for the PM in the "Planner" from EquipmentManager. The "View Planner" screen displays the date that is estimated for the next PM. This approximation of the dates that are chosen for the repairs is based on the average daily usage of the equipment. The dates adjust dynamically depending on the future usage unless the repair is manually changed by the "Pencil In Event".

In order to view the "View Planner" page, use the following procedure:

1. Select the check box (1) that is next to the equipment from the list on the "Planned Maintenance" screen. Refer to Illustration 1.

2. Click the "View Planner" button. Refer to Illustration 1. The "Planner" window will appear.

The "Planner" displays the items of information for the PM, with the first PM that is due at the beginning for the equipment that has been selected. To view the other PM due dates for this equipment, use the options that are in the calendar to search by a date, a month, or a year. To view the days between the PM due dates for a piece of equipment, you can use the "Back" and "Next" arrows that are located in the upper right-hand corner of the window.

"Pencil In Events"

In order to change the date of the next PM on the "Planner", use the following procedure:

1. From the "Planner" window, click the "Pencil In Events" button. The "Pencil In Events" screen will be displayed.



Illustration 9 g01716420

"Pencil In PM Events" screen

(10) "Pencil In Date" field

(11) "Save" button

2. Click the icon of a calendar next to the "Pencil In Date" field (10) and select a date from the popup window.
3. Click the "Save" button (11) .

Note: Once a "Pencil In Date" has been performed for the PM, the system will no longer adjust the date for the PM dynamically. Once that PM is complete the subsequent schedules for the PM revert to dynamic scheduling again.

Request Quote

A useful feature of Maintenance Watch is the ability to request a note for a PM directly from EquipmentManager. EquipmentManager will send an e-mail to the Dealer Administrator of the web site for your dealer. In order to request a quote, use the following procedure:

1. In order to request a note for a piece of machine, select the check box (1) for the equipment from the list on the "Planned Maintenance" screen. Refer to Illustration 1.
2. Click the "Request Quote" button. Refer to Illustration 1. The "Quotation Details" window will appear.

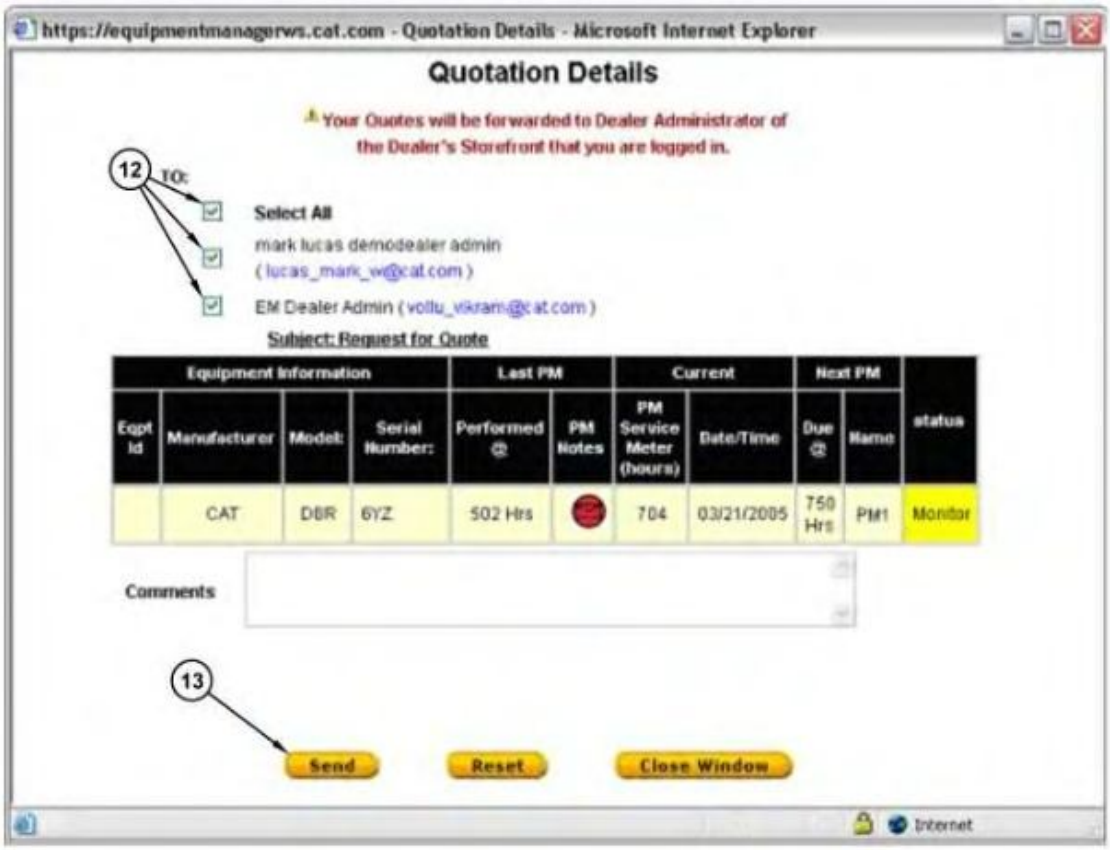


Illustration 10 g01716421

Requesting a PM Quote

(12) Check boxes

(13) "Send" button

3. In order to send a request to multiple Dealer Administrators, select the check boxes (12) next to any of the Dealer Administrator.
4. In order to send a comment to the selected Dealer Administrator, enter the comments in the "Comments" text field.
5. Click the "Send" button (13) . The "Mail Successfully Delivered" screen will be displayed.



Illustration 11 g01716422

"Message Delivered Successfully" screen

6. Click the "OK" button. Refer to Illustration 11.

"Mark PM Completed"

Once you have used the "PM Checklist" to complete a PM, mark the PM as completed so that the PM will no longer appear as an event in EquipmentManager. If you do not mark a PM as completed, the note will appear as PM that has been missed.

In order to mark a PM as completed, use the following procedure:

1. From the "Planned Maintenance" screen, select the check box (1) next to the equipment of the PM that is to be marked as a note completed. Refer to Illustration 1.
2. Click the "Mark PM Complete" button. Refer to Illustration 1. The "Mark Planned Maintenance (PM) Completed" window will appear.



Illustration 12 g01393310

"Mark Planned Maintenance (PM) Completed" screen

3. If the PM was missed, select the check box in the "Not Performed" column.
4. Enter the SMU of the equipment at the time the PM was performed in the "@ Service Meter" text field.
5. Click the icon of a calendar next to the "Date" field and select a date from the popup window.
6. Enter notes in the "Notes/Comments" text field.

   Note: "Notes/Comments" entered at the time a PM is marked as completed, append to the checklists for the next "PM Due". If the last "PM Due" is marked missed, the offset will revert to the defined fixed schedule.

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i03368451

Major Repair

SMCS - 7600; 7606



Illustration 1 g01738816

"Major Repair" screen

(1) Check box

(2) "View" drop-down menu

In addition to a planned maintenance, a Maintenance Watch subscription gives you the ability to schedule and track major repairs. On the "Event Summary" screen, select the check box (1) next to the equipment you wish to view major repairs and then select "Major Repair" from the "View" drop-down menu (2) . The "Major Repair" screen will be displayed. Refer to Illusrtation 1.

"Repair and Maintenance History"

Using Maintenance Watch, you can view a record of all previous major repairs that were performed on the equipment and entered through EquipmentManager.

In order view the major repair history, use the following procedure:

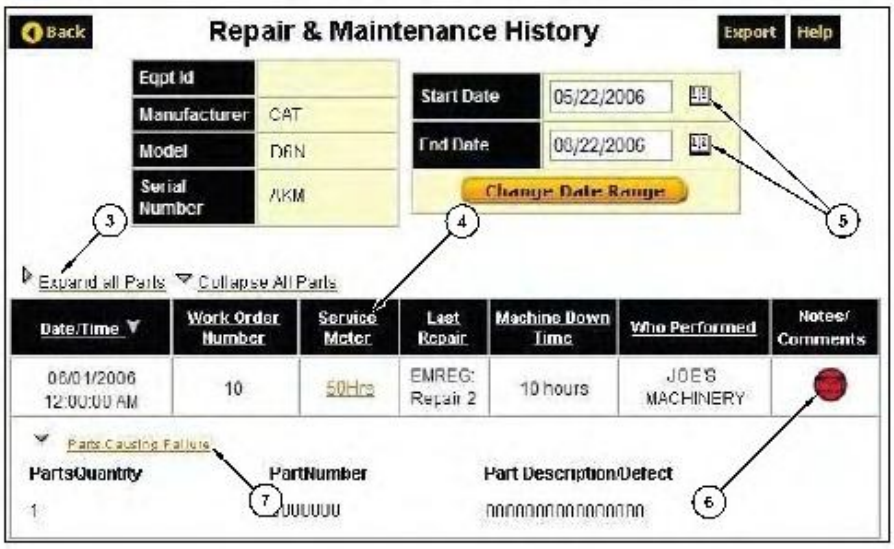


Illustration 2 g01738817

"Repair & Maintenance History" screen

(3) "Expand All Parts" link/icon

(4) "Service Meters" column

(5) Calendar icon

(6) Icon of and envelope

(7) "Parts Causing Failure" link/icon

1. On the "Major Repair" screen, in the "Service Meters" column (4) , click the value in the field. Refer to Illustration 2. The "Repair & Maintenance History" screen will be displayed.
2. Click the calendar icon (5) next to the "Start Date" and "End Date" fields and select a date to indicate a time period for the PM history.
3. In order view the parts causing failure for the major repair, click either the "Expand All Parts" link/icon (3) or the "Parts Causing Failure" link/icon (7) .
4. In order view the comments, click the icon of and envelope (6) in the "Notes/Comments" column.

Request Quote

You can request a quote for the next major repair directly from EquipmentManager. EquipmentManager will send an e-mail to the Dealer Administrator of the Dealer's Web site that you are logged in.

In order request a quote, use the following procedure:

1. From the "Major Repair" screen, select the equipment for which you wish to request a quote.
2. Click the "Request Quote" button. The "Quotation Details" screen will be displayed.

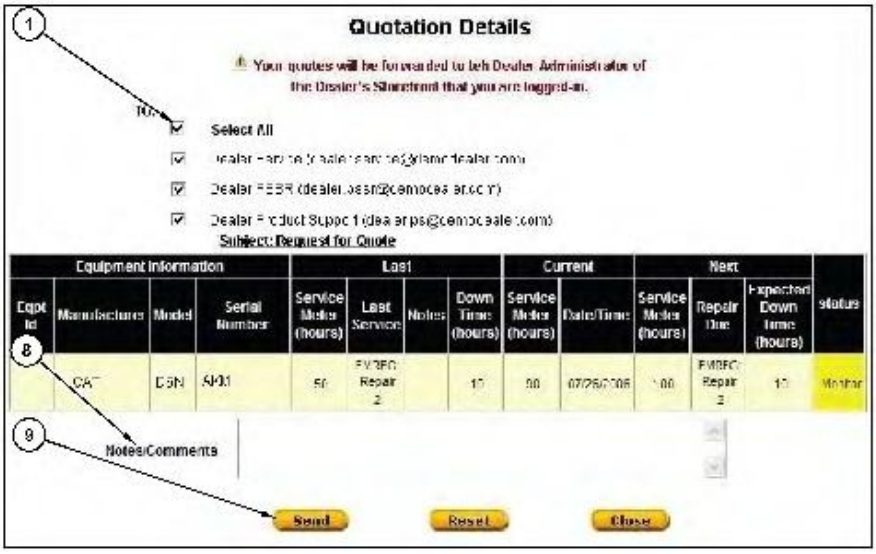


Illustration 3 g01738818

"Quotation Details" screen for requesting a quote

(1) Check box

(8) "Notes/Comments" text field

(9) "Send" button

3. Select the check box (1) next to the dealership personnel to whom you want to send the request.
4. In the "Notes/Comments" text field (8) , enter the comments you wish to send to the recipients.
5. Click the "Send" button (9) . The "Mail Successfully Delivered" screen will be displayed.



Illustration 4 g01738819

"Mail Successfully Delivered " message for a MR quote

6. Click the "OK" button. The details about the machine and the service event are included in the e-mail message.

View Planner

EquipmentManager places major repairs in the EquipmentManager planner. The planner displays the date that the repair should be performed if all conditions remain the same. The dates that are chosen for the repairs are estimated based on the average daily usage of the equipment. The dates adjust dynamically based on usage, unless the repair is manually penciled in.

1. From the "Major Repair" screen, select the check box next to the equipment for which you wish to view the planner. Refer to Illustration 1.

2. Click the "View Planner" button. Refer to Illustration 5. The "View Planner" window appears.

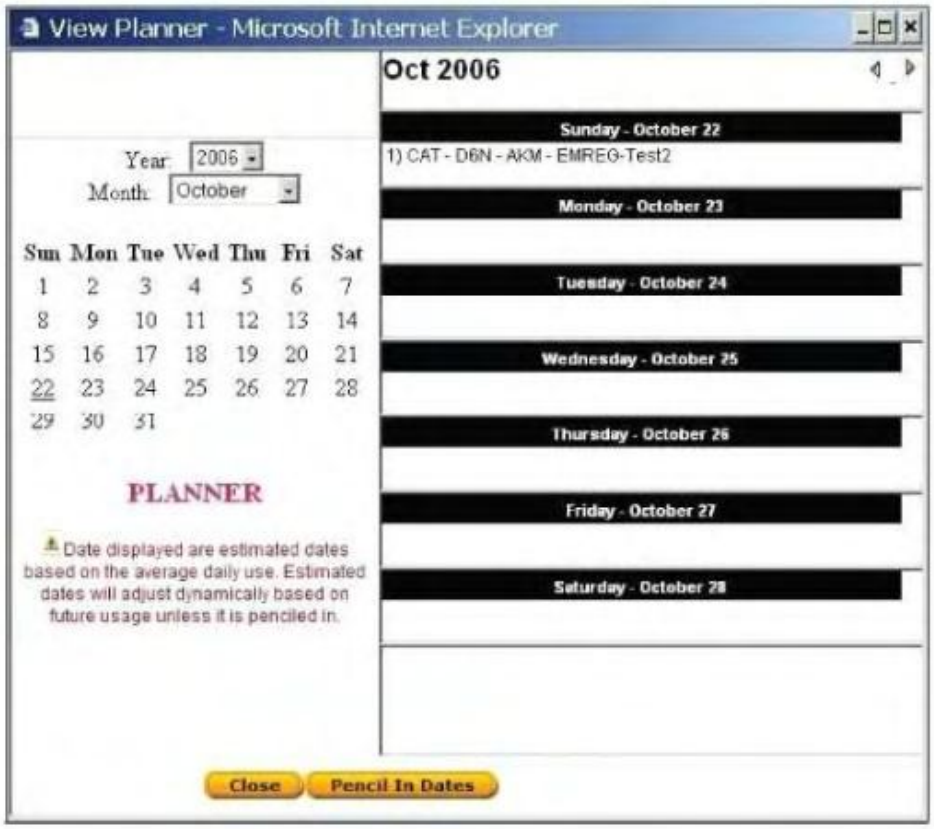


Illustration 5 g01392145

"View Planner" window

3. In order view other major repair due dates for this equipment, you can use the calendar's options to search by date, month, or year.

4. In order view days between equipment major repair due dates, you can use the back and next arrows in the upper-right corner of the window.

Pencil In Dates

If you wish to change the date of the next major repair on the planner, use the following procedure:

1. From the "Planner" window, click the "Pencil In Date" button. The "Pencil In Date" screen will be displayed.

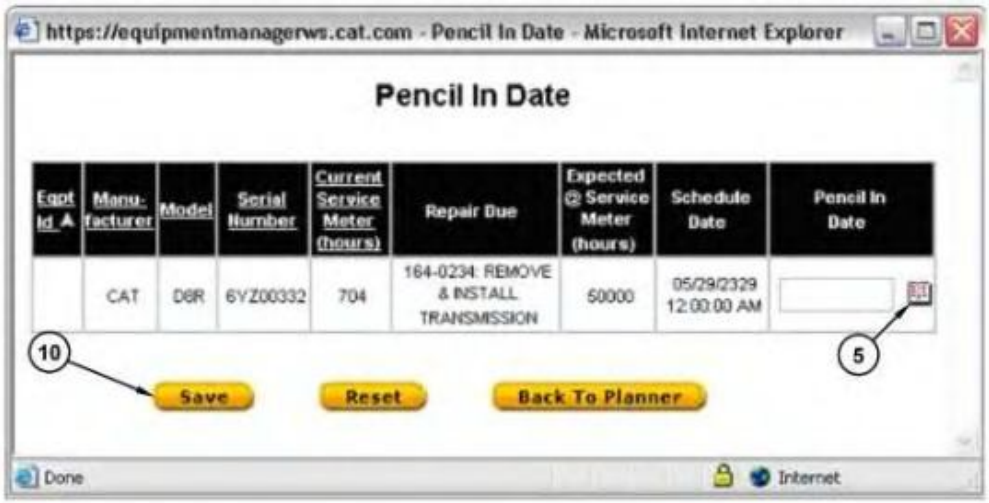


Illustration 6 g01738820

"Pencil In Date" screen for a major repair

(10) "Save" button

(5) Calendar icon

2. Click the calendar icon (5) next to the "Pencil In Date" field and select a date from the popup window.
3. Click the "Save" button (10) .

Note: Once you pencil in a major repair date, the system no longer dynamically adjusts that major repairs date. Once that major repair is complete, the subsequent major repairs revert back to dynamic scheduling.

Mark Repair Complete

Once you have completed a major repair, you need to mark the repair completed.

In order mark a major repair completed, use the following procedure:

1. From the "Major Repair" screen, select the check box next to the equipment with the repair you wish to mark completed. Refer to Illustration 7.
2. Click the "Mark Repair Complete" button. Refer to Illustration 7. The "Mark Repair Complete" screen appears.

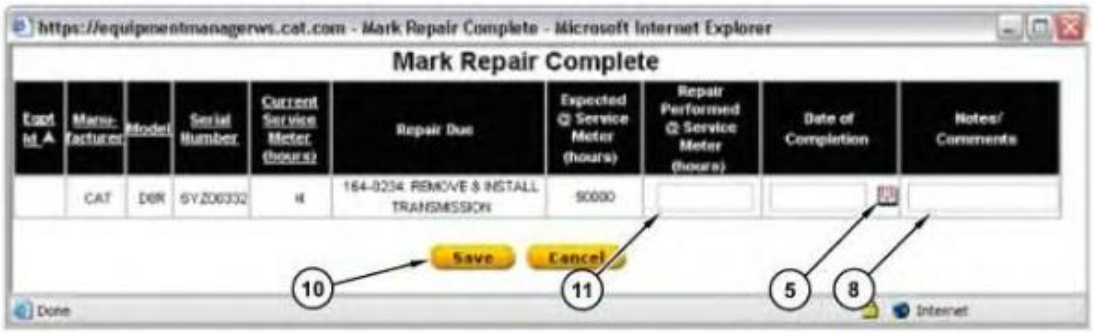


Illustration 7 g01738821

"Mark Repair Complete" screen

(10) "Save" button

(11) "Repair Performed @ Service Meter (hours)" text field

(5) Calendar icon

(8) "Notes/Comments" text field

3. Enter the SMU of the equipment at the time the repair was performed in the "Repair Performed @ Service Meter (hours)" text field (11) .
4. Click the calendar icon (5) next to the "Date of completion" field and select a date from the popup window.
5. Enter notes in the "Notes/Comments" text field (8) .
6. Click the "Save" button (10) .

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i02951552

Health Watch

SMCS - 7600; 7606

Overview

A subscription to Health Watch offers the following features:

- Displays the fuel results, fuel level history, fuel used history and refueling history.
- Identifies the onboard logged events and diagnostic codes and retains the events and codes in EquipmentManager machine history.
- Relays available troubleshooting procedures, enabled by SIS Web subscription.

By using these features you can quickly and easily monitor your entire fleet. You can detect trends which will help to improve fleet owning and operating costs.

Note: Diagnostic Codes are frequently referred to as Fault Codes or Event Codes.

Note: Health Watch information is dependent upon the machine model, year of production and Product Link model installed. Machines produced with electronic engines and transmissions equipped with Product Link model PL321SR normally can provide this information.

S·O·S Service Manager (S·O·S)

S·O·S alerts for fluid analysis may be provided in EquipmentManager if your dealership uses S·O·S Service Manager software in the dealership laboratory. S·O·S alerts will be displayed in the Exception Dashboard in the "Event Summary" display.

The S·O·S Service Manager is a software program that is available through your dealers web site. To view S·O·S details or reports for a sample, use the tool for viewing the S·O·S application on the web. Also, you may contact your Caterpillar dealer S·O·S services laboratory for your results. The report from the S·O·S services laboratory may be obtained from a fax or from e-mail. A paper copy of the report can be mailed as well.

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i03370084

Fuel Results

SMCS - 7600; 7606

The EquipmentManager software is able to collect data regarding the fuel consumption of your equipment. This data includes the following: fuel level, fuel usage and the history for refueling.

Note: The results that are displayed using "Fuel Results" are not results that are measured. The information that is viewed on the "Fuel Results" screen is calculated information. The calculations are based on the performance maps of the machine. The performance maps define specific performance characteristics of the machine. These characteristics determine the calculated fuel usage at different loading conditions. The result is the cumulative fuel consumption.

In order to view the fuel information for a specific machine, use the following procedure:

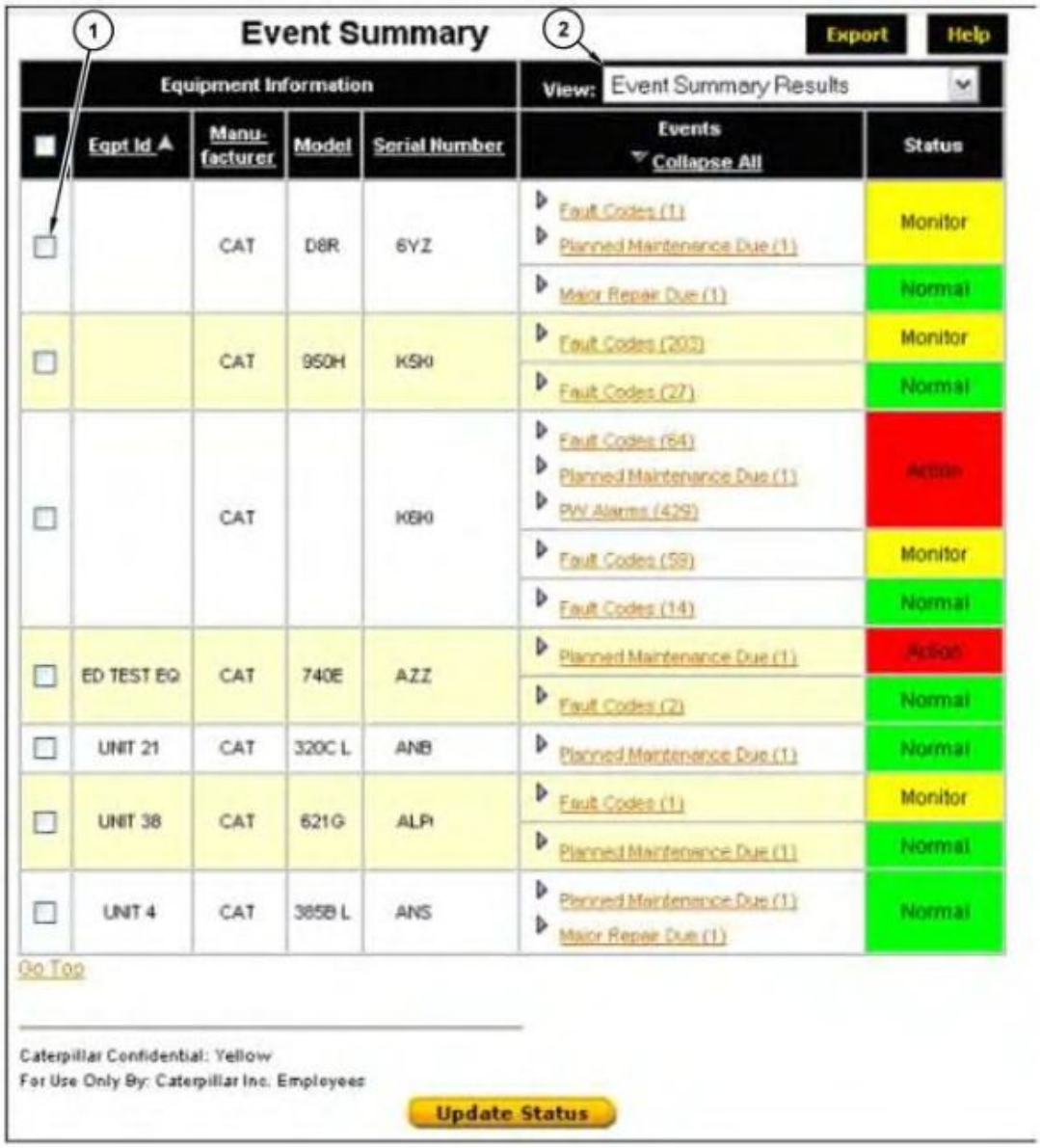


Illustration 1 g01739893

"Event Summary" screen

(1) Check box

(2) "View" drop-down menu

1. Navigate to the "Event Summary" screen. Refer to Illustration 1.
2. Search for the specific machine in the "Equipment Information" column.
3. Click in the check box (1) to the left of the machine in order to select the machine.

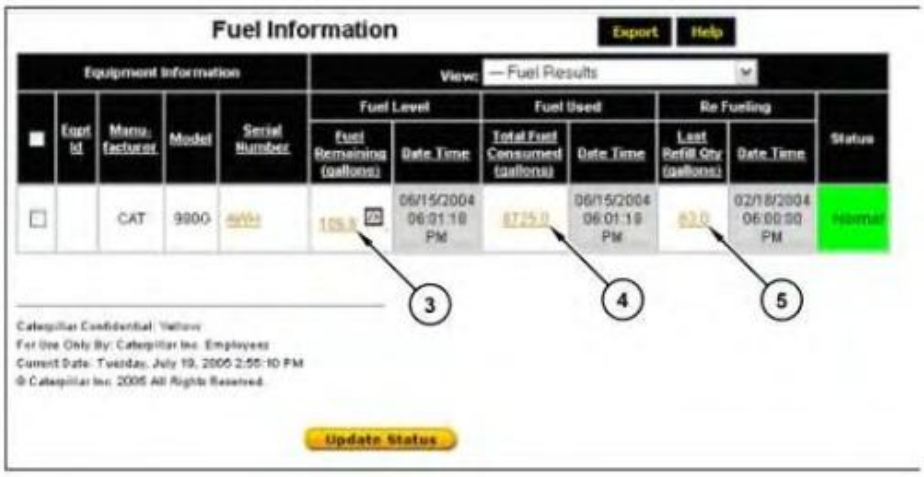


Illustration 2 g01739913

"Fuel Information" screen

4. Select "Fuel Results" from the "View" drop-down menu (2) .

   The "Fuel Information" screen will appear. Refer to Illustration 2. This screen will display the information for the selected machine.

   Click link (3) in order to view the "Fuel Level History" screen. Refer to ""Fuel Level History"". Click link (4) in order to view the "Fuel Used History" screen. Refer to ""Fuel Used History"". Click link (5) in order to view the "Refuel History" screen. Refer to ""Refuel History"".

"Fuel Level History"

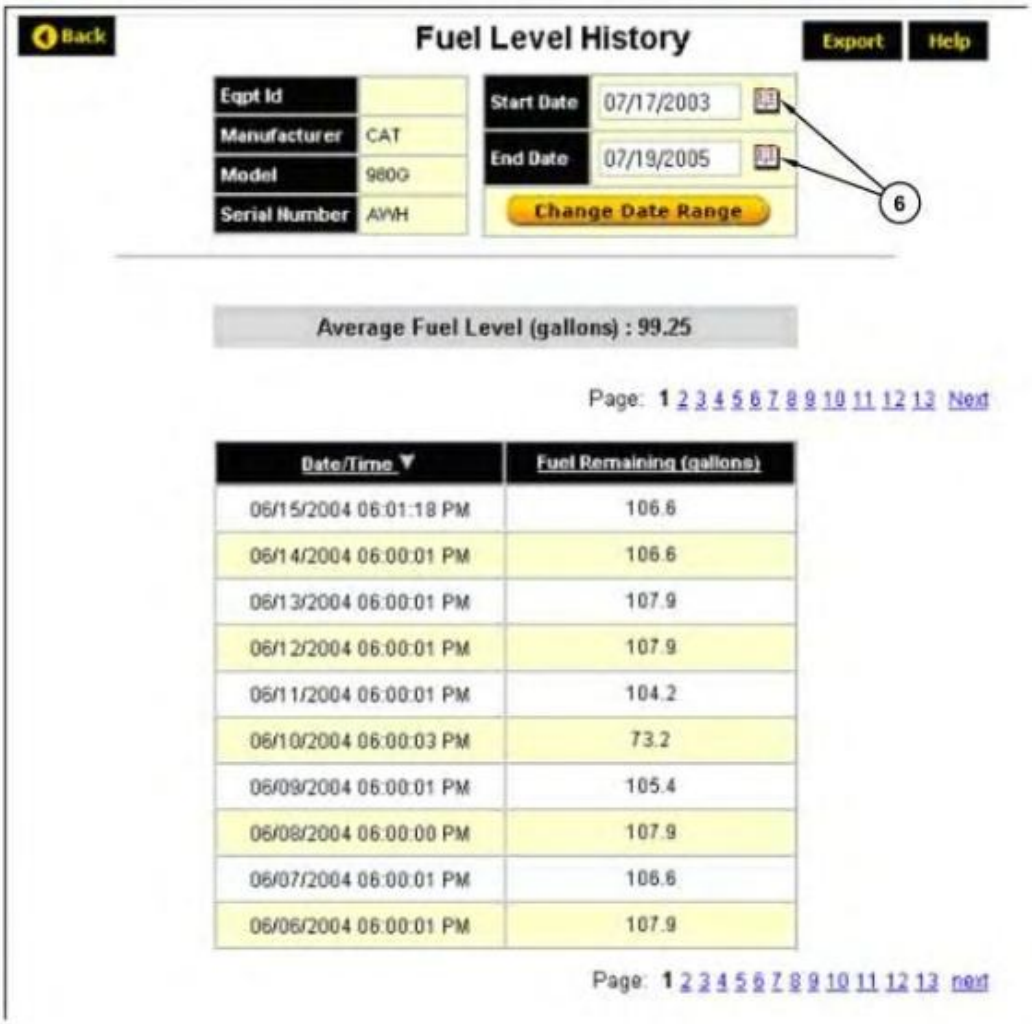


Illustration 3 g01739914

"Fuel Level History" screen

(6) Icon of the calendar

In order to view the "Fuel Level History" screen, use the following procedure:

1. From the "Fuel Information" screen, click on the number in the "Fuel Remaining (gallons)" column. The "Fuel Level History" screen is displayed. Refer to Illustration 3.
2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.
3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.
4. Click "Change Date Range". The information on the "Fuel Level History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

Graph of the Fuel Level

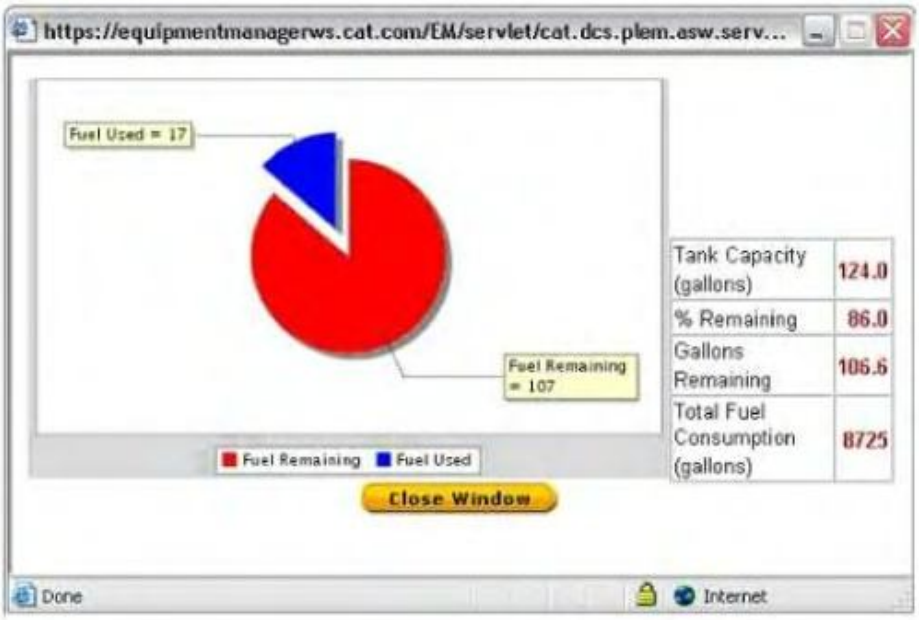


Illustration 4 g01253297

Graph of the existing fuel level

In order to view a graph of the existing fuel level of a machine, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the "Fuel Remaining (gallons)" column.
2. Find the row which displays the information for your specific machine.
3. Click on the icon of a machine in the "Fuel Remaining" column. A graph will appear in a popup window. Refer to Illustration 4. This graph will display information for the selected machine.
4. Click the "Close Window" button or click the "X" in the upper right corner in order to return to the "Fuel Information" screen.

"Fuel Used History"

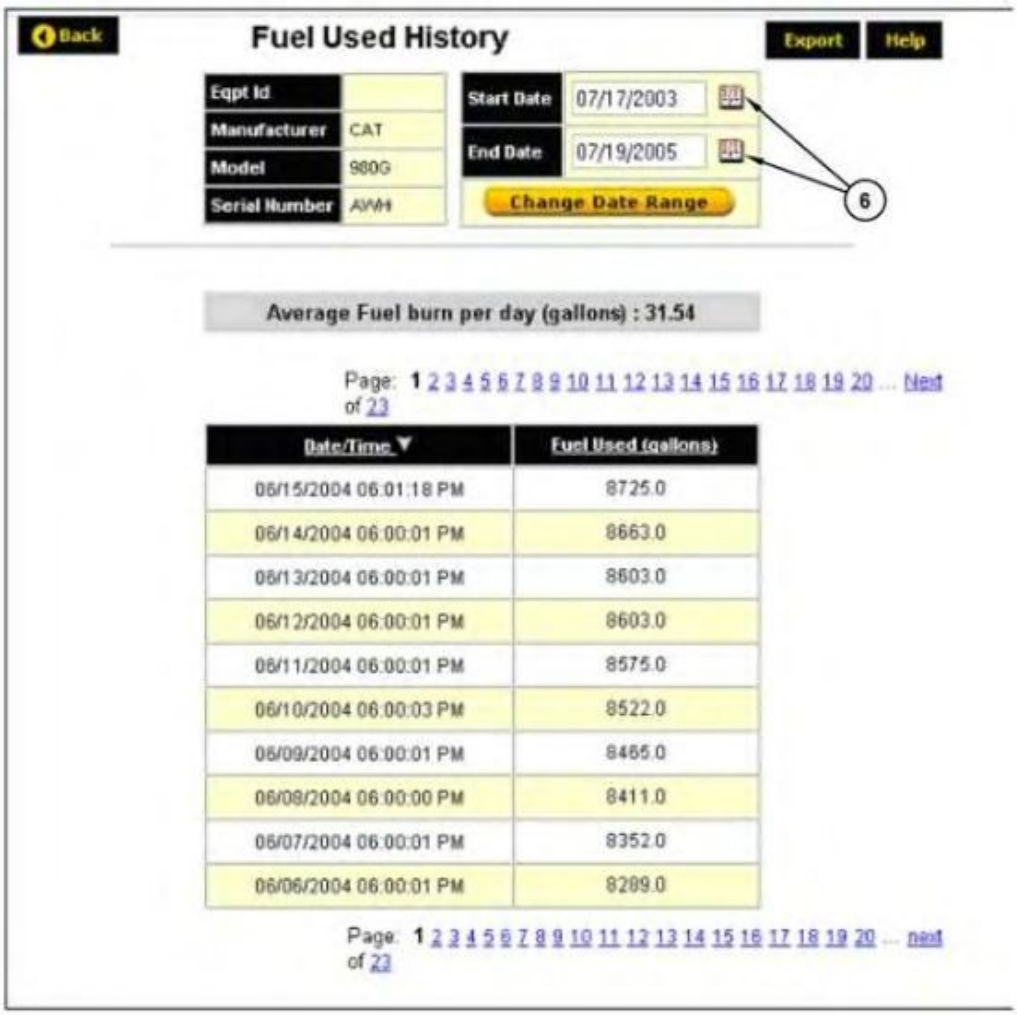


Illustration 5 g01739915

"Fuel Used History" screen

(6) Icon of the calendar

The "Fuel Used History" screen displays the history of fuel usage for a specific machine. Refer to Illustration 5. This amount of fuel usage is calculated by the engine Electronic Control Module (ECM).

In order to view the "Fuel Used History" screen, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the row with the information about your machine. Locate the "Total Fuel Consumed (gallons)" column. Click the number in the "Total Fuel Consumed (gallons)" column for your machine. The "Fuel Used History" screen will appear.

   Note: The results that are displayed using "Fuel Results" are not results that are measured. The information that is viewed on the "Fuel Results" screen is calculated information. The calculations are based on the performance maps of the machine. The performance maps define specific performance characteristics of the machine. These characteristics determine the calculated fuel usage at different loading conditions. The result is the cumulative fuel consumption.

2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.

3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.

4. Click "Change Date Range". The information on the "Fuel Used History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

"Refuel History"

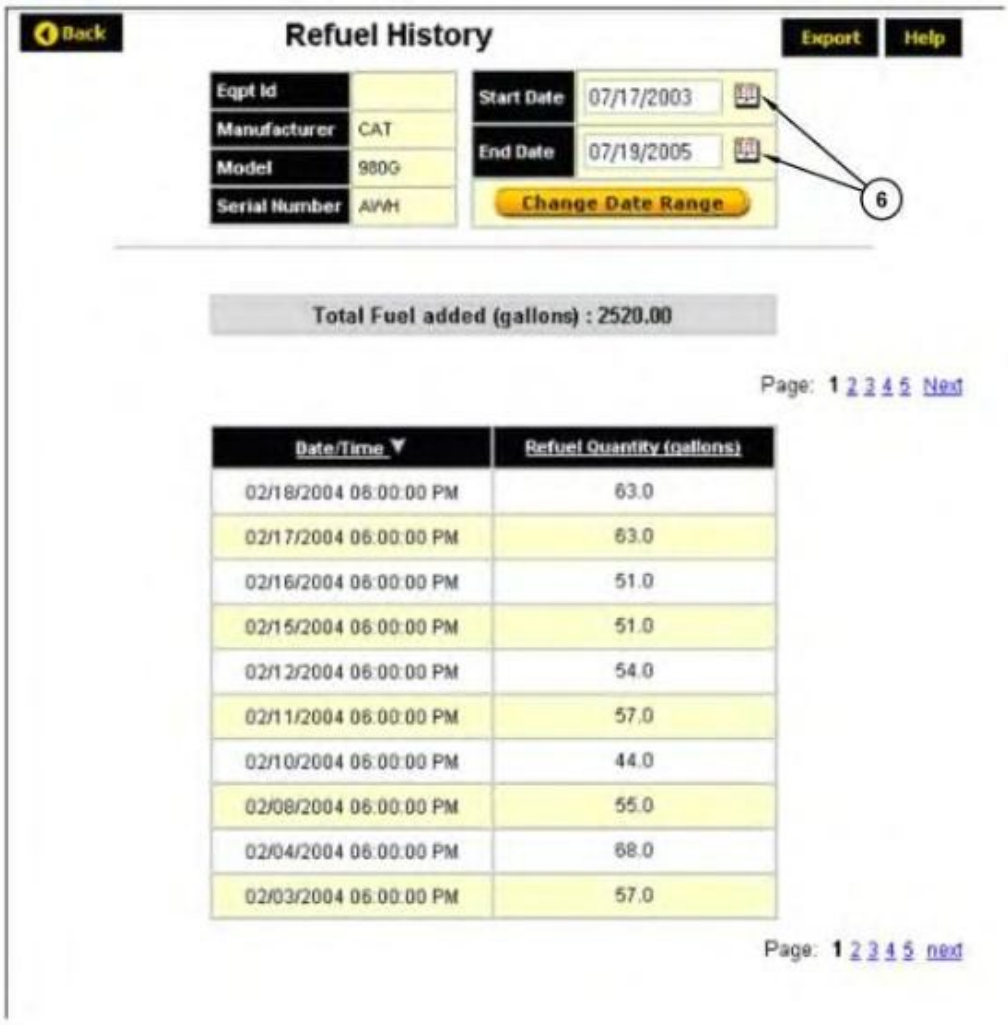


Illustration 6 g01739916

"Refuel History" screen

(6) Icon of the calendar

The "Refuel History" screen displays the history of refueling for a specific machine. Refer to Illustration 6.

In order to view the "Refuel History" screen, use the following procedure:

1. Navigate to the "Fuel Information" screen. Locate the row with the information about your machine. Locate the "Last Refill Qty. (gallons)" column. Click the number in the "Last Refill Qty. (gallons)" column for your machine. The "Refuel History" screen will appear.

   Note: The information about refueling is not provided by Product Link. This is a manual function in the "Administration" menu.

2. The start and the end date for the history must be selected. Click the icon of the calendar (6) next to the "Start Date". Input the desired start date.
3. Click the icon of the calendar (6) next to the "End Date". Input the desired end date.
4. Click "Change Date Range". The information on the "Refuel History" screen will now reflect the selected date range.
5. Click the "Back" button in order to return to the "Fuel Information" screen.

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Fault Codes

SMCS - 7600; 7606

Diagnostic codes are frequently referred to as fault codes or event codes. The fault codes that are provided by the EquipmentManager software provide valuable information. This information can be used to make decisions concerning the maintenance of your machine. Use the "Search Equipment" button in order to access the fault codes for your . The "Search Equipment" button is located on the EquipmentManager home screen. Select the check box (1) for the equipment from the "Equipment Summary" screen. Then, select "Fault Codes" from the "View" drop-down menu.

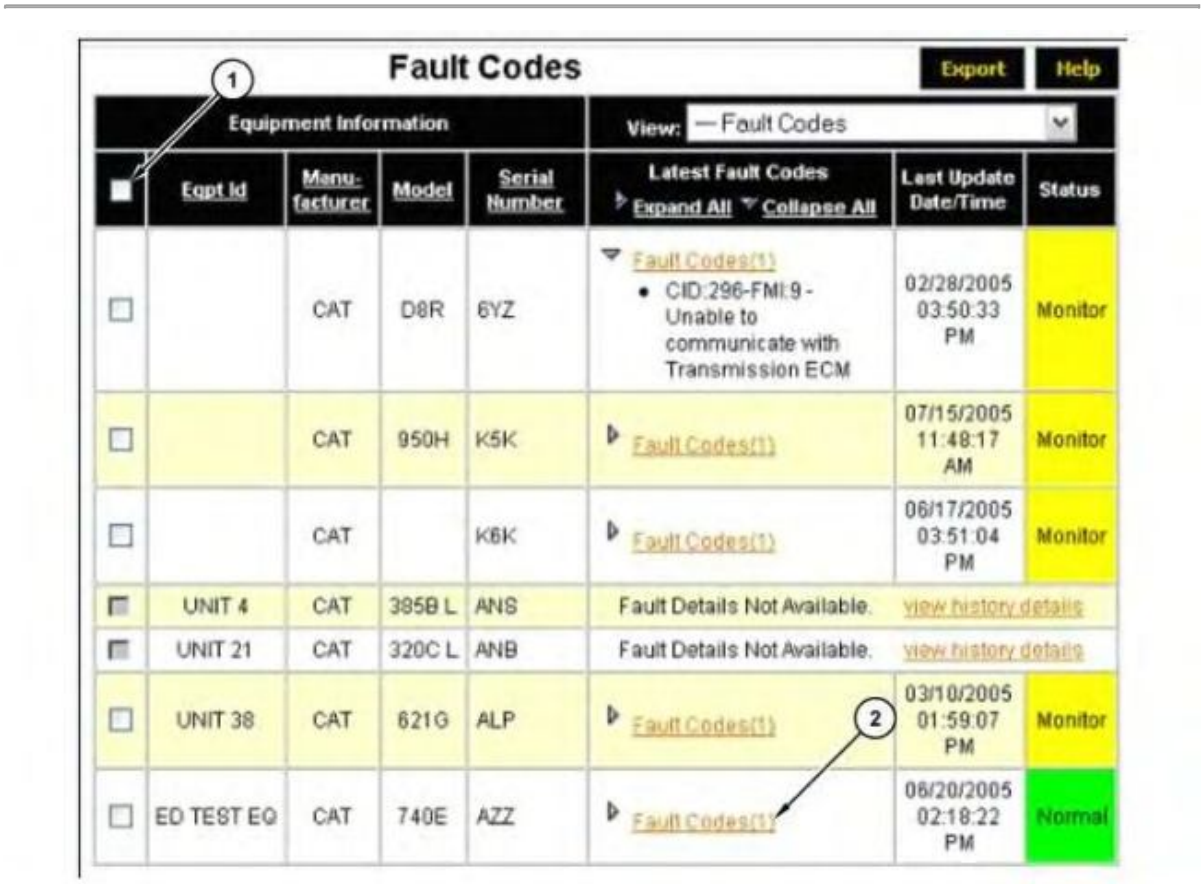


Illustration 1 g01737838

"Fault Codes" screen

(1) Check box

(2) "Fault Codes" link

View "Fault Code History" (Event code and Diagnostic Code)

By using Health Watch, you can view a record of all previous fault codes that were recorded through EquipmentManager software.

In order to view the "Fault Code History" screen, use the following procedure:

1. From the "Fault Codes" screen, click the "Fault Codes" link (2) or the "view history details" link in the "Latest Fault Codes" column. The "Fault Code History" screen will be displayed.

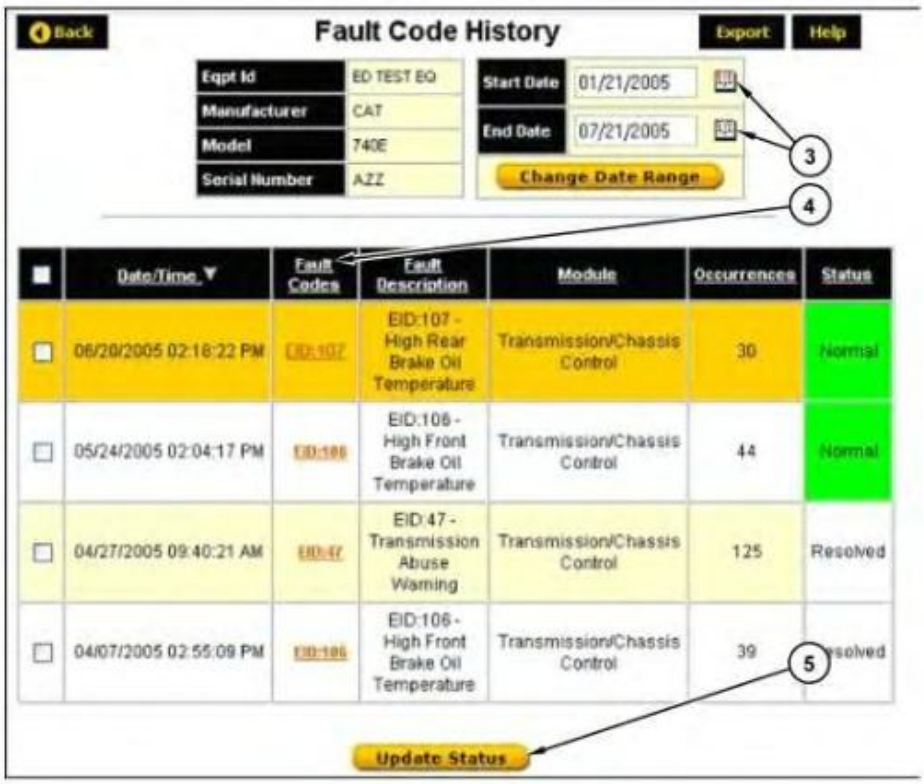


Illustration 2 g01737839

"Fault Code History"

(3) "Start Date" field and "End Date" field

(4) "Fault Codes" column

(5) "Update Status" button

2. Click on the icon for the calendar next to the "Start Date" field and "End Date" field (3) . Select a date in order to indicate a time period for the history of the fault code.

3. Click the "Change Date Range" button. The "Fault Code History" table will be updated to using the new date range.

   Note: The history of the fault code that is viewed in the EquipmentManager software will display all faults that are reported by Product Link. A machine Electronic Control Module (ECM) will automatically erase a diagnostic code after 100 hours of operation if the diagnostic code does not reappear within that period of time. If the machine ECM erases a diagnostic code automatically, the history of the fault code that is displayed by the EquipmentManager software may not match the history that is displayed by Caterpillar Electronic Technician software.

"Service Information for Fault Codes (SIS Web)"

In order to view detailed information about a particular code, EquipmentManager software interfaces with Service Information System (SIS). The link to SIS will provide troubleshooting procedures in order to resolve fault codes. For this link to work, a valid subscription to SIS is required.

In order to obtain service information for specific fault codes, complete the following precedure:

1. On the "Fault Code History " screen, locate the "Fault Codes" column (4) . Click on the fault code in order to view the service information for the fault code. The "Service Information for Fault Codes" screen will now display the information for your specific fault code. The troubleshooting procedure for the selected fault code will appear if there is a proper link in SIS.



Illustration 3 g01253373

"Service Information for Fault Codes" troubleshooting

2. The "Service Information for Fault Codes" screen for troubleshooting will display fault codes in the left column. Click on the hyperlink that applies to your fault code. The "Service Information for Fault Codes" will appear. This screen will display information about your fault code.

3. View the information in the "Information Types" and "Sections" columns. Click on the links that apply to your fault code. Click the "Close" button in order to return to the "Fault Code History" screen.



Illustration 4 g01253376

"Service Information for Fault Codes" information

"Update Status" for the Fault Code

EquipmentManager software enables you to update the status of a fault code. If the status of a fault code is updated to "Resolved", the fault code will no longer appear in the "Event Summary". The "Event Summary" screen is located on the home page. The home page may also be referred to as the Exception Dashboard.

In order to update the status of a fault code, use the following procedure:

1. View the "Fault Code" screen, or the "Fault Code History" screen. Click in the check box (1) that is next to the fault code in order to update the fault code. Then, click the "Update Status" button (5) . The "Update Status" window will appear.

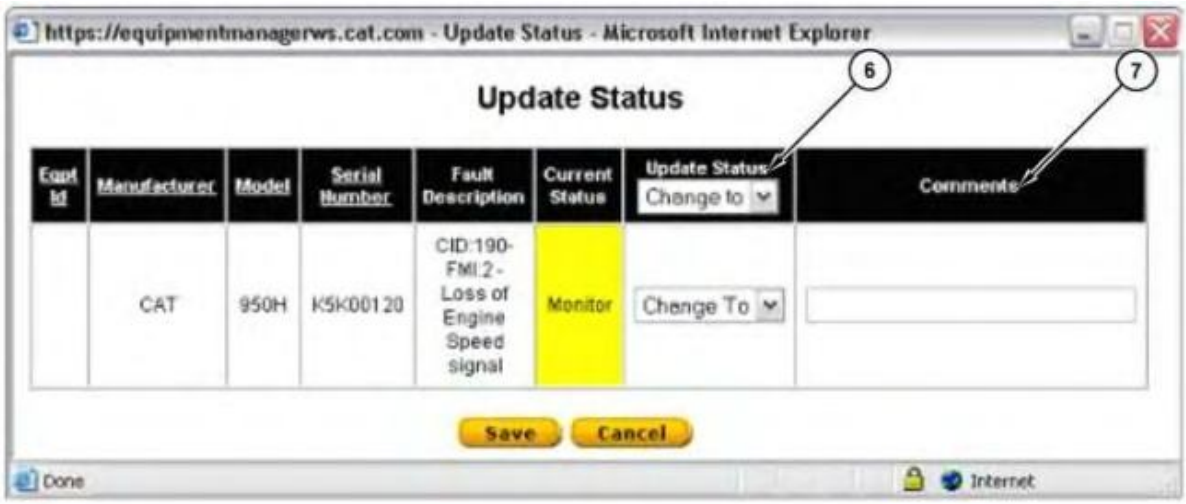


Illustration 5 g01737840

Fault code "Update Status"

(6) "Update Status" field

(7) "Comments" field

2. In the "Update Status" field (6) , select a new status. The following table displays the different possible selections for "Update Status":

Table 1

Status	Color	Importance
Action	RED	Highest
Monitor	YELLOW	Medium
Normal	GREEN	Lowest
Resolved	--	--

3. In the "Comments" field (7) , type your comments.
4. Click "Save". The status of the fault code is now updated.

Note: Once the status of an event is changed to "Resolved", the event will no longer be displayed in the "Exception Dashboard".

S·O·S Service Manager Software

S·O·S alerts for fluid analysis may be provided in EquipmentManager if your dealership uses S·O·S Service Manager software in the dealership's laboratory. S·O·S alerts will be displayed in the Exception Dashboard in the "Event Summary" display.

The S·O·S Service Manager tool is a software program that is available through your dealer's web site. In order to view S·O·S details or reports for a sample, use the tool for viewing the S·O·S application on the web. Also, you may contact your Caterpillar dealer's S·O·S laboratory for your results. The report from the S·O·S laboratory may be obtained from a fax or from e-mail. A paper copy of the report can be mailed as well.

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Systems Operation
EquipmentManager User Guide
Media Number -KENR6303-08 **Publication Date -01/05/2010** **Date Updated -18/05/2010**

i03347780

Reports

SMCS - 7600; 7606

Overview

EquipmentManager can also assists you in managing your equipment by generating reports can be saved or printed. The following types of reports are available:

- Product Usage
- Product Monitoring
- Operating and Maintenance Manual (OMM) (no PDF format, viewed on-line)
- Equipment Usage (no PDF format, viewed on-line and exported to save or to print)
- Active Fleet Report

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i03352506

Product Usage

SMCS - 7600; 7606

"Product Usage Report"

The "Product Usage Report" provides information on the "Product Usage" and "Fuel Usage". The "Product Usage" report may be displayed for a period of time that can span for multiple months and that can include the current day. So, the period for reviewing the history of the report can be selected to the preference of the user.

In order to generate a "Product Usage Report", use the following procedure:



Illustration 1 g01727293

"Product Usage Report" screen

(1) Radio button

(2) "View" drop-down menu

(3) "View Reports" button

1. Search for equipment and view the results on the "Event Summary" screen. In the "View" drop-down menu (2), select "Product Usage Report". The "Product Usage Report" screen will appear.

2. Select the radio button (1) that corresponds with the equipment in order to generate a report for the equipment.

3. Select "View Reports" (3). The "Product Usage" report appears as an Microsoft^{R} Excel file in a new window. You can save the report locally and you can print the report. Also, you can send an e-mail of the report.

   Note: The "Product Usage Report" is the calculated comparison of the percentage of operational hours and the total available hours. Total available hours are calculated as 24 hours times the number of days in the range of the date. In order to adjust the total available hours to represent planned hours of operation, type the daily hours in "Daily Product Usage Hours" field before generating the report.

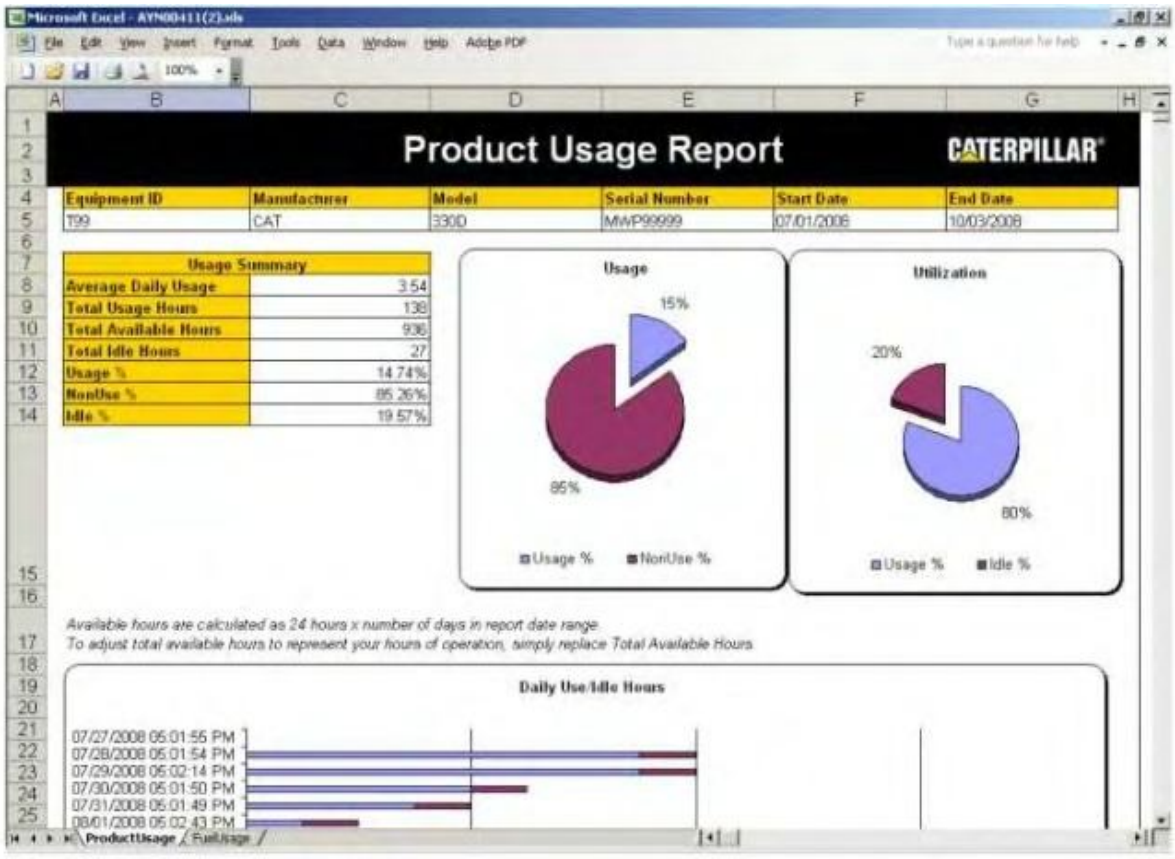
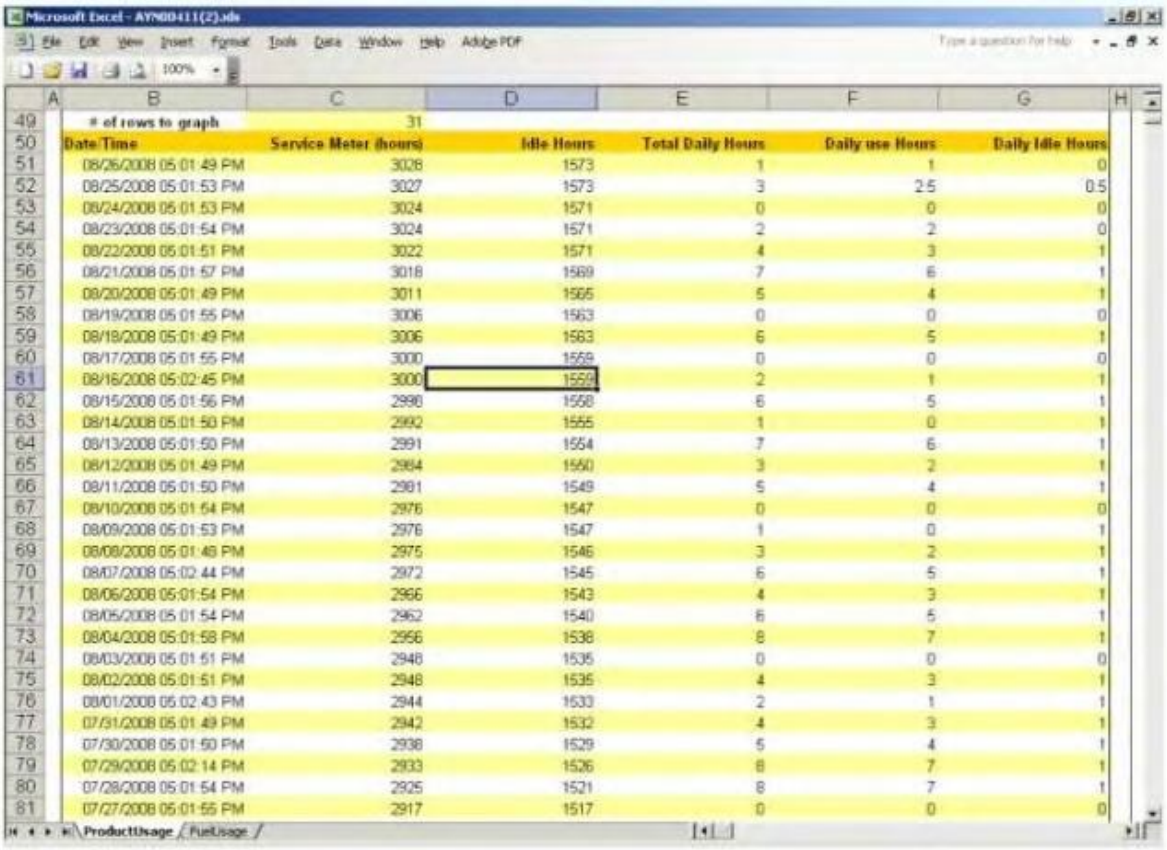


Illustration 2 g01727294

Table 1

"Product Usage Report"	

Field	Description
Header	
"Equipment ID"	The id of the equipment
"Manufacture"	The manufacturer of the equipment
"Model"	The model of the equipment
"Serial Number"	The serial number of the equipment
"Start Date"	The start date for the range of data
"End Date"	The end date for the range of data
"Usage Summary"	
"Average Daily Usage"	The average of daily hours for the dates that are within the range of the defined date
"Total Usage Hours"	The total hours for the dates that are within the range of the defined date
"Total Available Hours"	The total hours of available work for the machine that are within the range of the defined date
"Usage %"	The percentage of the operational time for the equipment as compared to the total available hours
"NonUse %"	The percentage of time the equipment was not in operation as compared to the total usage hours
"Idle %"	The percentage of time the equipment was in operation but engine speed was lower than 1150 rpm
"Usage" pie chart	A pie chart that displays the "Usage %" and the "NonUse %"
"Utilization" pie chart	The Utilization of the machine during hours of operation displayed in a pie chart with "Usage %" indicating the percentage of time the machine operated at an engine speed greater than 1150 rpm and "Idle %" indicating the percentage of time the machine operated at an engine speed lower than 1150 rpm
"Daily Use/Idle Hours" bar chart	A bar chart that displays the daily used hours and idle hours with the Y-axis representing the date and time and with the X-axis representing the number of hours of operation for the machine



	A	B	C	D	E	F	G	H
49		# of rows to graph	31					
50		Date/Time	Service Meter (hours)	Idle Hours	Total Daily Hours	Daily use Hours	Daily Idle Hours	
51		08/26/2008 05:01:49 PM	3028	1573	1	1	0	
52		08/25/2008 05:01:53 PM	3027	1573	3	2.5	0.5	
53		08/24/2008 05:01:53 PM	3024	1571	0	0	0	
54		08/23/2008 05:01:54 PM	3024	1571	2	2	0	
55		08/22/2008 05:01:51 PM	3022	1571	4	3	1	
56		08/21/2008 05:01:57 PM	3018	1569	7	6	1	
57		08/20/2008 05:01:49 PM	3011	1565	5	4	1	
58		08/19/2008 05:01:55 PM	3006	1563	0	0	0	
59		08/18/2008 05:01:49 PM	3006	1563	6	5	1	
60		08/17/2008 05:01:55 PM	3000	1559	0	0	0	
61		08/16/2008 05:02:45 PM	3000	1559	2	1	1	
62		08/15/2008 05:01:56 PM	2998	1558	6	5	1	
63		08/14/2008 05:01:50 PM	2992	1555	1	0	1	
64		08/13/2008 05:01:50 PM	2991	1554	7	6	1	
65		08/12/2008 05:01:49 PM	2984	1550	3	2	1	
66		08/11/2008 05:01:50 PM	2981	1549	5	4	1	
67		08/10/2008 05:01:54 PM	2976	1547	0	0	0	
68		08/09/2008 05:01:53 PM	2976	1547	1	0	1	
69		08/08/2008 05:01:48 PM	2975	1546	3	2	1	
70		08/07/2008 05:02:44 PM	2972	1545	6	5	1	
71		08/06/2008 05:01:54 PM	2966	1543	4	3	1	
72		08/05/2008 05:01:54 PM	2962	1540	6	5	1	
73		08/04/2008 05:01:58 PM	2956	1538	8	7	1	
74		08/03/2008 05:01:51 PM	2948	1535	0	0	0	
75		08/02/2008 05:01:51 PM	2948	1535	4	3	1	
76		08/01/2008 05:02:43 PM	2944	1533	2	1	1	
77		07/31/2008 05:01:49 PM	2942	1532	4	3	1	
78		07/30/2008 05:01:50 PM	2938	1529	5	4	1	
79		07/29/2008 05:02:14 PM	2933	1526	8	7	1	
80		07/28/2008 05:01:54 PM	2925	1521	8	7	1	
81		07/27/2008 05:01:55 PM	2917	1517	0	0	0	

Illustration 3 g01727295

Table 2

"Product Usage Report"	
Field	**Description**
Table	
"# of rows to graph"	The number of rows to display in the "Daily Use/Idle Hours" bar chart
"Date/Time"	The date and time of the Service Meter Hours and Idle Hours as reported by the Product Link Module (PLM)
"Service Meter (hours)"	The "Service Meter (hours)" that are reported by the PLM
"Idle Hours"	The "Idle Hours" that are reported by the PLM
"Total Daily Hours"	The number of operational hours of the equipment from the report from the previous day
"Daily use Hours"	The number of operational hours of the equipment at a higher rpm than 1150 rpm
"Daily Idle Hours"	The number of operational hours of the equipment at 1150 rpm or below 1150 rpm

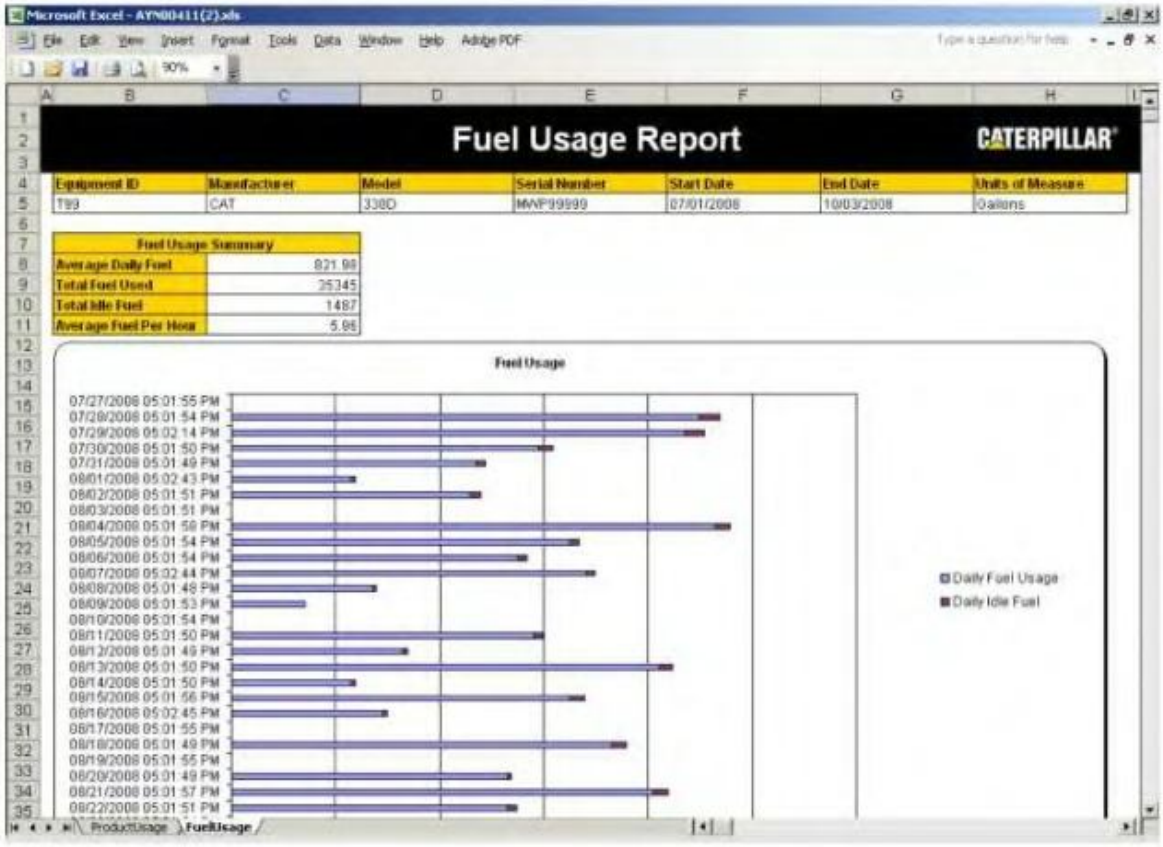


Illustration 4 g01727296

In order to access "Fuel Details", click the "FuelUsage" tab on the bottom of the Microsoft Excel file.

Table 3

"Product Usage Report"	
Field	**Description**
Header	
"Equipment ID"	The id of the equipment
"Manufacture"	The manufacturer of the equipment
"Model"	The model of the equipment
"Serial Number"	The serial number of the equipment
"Start Date"	The start date for the range of data
"End Date"	The end date for the range of data
"Units of Measure"	The units (liters, gallons) of measurement that are defined by the preferences of the user
"Fuel Usage Summary"	
"Average Daily Fuel"	The daily average of fuel that is burned for the dates that are within the range of the defined date
"Total Fuel Used"	The total volume of fuel that is burned for the dates that are within the range of the defined date

"Total Idle Fuel"	The total volume of fuel that is burned at idle for the dates that are within the range of the defined date
"Average Fuel Per Hour"	The comparison of the percentage of operational hours and the total available hours
"Fuel Usage" bar chart	A bar chart that displays the fuel that is burned daily were the X-axis represents the volume of fuel burned. displayed in the units of measurement preferred by the user

Note: "Service Meter (hours)", "Idle Hours", Fuel and Idle Fuel used for this report are values received during the scheduled updates. The time of the day for these scheduled reports is defined by the "First Report Time" value and the value can be viewed in the "General Registry". The schedule report time can be changed over the air. Refer to theSystems Operation, "Manage Hardware" for more information.

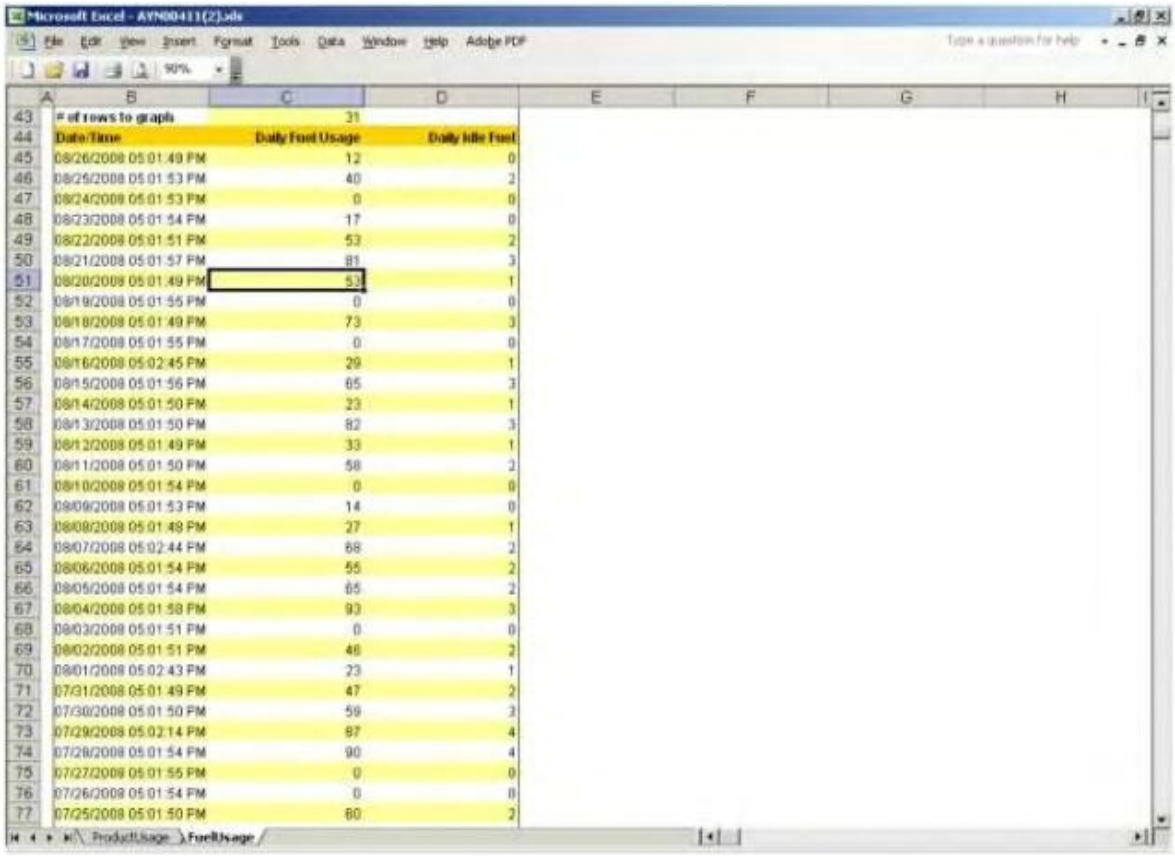


Illustration 5 g01727535

Table 4

"Product Usage Report"	
Field	**Description**
Table	
"# of rows to graph"	The number of rows to display in the "Daily Use/Idle Hours" bar chart
"Date/Time"	The date and time of the "Service Meter (hours)" and "Idle Hours" as reported by the PLM

"Daily Fuel Usage"	Displaying the volume of fuel consumed by the equipment from the report from the previous day in the units of measurment preferred by the user
"Daily Idle Fuel"	The volume of fuel consumed during idle operation report from the previous day. Displayed in the user preference for units of measure

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i03366743

Product Monitoring

SMCS - 7600; 7606

Product Monitoring Report

This report provides a listing of hours, location, cumulative fuel burned and diagnostic codes sent by the Product Link Module (PLM). The " Product Monitoring Report" may be displayed for a period of time that spans multiple months and can include the current day. So, the report history period can be selected to the user preference for period of review.

In order to generate a" Product Monitoring Report", use the following procedure:

1. Search for equipment and view the results on the "Event Summary" screen. In the "View " box, select "Product Monitoring Report". The "Product Monitoring Report" screen appears.

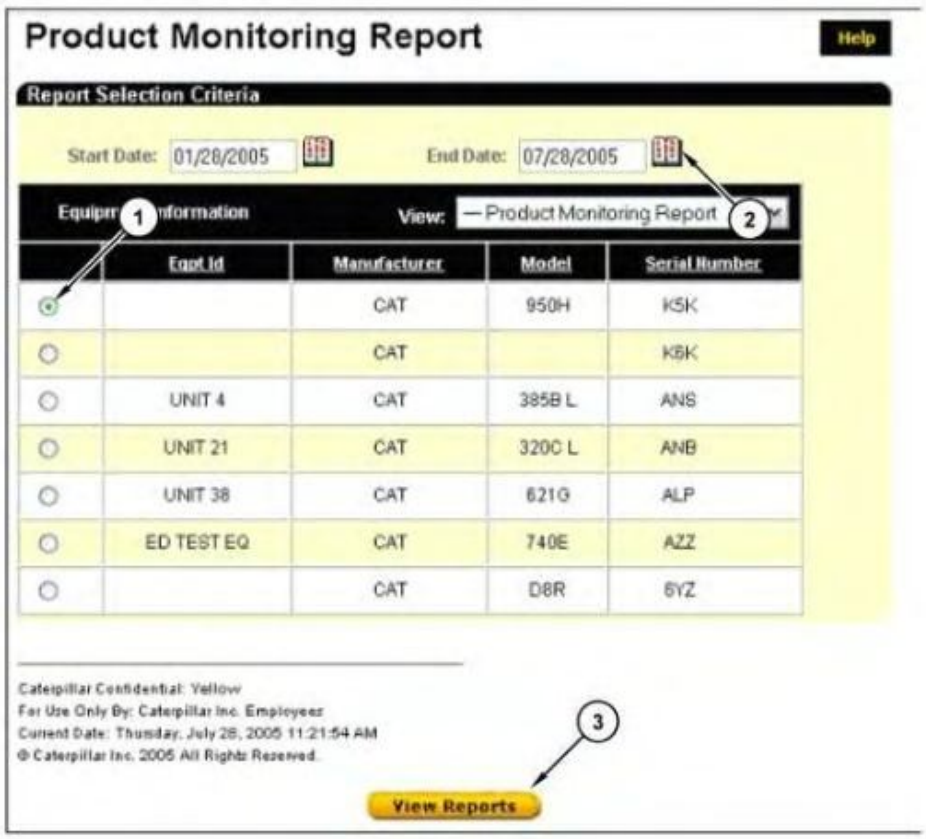


Illustration 1 g01737833

Product Monitoring Report

(1) Radio button

(2) "Start Date" and the "End Date"

(3) "View Reports" button

2. Select the "Start Date" and the "End Date" (2) that corresponds with the period for the "Product Monitoring Report". Refer to Illustration 1.
3. Select the radio button (1) that corresponds with the equipment for which you wish to generate a "Product Monitoring Report".
4. Click the "View Reports" button (3) . The "Product Monitoring Peport" appears as a PDF file in a new window. You can save the report locally, print the report, and e-mail the report.

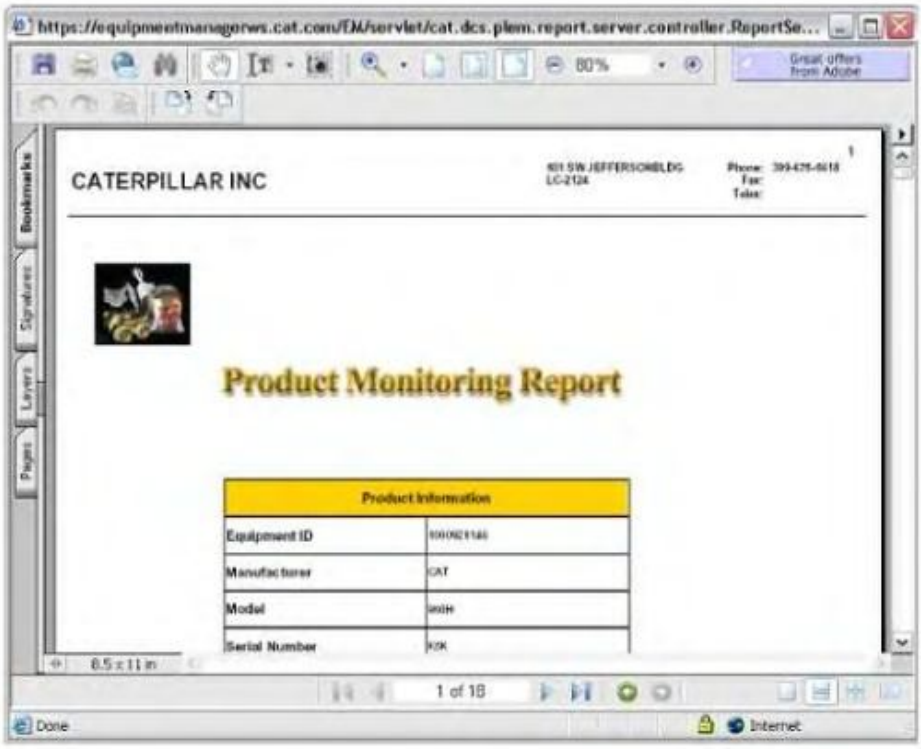


Illustration 2 g01254175

"Product Monitoring Report" PDF

Product Monitoring Report Cover Page



Illustration 3 g01254184

"Product Monitoring Report" cover page

The following table lists the fields that are found on the "Product Monitoring Report" cover page. Refer to Illustration 3.

Table 1

Field	Field Description
Equipment ID	The Equipment ID of the machine for which the report is being generated.
Manufacturer	The Manufacturer of the machine for which the report is being generated.
Model	The Model of the machine for which the report is being generated.
Serial Number	The Serial Number of the machine for which the report is being generated.
Principal Dealer	The name of the Principal Dealer of the machine for which the report is being generated.

Type	The type of report that you are viewing. In this case the type is "Product Usage Report".
Report for the Month Of	The month and year of the data that is being displayed in this report in the form MON-YYYY.
Report Generated Date	The date that the report was generated in the form DD-MON-YYYY.

"Product Monitoring Report" and Details

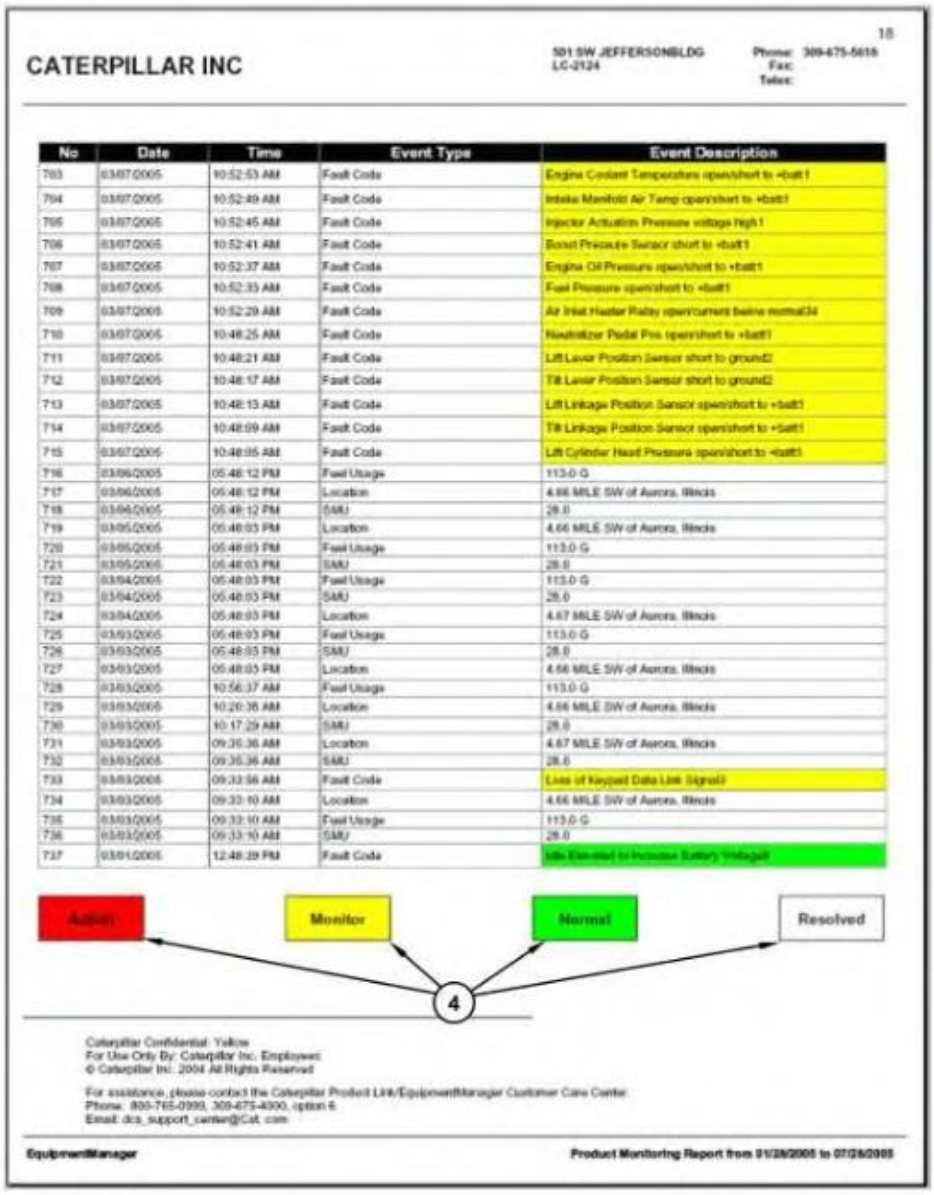


Illustration 4 g01737834

"Product Monitoring Report" details

(4) Event status

After the cover page, the "Product Monitoring Report" displays a table that lists all the events reported by the PLM for the selected time period. Table 2 lists the fieldsthat are in this table. Refer to Illustration 4.

Table 2

Field	Description
No	The events are numbered sequentially and this number is displayed in the "No" column.
Date	The date the event was recorded in MM/DD/YYYY format.
Time	The time the event was recorded in Hr:Min:Sec AM/PM format.
Event Type	The type of event that was recorded. Possible values include: Fault Code, SMU, Fuel Usage, etc.
Event Description	A description of the event. This field is color coded by the event status (4) : "Normal", "Monitor", "Action", and "Resolved".

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Operation and Maintenance Manual

SMCS - 7600; 7606

Operation and Maintenance Manual Report

The Operation and Maintenance Manual (O & MM) report provides a link to the Service Information System (SIS) Web site. You can access O & MM information for a specific Caterpillar machine through EquipmentManager. In order to use this feature, you must have access to the SIS Web site.

In order to view an O & MM report, use the following procedure.

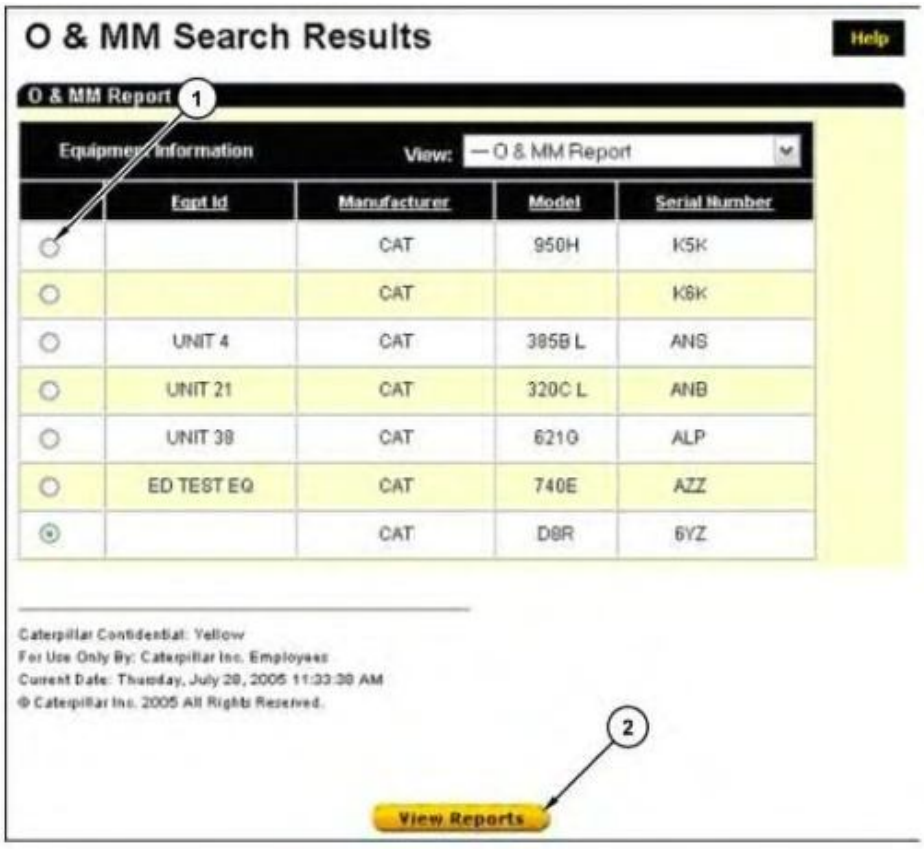


Illustration 1 g01737813

"O & MM Search Results" screen

(1) Radio button

(2) "View Reports" button

1. Search for equipment and view the results on the Event Summary screen. In the "View" box, select "O & MM Report". The "O & MM Search Results" screen appears. Select the radio button (1) for the equipment for which you wish to generate an O & MM report.



Illustration 2 g01254304

Selecting an O & MM for configuration from SIS Web

2. Click "View Reports" button (2) . The Service Information System (SIS) Web site appears in a new window. If there is more than one O & MM available for the machine, a message for selcting a configuration will appear. Refer to Illustration 2.

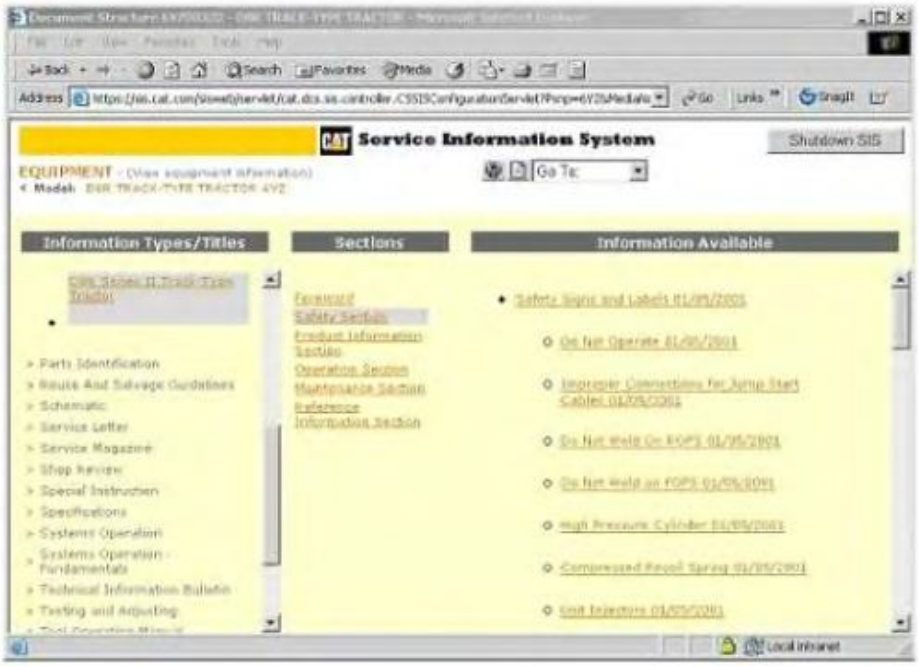


Illustration 3 g01254309

SIS Web – O & MM

3. Click the hyperlink for one of the listed O & MM configurations. A web page displays the manual for the selected configuration. Refer to Illustration 3.

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Equipment Usage

SMCS - 7600; 7606

The Equipment Usage report will calculate the usage of selected machines in hours for a selected period of days, weeks, months, or years. This report also displays the last location reported during the selected period.

To view a summary of the Equipment Usage on a machine, use the following procedure.

1. From the "Event Summary" screen, select the checkbox next to the equipment for which you wish to view equipment usage.
2. From the "View" drop down menu, select "Equipment Usage Summary". The "Equipment Usage Summary" screen is displayed.

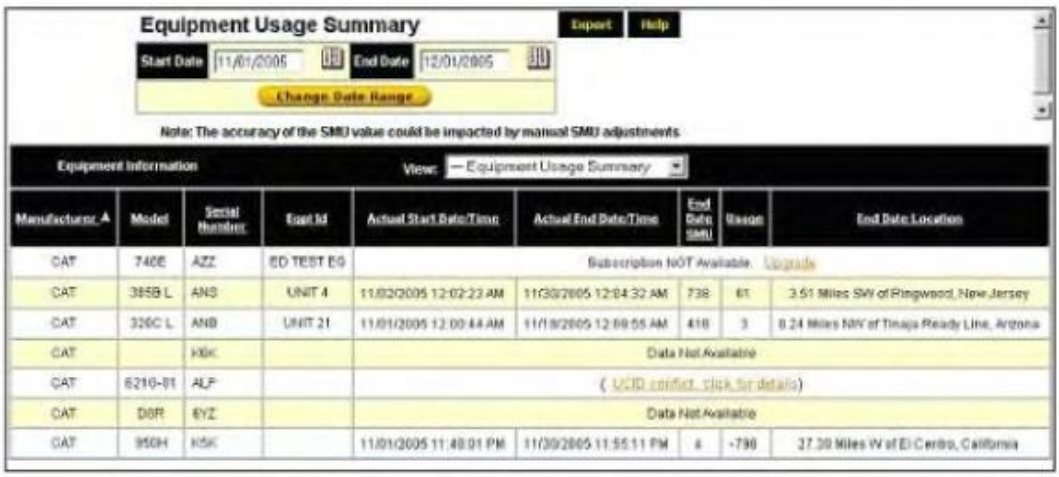


Illustration 1 g01254631

Equipment Usage Summary Screen

3. To change the date of the summary, click the calendar icons next to the "Start Date" and/or "End Date" fields and select a date from the pop up calendar, then click "Change Date Range". A new Equipment Usage Summary is displayed.

Note: The accuracy of the SMU value could be impacted by manual SMU adjustments.

Exports

The Export function enables you to export your current view to multiple file formats. The data can then be sorted, filtered, charted, manipulated, and shared with others.

In order to export data to an Excel spreadsheet, perform the following steps:

1. On the "Equipment Usage Summary" screen, click Export. The "Export" window appears.



Illustration 2 g01393488

Export Window

Note: You can export data to other file formats. Lotus 1, 2, 3 works similarly to Excel. Tab Delimited Text enables easy import into other applications like Access.

2. Select "MS Excel Spreadsheet", and then click "OK".

   The "File Download" dialog box appears.

3. Click "Save" to save the file as a spreadsheet on your hard drive, where you can manipulate the file using standard Excel spreadsheet functions such as "Average and Chart", or share the file electronically.

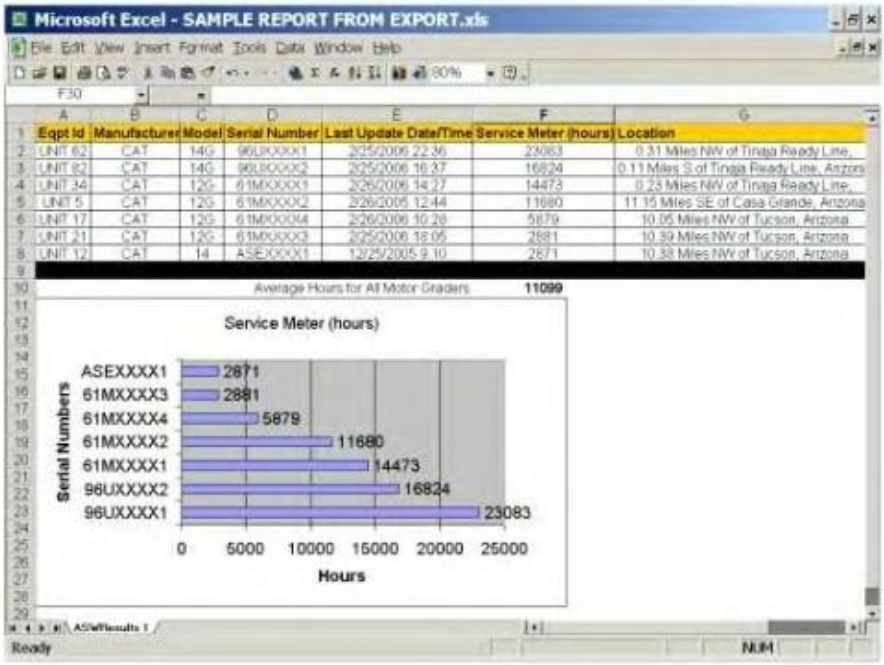


Illustration 3 g01393494

Note: You can export to the Maintenance Control System (MCS) (location and SMU page export only). This export creates a fixed width .txt file that can be imported into the MCS.

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Systems Operation
Machine Security System
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i04008433

General Information

SMCS - 7631

The Cat® machine security system (MSS) discourages unwanted operation of a machine. The MSS uses the new Cat® electronic key. The Cat® electronic key contains an electronic chip. The electronic chip has a unique identification number (ID). An exciter coil is mounted around the key start switch. The exciter coil reads the ID of the key.

The electronic control module (ECM) of the MSS is set up with the ID of the keys of the intended users. When the MSS is armed, the ECM validates the ID of the key in the keyswitch. If that ID is in the list of authorized keys in the ECM and the key is valid, the machine will operate normally. If that ID is not in the list of authorized keys or the key is not valid, the MSS will keep the machine functions disabled.

Components

The MSS consists of the following components:

- ECM
- Cat® electronic key
- Exciter coil
- Status indicator

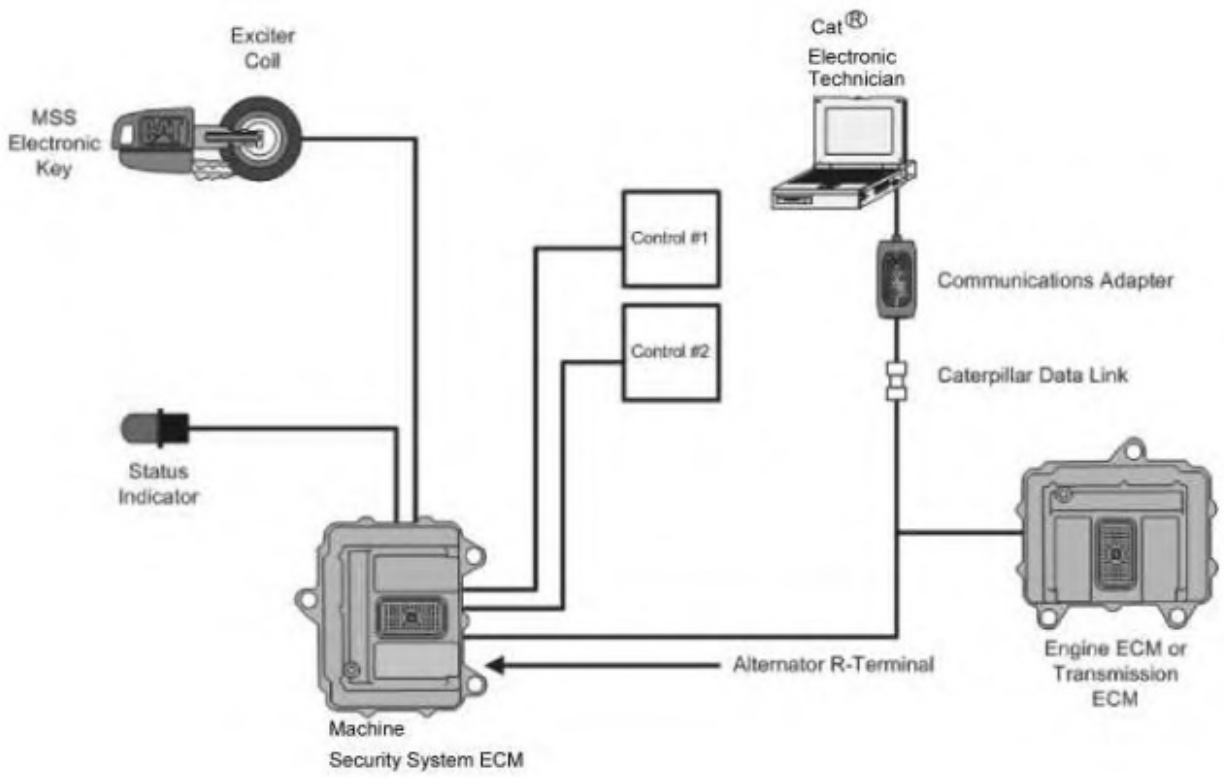


Illustration 1 g02181780

Machine security system (MSS)

The ECM for the machine security system is a hardened computer that is designed specifically for the MSS.

The Cat® electronic key for the MSS contains an electronic chip that is embedded in the head of the key. This chip in the head of the key contains a unique identification number. The Cat® electronic key uses the same key cut as the standard Cat® key. The electronic key can be used to operate any machine that uses the current Cat® keyswitch. The Cat® electronic key comes in a gray color or a yellow color. Cat® electronic keys are not configurable.

The exciter coil of the MSS is a ring shaped device. The exciter coil is mounted around the existing Cat® keyswitch. The exciter coil is used to read the ID that is contained in the Cat® electronic key.

Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS ECM will not read the key and the machine will not start.

The status indicator for the MSS is mounted in the dash of the machine near the keyswitch. The status indicator will give basic information about the MSS to the operator of the machine. The status indicator has two colors: red and green.

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Systems Operation
Machine Security System
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i04008039

System Overview

SMCS - 7631

The machine security system (MSS) is designed to restrict operation of a machine. A list of the authorized electronic keys for a machine is contained in the electronic control module (ECM) for the MSS. Only a Cat® electronic key that is authorized can disarm the MSS. Disarming is accomplished by assigning the ID of an electronic key to the ECM for the MSS. The Cat® Electronic Technician (Cat® ET) service tool must be used to program the ECM with the authorized keys.

When the exciter coil is used with MSS, the electronic key is placed in the keyswitch of the machine and turned to the ON position. The ECM will read the unique ID that is stored in the key. The ECM will then compare this ID to the list of authorized keys.

If the ID of the key that is read matches an authorized key, the following actions will occur:

- The status indicator will turn a green color.
- The MSS will disarm allowing the machine to operate.

If the ID of the key that is read does not match the list in the ECM, the following actions will occur:

- The status indicator will become a red color.
- The MSS remains in the armed state.
- The machine will remain disabled.

Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS ECM will not read the key and the machine will not start.

The machine security system can be installed in a combination of ways:

1. **Electronic Control**

   The MSS disables the machine by controlling up to two devices (relays) that are used to power a critical machine system.

2. **Immobilizer**

   The MSS disables the machine by communicating with other electronic control modules across the Cat® Data- Link (CDL) and disabling critical machine functions.

To change the list of authorized keys or configuration parameters, the user must have one of the following items:

- Cat® Electronic Technician (Cat® ET) service tool and a key with master access level for that specific machine security system
- Cat® ET and a factory password

When a key with the master access level is not available, a factory password is required to change certain parameters in the configuration.

Refer to Testing and Adjusting, "Factory Password - Obtain" for additional information on factory passwords.

The Cat® ET screen for the factory level security password will display the following parameters:

- ECM serial number
- Product ID (Serial number of the machine)
- Serial number of the service tool
- Reason code
- Total tattletale number

To obtain the proper passwords, the information must be given to an authorized Cat® dealer.

If a key with the master access level for the machine is not available, a factory password must be entered before changes can be made. The following information is needed before you call for a factory password:

Table 1

Information That is Needed for the Factory Password	
Product Identification	
Software Part Number from MSS ECM	
Serial Number from ET	
Tattletale	
Reason Code	99 or 4

Note: The password may only be used for one programming session. A different password will be required after you exit the Cat® ET screen.

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Systems Operation
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i02173281

Normal Operation

SMCS - 7631

Reading the ID of a Key

Before you can operate the machine, the MSS must identify a valid electronic key ID. This is done via the exciter coil.

Exciter Coil

When the key is turned to the ON position, the MSS enters the read mode. The MSS then checks for a valid electronic key ID. If the electronic key ID matches an electronic key ID that is stored in the MSS ECM, then the MSS ECM will supply power to the output drivers of the MSS ECM. An "enable" message is also sent via the CAT data link to the other electronic control modules that are on the machine. The machine will operate normally.

Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If there is more than one electronic key near the exciter coil, the MSS ECM will not be able to read the key and the machine will not start.

Note: On machines that are equipped with electronic control modules that are MSS aware and the MSS ECM is activated for the first time, the MSS will enter the Advanced Mode. In the event that the MSS ECM has failed or the MSS ECM has been removed, the other critical machine operations that are controlled by the other electronic control modules will not operate.

Timeouts

After a machine has been started successfully, the operator will have 30 seconds after the machine is turned off before the MSS is automatically armed. The operator is not required to manually arm the system.

If the MSS is unable to read an electronic key ID, the system will remain armed.

When the MSS identifies a key with an invalid electronic key ID, the system will remain armed.

Armed

When the MSS is armed, the two output drivers are open. This disables the power that is supplied to each component that is powered by the output drivers. The machine will not be able to operate normally. When the system has been armed, the red LED of the status indicator will illuminate.

There are two states of operation within the "armed" mode.

1. **"MSS Armed"**

   When no power is applied to the MSS, the MSS will default to "armed" state. When power is applied to the MSS, and all timeouts have expired, the MSS will return to the "MSS Armed".

2. **"MSS Read"**

   Exciter Coil

   When the keyswitch is first moved to the ON position, the MSS tries to read the electronic key ID. The ECM will continue reading attempts until an ID is read or the read timeout expires. If an ID is read, the MSS changes to the "MSS read" state. If the read timeout expires, the MSS will turn the red LED of the status indicator on and the MSS will remain armed.

   Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If there is more than one electronic key near the exciter coil, the MSS ECM will not be able to read the key and the machine will not start.

Disarm

When the MSS is disarmed, the machine can be operated. The MSS has enabled the starter and main circuits on the machine. A message is sent to the other machine ECM(s) over the Cat data link. The machine will be able to start. The green LED of the status indicator will illuminate.

There are two ways to disarm the machine:

- Use a valid electronic key for this machine.
- Use a Cat Service Tool (Electronic Technician) with a "Master Access Level" key or a factory password to modify the configuration of the system.

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i01928230

Operation of Status Indicator

SMCS - 7631

The Machine Security System uses a status indicator that is mounted in the cab near the key start switch. The status indicator provides a visible alert of the presence of the security system. When the MSS is armed and the key start switch is first turned to ON or START positions, the status indicator will momentarily display a red light. This provides a warning that the machine is armed with a security system.

Status Indicator



Illustration 1 g01002949

Typical installation of the Status Indicator

(1) Status Indicator

(2) Keyswitch with Exciter Coil

The state of the MSS is displayed by the status indicator in accordance with Table 1. The operator can use the status indicator to determine the status of the system or for troubleshooting.

Table 1

Status Indicator	Description
Continuously Red	The MSS is armed. (1)
Continuously Green	The MSS is disarmed. The green LED will remain ON 30 seconds after powerdown. After the 30 seconds have passed the MSS automatically returns to the "armed" mode.
Continuously Orange (2)	**The red LED and the green LED of the status indicator are tested momentarily by the MSS ECM at powerup. The status indicator will remain on if No "application" software is detected in the electronic control module (ECM).**
The green LED and the red LED alternately blink for ten minutes.	The MSS is disarmed. This indicates that the voltage of backup battery in the MSS is low. The MSS is permanently disarmed.

(1) The red LED will remain ON while the key is in the ON position or until a valid key is read. The red LED will turn OFF approximately 3 seconds after the key is turned to the OFF position.

(2) The red LED and the green LED are continuously ON.

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Systems Operation
Machine Security System
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i04008149

Key Information

SMCS - 7631

You may configure the machine security system to recognize 255 authorized keys. This list contains those keys that will disarm the machine security system. The user adds keys to this list.

The ECM can store five configuration parameters that identify each electronic key. These parameters are listed below:

- Description
- Access level
- Expiration date
- ID1
- ID2

The parameters are not stored in the electronic key. A complete list of the configuration parameters that are available in the Cat® Electronic Technician (Cat® ET) are listed below:

1. Add an electronic key.
2. Change the following information that is related to the electronic key.
    a. Access level
    b. Expiration date
    c. Description
3. Delete an electronic key.
4. Security bypass times
5. Set the internal clock.
6. Fleet configuration

Note: Refer to the Testing and Adjusting, "Key - Program" section for additional information on items 6 2.a 2.b 2.c 3 and 5. Refer to the Systems Operation, "System Disarm Feature" section for additional information on item 4.

Note: A single electronic key can be used on as many machines with an MSS as desired. A separate key for every machine is not necessary. Key strategies will vary depending on machine fleet usage. The following parameters can be different on each machine: Description, Access Level and Expiration Date. The ID will be the same on all the machines.

Note: The features of the MSS are supported in version 2004A SP1 or later of the Cat® ET service tool.

Table 1

Description	Access Level	Expiration Date	ID1	ID2
Operator 2	Standard	Disabled	58396874	52398427
Operator 1	Standard	Disabled	86935748	87458963
Key 2	Standard	10/24/2000 12:00am	36454896	65842781
Key 1	Standard	6/15/2000 6:00pm	23548719	65842781
John	Master	Disabled	0	59377777
Foreman	Master	Disabled	23548719	36525897

ID1 & ID2 (ID &ID2)

The ID that is stored in the electronic key is a 16-digit number. The number is displayed as two 8-digit numbers in the Cat® ET service tool. These fields are known as ID1 and ID2. When the numbers are combined, the complete ID number is formed. The MSS ECM uses this ID to associate a key to the set of parameters in the list of keys.

In Table 1, the fourth entry and the sixth entry have the same ID1. These keys are still unique since ID2 is different. Entries in the list may have the same information for the following items: Description, Access Level and Expiration Date. You may choose a description of 11 characters or less for each key in the list of keys. There can be multiple entries in the list with the same description. Create a description so that the key describes either the owner of the key or the function of the user.

Note: Do not to make duplicate descriptions for the electronic keys.

Access Level

You may assign one of two access levels to a key in the list of keys. The levels are either "Standard" or "Master". Both access levels allow the key to disarm the system for operation. The master access level also gives the user the ability to modify the settings of the machine security system with the Cat® ET service tool.

The standard access level is for normal operation of the machine. The master access level should be restricted to those persons that need to modify the settings of the machine security system.

Expiration Date

An expiration date may be assigned to any key in the list of keys. This expiration date is defined in 6 hour intervals on a given date. The third entry and the fourth entry in Table 1 contain an expiration date. For all of the other keys in Table 1, the column with the expiration date is filled with "Disabled". "Disabled" indicates that those entries do not have an expiration date. The machine security system has an internal clock. Once the internal clock has passed the expiration date for a key, that key will no longer disarm the system. However, the entry will not be deleted from the list of keys. A new expiration date can be set, or the feature can be disabled. A possible use for the expiration date is used with a rental contract.

Note: If the expiration time is reached while the machine is in operation, the machine will continue to run. When the machine is shut down and the 30 second timer has timed out, the machine will not be allowed to restart.

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Systems Operation
Machine Security System
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i02163445

Scheduled Access - "Security System Bypass Times"

SMCS - 7631

The Machine Security System can be programmed to disarm for a period of time. The MSS can be set to disarm for different time periods on each day. Within these periods of time, any Caterpillar key (a standard key or an electronic key) will operate the machine.

Note: It is not possible to configure the "bypass times" for an individual electronic key. The "bypass times" are not associated to an individual electronic key.

"Security System Bypass Times" are time periods that can be set to automatically disarm the Machine Security System. An electronic key is not required during these periods. This feature can be used for the normal work shift of the machine. Outside the normal work shift, the Machine Security System would be armed. When the MSS is armed an electronic key is required to start the machine. This feature would minimize the number of electronic keys that are needed.

Table 1

"Sunday Security System Bypass Start Time"	00:00
"Sunday Security System Bypass Stop Time"	00:00
"Monday Security System Bypass Start Time"	6:00
"Monday Security System Bypass Stop Time"	18:00
"Tuesday Security System Bypass Start Time"	6:00
"Tuesday Security System Bypass Stop Time"	18:00
"Wednesday Security System Bypass Start Time"	6:00
"Wednesday Security System Bypass Stop Time"	18:00
"Thursday Security System Bypass Start Time"	6:00
"Thursday Security System Bypass Stop Time"	18:00
"Friday Security System Bypass Start Time"	6:00
"Friday Security System Bypass Stop Time"	12:00

"Saturday Security System Bypass Start Time"	12:00
"Saturday Security System Bypass Stop Time"	12:00

Table 1 shows an example of "Security System Bypass". The "Start Time" is the time when the Machine Security System will disarm. The Machine Security System will return to the "armed" state at the "Stop Time". Between these two periods of time, any Caterpillar key will operate the machine. Thus, the MSS is disarmed during this period of time.

All times are based on a 24 hour clock. For example, 6:00 am is 06:00 and 3:00 pm is 15:00. The Machine Security System will be disarmed during the times that are listed below: Monday through Thursday from 06:00 to 18:00

On Friday, the MSS is disarmed for only half of the workday. After 12:00 on Friday, the Machine Security System will be armed automatically. Operation will be restricted to operators with electronic keys that are authorized in the MSS ECM on that machine. Refer to Table 1.

The Machine Security System is "armed" on the weekend. Because the "Start Time" and the "Stop Time" are set for the same time, the Machine Security System will be armed throughout the day.

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Systems Operation
Machine Security System
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i01756976

Diagnostic Operation

SMCS - 7631

A diagnostic code indicates that the ECM has detected one or more of the following conditions:

- an invalid signal from an input
- an improper feedback from an output
- an internal error

One method of displaying diagnostic information is provided:

- Diagnostic codes with descriptive text can be viewed with the Caterpillar Electronic Technician (ET).

Display the diagnostic code with the Caterpillar Electronic Technician.

This method of displaying the diagnostic codes uses the service tool to display the codes. The Component Identifier (CID) identifies the specific component for a specific diagnostic. The Failure Mode Identifier (FMI) identifies the type of diagnostic that was detected. The diagnostic codes allow consistent identification of the problem. The service tool is used to display the CID-FMI with descriptive text for each combination. The descriptive text will help to avoid mistakes in interpreting the codes.

Active Diagnostics

Active diagnostics indicate the presence of active diagnostic codes in the MSS. A diagnostic code informs the operator that a problem exists with the MSS.

If the Cat service tool is available, the service tool can be used to display all active diagnostic codes. The service tool will also display codes that have been logged.

Logged Diagnostics

A logged diagnostic will record problems that are intermittent in the Machine Security System. Logged diagnostics eliminate the need to duplicate problems that are intermittent. Logged

diagnostics will increase the accuracy of diagnosis. The time that is required to troubleshoot a problem is reduced with the use of Diagnostics. Logged diagnostics eliminate the need for trip recorders that are used to capture intermittent diagnostic information.

The control module's memory is used to store diagnostic information. When a diagnostic is detected the following information is logged:

- The CID will identify the component that has failed.
- The FMI will describe the problem.
- Number of occurrences of the diagnostic code
- The time of the first occurrence that the diagnostic was detected.
- Last occurrence time, when the diagnostic was last detected (stored with both machine hours and RTC stamp)

The problems which can be logged are listed in Troubleshooting, "Diagnostic Code Procedures".

The MSS logs the number of times that the machine is started with the methods that are listed below:

- Starting using an unauthorized method

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Events

SMCS - 7631

An event indicates that the MSS is not operating correctly. An event does not indicate that there is a failure with the system.

The MSS records data for the events that are listed in Table 1.

Table 1

Events that are logged by the Machine Security System	
Event Identifier	**Description**
E273	"Machine operation attempted using an invalid key"
E274	"Security override used"
E252	"Loss of Key Table Information"

Logged Events

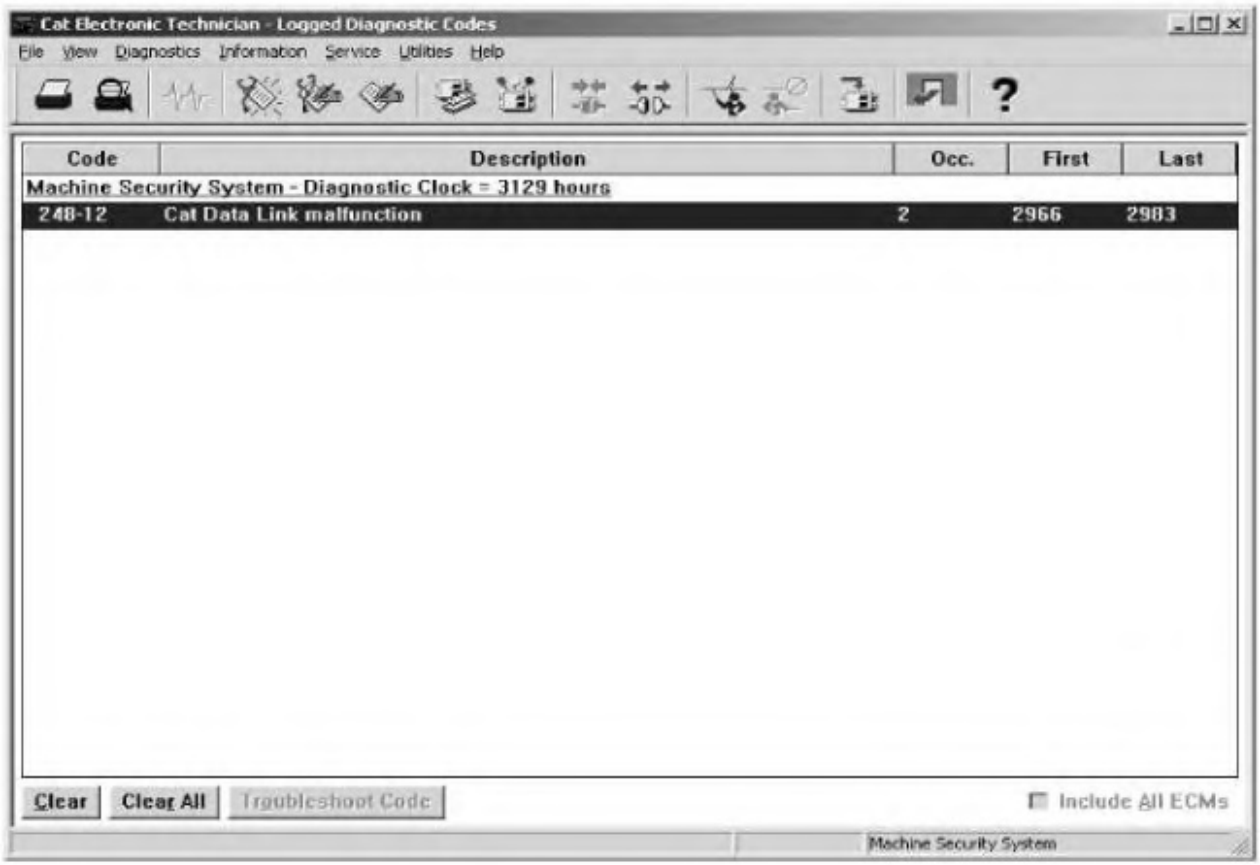


Illustration 1 g01097063

"Logged Event Codes" screen from the Caterpillar Electronic Technician for the Machine Security System

Logged events provide a secure list of events that are critical to the security of the machine. The ECM for the MSS is used to store information about events. When an event is detected, the following information is logged:

- EID for the event
- Number of occurrences
- Time of the first occurrence of the event
- Time of the last occurrence of the event

Note: The ECM will record a maximum of 127 occurrences of the events. The newest event replaces the oldest event after 127 events have been stored in the memory of the ECM.

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i01757006

Protected Functions

SMCS - 7631

There are two levels of protection:

- An electronic key with standard access level and a non-electronic key
- An electronic key with master access level (factory password)

The requirements for each level are explained below:

An Electronic Key with Standard Access Level and a Non-electronic Key

- The table of the MSS keys can be viewed but the table can not be modified.
- The configuration settings of the MSS can be viewed but the settings can not be modified.

Electronic Key with Master Access Level

A factory password or a master access level is needed to modify any settings through the service tool.

- The settings for the MSS can be modified.
- The list of valid key IDs can be modified.
- The logged events can be cleared.

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Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i01377769

Service Operation Using Machine Security System

SMCS - 7631

The onboard interface has several purposes. The interface can provide the following information to the operator: diagnostic feedback and event feedback. The system can also be programmed through the onboard interface.

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i01377916

Service Operation Using Service Tool

SMCS - 0785-UE; 7631

The service tool is used to communicate with the ECM for the following information:

- display and control of code
- programming
- management
- diagnostics
- events

To properly protect the machine, the service tool requires a factory password or a key with the master access level before any modifications can be made to the MSS.

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Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i02170060

Electronic Control Module (ECM)

SMCS - 7610-MCH

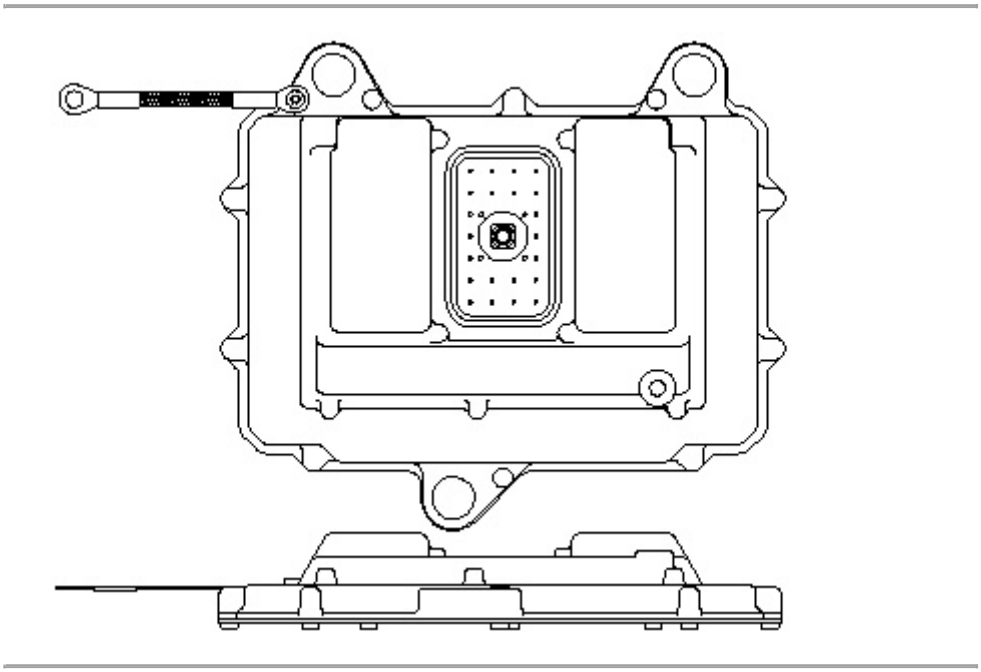


Illustration 1 g00743068

ECM Inputs

Keyswitch

The key start switch is also used as an input signal to the MSS. The input from the key switch is used to determine when the machine is on. Battery voltage is connected to this input through the ON and START positions of the keyswitch. When the machine is operating and the alternator is charging, the voltage on this input will be 14.1 - 15.1 Volts for a 12 Volt system and 27.6 - 29.6 Volts for a 24 Volt system. When the machine is not running, the voltage on this input will be approximately 12 Volts for a 12 Volt system and approximately 24 Volts for a 24 Volt system.

Alternator "R Terminal"

The input for the hour meter is connected to the terminal R on the alternator. The signal from the terminal R is a square wave when the engine is running. The frequency is proportional to engine RPM. The frequency will be within the range of 0 to 2 kHz. This is pin 26 of the Machine Security System ECM.

ECM Outputs

Status Indicator

The status indicator displays status of the system. The status indicator has three connections. One of the three connections is for a ground. Another connection is for the red LED. The third connection is for the green LED.

Low Voltage Indication of the Electronic Control Module's Internal Backup Battery

The internal backup battery is used to maintain the list of keys and the Bypass schedule when the machine is turned off. The battery should last 10 years or more. The internal backup battery is NOT serviceable.

The MSS ECM monitors the battery voltage. The ECM notifies the operator of a low voltage condition by alternately blinking the red LED and green LED for ten minutes. The MSS is permanently disarmed when the low voltage condition is detected.

Output Drivers

Two output drivers are available to control relays or solenoids on the machine. Unless a valid "key ID" has been identified by the system, the drivers will remain without power. **The drivers are rated at 3 amperes**.

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System Components

SMCS - 7631

Cat® Electronic Key

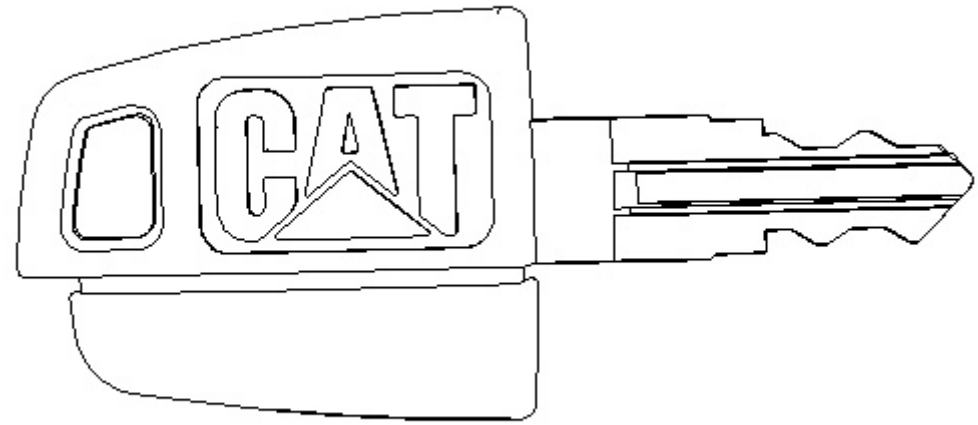


Illustration 1 g00793955

The Cat® electronic key

The Cat® key is the universal key for all Caterpillar machines. The electronic key has an electronic chip that is embedded inside the head of the key. The electronic keys are gray or yellow.

Exciter Coil

The exciter coil provides communication between the electronic key and the control module.

The exciter coil is mounted around the keyswitch. This position allows the exciter coil to communicate with the electronic key. Any ferrous metal between the coil and the electronic key will interfere with the communications. Mounting the coil in the same plane as the top of the keyswitch will minimize the interference.

Note: Ensure that you have only one electronic key near the exciter coil when the machine security system (MSS) reads the key. If more than one electronic key near the exciter coil, the MSS ECM will not read the key and the machine will not start.

The exciter coil is connected to the harness via a 2-pin connector and a length of wire.

Status Indicator

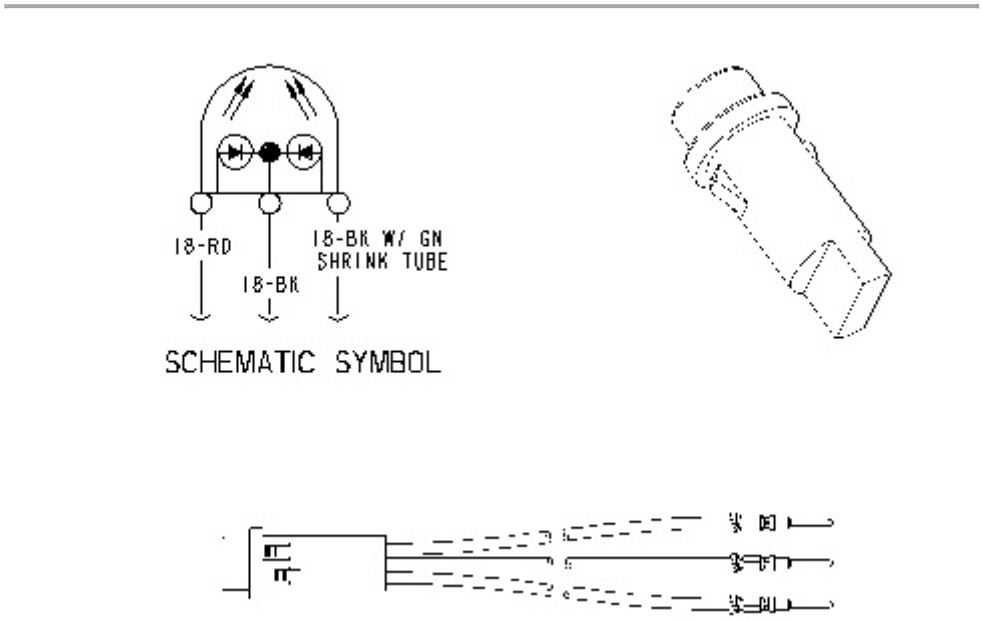


Illustration 2 g00862013

The state of the MSS is displayed by the status indicator. The green LED of the status indicator turns on when the system is disarmed. The machine should start. The red LED of the status indicator turns on when the system is armed and an invalid electronic key has been read by the MSS. The machine should not start. Both LEDs will turn on, producing an orange light if the application software of the MSS has not been programmed into the ECM.

Ferrite Coil



Illustration 3 g00896395

Ferrite Coil

The ferrite coil is used to suppress radio frequency emissions. The ferrite coil must be mounted within 400 mm (16 inch) of the ECM. The ferrite coil is used to ensure that the MSS is in compliance with international regulations.

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Cat Data Link

SMCS - 7631

The Cat Data Link can connect the ECM for the MSS to the following items:

- Service tools
- Onboard controls
- Monitoring systems

The service tool can send information to the MSS through the Cat Data Link. The MSS can provide information over the Cat Data Link to the following items: transmission control, engine control and service tool. The information can be for diagnostics, or the information can be used to control other systems on the machine.

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04526739

System Overview

SMCS - 7606

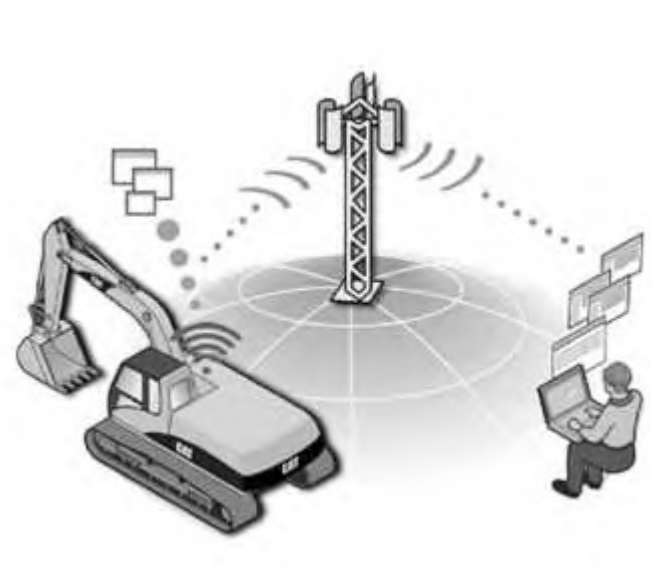


Illustration 1 g02167864

The PL522 and 523 is a communications device that uses a cellular network in order to transmit information to the following: Caterpillar, Caterpillar dealers and Caterpillar customers. The unit contains a Global Positioning System (GPS) satellite receiver and a cellular communication transceiver.

Note: The time periods that are referenced in this publication are dependent upon the performance of the communications network which may vary at times.

The PL522 and 523 are compatible with the communication protocol that is used on the Cat Data Link. All logged events and diagnostic codes that are available to the Caterpillar Electronic Technician (Cat ET) on the Cat Data Link can be sent to the web interface, VisionLink. The PL522 and 523 are not compatible with the communication protocol that is used on the ATA data link for on-highway trucks.

The PL522 and 523 enables the customer to receive the following information: SMH (Service Meter Hours), location, diagnostic codes, events and other Cat Data Link (CDL) information.

The system allows two-way communication between the machine and a remote user such as a Caterpillar dealer or a customer. At any time, a user can request updated information from a machine. Also, the system parameters for the PL522 and 523 module can be changed. The information goes from the machine to VisionLink via the cellular communications network.

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04456172

System Components

SMCS - 1408

Electronic Control Module (ECM)



Illustration 1 g02167935

PL522 and 523 ECM

The PL522 and 523 are electronic control modules (ECM). The ECM is initially setup by using a laptop computer with the Caterpillar Electronic Technician (Cat ET) software. In order to use the

new PL522 and 523 features, update to the latest version of Cat ET. Refer to Special Instruction, REHS2368 for more information on installing the PL522 and the 523.

Ensure that the PL522 and 523 modules are installed with the available shock mount kit. All machines require shock mounting.

Inputs

The PL522 and 523 can be set up to receive information from components about machine operations by using switch-to-ground type inputs. Switches provide ON or OFF (closed or open) signals to the switch inputs of the PL522 and 523. The inputs to the PL522 and 523 are listed in the table for the 70 pin connector.

Input/Output

The PL522 and 523 use the Cat Data Link in order to communicate with other electronic control modules. The Cat Data Link is bidirectional. The data link allows the PL522 and 523 to receive information. The Cat Data Link also allows the PL522 and 523 to send information.

A module identifier (MID) is assigned to each ECM. The MID for the PL522 and 523 is 161.

Table 1

Product Link Contact Description		
Contact Number	Function	Type
34	CAN Low	Input
50	CAN High	Input
42	CAN Shield	Input
52	+ Battery	Power
65	Ground	Ground
54	Alternator R -Terminal	Input
70	Key switch	Input
8	Cat Data Link +	Input/Output
9	Cat Data Link -	Input/Output
45	Spare Digital Input 1	Switch Input (Open/Ground)
46	Spare Digital Input 2	Switch Input (Open/Ground)
47	Spare Digital Input 3	Switch Input (Open/Ground)
55	Spare Digital Input 4	Switch Input (Open/Ground)

Adapter Plates



Illustration 2 g02168153

PL522 and 523 ECM Adapter Plates

The adapter plates allow a dealer to mount a PL522 or 523 in a place originally planned for a PL151/PL201.

Wiring Harnesses

The installation kit includes the control harness assembly. The wiring harness is enclosed in a protective braided cover.

ECM Harness

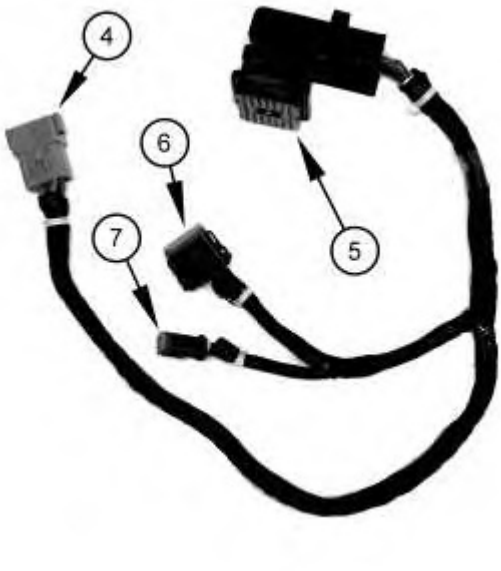


Illustration 3 g01336465

(4) 12 pin receptacle connector (J1)

(5) 70 socket plug connector (P1)

(6) 12 socket plug connector (P2)

(7) 2 socket plug connector (P3)

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04456189

Installation Parameters Configure

SMCS - 7606

Installation Parameters Configured for PL522 and 523

1. Ensure that the correct steps have been taken to connect the computer with Cat ET software to the Product Link system. Refer to Systems Operation, "Configuration".
2. Click the "Connect" icon or click "File" on the menu bar. Click "Connect" from the selections on the pull-down menu in order to establish communication with the PL522 or 523.

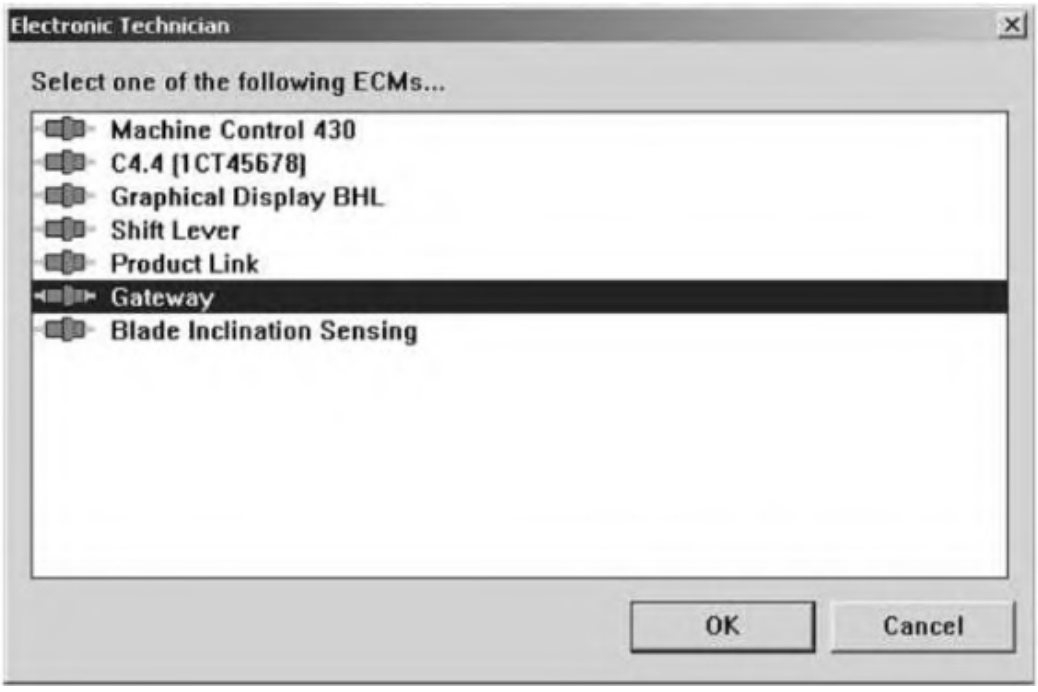


Illustration 1 g02168713

"Select an ECM" Screen

3. The PL523 device is listed as "Vital Information Management System (VIMS) Main Module" as the Cat Data Link connection is made with the gateway board within the device. Select "VIMS Main Module"or "Product Link" from the list of available ECMs. Refer to Illustration 1.

4. Click "OK".

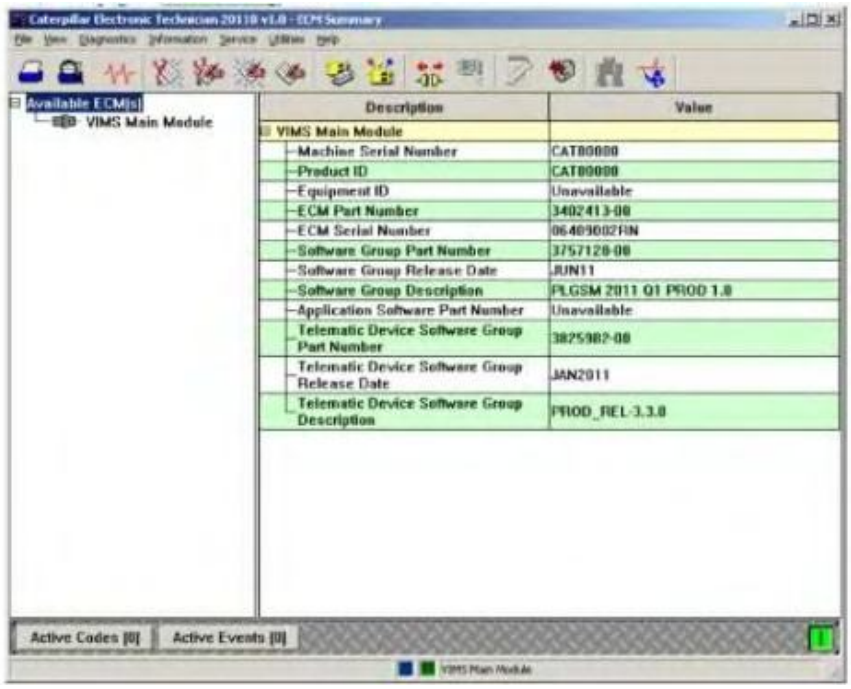


Illustration 2 g02666356

5. Once you are connected, click the "Configuration Tool" icon or select "Service" from the menu. Click "Configuration" from the drop-down menu in order to view the configuration screen.



Illustration 3 g02666396

PL522 and 523 Configuration Screen

6. Highlight "VIMS Main Module" and then click "Expand All". Refer to Illustration 3.

   Note: Internet Protocol parameters should NOT be modified.

7. Double click the desired parameter or select the desired parameter and click "Change". A dialog box will appear. Also, a list will appear that will show all of the possible parameter values.

8. Click "OK" after changing each parameter in order to return to the configuration screen.

ReferenceRefer to the "Machine Serial Number" portion of this section for information about the "Product ID" that is used in the PL522 and 523 system. Refer to Illustration 4 for an example of a machine serial number.

Machine Serial Number

The Machine Serial Number is used by the PL522 and 523 system for routing information by the machine and displaying information by the machine.

Note: The serial number for a non-Caterpillar machine can be any alphanumeric characters up to 17 characters long such as "147433789DBS".

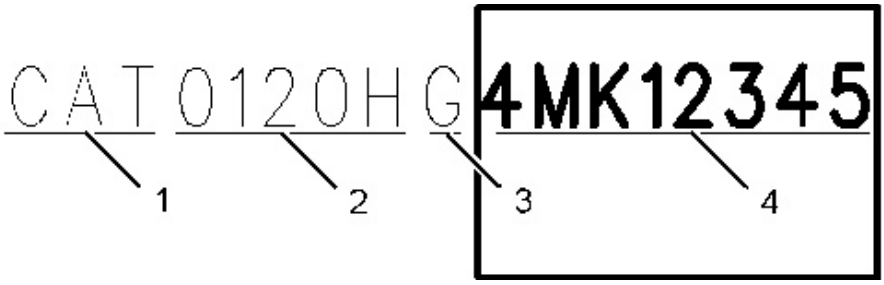


Illustration 4 g02168775

(1) Caterpillars World Manufacturing Code (characters 1 - 3)

(2) Machine description (characters 4 - 8)

(3) Check character (character 9)

(4) Machine Indicator Section (MIS) or Product Sequence Number (characters 10 - 17). These characters were previously referred to as the Serial Number.

For Caterpillar machines, enter only the last eight characters of the "Machine Serial Number". Refer to Illustration 4 for an example of a machine serial number. For Non-Caterpillar machines, enter the entire machine serial number.

First Quarter 2001, the Caterpillar Product Identification Number (PIN) changed from 8 characters to 17 characters. The "Product ID" that is required by the PL522 and 523 system is the last eight digits. Do not start the serial number with a space. Do not abbreviate the serial number. For example, "1AA00123"should not be shortened to "1AA123". Do not use uppercase "O" instead of zero "0". Refer to Item (4) in Illustration 4.

"Machine Maintenance Mode" Screen

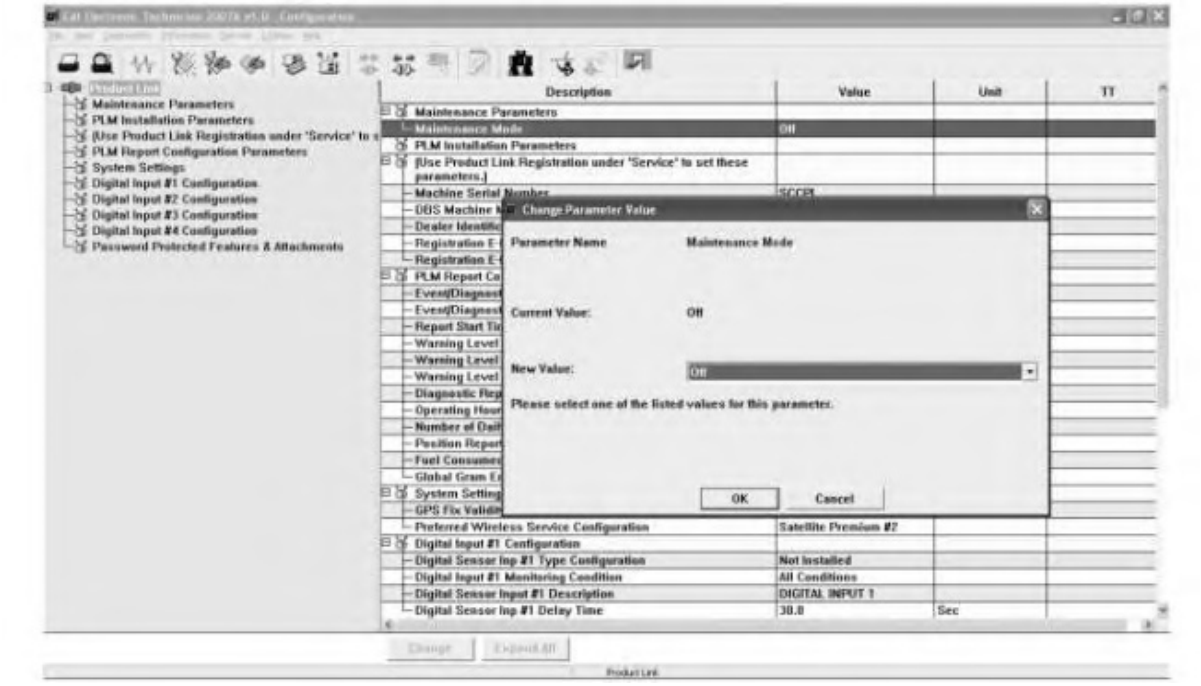


Illustration 5 g01361626

"Machine Maintenance Mode" Screen

The maintenance mode is used to prevent diagnostic and event messages from being reported when performing maintenance on the machine. This value should be reverted to "Off" after the servicing is complete. This value also reverts to "Off" after 12 calendar hours in order to ensure proper operation (long term) of the system. If an event or diagnostic does occur when the maintenance mode is active, the event is ignored until the maintenance mode is turned off. Remember to clear any diagnostic codes that were created during maintenance. If you do not remember, the diagnostic codes will be transmitted once the maintenance mode is turned off.

To disable the PLM from sending any diagnostic or event messages while performing maintenance, select the "On" value. To continue normal operation of the system after maintenance is done, select the "Off" (default) value.

"Synchronize Service Hour Meters" for PL522 and 523

The machine maintains a function that is called "Sync Clock". In a PL522 or 523 system, the PL522 or 523 clock can be the master or the slave. This criteria is automatically determined by the priority that is provided to each ECM when the machine is designed. In most cases, the PL522 and 523 will not be the master ECM. If PL522 or 523 is not the master, use the "Synchronize" button to synchronize the PL522 or 523 SMH to the master ECM SMH. The PL522 or 523 can be the master ECM if the following scenarios occur:

- No other ECM on the machine is SYNC clock capable/enabled as displayed in Cat ET.
- No other ECM on the machine has a priority higher than Product Link. This priority cannot be changed and is automatically determined when the machine is first powered.

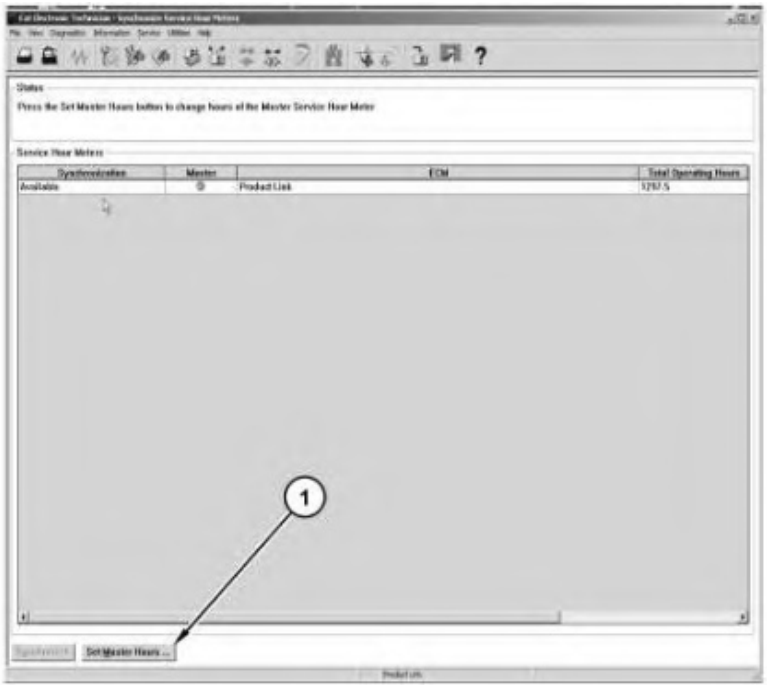


Illustration 6 g02270617

"Synchronize Service Hour Meters" Screen

In order to perform the "Synchronize Service Hour Meters" function, select the "Service" menu, and "Synchronize Service Hour Meters" from the drop-down menu. When the PL522 or 523 is the master ECM, select the "Set Master Hours" button. Once the master hours have been set, click the"Synchronize" button in order to synchronize any other sync-clock capable/enabled ECM. Refer to Illustration 6.

Note: In order to change the SMH to a value lower than the current value, a factory password will be required.

Note: When a PL522 or a 523 is not the master ECM, the PL522 or 523 module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is greater than 50 hours, a MID 122 - EID 0861 - WCI 01 diagnostic will be generated in Cat ET indicating that a manual sync is required. In that instance, sync the hours (Service/Synchronize Service Meter Hours) unless the master ECM hours are incorrect.

If a PL522 or a 523 is not the master ECM, and the master ECMs hours are not correct, troubleshoot on machine side. Do not replace the PL522 or 523 module.

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04486633

Configuration

SMCS - 7606

Connecting a Computer to the Product Link System

Required Software

Verify that PL522 and 523 has installed the latest flash file.

Supported Connections for Hardware

The PL522 and 523 ECMs are configured with Cat ET by using CA-2 or CA-3.

Installations Only - The Communication Adapter Group hardware is connected between the machine service connector and the PC serial port or parallel port. The Cat ET "Communications Interface Device" is configured for the "Caterpillar Communications Adapter II (RP1210)".

Note: The configuration parameters for the "Communications Interface Device" are found in Cat ET under "Utilities" menu, "Preferences" drop-down menu.

Configure Computer Interface Communications for Cat ET

The following examples of screens show configuring communications for the computer in order to use Cat ET through the Communications Adapter II.

1. Use the Communication Adapter Gp to connect a computer with the required Cat ET software to the serial service connector of the wiring harness.

2. Select "Utilities" on the tool bar.

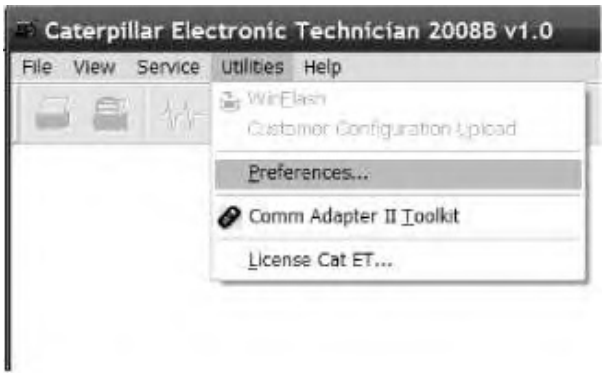


Illustration 1 g02225153

3. From the drop-down menu, select "Preference".

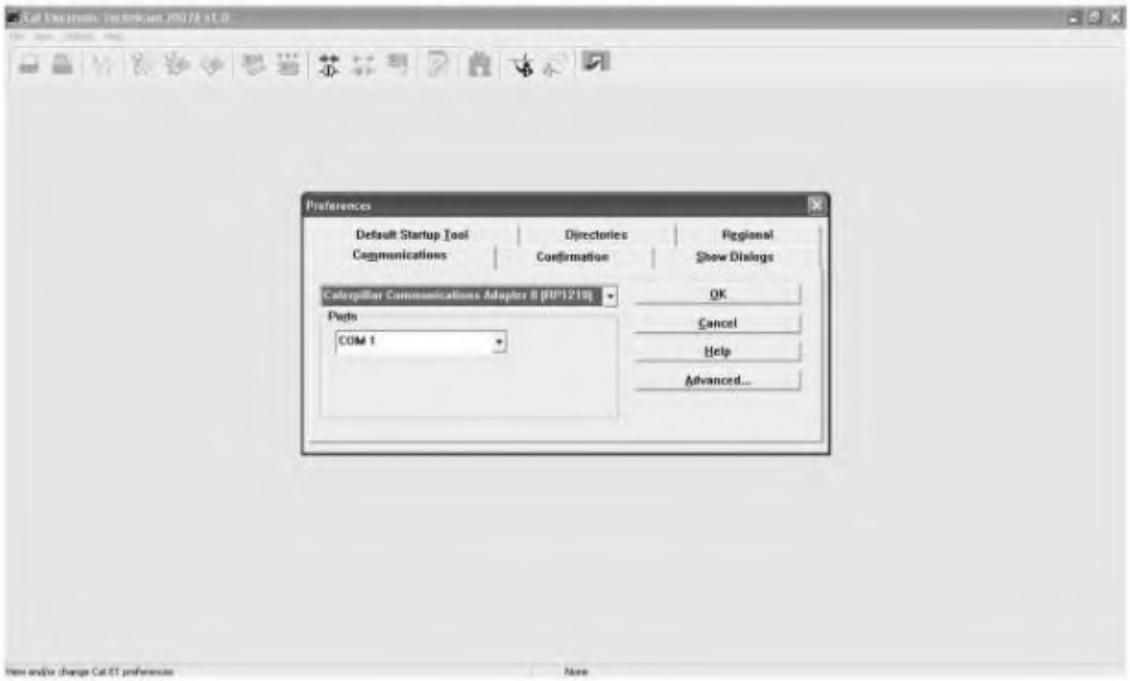


Illustration 2 g01361214

"Preference" Section for Cat ET

4. From the "Communications" tab, click the drop-down menu and select "Caterpillar Communications Adapter II".

Configure Product Link PL522 and 523

This section provides information for the user in order to configure the machine serial number which is required for purchasing Software Enabled Attachments (SEA).

1. There are three ways to access the configuration screen. Select one of the following options:
    - Select "Service" and select "Configure" on the menu bar.

- Press the "F5" key.
- Select "ECM Configuration Icon" on the tool bar.

2. Ensure that steps have been taken to connect to the computer with Cat ET software to the Product Link system. Refer to "Connecting a Computer to the Product Link System".
3. Click the "Connect" icon or click "File" on the menu bar. Click "Connect" from the pull-down menu in order to establish communication with the PL522 and 523.
4. After the computer has connected to the PL522 or 523, click the "Configuration Tool" icon. Select the "Service" menu, "Configuration" drop-down menu in order to view the Configuration screen.
5. Double click the desired parameter or select the desired parameter. Click "Change". A dialog box will appear with a scroll down list that will show all of the possible parameter values.
6. Click "OK" after changing each parameter in order to return to the Configuration screen.

Refer to the Systems Operation, "Commands" for information about registering the Product Link system.

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04487929

Spare Input Configure

SMCS - 7606-IV

The "Digital Input Configurations" should be verified. If a change is required, configure digital inputs through VisionLink application. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Inputs" for an example of types of switches. Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "System Schematic" for an example of a wiring diagram for the inputs.

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Systems Operation
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04456495

Commands

SMCS - 7606

Product Link Module(PLM) Commands

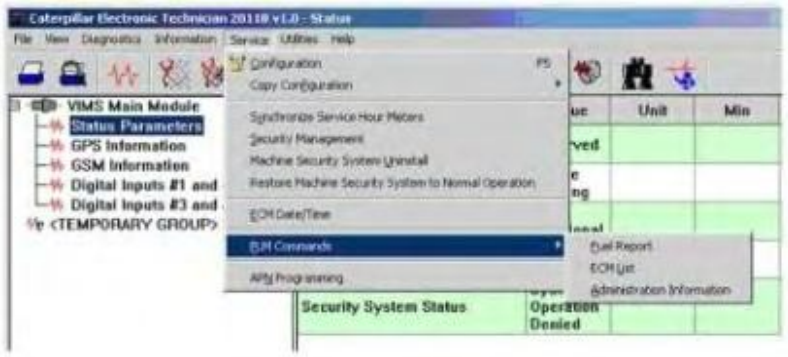


Illustration 1 g02696836

There are five commands that can be completed by selecting "Service" from the menu bar and "PLM Commands" from the drop-down menu in Cat ET. Refer to Illustration 1.

Fuel Report - This command sends a fuel report.

ECM List - This command sends up an "ECM List Report" after waiting a few minutes. The "ECM List Report" includes a list of all ECM modules connected to the Cat Data Link. The report also lists the associated serial numbers, software part numbers, and sync-clock status detected by the PL522 and 523. The "ECM List" is automatically sent at the time of registration. The "ECM List" contains a unique identifier for each ECM that is detected by the Cat Data Link.

Administration Message - This command sends an Administration message.

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Systems Operation
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906886

System Overview

SMCS - 7606

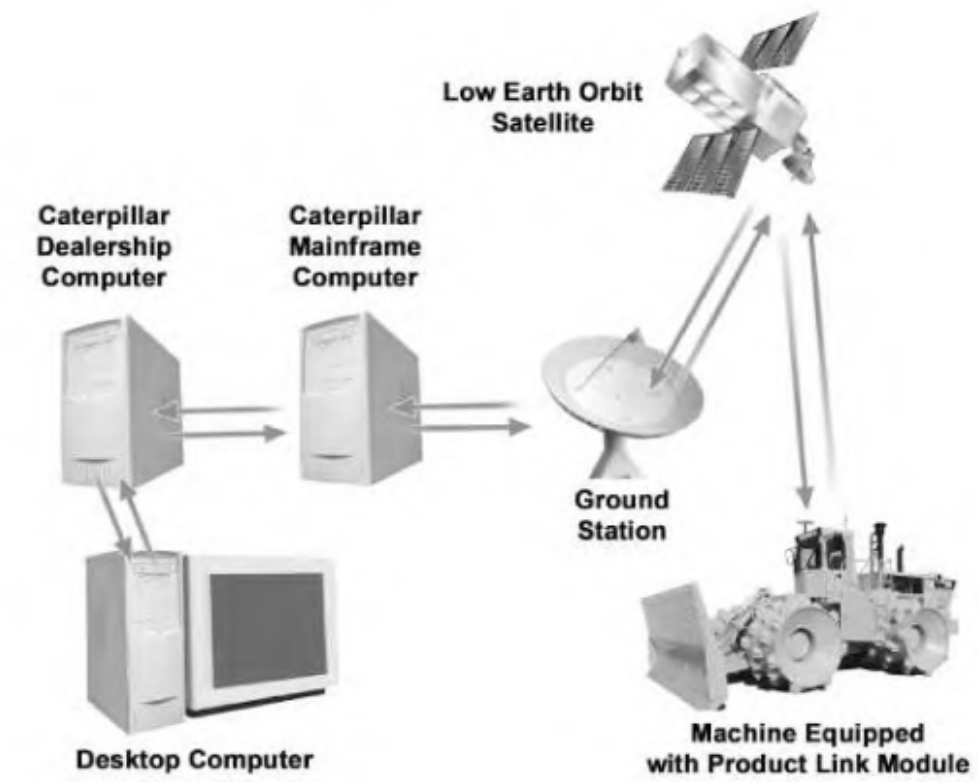


Illustration 1 g01325084

The Product Link PL121SR is a communications device that uses satellites in order to transmit information to the following list: Caterpillar, Caterpillar dealers and Caterpillar customers. The unit contains a Global Positioning System (GPS) satellite receiver and a low earth orbit communication satellite transceiver.

Note: The time periods that are referenced in this publication are dependent upon the performance of the communications network which may vary at times.

The Product Link PL321SR is compatible with the communication protocol that is used on the Cat Data Link. All logged events and diagnostic codes that are available to the Caterpillar Electronic Technician (Cat ET) on the Cat Data Link can be sent to the satellite. The Product Link is not compatible with the communication protocol that is used on the ATA data link for on-highway trucks.

The Product Link PL121SR provides the customer with the following information: location, SMH (Service Meter Hours) and Fence capabilities of communication and configuration.

The Product Link PL321SR system provides the customer with the capabilities of the PL121SR system as well as the capability of the Product Link PL300 Electronic Control Module (ECM). The Product Link PL321SR system enables the customer to communicate and to configure the following functions: diagnostic codes, events and other Cat Data Link information.

The system allows two-way communication between the machine and a remote user such as a Caterpillar dealer or a customer. At any time, a user can request updated information from a machine. Also, the system parameters for the Product Link module can be changed. The information goes from the machine to a satellite. Then, the information goes to the ground station. The receiving station transfers the data to Caterpillar. The information can then be sent to Caterpillar dealers and customers.

Scheduled Reporting

The PL121SR or the PL321SR system can be set up to report on a regular schedule to the Equipment Manager system. The schedule can be selected by using Caterpillar Electronic Technician (Cat ET) software for both of the Product Link systems. The schedule can be modified with EquipmentManager or Cat ET software.

Note: The PL321SR system consists of the PL121SR system plus the PL300 ECM.

Fences

Fences are a feature of the Product Link PL121SR and PL321SR systems. These Fences can be set up only through EquipmentManager. Fences can be carried out in three ways:

- Inclusive Geo-Fence sets up a "virtual fence" around a work site. Once Inclusive Geo-Fence is activated, a report is generated if the machine leaves the work site area.
- Exclusive Geo-Fence sets up a "virtual fence" around areas that the machine is not allowed to enter. A report is generated if a machine enters a restricted area.
- Time Based Fence allows the owner of a machine to choose the time that a machine can be operated. A report is generated if the machine is operated outside of the time that is set for machine operation.

Note: When a fence is activated, Product Link will send an event message to EquipmentManager.

PL321 only - If the alarm is still active on consecutive days, EquipmentManager will display a new Product Watch Event. EquipmentManager will send the appropriate event reaction once with the daily standard message. EquipmentManager will send the appropriate event reaction the next time the alarm is activated.

PL121 only - EquipmentManager will not display an alarm on consecutive days (regardless of active status) unless the machine leaves the work site or the machine enters a restricted area again.

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Systems Operation
Product Link 121S/300
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i05346620

System Components

SMCS - 1408

Electronic Control Module (ECM)

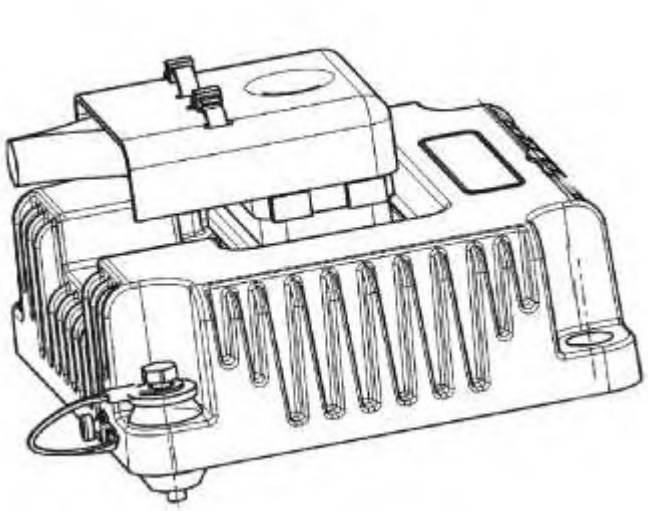


Illustration 1 g01458173

PL300 ECM with 70 pin Wiring Harness Connector Installed

The Product Link PL300 is an electronic control module (ECM). The ECM is initially setup by using a laptop computer with the Caterpillar Electronic Technician (Cat ET) software. The PL300 is designed for use with the PL121SR radio. PL321SR is the designation for the system that uses both the PL121SR radio and the PL300 ECM. In order to use the new Product Link features, update to the latest version of Cat ET. Refer to Special Instruction, REHS2365 for more information on installing the PL121SR and the PL300.

The Product Link PL121SR provides the customer with location, SMH (Service Meter Hour), and Geo-Fencing communication and configuration capabilities.

The Product Link PL321SR provides the customer with the capabilities of the PL121SR system and with the capability of the PL300 ECM to communicate and configure the diagnostic codes, events, and other Cat Datalink® information.

A Product Link PL121SR system can be converted to a Product Link PL321SR system by adding the PL300 ECM to the PL121SR radio.

Ensure that the Product Link PL300 module is installed with the available shock mount kit.

Inputs

The Product Link PL300 can be set up to receive information from components about machine operations by using switch to ground type inputs. Switches provide ON or OFF (closed or open) signals to the switch inputs of the Product Link. The inputs to the Product Link are listed in the table for the 70 pin connector. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Spare Inputs" for more information.

Input/Output

The Product Link PL300 uses the Cat Datalink® in order to communicate with other electronic control modules. The data link is bidirectional. The data link allows the PL300 to receive information. The data link also allows the PL300 to send information.

A module identifier (MID) is assigned to each ECM. The MID for the PL300 is the number 122.

Table 1

Product Link Contact Description		
Contact Number	**Function**	**Type**
34	CAN Low	Input
50	CAN High	Input
42	CAN Shield	Input
52	+ Battery	Power
65	Ground	Ground
54	Alternator R -Terminal	Input
70	Key switch	Input
8	Cat Datalink +	Input/Output
9	Cat Datalink -	Input/Output
45	Spare Digital Input 1	Switch Input (Open/Ground)
46	Spare Digital Input 2	Switch Input (Open/Ground)
47	Spare Digital Input 3	Switch Input (Open/Ground)

55	Spare Digital Input 4	Switch Input (Open/Ground)

PL121SR Radio

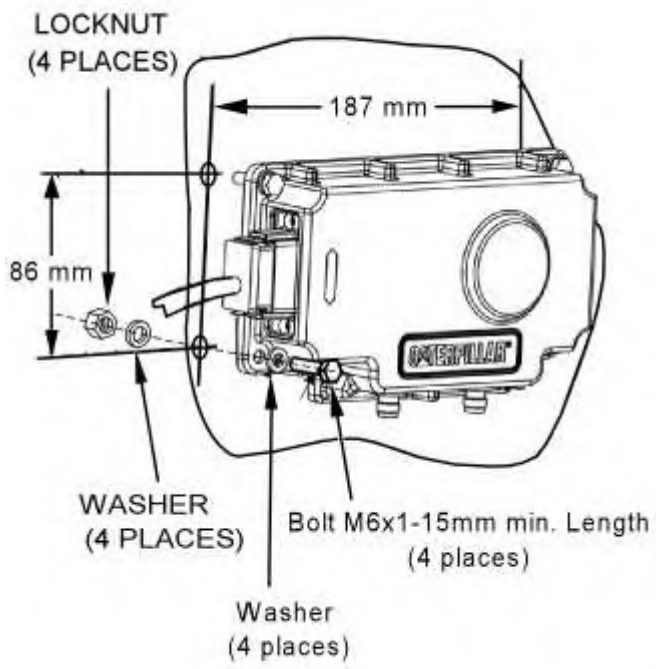


Illustration 2 g01121196

Mounting method for the PL121SR Radio

The antennas that can be used on the PL121SR are for satellite communication system and for the GPS system.

Shock mounting is not required or available for the PL121SR radio.

Adapter Plates

The adapter plates allow a dealer to mount a PL300 in a place originally planned for a PL151/PL201.



Illustration 3 g01104288

PL300 ECM Adapter Plates

Wiring Harnesses

The installation kit includes the control harness assembly. The wiring harness is enclosed in a protective braided cover.

Radio Harness

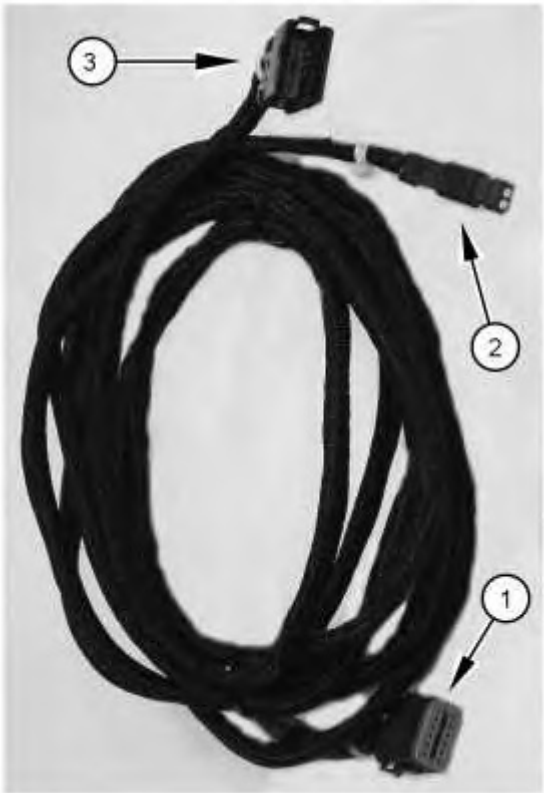


Illustration 4 g01103872

2 m (6.6 ft) PL121SR Radio Harness

(1) 12-pin plug connector (P1)

(2) 2-pin receptacle connector (J2)

(3) 12-pin receptacle connector (J1)

ECM Harness

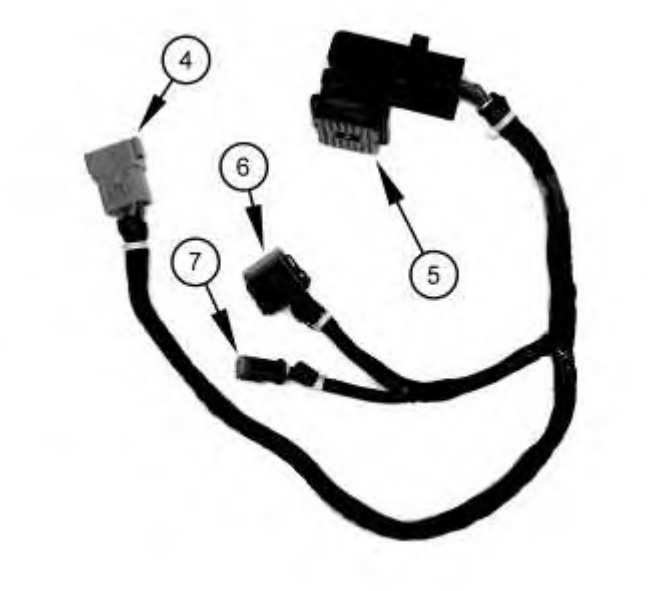


Illustration 5 g01336465

(4) 12-pin receptacle connector (J1)

(5) 70-socket plug connector (P1)

(6) 12-socket plug connector (P2)

(7) 2-socket plug connector (P3)

Conversion Harness

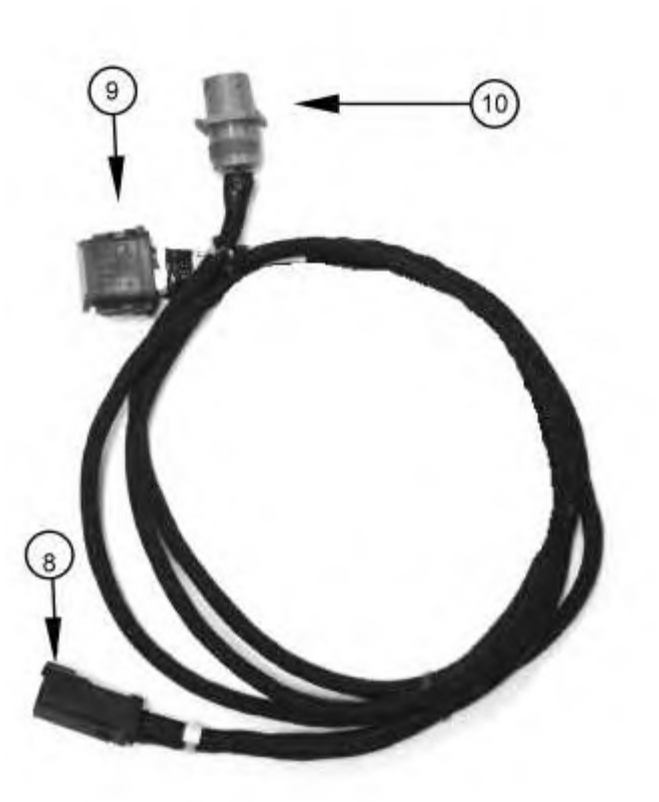


Illustration 6 g01336474

(8) 6-pin receptacle connector (J1)

(9) 12-pin plug connector (P1)

(10) 3-pin round receptacle connector (J2)

Legacy Harness

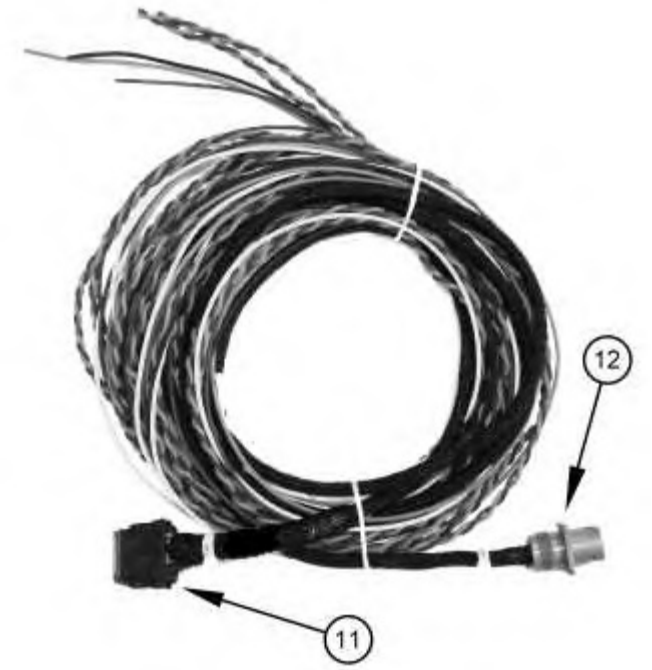


Illustration 7 g01336488

(11) 12-pin plug connector (P1)

(12) 3-pin receptacle connector (J1)

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Systems Operation
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i04905748

Spare Inputs

SMCS - 7610-IV

Spare Inputs

Spare inputs are not supported for the Product Link PL121SR radio.

The Product Link PL300 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (CAT ET service tool). The inputs can be configured to be normally open or normally closed. There is a programmable delay time for actuation of these inputs. CAT ET requires a value to be entered for this delay. These inputs can only be used by switches to ground. These inputs cannot be dependent on other machine parameters. The inputs are programmable based on the following criteria:

- Status of the keyswitch
- Engine status (running)

The PL300 spare inputs are listed in table 1.

Table 1

Product Link Contact Descriptions	
Main Connector Contact (70 pin)	**Description of the Input**
45	Spare Digital Input 1
46	Spare Digital Input 2
47	Spare Digital Input 3
55	Spare Digital Input 4

Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "System Schematic" for a diagram of the digital input circuitry.

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i04905751

Configuration

SMCS - 7606

Connecting a Computer to the Product Link System

Required Software

Verify that Product Link has installed the latest flash file.

Supported Connections for Hardware

The PL121SR Radio and PL300 ECM are configured with CAT ET by using the following communications interfaces:

PL121SR Installations Only - The **245-7310** Control Harness Assembly (Serial Service Cable) is connected between the PC serial port and the serial service connector on the radio legacy harness or the conversion harness. The CAT ET "Communications Interface Device" is configured for "Embedded Communications Adapter".

PL121SR plus the PL300 Installations Only - The **171-4400** Communication Adapter Group hardware is connected between the machine service connector and the PC serial port or parallel port. The CAT ET "Communications Interface Device" is configured for the "Caterpillar Communications Adapter II (RP1210)".

Note: The configuration parameters for the "Communications Interface Device" are found in CAT ET under "Utilities" menu, "Preferences" drop-down menu.

Configure Computer Interface Communications for CAT ET

The following examples of screens show configuring communications for the computer in order to use CAT ET.

1. Use the **245-7310** Serial Service cable to connect a computer with the required CAT ET software to the serial service connector of the wiring harness.

2. Select "Utility" on the tool bar.

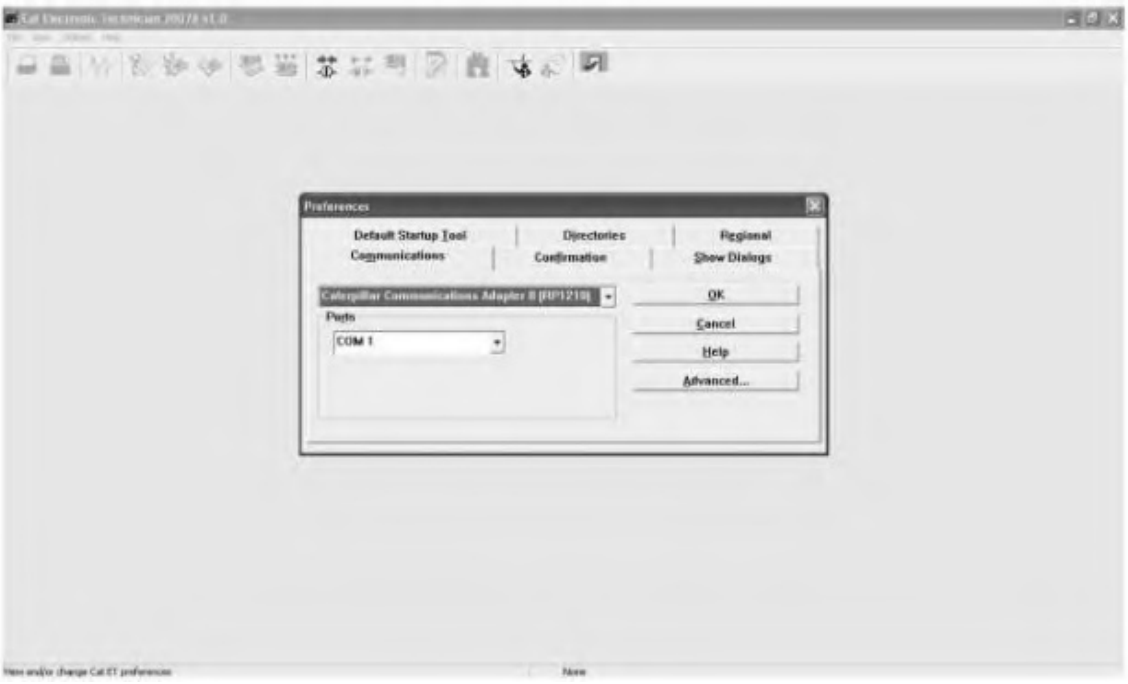


Illustration 1 g01361214

"Preference" Section for CAT ET

3. From the drop-down menu, select "Preference".



Illustration 2 g01361220

"Preference" Section for CAT ET

4. From the "Communications" tab, click the drop-down menu and select "Caterpillar Embedded Communication Adaptor".

Configure Product Link PL121SR Radio and PL300 ECM

This section provides information for the user in order to configure the parameters required for the Product Link system during installation. After the "Machine Serial Number","Machine Make Code", and the "Dealer ID" are set, the unit will auto-register the Product Link system.

There are a number of parameters that need configured for the Product Link. There are default values that are loaded. Many of the default values are acceptable in most applications. However, care must be followed in setting these parameters to ensure proper operation. Also, care will help avoid increased costs for messaging. Enter the "Product Link Module (PLM) Installation Parameters" last to ensure proper registration. Select the configuration screen by selecting the icon on the tool bar or by using the pull-down menus from the menu bar.

Two communications adapters are available in order to flash program the electronic control modules. The **7X-1700** Communications Adapter can be used, or the **171-4400** Communication Adapter II can be used.

After the Product Link has been configured, the radio must be registered with the Equipment Manager system. If installing only the PL121SR Radio (no PL300 ECM), configure the radio as described in PL121SR "Installation Parameters Configure - Radio Only" section. If installing the PL121SR and the PL300 ECM, configure the radio and ECM as described in the "Installation Parameters Configure for PL321SR System (PL121SR Radio and PL300 ECM)".

1. There are three ways to access the configuration screen. Select one of the following options:
    - Select "Service" and select "Configure" on the menu bar.
    - Press the "F5" key.
    - Select "ECM Configuration Icon" on the tool bar.
2. Ensure that steps have been taken in order to connect the computer with CAT ET software properly to the Product Link system. Refer to "Connecting a Computer to the Product Link System".
3. Click the "Connect" icon or click "File" on the menu bar. Click "Connect" from the pull-down menu in order to establish communication with the PL121SR radio.
4. After the computer has connected to the PL121SR radio, click the "Configuration Tool" icon. Select the "Service" menu, "Configuration" drop-down menu in order to view the Configuration screen.
5. Double click the desired parameter or select the desired parameter. Click "Change". A dialog box will appear with a scroll down list that will show all of the possible parameter values.
6. Click "OK" after changing each parameter in order to return to the Configuration screen.

Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "Commands" for information about registering the Product Link system.

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Systems Operation
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905773

Installation Parameters Configure

SMCS - 7606

Installation Of PL121SR Only

Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration" for the following information:

- Preparing a laptop computer to interface with the Product Link system
- Accessing the parameters for installation
- Changing the parameters for installation

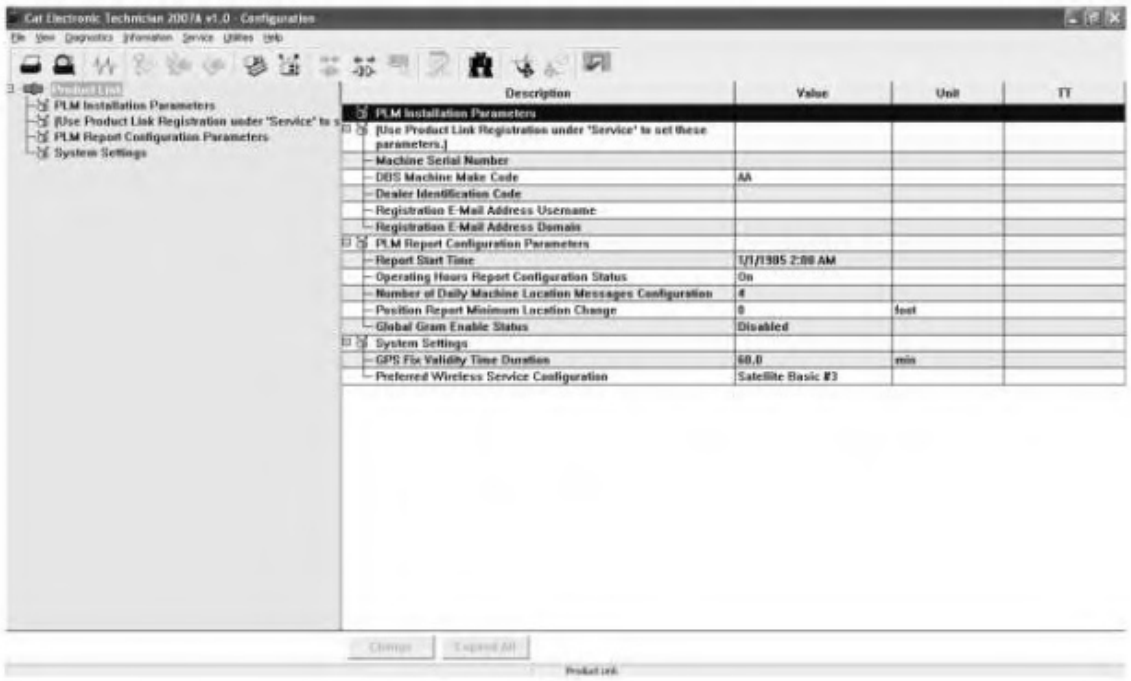


Illustration 1 g01360584

Configuration Screen of CAT ET for PL121

Table 1

Parameter Table			
Parameter	**Description**	**Configuration**	**Notes**
Machine Serial Number	The Machine Serial Number is used by the Product Link system for routing and displaying information by the machine.	For a non-Caterpillar machine, enter the machine serial number. For Caterpillar machines, enter the last eight characters of the new 17 character PIN for this value. Refer to Illustration 2.	The maximum length is 17 characters. Do not start the serial number with a space. Do not abbreviate the serial number. For example, "1AA00123" should not be shortened to "1AA123". Do not use uppercase "O" instead of zero "0".
DBS Machine Make Code	The DBS Machine Make Code parameter defines the make of the machine where Product Link is installed.	Enter the appropriate value for the DBS Machine Make Code.	Only two upper case alpha-numeric characters are allowed for this value. "AA" is the default code that represents only a Caterpillar machine. All other codes of manufacturer's are determined by individual dealers. Refer to your work order or your DBS dealers administrator for the correct code to use on non-Caterpillar machines.
Dealer Identification Code	The Dealer Identification Code is utilized by the Product Link system for routing and displaying information so that the information is visible to personnel in a dealership office.	Enter the correct value for the Dealer Identification Code.	This value can contain up to six characters that are uppercase and alphanumeric characters. All machines must be registered with the ID number for the main branch of the dealership.
Registration E-Mail Address Username	The Registration E-Mail Address Username in conjunction with the Registration E-Mail Address Domain defines the e-mail address that should receive confirmation of the machines registration status.	In the registration screen, the username and domain are entered as a complete email address. (yourname@youremail.com)	The Registration E-Mail Address Username refers to portion of the e-mail address before the @ symbol. (If your email address was yourname@youremail.com, the username would be "yourname")
Registration E-Mail Address Domain	The Registration E-Mail Address Domain in	In the registration screen, the username and domain are entered	The Registration E-Mail Address Domain refers to portion of the e-mail address

	conjunction with the Registration E-Mail Address Username defines the e-mail address that should receive confirmation of the machines registration status	as a complete email address. (yourname@youremail.com)	after the @ symbol. (If your email address was yourname@youremail.com, the domain would be "youremail.com")
Report Start Time	The Report Start Time parameter sets the time used as the initial report time for calculating when subsequent reports are sent. The Report Start Time parameter is also used as the basis for calculating "Next Scheduled" events and diagnostic messages. Additional Information Standard reports for Product Link are sent at time-based intervals. Position reports are sent every 6 hours. A service meter report is sent every 24 hours. The messages will arrive as close as possible to the scheduled time. The messages may not arrive exactly on the scheduled time as the transmissions are automatically optimized for maximum efficiency of the Product Link system.	Enter the correct local time value for the reporting start time. Consideration should be given to the time selected for the start time. For an example, if a machine normally operates between 7AM and 4PM, you would want to set the start time to a value somewhere between 7AM and 4PM, preferably, shortly after 7AM.	A "Get PC Date/Time" button is supplied for an easy entry of the current date and time.
Operating Hours Report Configuration Status	The Operating Hours Report Configuration Status parameter defines whether	To send the standard message once per day, select the "On" value. In order to not send a standard message once per day, select the"Off" value.	

	once-per-day standard message is sent.		
Number of Daily Machine Location Messages Configuration	The Number of Daily Machine Location Messages Configuration parameter defines the number of machine location reports sent to the office. The reports are spread evenly across a 24 hour period with the first report sent at the defined Report Start Time. Currently you can choose to have (0 - 4) position reports sent per day.	Enter the number (0 - 4) of machine location reports to send daily to the office.	If you select four reports, the reports will be sent every 6 hours. If you select three reports, the reports are sent every 8 hours and so on.
Global Gram Enable Status	The Global Gram Enable Status configures how the Product Link sends messages when a ground station is not in view to the satellites. Global grams are used in areas of the world where there are no ground stations for Orbcomm signal reception.	If the machine will operate in areas where there are no ground stations for Orbcomm signal reception, select "Enabled". If the machine will operate in areas where there are ground stations for Orbcomm signal reception, leave the parameter set to the default "Disabled".	If there are any questions, consult your Cat dealer in order to determine if Global Grams are required.
Position Report Minimum Location Change	The Position Report Minimum Location Change sets the distance the machine must move in order for a position report to be queued.	If the value is set to '0', the machine will send four position reports a day - regardless of movement. If the value is set to anything other than '0', the machine will only send a position report if the minimum location requirement has been met - regardless of the value selected for the Number of Daily Machine Location Message Configuration.	In an existing PL121 system or a new PL321 system, the parameter automatically defaults to 0. In an existing PL321 system, the parameter will need to be changed to 0 - or the minimum distance preferred.
GPS Fix Validity Time Duration	The GPS Fix Validity Time Duration parameter allows users to select the amount of time a GPS fix is	The minimum amount of time is 30 minutes. The maximum is 1440 minutes. The default is 60 minutes.	

	required before a position is considered 'Valid' or 'Invalid'.		
Preferred Wireless Service Configuration	The Preferred Wireless Service Configuration parameter allows users to select the correct wireless service for wireless devices.	Satellite Basic "#3" is the default for the Preferred Wireless Service Configuration value for the PL121SR.	This parameter is not configurable.

Machine Serial Number

Note: The serial number for a non-Caterpillar machine can be any alphanumeric characters up to 17 characters long such as "147433789DBS". When using a non-Caterpillar machine serial number, be sure to change the Make Code from "AA" to the appropriate 2-character value.

For Caterpillar machines, enter only the last eight digits of the "Machine Serial Number". Refer to Illustration 2 and Illustration 3 for examples of two machine serial numbers.

Note: "PLM Installation Parameters" section cannot be changed in the Configuration screen. These parameters must be changed using the "Service " menu, "Product Link Registration" drop-down menu option.

First Quarter 2001, the Caterpillar Product Identification Number (PIN) changed from 8 characters to 17 characters. The "Product ID" that is required by the Product Link System is the last eight digits. Refer to Item (4) in Illustration 2.

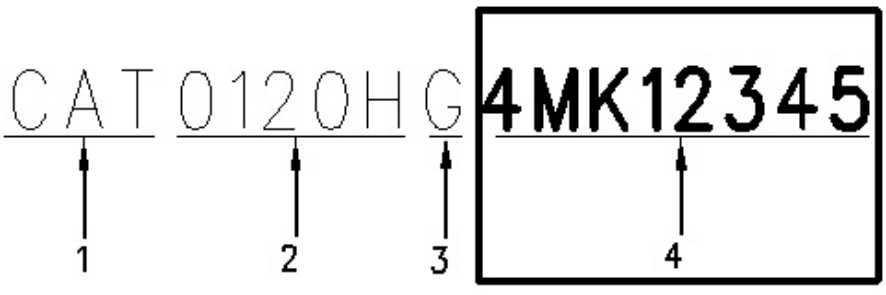


Illustration 2 g01126595

(1) Caterpillar's World Manufacturing Code (characters 1 - 3)

(2) Machine description (characters 4 - 8)

(3) Check character (character 9)

(4) Machine Indicator Section (MIS) or Product Sequence Number (characters 10 - 17). These characters were previously referred to as the Serial Number.

"Product Link Registration" Screen



Illustration 3 g01360675

Screen of New Configuration Method via "Service" Menu, "Product Link Registration" Drop-down Menu

"Report Start Time" Screen

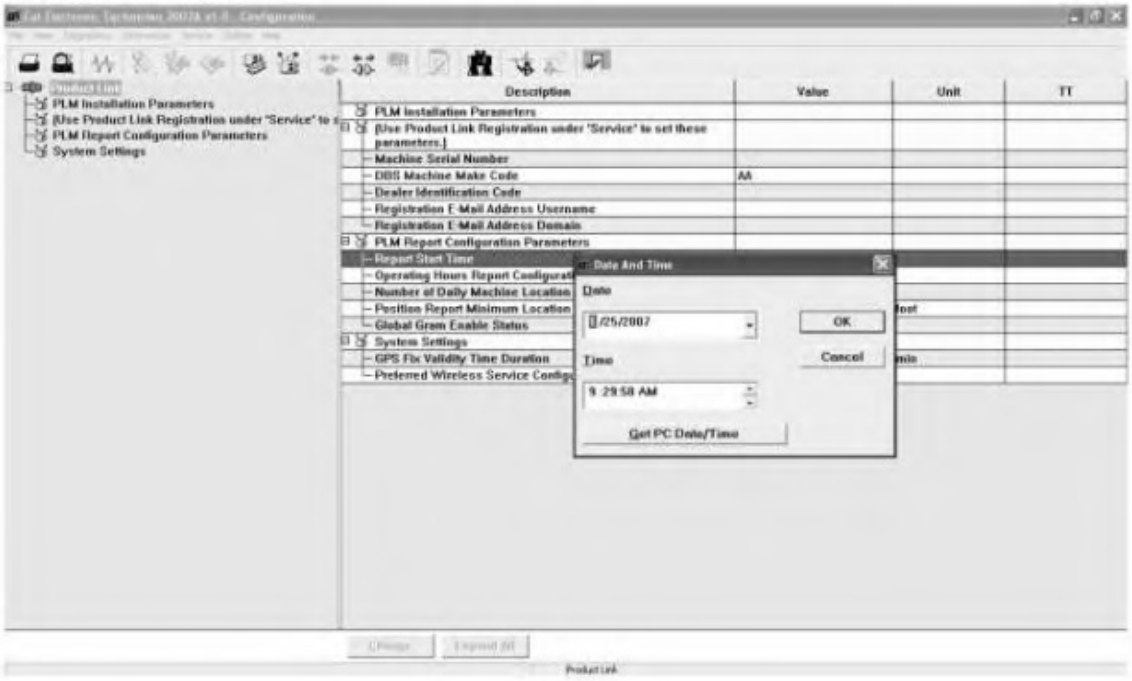


Illustration 4 g01361252

"Report Start Time" Screen

"Operating Hours Report Configuration" Screen

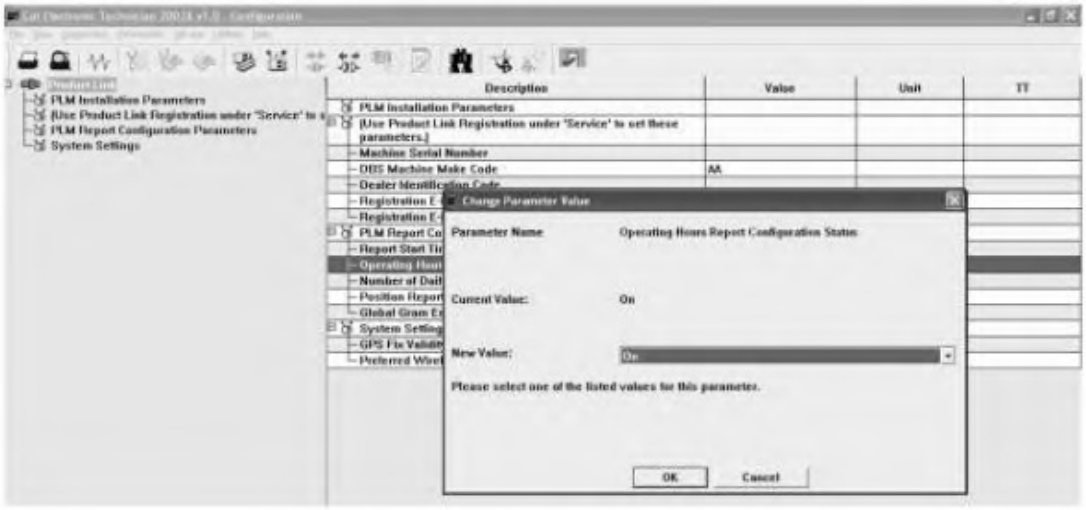


Illustration 5 g01361257

"Operating Hours Report Configuration" Screen

"Number of Daily Machine Location Messages" Screen

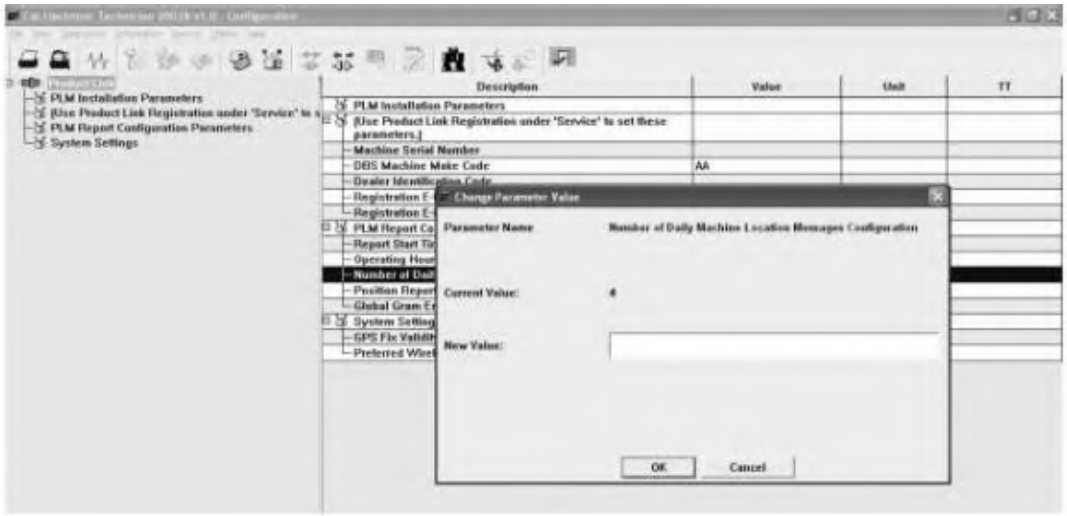


Illustration 6 g01361269

"Number of Daily Machine Location Messages" Screen

"Position Report Minimum Location Change" Screen

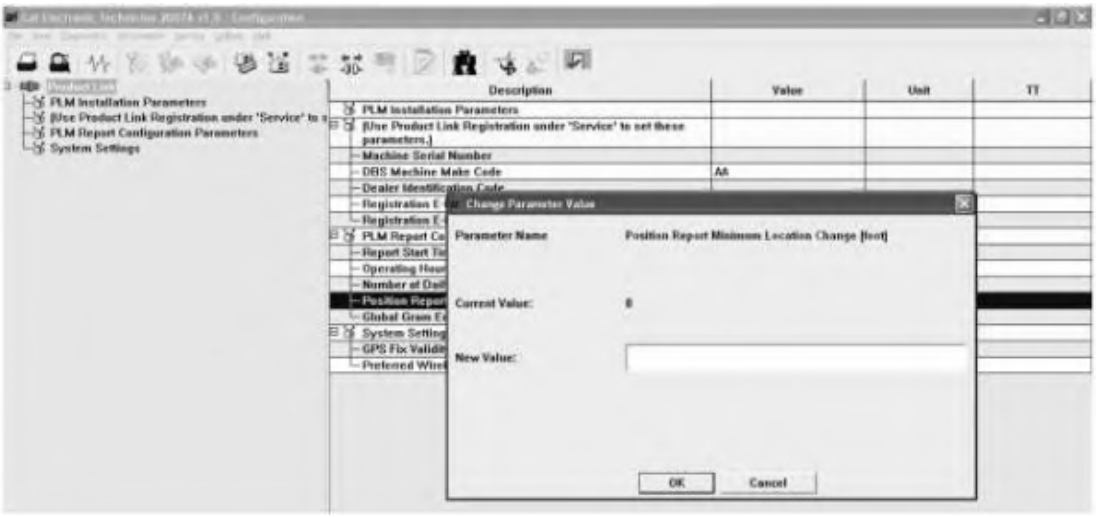


Illustration 7 g01360603

"Position Report Minimum Location Change" Screen

"Global Gram Enable Status" Screen

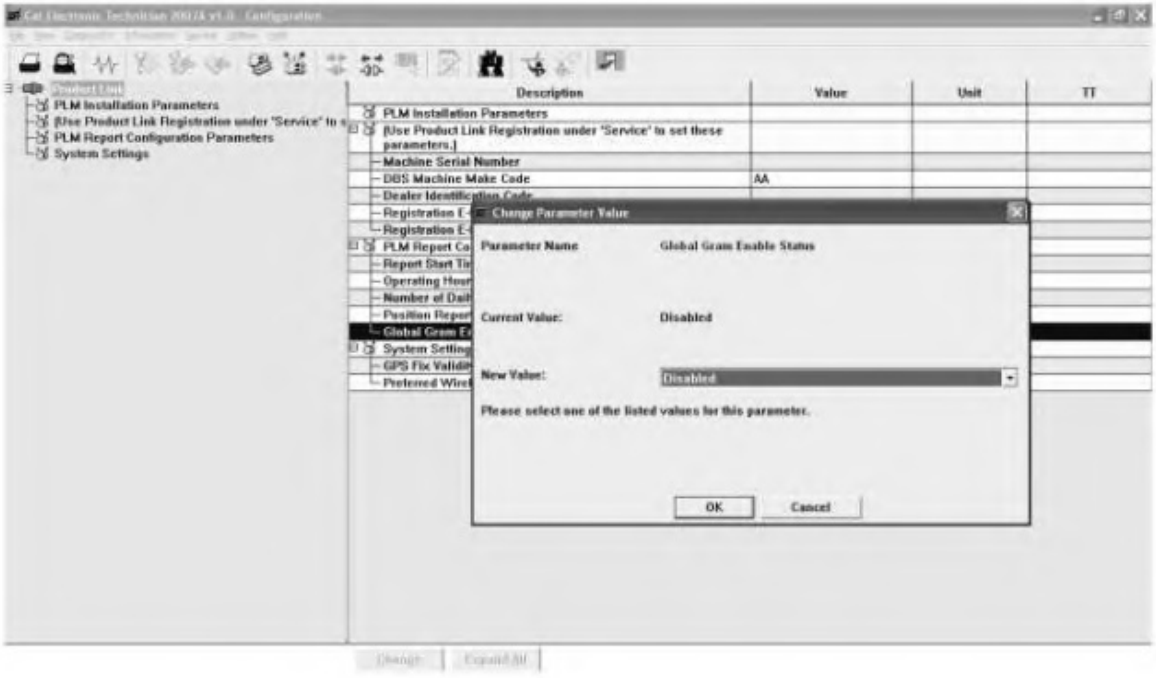


Illustration 8 g01361286

"Global Gram Enable Status" Screen

"GPS Fix Validity Time Duration" Screen

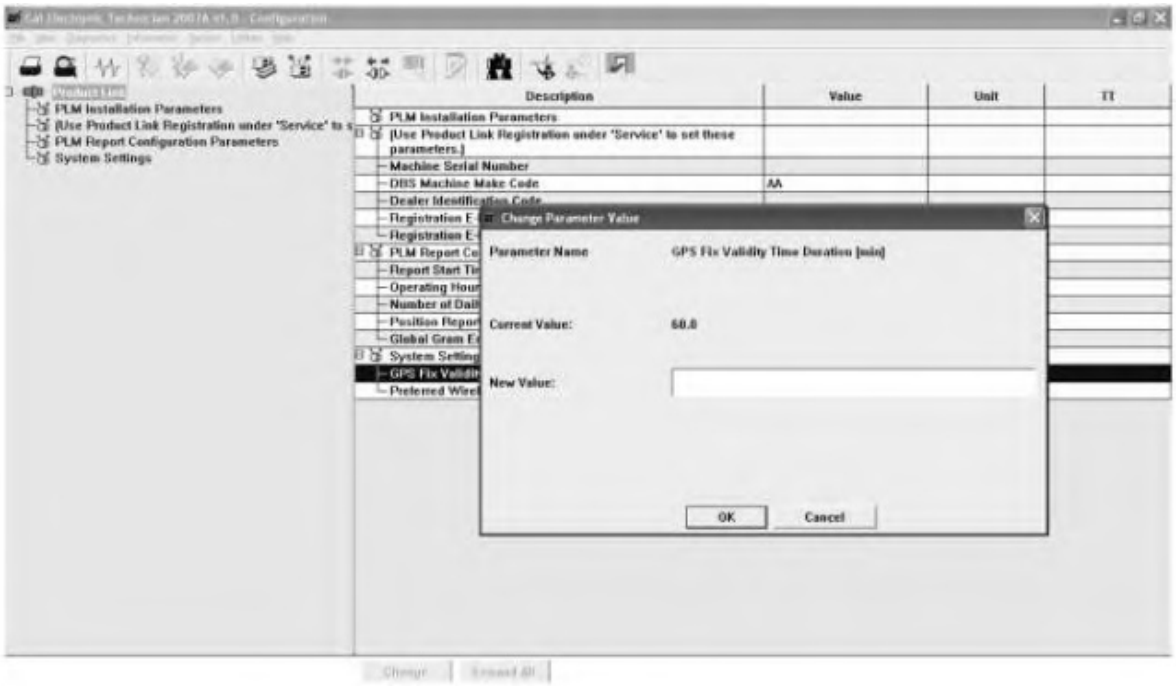


Illustration 9 g01360606

"GPS Fix Validity Time Duration" Screen

"Preferred Wireless Service Configuration" Screen

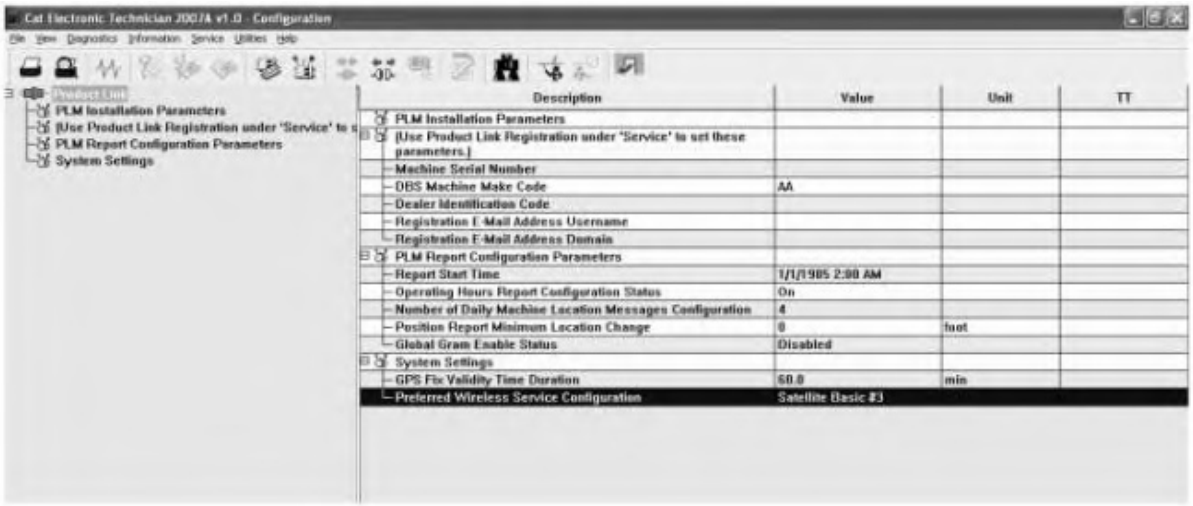


Illustration 10 g01361300

"Preferred Wireless Service Configuration" Screen

Installation Parameters Configure for PL321SR System (PL121SR Radio and PL300 ECM)

1. Ensure that steps have been taken in order to connect the computer with CAT ET software properly to the Product Link system. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration".

2. Click the "Connect" icon or click "File" on the menu bar. Click "Connect" from the selections on the pull-down menu in order to establish communication with the PL321SR System.

3. Select the "Product Link" from the "Select an ECM" field.

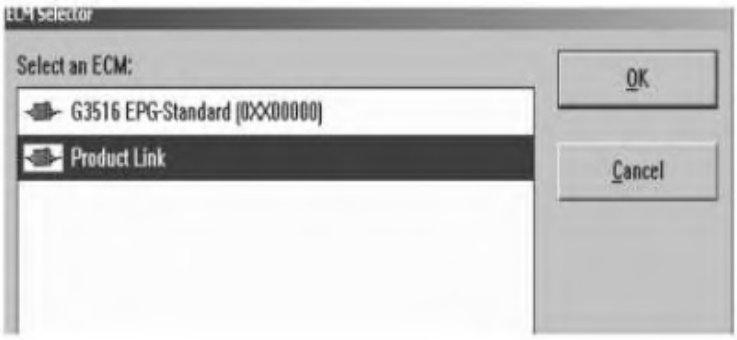


Illustration 11 g01119224

"Select an ECM" Screen

4. Click "OK".

5. Once you are connected, click the "Configuration Tool" icon or select the "Service" menu," Configuration" drop-down item in order to view the configuration screen.

6. Highlight "Product Link" and then click "Expand All".

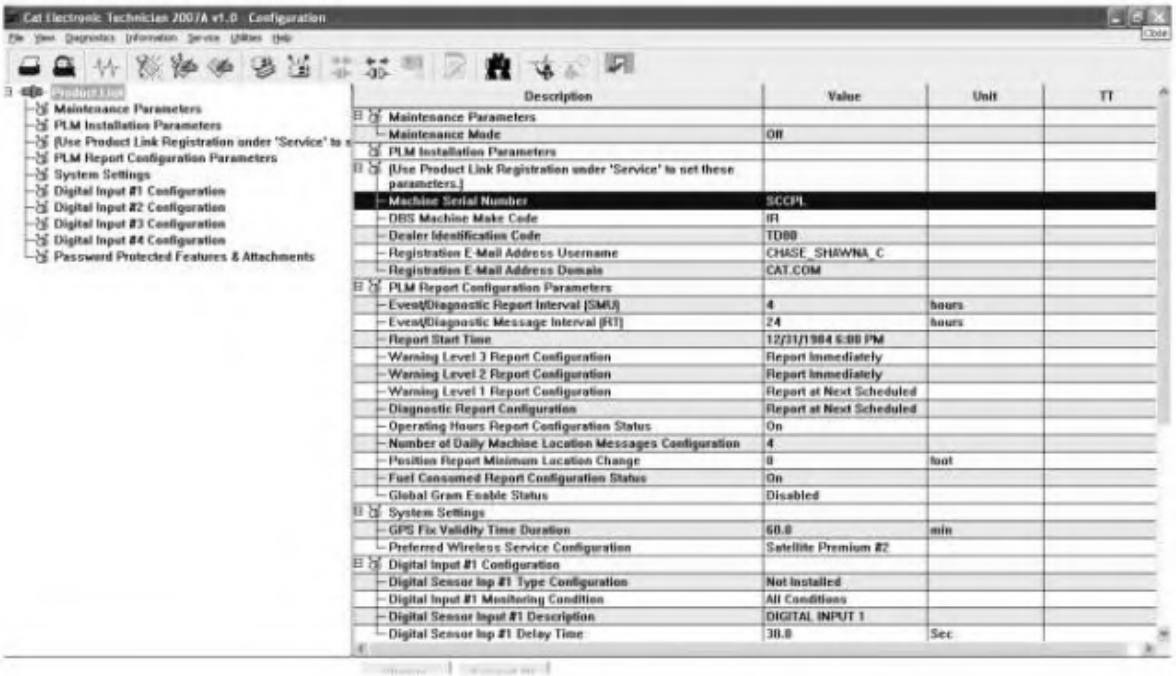


Illustration 12 g01361816

PL321 Configuration Screen

7. Double click the desired parameter or select the desired parameter and click "Change". A dialog box will appear. Also, a list will appear that will show all of the possible parameter values.

   Note: "PLM Installation Parameters" section cannot be changed in the Configuration screen. These parameters must be changed using the "Service " menu, "Product Link Registration" drop-down option.

8. Click "OK" after changing each parameter in order to return to the configuration screen.

Note: The "Report Start Time" parameter should be set to generate reports while the machine is powered up to avoid having a time designated for the system to report while the machine is powered down.

Refer to the "Machine Serial Number" for information about the "Product ID" that is used in the Product Link system. Refer to Illustration 2 for an example of a machine serial number.

Refer to Table 2 for an explanation of the parameters for installation.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Report Parameters Configure" for an explanation of the parameters (report). Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Wireless Service Configure" for an explanation of the parameter (wireless service). Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Spare Input Configure" for an explanation of the parameters (spare input).

Table 2

PLM Installation Parameters			
Parameter	**Description**	**Configuration**	**Notes**
Maintenance Mode	The Maintenance Mode is used to prevent diagnostic and event messages from being reported when performing maintenance on the machine. This value should be reverted to "Off" after the servicing is complete. This value also reverts to "Off" after 12 calendar hours in order to ensure proper operation (long term) of the system. If an event (diagnostic) does occur when the Maintenance Mode is active, the event (diagnostic) is ignored until the Maintenance Mode	To disable the PLM from sending any diagnostic or event messages while performing maintenance, select the "On" value. To continue normal operation of the Product Link system after maintenance is done, select the "Off" (default) value.	

	is turned off. Remember to clear any diagnostic codes that were created during maintenance. If you do not remember, the diagnostic codes will be transmitted once the Maintenance Mode is turned off.		
Machine Serial Number	The Machine Serial Number is used by the Product Link system for routing information by the machine and displaying information by the machine.	For Non-Caterpillar machines, enter the machine serial number. For Caterpillar machines, enter only the last eight characters of the new 17 character PIN for this value.	The maximum length is 17 characters. Do not start the serial number with a space. Do not abbreviate the serial number. For example, "1AA00123"should not be shortened to "1AA123". Do not use uppercase "O" instead of zero "0".
DBS Machine Make Code	The DBS Machine Make Code parameter defines the make of the machine where Product Link is installed.	Enter the appropriate value for the DBS Machine Make Code.	Only two upper case alphanumericcharacters are allowed for this value. "AA" is the default code that represents only a Caterpillar machine. All other manufacturers codes are determined by individual dealers. Refer to your work order or your dealer DBS administrator for the correct code to use on non-Caterpillar machines.
Dealer Identification Code	The Dealer Identification Code is utilized by the Product Link system for routing and displaying information so that the information is visible to personnel in a dealership office.	Enter the correct value for the Dealer Identification Code.	This value can contain up to six upper case alphanumeric characters. Most machines should be registered with the ID number for the main dealership location.
Registration E-Mail Address Username	The Registration E-Mail Address Username in conjunction with the Registration E-Mail Address Domain defines the e-mail address that should receive confirmation	In the registration screen, the username and domain are entered as a complete email address. (yourname@youremail.com)	The Registration E-Mail Address Username refers to portion of the e-mail address before the @ symbol. (If your email address was yourname@youremail.com, the username would be "yourname")

	of the machine registration status.		
Registration E-Mail Address Domain	The Registration E-Mail Address Domain in conjunction with the Registration E-Mail Address Username defines the e-mail address that should receive confirmation of the machine registration status	In the registration screen, the username and domain are entered as a complete email address. (yourname@youremail.com)	The Registration E-Mail Address Domain refers to portion of the e-mail address after the @ symbol. (If your email address was yourname@youremail.com, the domain would be "youremail.com")

"Machine Maintenance Mode" Screen

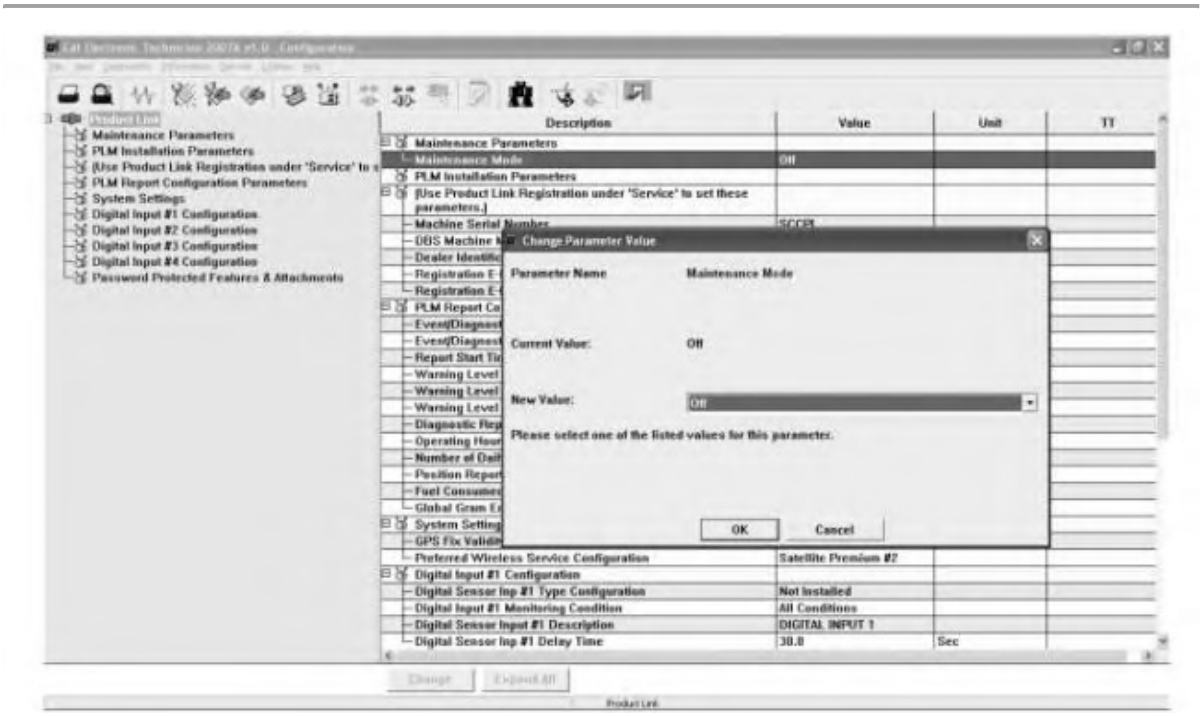


Illustration 13 g01361626

"Machine Maintenance Mode" Screen

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Report Parameters Configure

SMCS - 7606-RPT

This section provides information about the reports and messages that are sent from the Product Link system. For information in order to access and change parameters, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration".

Table 1

PLM Report Configuration Parameters			
Event/Diagnostic Report Interval (SMU)	The Event/Diagnostic Report Interval determines the time frame (measured in units of machine operating hours) the Product Link will report a repeat occurrence of an event/diagnostic code.	Enter the appropriate value for the reporting interval.	The minimum value is 4 hours. The default is 4 hours, meaning that an event/diagnostic update message will not be resent for a specific event/diagnostic until the machine has operated for 4 hours after the last transmitted occurrence of the event/diagnostic. At the next event/diagnostic occurrence after the time period elapses, another message will be sent. All events/diagnostics are recorded and may be viewed with Cat ET. A machine ECM will self erase a diagnostic if the diagnostic does not reappear after 100 operating hours. When this happens, the event history screen in the EM application will show a diagnostic that occurred 100 hours in the past, but that no longer shows up in

			Cat ET because the diagnostic has not reoccurred.
Event/Diagnostic Message Interval (RT)	The Event/Diagnostic Message Interval (RT) parameter sets the time period (measured in units of real time (or calendar) hours) before an event/diagnostic message update is sent. This time period is calculated from the "Report Start Time". An event/diagnostic scheduled message will be sent if any Event/Diagnostic code has occurred since the last scheduled message was sent.	Enter the appropriate value for the reporting interval.	This value is only valid if the event or diagnostic report intervals are set to Next Scheduled. The minimum value is 20 hours. The default is 168 hours (1 week).
Report Start Time	The Report Start Time parameter sets the time used as the initial report time for calculating when subsequent reports are sent. The Report Start Time parameter is also used as the basis for calculating "Next Scheduled " events and diagnostic messages. Additional Information: Standard reports for Product Link are sent at time-based intervals. The messages will arrive as close as possible to the scheduled time. The messages may not arrive exactly on the scheduled time as the transmissions are automatically optimized for maximum efficiency of the Product Link system.	Enter the correct local time value for the reporting start time. Consideration should be given to the time selected for the start time. For an example, if a machine normally operates between 7AM and 4PM, you would want to set the start time to a value somewhere between 7AM and 4PM, preferably, shortly after 7AM.	A "Get PC Date/Time" button is supplied for easy entry of the current date and time.
Warning Level 1/2/3 Report Configuration	The Warning Level 1/2/3 Report Configuration parameter defines when to send messages from the Product Link system when a level 1, level 2, or level 3 event is reported	To send a message immediately when an event occurs, select the "Immediate" value.	When an event reoccurs, a message is sent if the event/diagnostic report interval has expired. If the reporting interval has not expired, the event is only logged as an occurrence in

	from other ECMs (Electronic Control Modules) on the machine. The events reported match the events reported on Cat ET Logged Events screen.		the Product Link module. To queue messages about events and send events in a batch based on the next scheduled interval calculated from the report start time, select the "Next scheduled" value. To never log or send messages about events to the office, select the "Never" value.
Diagnostic Report Configuration	The Diagnostic Report Configuration parameter defines when to send messages from the Product Link system when a diagnostic event is reported from other Electronic Control Modules (ECMs) on the machine. The diagnostics reported match the diagnostics reported on the Cat ET Logged Diagnostics screens.	To send a message immediately when a diagnostic event occurs, select the "Immediate" value. Only logged events and diagnostics are sent in the message.	When a diagnostic event reoccurs, a message is sent if the event/diagnostic report interval has expired. If the reporting interval has not expired, the diagnostic event is only logged as an occurrence in the Product Link module. To queue messages about diagnostic events and send events in a batch based on the next scheduled interval calculated from the report start time, select the "Next scheduled" value. To never log or send messages about diagnostic events to the office, select the "Never" value.
Operating Hours Report Configuration Status	The "Operating Hours Report Configuration Status" parameter defines whether the operating hours will be displayed in Equipment Manager.	To have operating hours in Equipment Manager, select the "ON" value. To not have the operating hours displayed in Equipment Manager, select the "OFF" value.	
Number of Daily Machine Location Messages Configuration	The Number of Daily Machine Location Messages Configuration parameter defines the number of machine location reports sent to the office. The reports are spread evenly across a 24 hour period with the first report sent at the defined	Enter the number (0-4) of machine location reports to send daily to the office.	If you select four reports, the reports will be sent every 6 hours. If you select three reports, the reports are sent every 8 hours.

	Report Start Time. Currently you can choose to have zero to four position reports sent per day. If the machine has moved less than the position Report Minimum Location Change, Product Link will not send the position report.		
Position Report Minimum Location Change	The Position Report Minimum Location Change sets the distance the machine must move in order for a position report to be queued.	If the value is set to '0', the machine will send four position reports a day - regardless of movement. If the value is set to anything other than '0', the machine will only send a position report if the minimum location requirement has been met - regardless of the value selected for the Number of Daily Machine Location Message Configuration.	In an existing PL121 system, the parameter automatically defaults to 0. In an existing PL321 system, the parameter will need to be changed to 0 - or the minimum distance preferred.
Fuel Consumed Report Configuration Status	The Fuel Consumed Report Configuration Status parameter defines whether a fuel consumption report is sent as part of the standard message once per day.	To send a fuel consumption report as part of the once-per-day standard message, select the "On" value. In order to not send a fuel consumption report as part of the standard message once per day, select the "Off" value.	Engine ECM must support this feature for Product Link to report the values. In the case of dual engine machines, Product Link will report the combined fuel usage from both engines as a single value to the BackOffice. If communication is lost with one of the engines, the last valid combined value will be reported. The value will be instead of the individual value. The combined value will be resumed once both engines respond on the CDL.
Global Gram Enable Status	The Global Gram Enable Status configures how the Product Link sends messages when a ground	If the machine will operate in areas where there are no ground stations for	If there are any questions, consult your Caterpillar Dealer in order to

	station is not in view to the satellites. Global grams are used in areas of the world where there are no ground stations for VHF signal reception.	VHF signal reception, select "Enabled". If the machine will operate in areas where there are ground stations for VHF signal reception, leave the parameter set to the default "Disabled"	determine if Global Grams are required.

Refer to Table 1 for information about each of the following parameters.

"Event/Diagnostic Report Interval (SMU)" Parameter

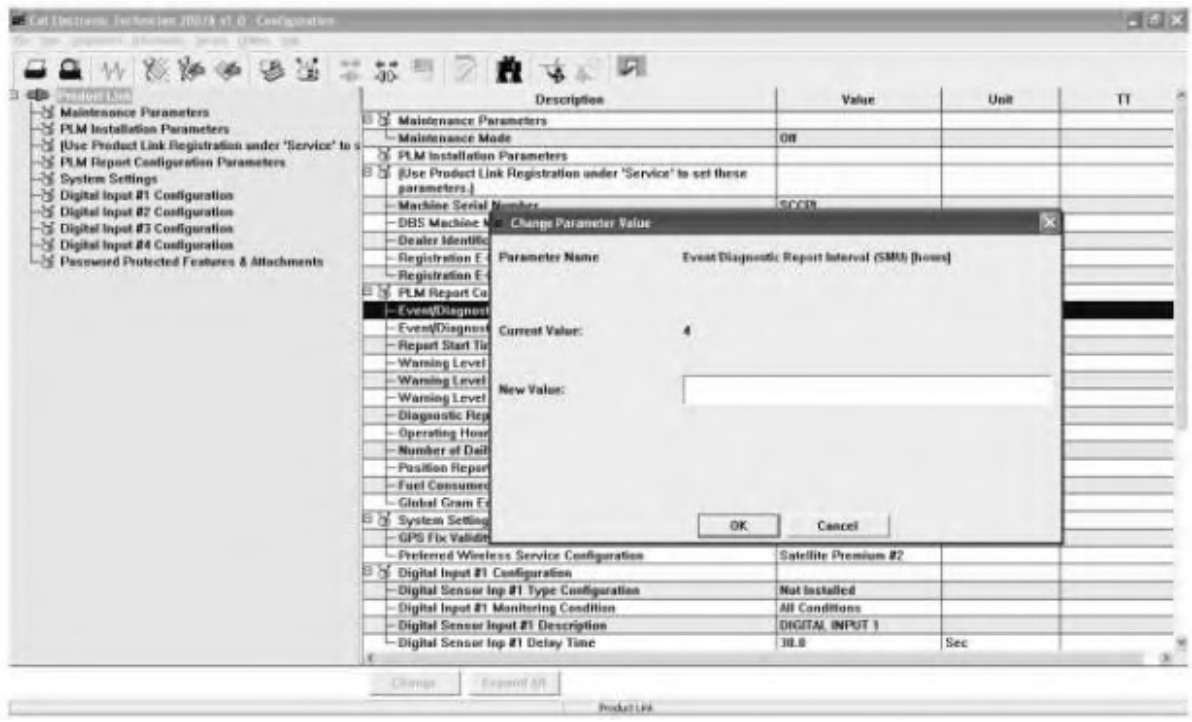


Illustration 1 g01361846

Screen of "Event/Diagnostic Report Interval (SMU)" Parameter

"Event/Diagnostic Message Interval (RT)" Parameter

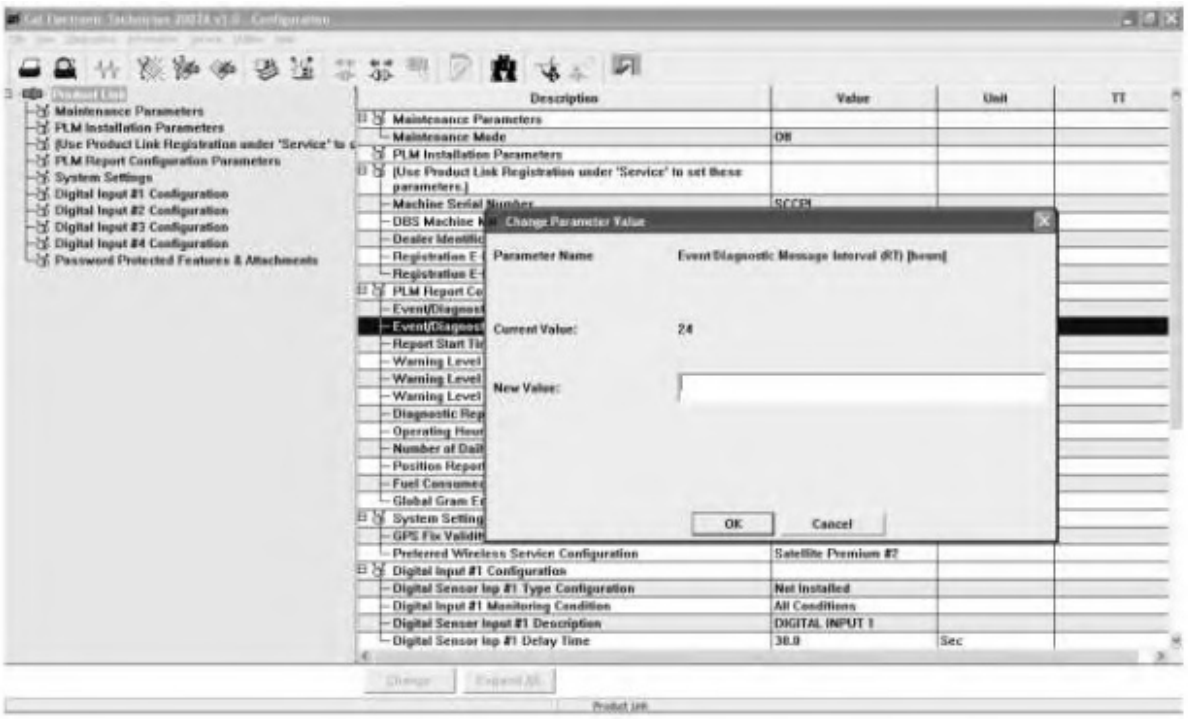


Illustration 2 g01361848

Screen of "Event/Diagnostic Message Interval (RT)" Parameter

"Report Start Time" Parameter

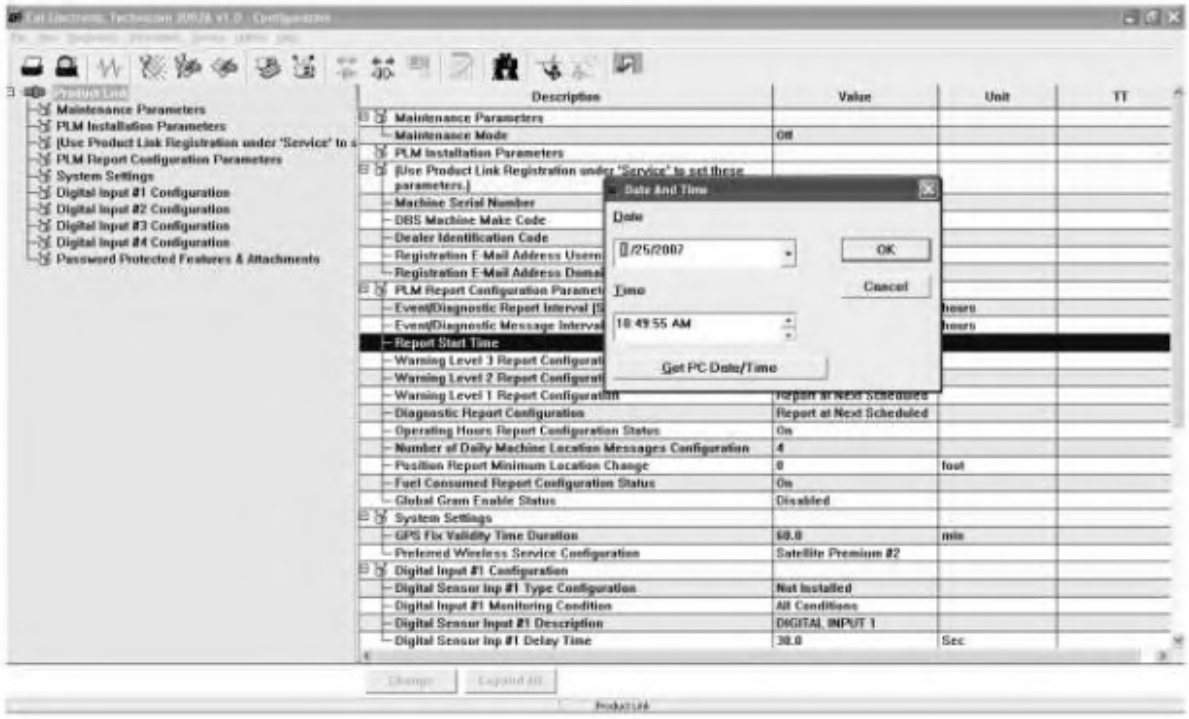


Illustration 3 g01361850

Screen of "Report Start Time" Parameter

"Warning Level (1/2/3) Report Configuration" Parameter

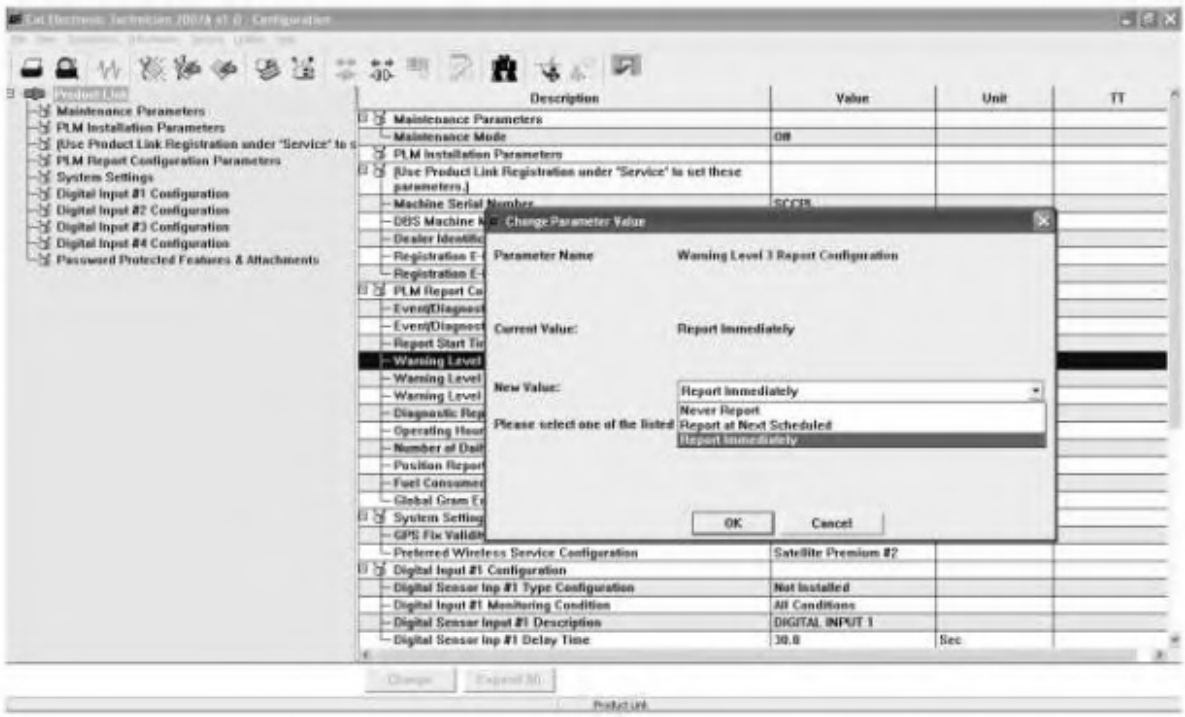


Illustration 4 g01361851

Screen of "Warning Level (1/2/3) Report Configuration" Parameter

The "Warning Level Report Configuration" parameter information is the same for each warning level report.

"Diagnostic Report Configuration" Parameter

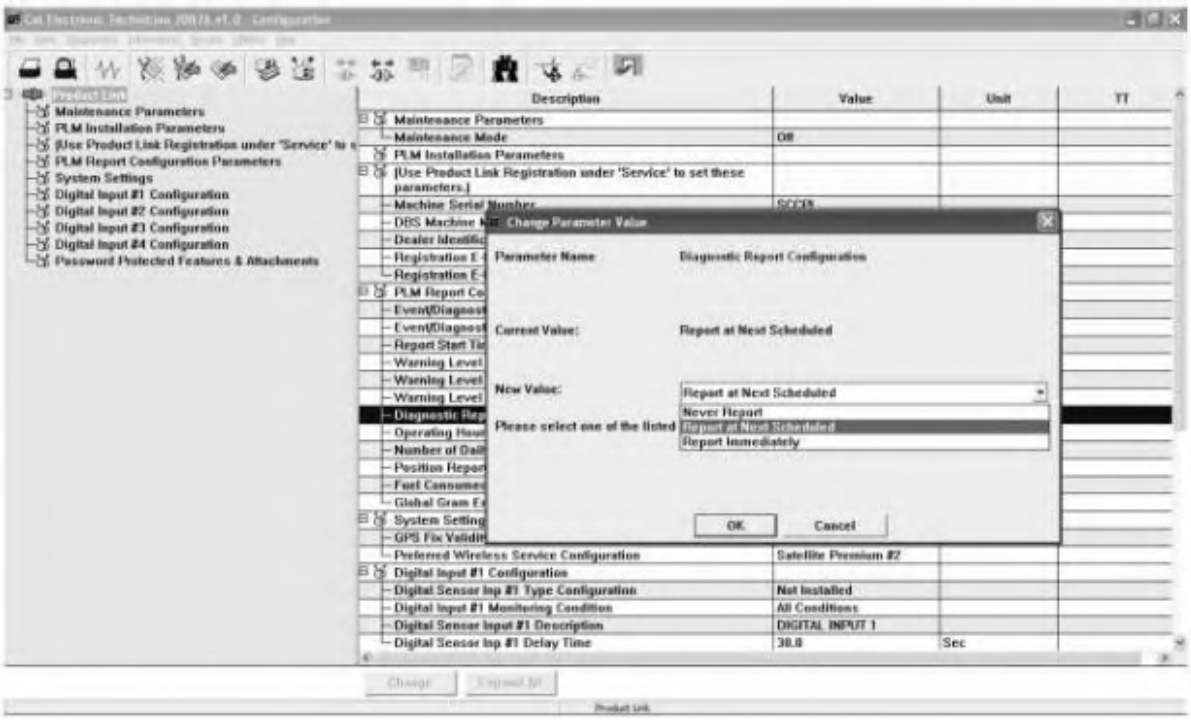


Illustration 5 g01361853

Screen of "Diagnostic Report Configuration" Parameter

"Operating Hours Report Configuration Status" Parameter

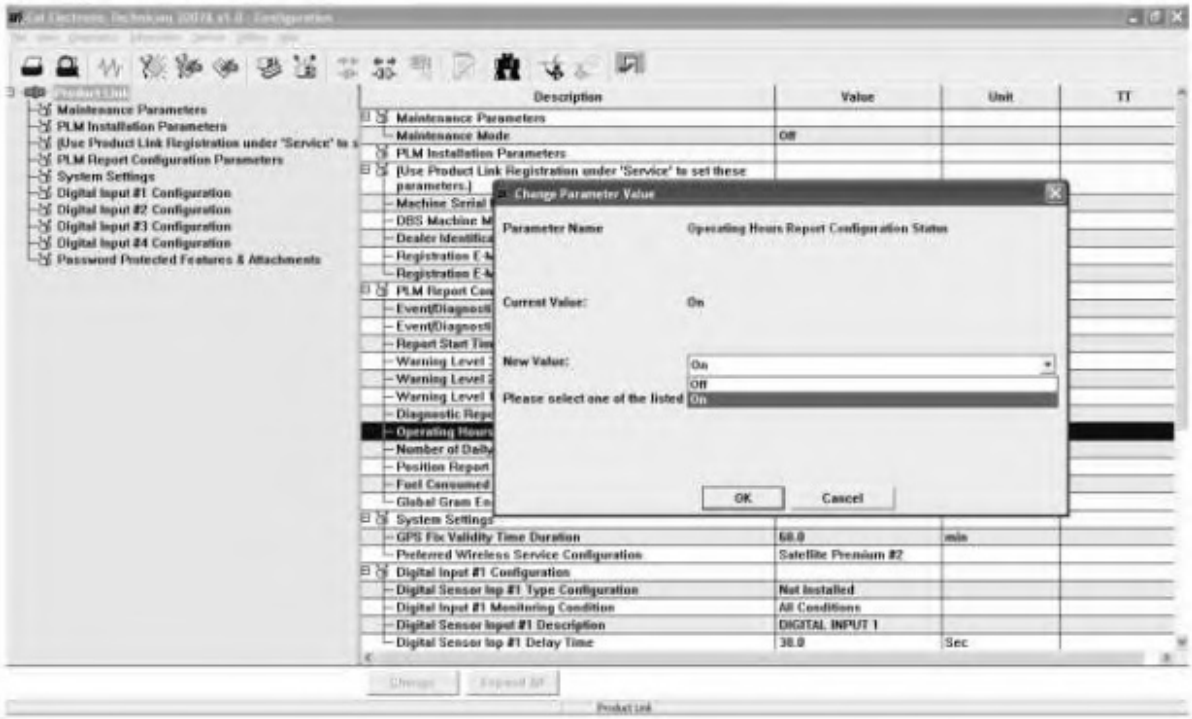


Illustration 6 g01361742

Screen of "Operating Hours Report Configuration Status" Parameter

"Number of Daily Machine Location Message Configuration" Parameter

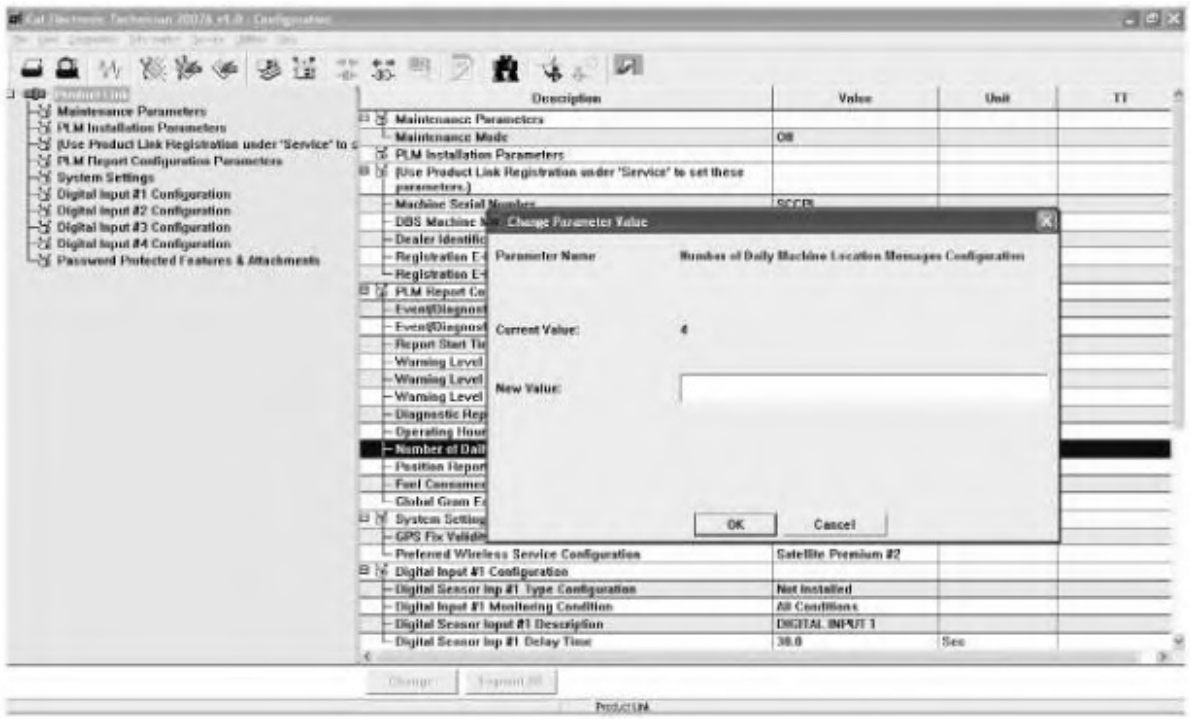


Illustration 7 g01361743

Screen of "Number of Daily Machine Location Message Configuration" Parameter

"Position Report Minimum Location Change" Parameter

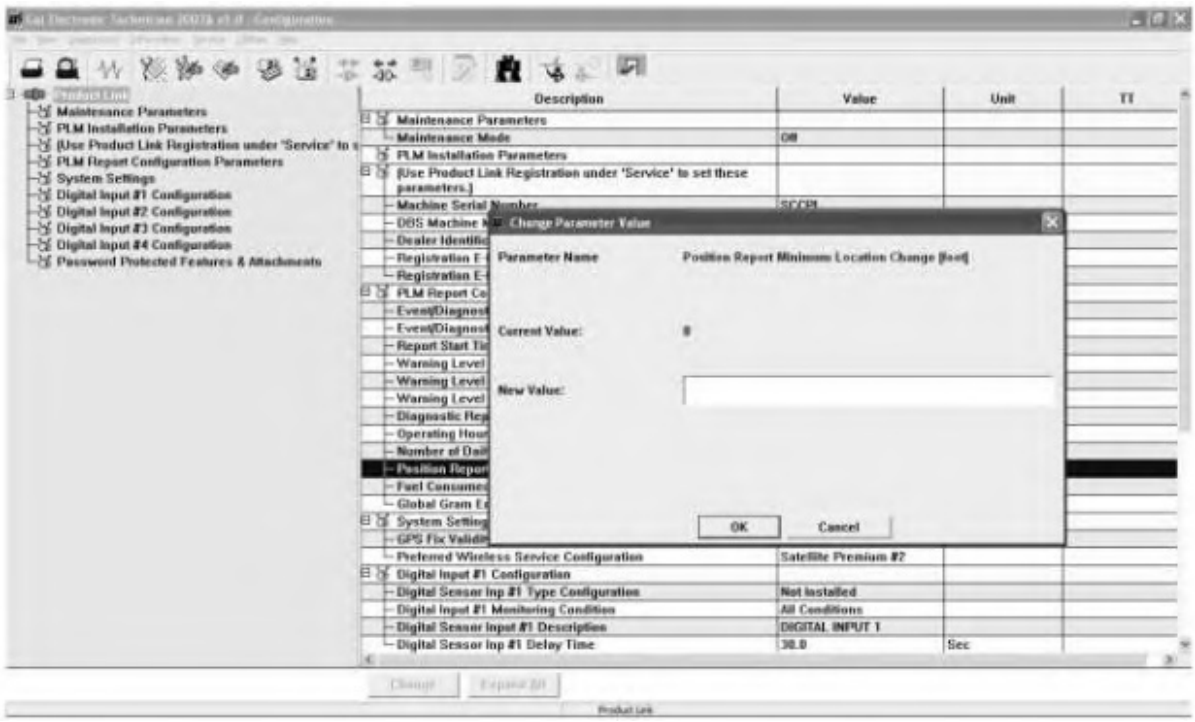


Illustration 8 g01361744

Screen of "Position report Minimum Location Change" Parameter

"Fuel Consumed Report Configuration Status" Parameter



Illustration 9 g01361745

Screen of "Fuel Consumed Report Configuration Status" Parameter

"Global Gram Enable Status" Parameter

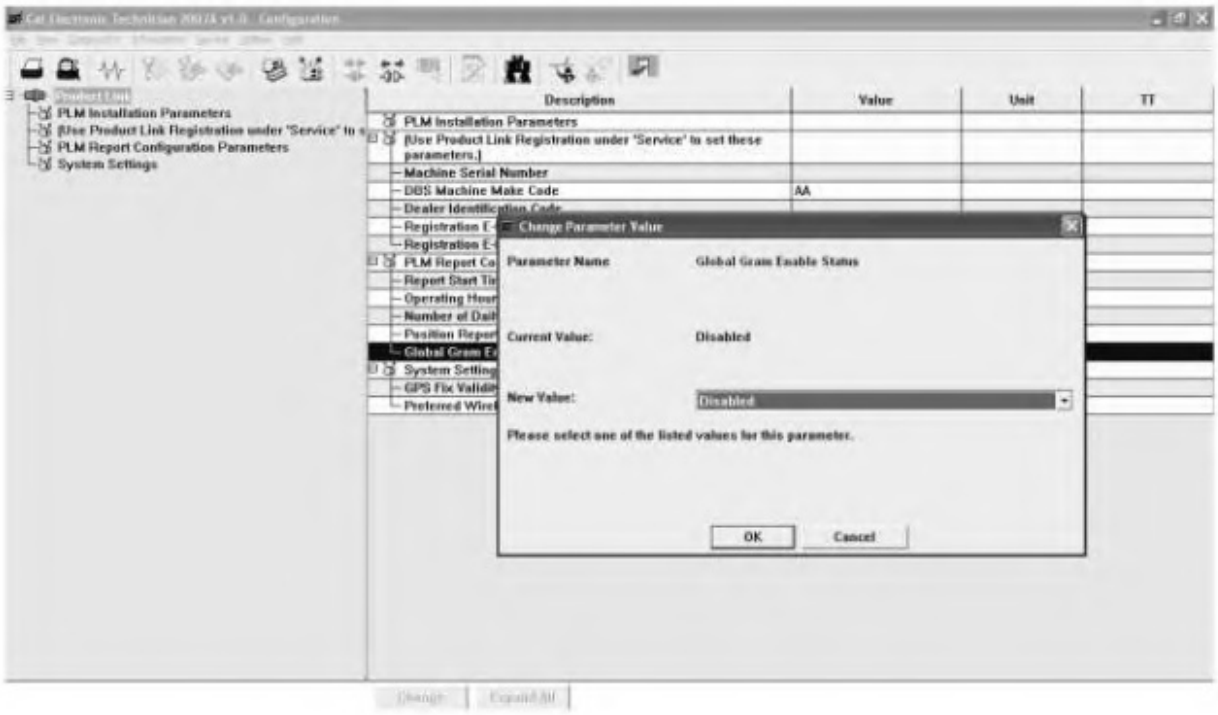


Illustration 10 g01361286

Screen of "Global Gram Enable Status" Parameter

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i04905776

Wireless Service Configure

SMCS - 7606

The "Preferred Wireless Service Configuration" parameter displays the current configuration for the customers wireless service. This parameter cannot be configured.

Table 1

Type of Module	**Cat ET 2004B and higher**
PL121	Satellite Basic #3
PL321	Satellite Premium #2

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i04905804

Spare Input Configure

SMCS - 7606-IV

The "Digital Input Configurations" should be verified. Once verified, the "Digital Input Configurations" should be changed if required. These values are used to configure the digital sensors "#1", "#2", "#3", and "#4" of the Product Link system. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Spare Inputs" for an example of types of switches. Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "System Schematic" for an example of a wiring diagram for the inputs.

Note: The following information is applicable to all four of the digital inputs.

"Digital Input Configuration"

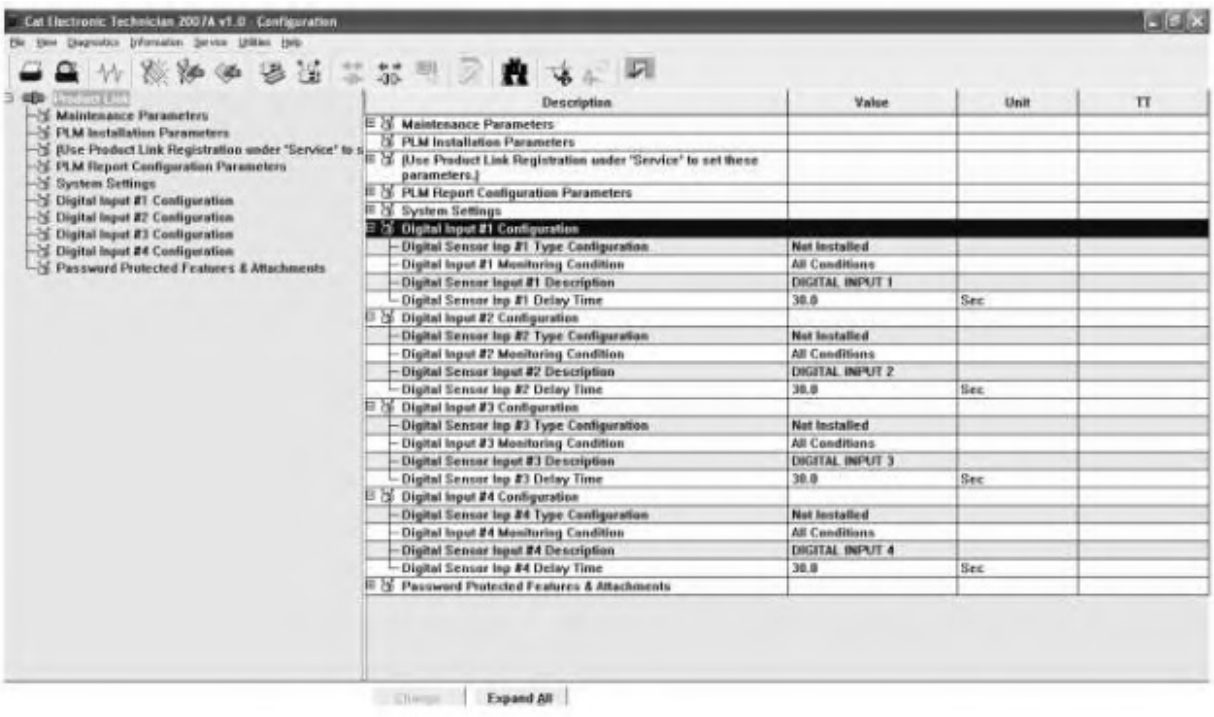


Illustration 1 g01361917

Table 1

Digital Input 1, 2, 3, or 4			
Sensor	**Definition**	**Configuration**	**Notes**
"Digital Sensor Input 1, 2, 3, or 4 Configuration Type"	The "Digital Sensor Input 1, 2, 3, or 4 Configuration Type" parameter defines whether a sensor is attached and, if attached, the state of the switch contacts under normal operating conditions (Normally Open or Normally Closed).	"Not Installed": The user cannot set the sensor to "Not Installed". No sensor attached to the input. The user can set the type of sensor by the following methods: "Not Configured": Sensor may be attached to the input but not in use. "Normally Closed": Sensor is at a closed (or low) state under normal operating conditions. "Normally Open": Sensor is at an open (or high) state under normal operating conditions.	The user cannot set the sensor to "Not Installed". "Not Installed" is the factory default.
"Digital Input 1, 2, 3, or 4 Monitoring Condition"	Defines the monitoring condition for the digital input. If the digital input is in the alarm state (opposite the normal state) as specified in "Digital Sensor Input 1, 2, 3, or 4 Type Configuration", for the delay time specified in "Digital Sensor Input 1, 2, 3, or 4 Delay Time", while the "Digital Input 1, 2, 3, or 4 Monitoring Condition" is true, an event is recorded and sent to the Equipmentmanager application.	Set for the desired monitoring condition as follows: All Conditions: Will monitor input without regard to key position or engine status. Key Off/Engine Off. Will monitor the digital input when key is OFF and engine is not running. Key On/Engine OFF: Will monitor the digital input when key is ON	"All Conditions" is the factory default. With key Off/Engine Off, status changes will only be monitored when the PL300 wakes up for scheduled reports. An Input on these switches will not trigger the PL300 to "wake up".

		and engine is not running. Key On/Engine On: Will monitor input when key is ON and engine is running.	
"Digital Sensor Input 1, 2, 3, or 4 Description"	The "Digital Sensor Input 1, 2, 3, or 4 Description" parameter is a 24 character field used to describe what the sensor is monitoring. This value is used in the office software to display the sensor status.	Enter a maximum of 24 characters for the description of the digital sensor input, for example "TRACK TENSION SENSOR".	The default is "DIGITAL INPUT 1, 2, 3, or 4".
"Digital Sensor Input 1, 2, 3, or 4 Delay Time"	Defines the delay time before an alarm condition is recorded. If the digital input is in the alarm state (opposite the normal state) as specified in "Digital Sensor Input 1, 2, 3, or 4 Type Configuration", for the delay time specified in "Digital Sensor Input 1, 2, 3, or 4 Delay Time", while the "Digital Input 1, 2, 3, or 4 Monitoring Condition" is true, an event is recorded and sent to the Equipmentmanager application. It is important to set this time correctly so spurious alarms are not set or alarms are missed.	Enter the delay time value for the digital sensor input in seconds.	The default value is 30.0 seconds. This value can be between 0.1 to 1200 seconds.

"Digital Sensor Input #x Type Configuration" Parameter

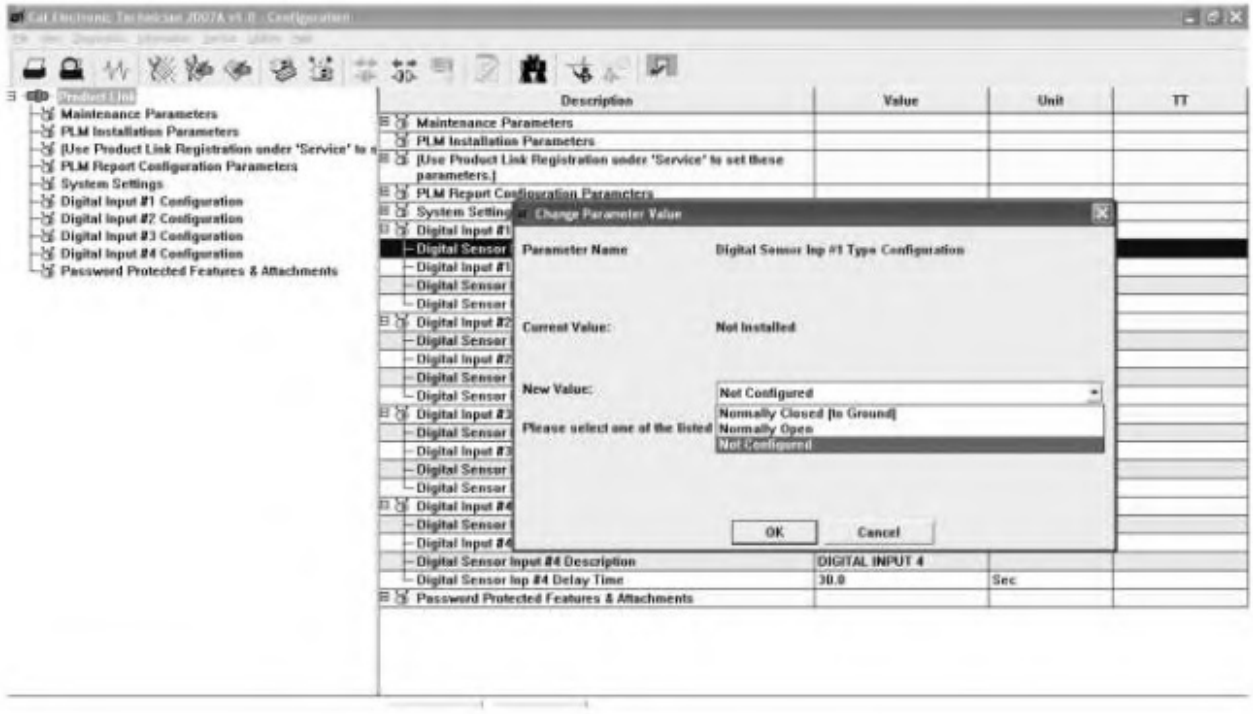


Illustration 2 g01361927

"Digital Input Type Configuration" Screen

The digital sensor type configuration informs the system of how to interpret the data from the attached sensor. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration" for the following information:

- Accessing parameters
- Changing parameters

Refer to Table 1 for further information about this parameter.

"Digital Sensor Input #x Monitoring Condition" Parameter

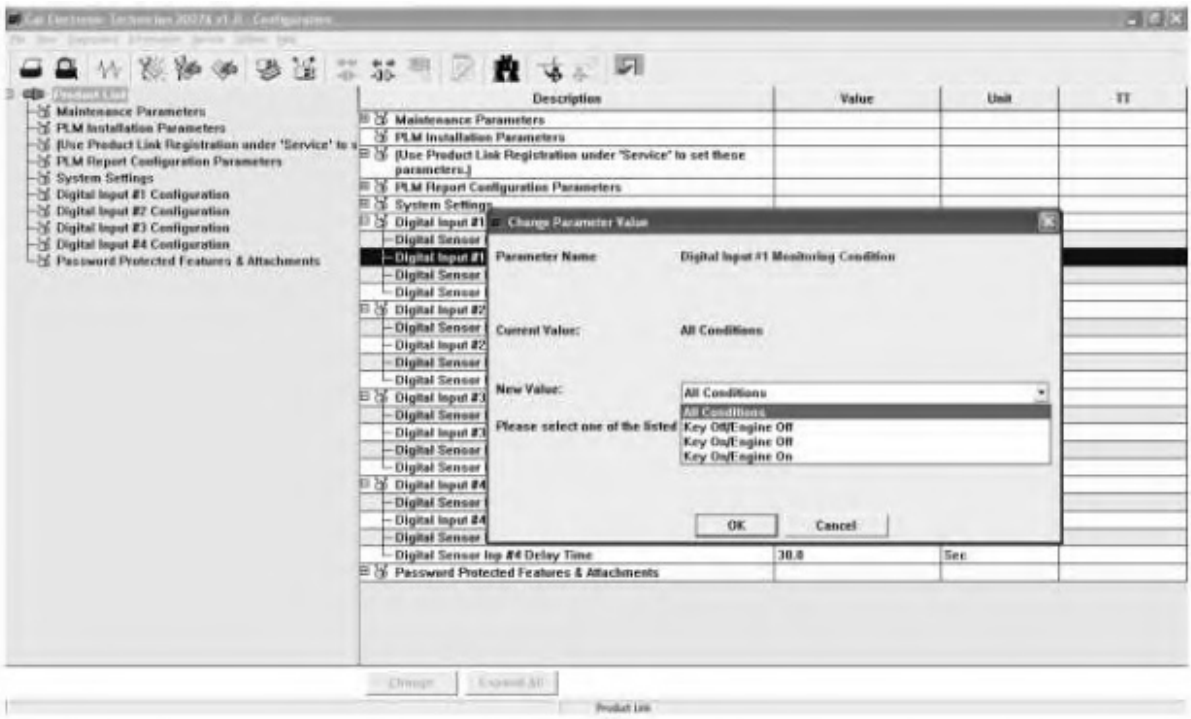


Illustration 3 g01361928

"Digital Input Monitoring Condition" Screen

Refer to Table 1 for further information about this parameter.

"Digital Sensor Input #x Description" Parameter

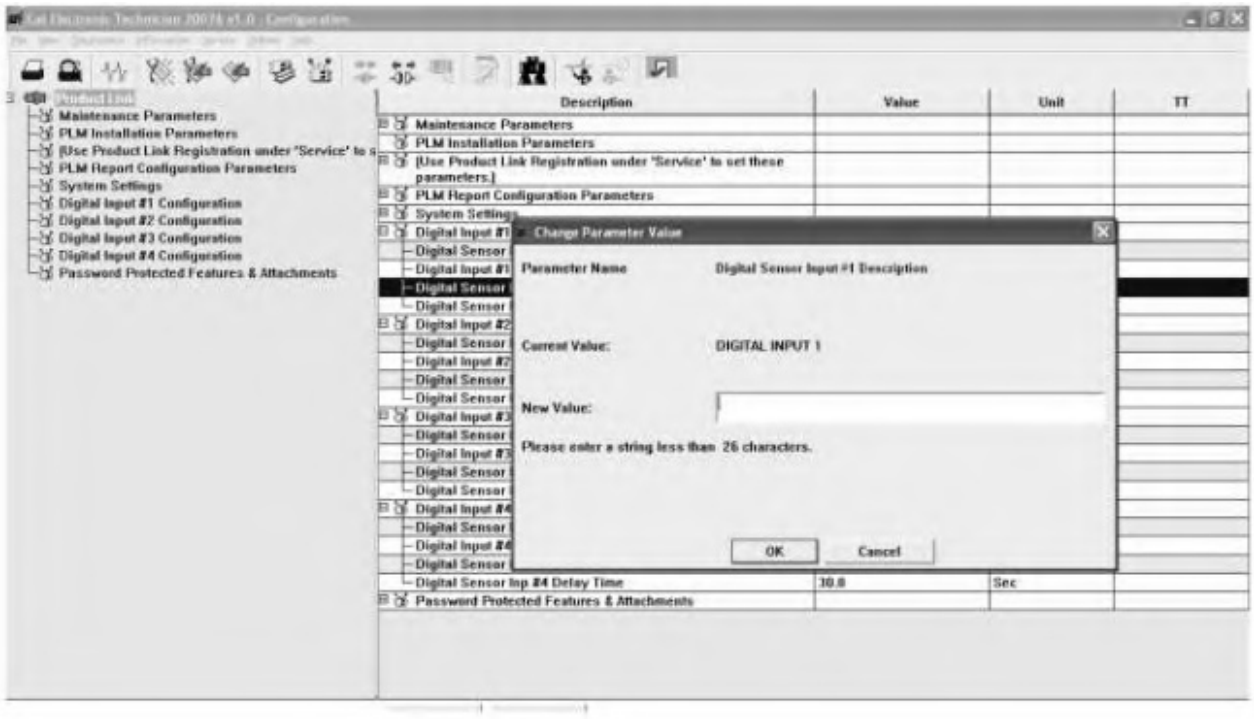


Illustration 4 g01361929

"Digital Spare Input Description" Screen

Refer to Table 1 for further information about this parameter.

Digital Sensor Input #x Delay Time

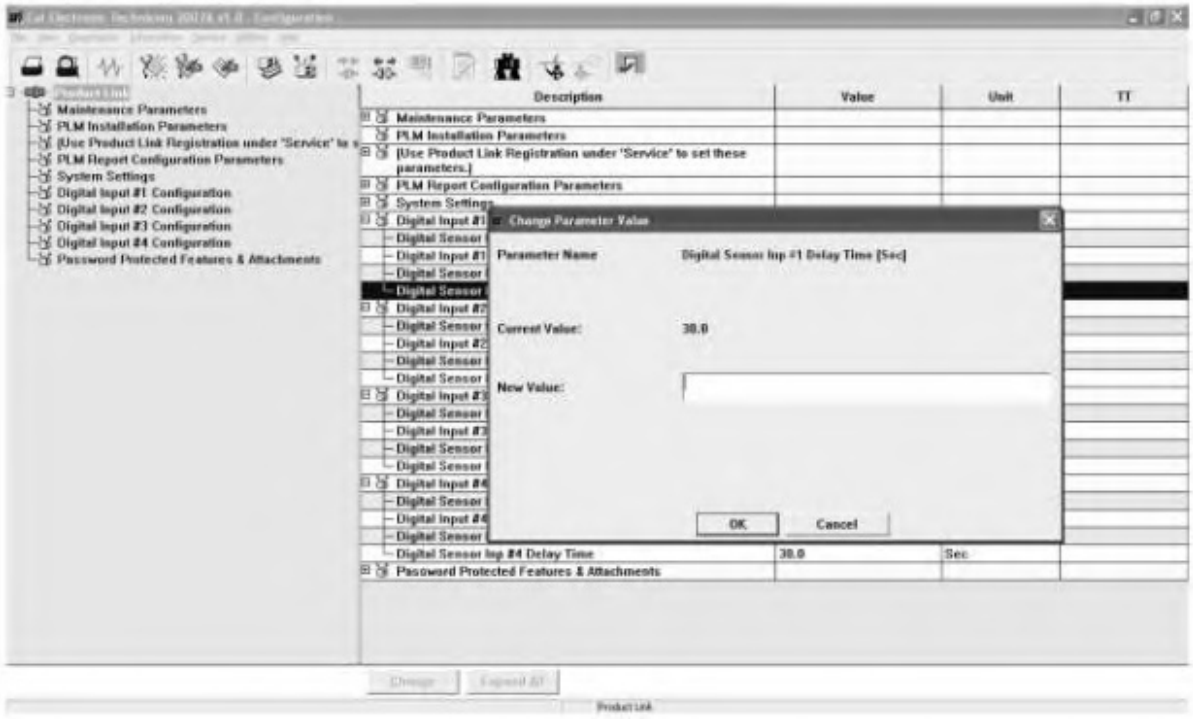


Illustration 5 g01361930

"Digital Input Delay Time" Screen

Refer to Table 1 for further information about this parameter.

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Systems Operation
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906908

Commands

SMCS - 7606

"Synchronize Service Hour Meters" for PL321

In order to perform the "Synchronize Service Hour Meters" function, select the "Service" menu, and "Synchronize Service Hour Meters" from the drop-down menu.

The machine maintains a function that is called "Sync Clock". In a PL321 system, the Product Link clock can be the master or the slave. This criteria is automatically determined by the priority that is provided to each ECM when the machine is designed. In most cases, Product Link will not be the master ECM. If Product Link is not the master, the user must use the "Synchronize" button in order to synchronize the Product Link SMH to the master ECM SMH. Product Link could be the master ECM if the following scenarios occur:

- No other ECM on the machine is SYNC clock capable/enabled.
- No other ECM on the machine has a priority higher than Product Link.

If Product Link is the master ECM, the user should select the "Set Master Hours" button. Once the master hours have been set, click the"Synchronize" button in order to synchronize any other sync-clock capable/enabled ECM. Refer to Illustration 1.

Note: In order to change the SMH to a value lower than the current value, a factory password will be required.

Note: In a PL321 system using sync-clock where Product Link is not the master ECM, the Product Link module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is greater than 50 hours, a diagnostic will be generated in Cat ET that indicates that a manual sync is required. In that instance, sync the hours (Service/Synchronize Service Meter Hours) unless the master ECM hours are incorrect.

If Product Link is not the master ECM, and the master ECM hours are not correct, troubleshoot on machine side. Do not replace the Product Link module.

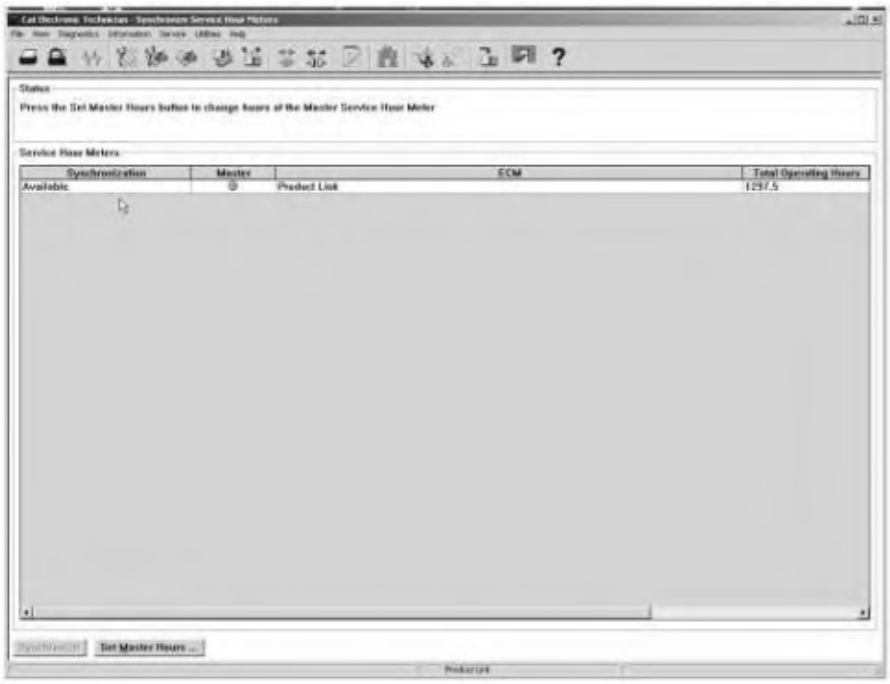


Illustration 1 g01362745

"Synchronize Service Hour Meters" Screen

"PLM Commands"

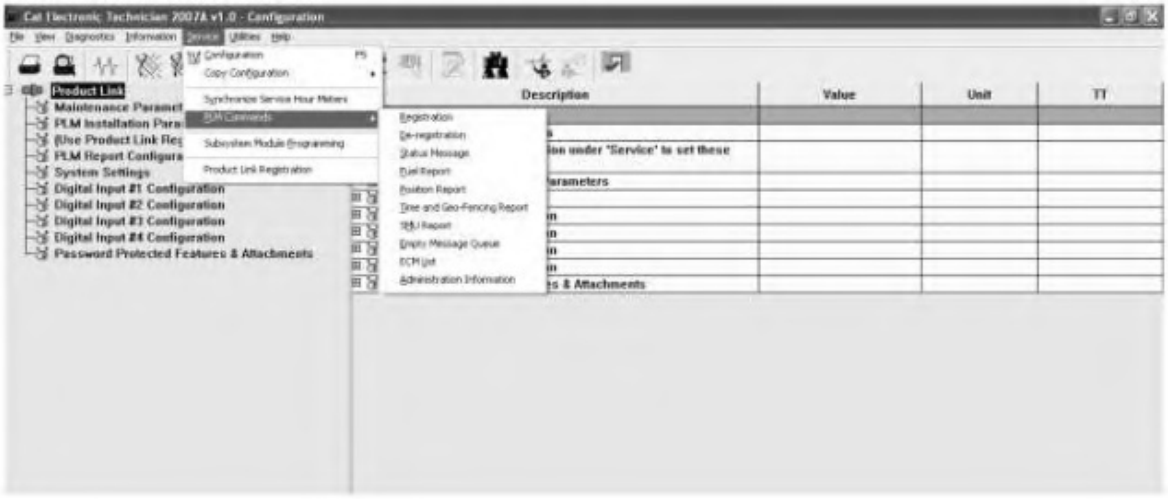


Illustration 2 g01362129

"PLM Commands" Menu for Cat ET

There are ten commands that can be completed by selecting "Service/PLM Commands" from the menu bar in Cat ET.

Registration - This command automatically queues a registration message and an administration message. The registration message will queue up and wait for the next available satellite to complete the process. The parameters "Queued Registration Messages"and "Queued Administration Messages" in "Message Queue" will show a value of "1". When the registration message and administration messages has been successfully transmitted, the value will change back to "0". This registration process can take from 15 minutes to 1 hour. The time frame is dependent on the performance of the communications network.

Note: Performing the registration process will activate the installed system. Complete the configuration process prior to performing the registration process.

Note: In order to register Product Link, the Product Link antenna must have a clear view of the sky for detecting satellites. Therefore, if the machine is inside of a building or another structure that would prevent a clear view of the sky, the machine will need to be moved outside. The yellow LED and the orange LED on the PL121SR radio should be solid in order to ensure that a lock has been established with the satellite. If the LED indicators for the radio cannot be observed, then the user can look in Cat ET at "Satellite Information" and "Satellite Communication Status" in order to determine that satellite communication has been established.

De-registration - This command de-registers the Product Link before removing the unit for installation on another machine. This command will set all of the fields back to the default values. This command will clear the memory of the unit. All of the Fence settings and diagnostics in the memory are erased. After the message is "queued", the message should enter the Message Queue. This message can be viewed by observing "Message Queue" for the Product Link ECM. After the message has been transmitted, the unit can be removed. The unit can be reinstalled on another machine.

Status Message - This command queues the following status descriptions: SMH, location and fuel.

Fuel Report - This command queues a fuel report.

Position Report - This command queues a position report.

Time and Geo-Fencing Report - This command queues a "Time and Geo-Fencing Report" report.

SMH Report - This command queues a "SMH" report.

Empty Message Queue - This command clears all messages out of the message queue. This command can be used in order to clear messages that are inadvertently added to the queue.

ECM List - This command queues up an "ECM List Report" after a wait of a few minutes. The "ECM List Report" includes a list of all ECM modules (and the associated serial numbers, software part numbers, and sync-clock status) detected by the Product Link that are connected to the Cat Datalink. The "ECM List" is automatically sent at the time of registration. The "ECM List" contains a unique identifier for each ECM that is detected by the Cat Datalink

Administration Message - This command queues an Administration message. This message contains data from the "Configuration"screen. The following examples are data examples: "PLM Report Configuration Parameters", "System Settings" and "Digital Input Configurations".

Note: Once these entries have been entered, the Product Link Module will automatically queue an Administration message after 15 minutes. The Product Link can be forced to queue a message sooner by using this command.

In order to register a module for the first time, follow the procedure that is listed below.

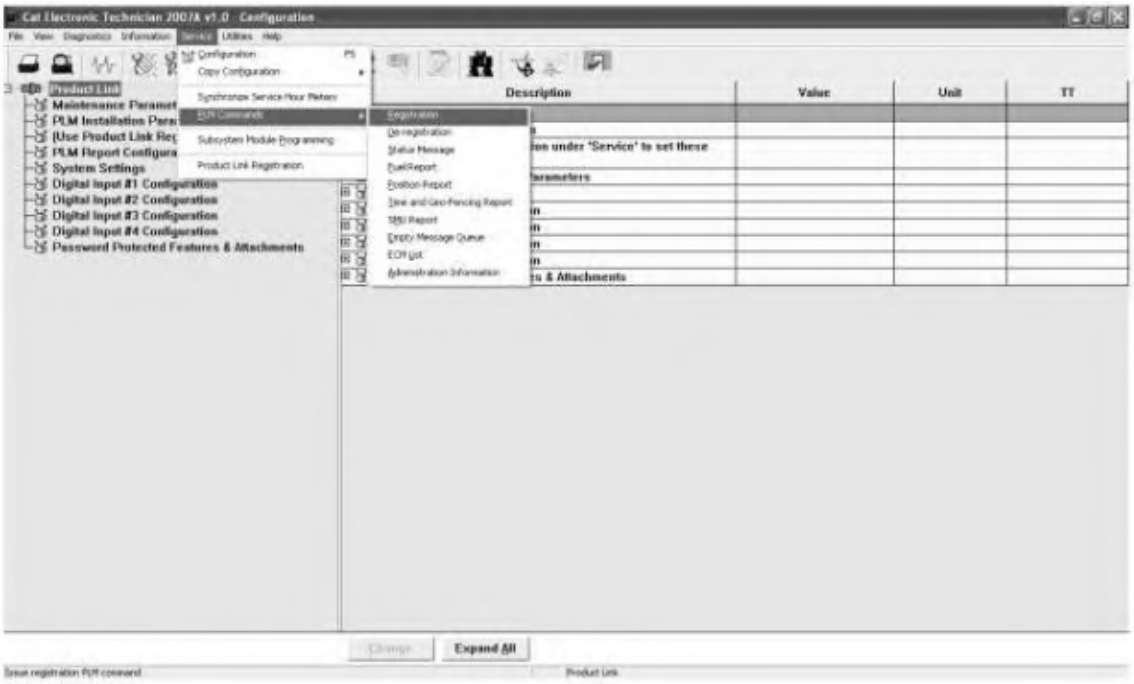


Illustration 3 g01362222

"Registration" Screen

1. Click "Service" on the toolbar. Select "Product Link Registration". Refer to Illustration 3.
2. Enter information in the following fields: "Machine Make Code", "Machine Serial Number", "Dealer Code", "Confirmation Email Address" (optional) and "Service Meter Hours". Refer to Illustration 5.

   Note: In a PL321 system, the machine serial number will be auto filled via information from the other ECMs on the CDL. The user will have the option to "Synchronize Service Meter Hours" if the PL321 is considered a "slave". The user will have the option to "Set Master Hours" if the PL321 is considered the "master". Refer to Illustration 4.

   Note: This will not change the SMH on other ECMs. Only the SMH on Product Link will be modified.
3. Click "Register". Refer to Illustration 5.
4. After "Registration" is selected, a dialog box will appear. The message will ask "Are you sure?". Click "Yes" or click "No". Clicking "Yes" will queue the registration messages and administration messages.
5. A confirmation message will be displayed. Click "OK"

   Note: After receiving a confirmation, you will be returned to the "Registration" screen.



Illustration 4 g01369431

PL321 "Registration Configuration" Screen

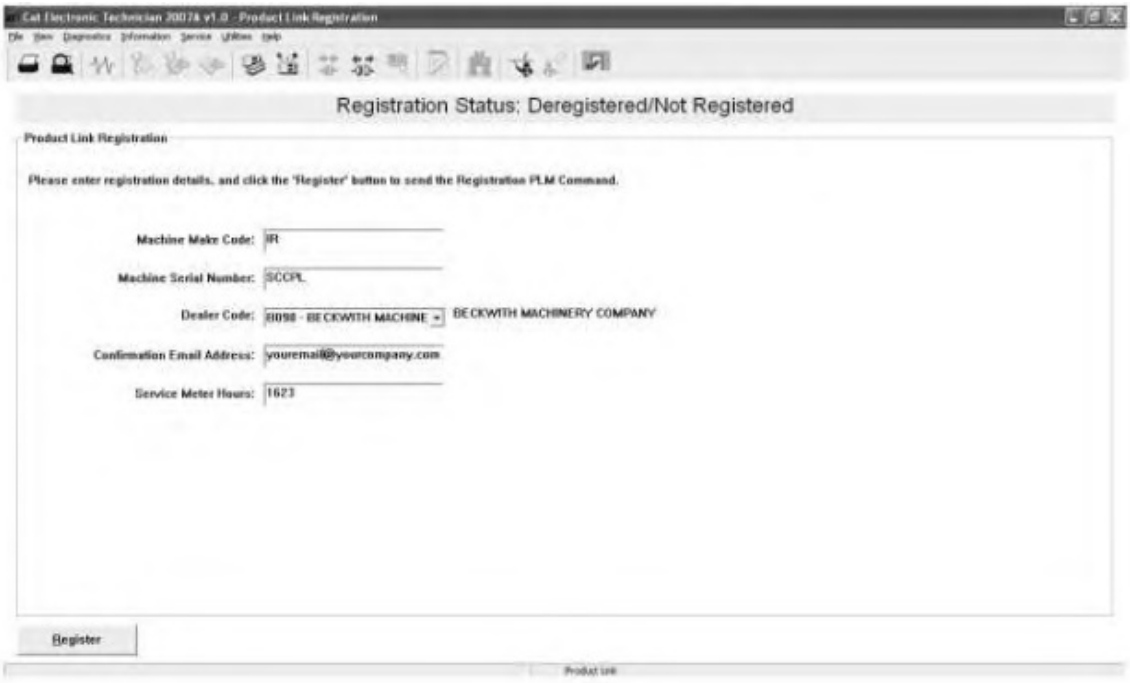


Illustration 5 g01362209

PL121 "Registration Configuration" Screen

In order to register the system again, follow the procedure that is listed below.

1. Click "Service" on the tool bar. Select "PLM Commands". Click "Registration" on the pull-down menu in order to start the registration process. Refer to Illustration 3.

2. After "Registration" is selected, a dialog box will appear. The message will ask "Are you sure?". Click "Yes" or click "No".

3. The registration message and administration message will "queue up".The parameters "Queued Registration Messages" and "Queued Administration Messages" in "Message Queue" will show a value of "1". When the registration message has been successfully transmitted, the value will change back to "0". This registration process can take from 15 minutes to 1 hour. This time frame depends on performance of the communications network.

   Note: The "Status Parameters" PLM Registration Status will change immediately to "Confirmation Pending". The "PLM Registration Status" will change to "Registered" once the module receives the confirmation that "the message was received and processed successfully in the backoffice (EM)". If the message was not processed successfully in the BackOffice, the "PLM Registration Status" will change to "Failed". If this occurs, the parameters should be verified for accuracy. If changes are required, repeat the original registration process via "Service", "Product Link Registration". Illustrations 6 and 7 are examples of the queued status screens for registration messages.

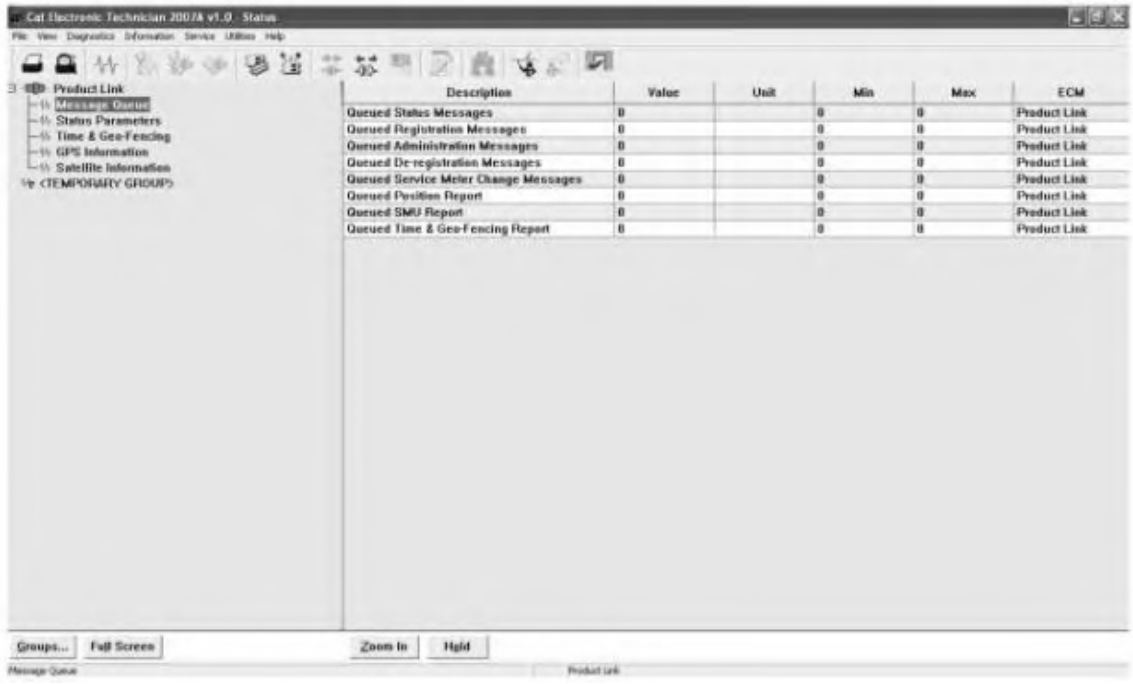


Illustration 6 g01362236

"Queue Status" Screen (PL121SR)

Note: The "Queued Registration Messages" and the "Queued Administration Messages" value will be "1 " while the messages are still in the queue.

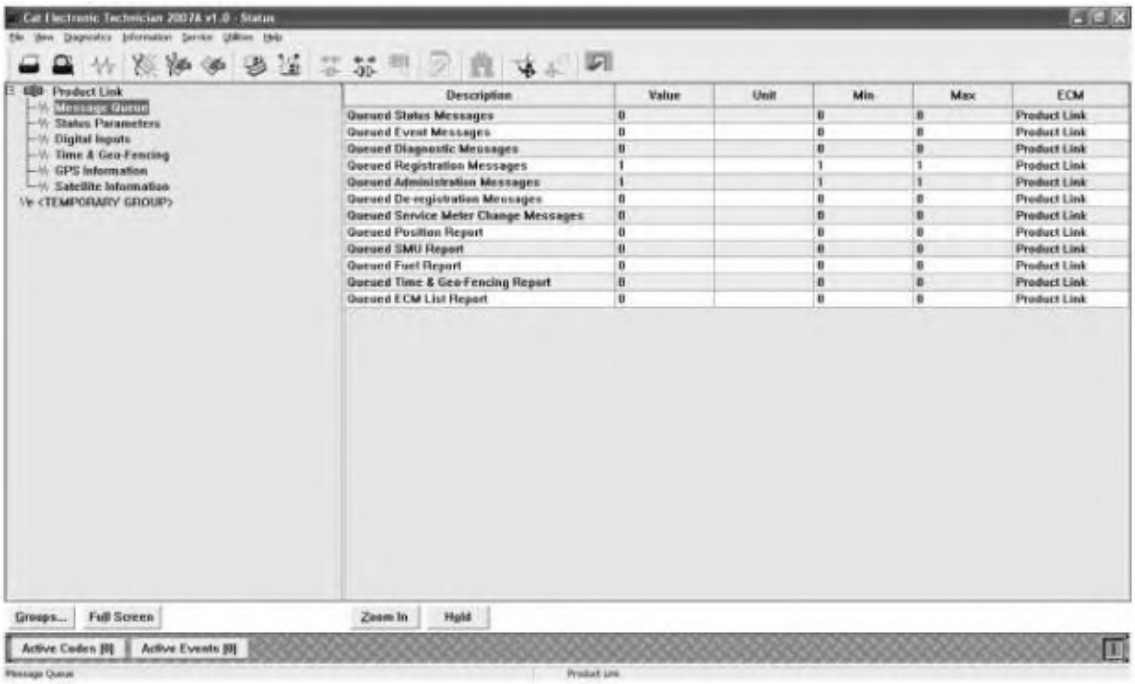


Illustration 7 g01362237

"Queue Status" Screen (PL321SR)

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i02510616

Wiring Harness (Open Circuit) - Test

SMCS - 1408-081

An open is a failure of an electrical circuit that results in no flow of electrical current. An open circuit is usually caused by failed electrical wires or a poor connection of electrical connectors. If an electrical wire or a connection is broken, the flow of electrical current through the circuit is interrupted. A normally closed circuit will have less than 5 ohms of resistance. The following procedure explains the test for an open circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR AN OPEN CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.

5. At the other connector of the machine harness, use the multimeter probes to measure the resistance from the contact of the suspect wire to frame ground.

   Expected Result: The resistance is less than 5 ohms.

   OK - The resistance is less than 5 ohms. The harness circuit is correct.

   Stop.

   NOT OK - The resistance is greater than 5000 ohms. There is an open in the machine harness.

   Repair: Repair the machine harness or replace the machine harness.

Stop.

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i01547498

Wiring Harness (Short Circuit) - Test

SMCS - 1408-081

A short circuit is a failure of an electrical circuit that results in undesired electrical current. Usually, a short circuit is a bypass of the circuit across a load. For example, a short across the wires in a circuit for a lamp produces too much current in the wires but no current is felt at the lamp. The lamp is shorted out. The resistance in a normal circuit is greater than 5000 ohms. The following procedure explains the test for a short circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR A SHORT CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At the machine harness connector for the ECM, place one of the multimeter probes on the contact of the suspect wire.

5. Use the other multimeter probe to check the resistance across all other contacts in the connector(s) of the ECM and frame ground.

   Expected Result: The resistance is greater than 5000 ohms for all the measurements.

   OK - The resistance is greater than 5000 ohms for all the measurements. The harness circuits are correct.

   Stop.

   NOT OK - The resistance is less than 5 ohms. There is a short in the machine harness. The short is between the suspected wire and the wire with the lowest resistance measurement.

Repair: Repair the machine harness or replace the machine harness.

Stop.

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i01621893

Electronic Control Module (ECM) - Flash Program

SMCS - 6700-591-EK2; 7610-591-WTL

Perform the following procedure in order to flash program the ECM. The ECM is flashed in order to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (ET) contains the program WinFlash. WinFlash is used in order to load software into the ECM. The following procedure is used in order to FLASH software into the ECM.

1. **Procedure**

    a. Connect the data link cable between the communication adapter and the electronic technician.

    b. Connect the data link cable between the communication adapter and the diagnostic connector of the machine.

    c. Turn the disconnect switch and the key start switch to the ON position.

    d. Use WinFlash in order to load the software.

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i01402879

Electronic Control Module (ECM) - Replace

SMCS - 6700-510-EK2; 7610-510-WTL

Prior to replacement of the auxiliary hydraulics ECM, ensure that replacement is absolutely necessary. The ECM is unlikely to fail. Always check that battery voltage is available to the ECM. Battery voltage is required between connector contact 1 and connector contact 3.

Note: The ECM is located under the floorplate. The pedals and the floorplate must be removed in order to gain access to the ECM.

1. Turn the disconnect switch and the key start switch to the OFF position.
2. Disconnect the machine harness from the ECM.
3. Remove the ECM.
4. Make sure that the replacement ECM has the correct part number. This is important because the interlock ECM uses the same housing.
5. Connect the machine harness to the ECM.
6. Install the replacement ECM.
7. Turn the disconnect switch and the key start switch to the ON position.
8. Flash the proper software into the ECM. Use the CAT ET to download the software.

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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01039743

Glossary of Electrical Terms

SMCS - 6700-EK2

Active - This pertains to the status of a fault or to the status of a service code. When the fault is active, the fault is currently present.

+Battery - This pertains to any of the harness wiring which is part of the circuit that connects to the positive battery post.

+V - +V is a constant voltage that is supplied to a component. This voltage provides electrical power for the component's operation. +V is provided by an electronic control module or the battery.

Caterpillar Electronic Technician (ET) - This is a diagnostic service tool for a personal computer (PC).

Clear - This pertains to removing diagnostic information from the memory of the ECM. Before clearing a fault, a fault must be on hold and a fault must not be present.

Component Identifier (CID) - A CID is a code that is used to identify a particular component. The CID is a four digit code that is shown on the ECM display when the ECM is in service mode or normal mode.

Connector Contact - A connector contact is the component that actually makes the electrical connection between the harness connector and another connector plug. Connector contacts are either pins or sockets.

Detected Fault - This is a fault that has been found by the ECM. The fault is recorded and diagnostic information is available in the service mode.

Diagnostic - This is a code that pertains to abnormal information. Diagnostic information is available when the ECM is in service mode.

Electronic Control Analyzer Programmer (ECAP) - This is a service tool which helps diagnose electronic control systems.

Fault - A fault is a failure of a component or a circuit in an ECM system. The ECM detects a fault when a signal at the ECM connector is outside a valid range. An FMI and a CID identify the type of fault.

Failure Mode Identifier (FMI) - An FMI is a diagnostic code that identifies the type of failure that has occurred. This code is shown on the Caterpillar® Monitoring System.

Hold or On Hold - This pertains to the holding of diagnostic information that is shown in the display area when the ECM is in the service mode. It is necessary to hold the set of diagnostic information before troubleshooting or clearing.

Jumper - A jumper is a piece of wire that is used to make an electrical connection during troubleshooting.

Module Identifier (MID) - A MID is a diagnostic code that identifies the ECM which diagnosed the fault. The three-digit code is displayed in the display area of the Caterpillar® ET when the machine is in the service mode. The MID for the auxiliary hydraulic ECM is 06A.

Present - This pertains to the status of a fault or the status of a service code. The fault is currently active when the fault is present.

Service Code - A service code describes a condition in an electrical system. This code is stored in the ECM for the service technician. The code is made up of the CID, the FMI, and the MID.

Signal - Signals are the inputs to the ECM. A ground signal has continuity with the frame ground. An open signal is not connected to the frame ground and the voltage is approximately 9.5 DCV. A +battery signal is at the same voltage as the battery.

Signal Wire - The signal wire is the harness wire that provides a connection to the sensor or the switch input to the ECM.

Switch Input - The switch input is any input to the ECM which is expecting a ground signal, an open signal or a +battery signal.

System Voltage - System voltage is the actual voltage that exists between the positive battery post and the frame ground. System voltage is also known as +battery voltage.

Undetected Fault - This is a fault that is not detected by the ECM, but the fault is found by the operator or by a service technician.

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Testing and Adjusting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01992179

System Schematic

SMCS - 7566

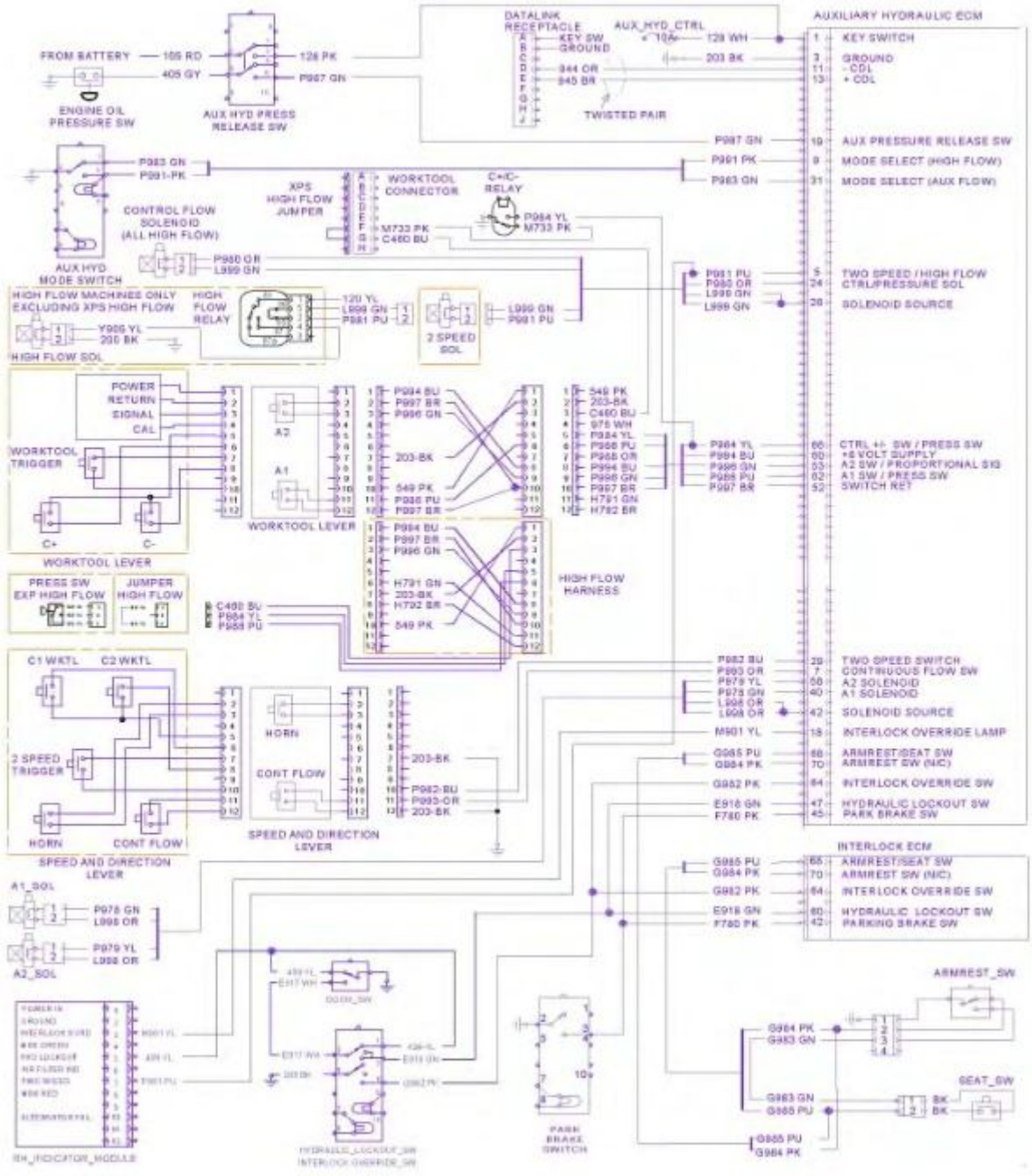


Illustration 1 g01033612

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i01995812

Electronic Control Module (ECM) - Replace

SMCS - 7630-510

Prior to replacement of the interlock ECM, ensure that replacement is absolutely necessary. The ECM is unlikely to fail. Always check that battery voltage is available to the ECM. Battery voltage is required between connector contact 1 and connector contact 3.

1. Turn the disconnect switch and the key start switch to the OFF position. The disconnect switch is optional.
2. Raise the cab. See Operation and Maintenance Manual, "Raising the Cab".
3. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.
4. Disconnect the machine harness from the ECM.
5. Remove the ECM.
6. Make sure that the replacement ECM has the correct part number. This is important because the auxiliary hydraulic ECM uses the same housing.
7. Install the replacement ECM.
8. Connect the machine harness to the ECM.
9. Lower the cab. See Operation and Maintenance Manual, "Lowering the Cab".
10. Turn the disconnect switch and the key start switch to the ON position.

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Testing and Adjusting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01035632

Glossary of Electrical Terms

SMCS - 7630

+Battery - This pertains to any of the harness wiring which is part of the circuit that connects to the positive battery post.

+V - +V is a constant voltage that is supplied to a component. This voltage provides electrical power for the component's operation. +V is provided by an electronic control module or the battery.

Caterpillar Electronic Technician (ET) - This is a diagnostic service tool for a personal computer (PC).

Component Identifier (CID) - A CID is a code that is used to identify a particular component. The CID is a four digit code that is shown on the ECM display when the ECM is in service mode or normal mode.

Connector Contact - A connector contact is the component that actually makes the electrical connection between the harness connector and another connector plug. Connector contacts are either pins or sockets.

Detected Fault - This is a fault that has been found by the ECM.

Fault - A fault is a failure of a component or a circuit in an ECM system. The ECM detects a fault when a signal at the ECM connector is outside a valid range.

Failure Mode Identifier (FMI) - An FMI is a diagnostic code that identifies the type of failure that has occurred. This code is shown on the Caterpillar® Electronic Technician.

Jumper - A jumper is a piece of wire that is used to make an electrical connection during troubleshooting.

Signal - Signals are the inputs to the ECM. A ground signal has continuity with the frame ground. An open signal is not connected to the frame ground and the voltage is approximately 5 DCV. A +battery signal is at the same voltage as the battery.

Signal Wire - The signal wire is the harness wire that provides a connection to the sensor or the switch input to the ECM.

Switch Input - The switch input is any input to the ECM which is expecting a ground signal, an open signal or a +battery signal.

System Voltage - System voltage is the actual voltage that exists between the positive battery post and the frame ground. System voltage is also known as +battery voltage.

Undetected Fault - This is a fault that is not detected by the ECM, but the fault is found by the operator or by a service technician.

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Previous Screen

Product: SKID STEER LOADER
Model: 236B SKID STEER LOADER HEN
Configuration: 236B 246B 252B 262B SKID STEER LOADER HEN00001-06749 (MACHINE) POWERED BY 3044C Engine

Testing and Adjusting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i04645009

System Schematic

SMCS - 7566

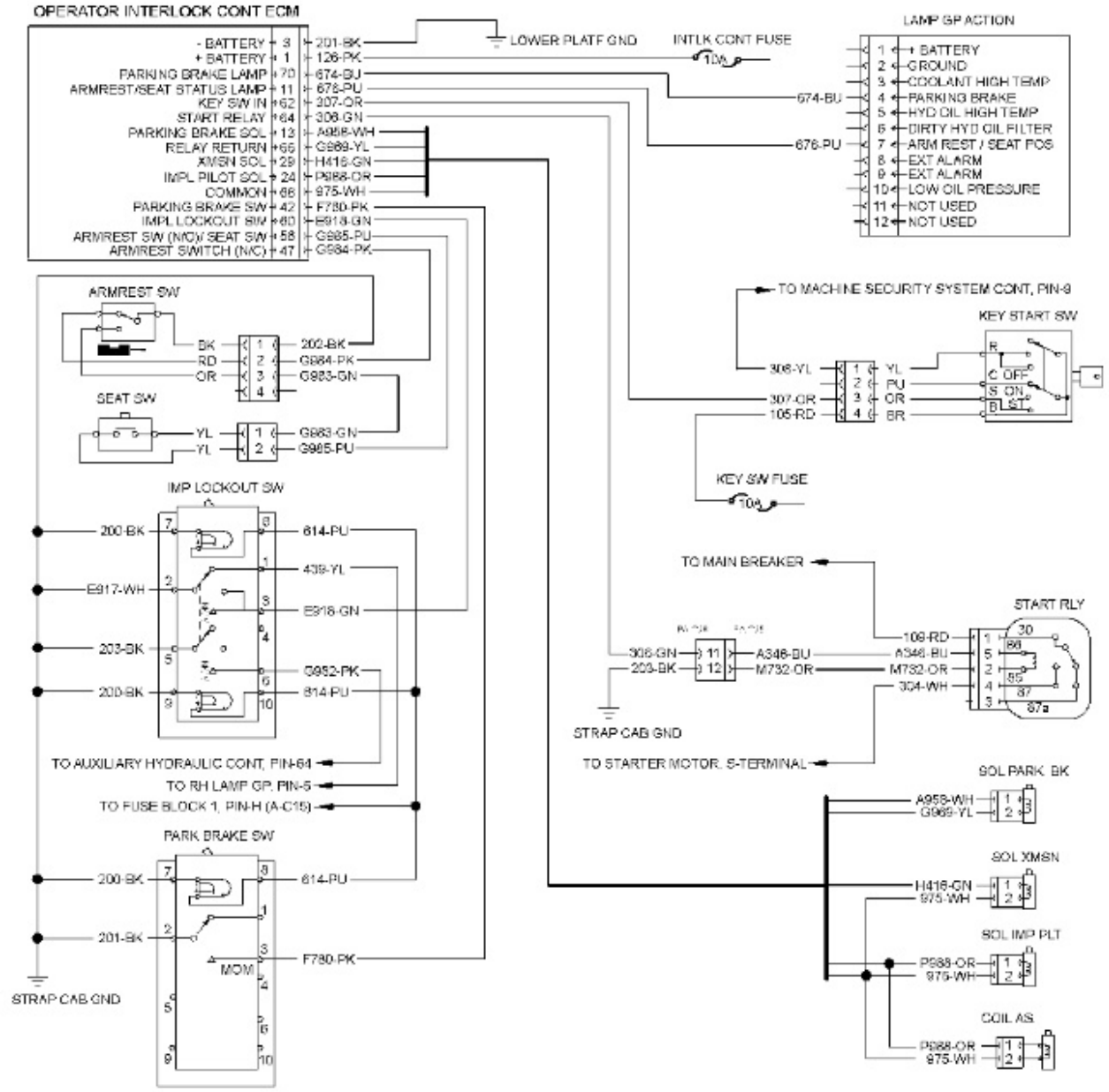


Illustration 1 g02788816

Schematic for the electrical control system for the interlock system

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Product: SKID STEER LOADER
Model: 236B SKID STEER LOADER HEN
Configuration: 236B 246B 252B 262B SKID STEER LOADER HEN00001-06749 (MACHINE) POWERED BY 3044C Engine

Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02686950

Alternator - Test

SMCS - 1405-081

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
237-5130	Digital Multimeter	1
225-8266	Ammeter Tool Gp	1

1. Put the positive lead "+" of the multimeter on the "Bat" terminal of the alternator. Put the negative "-" lead on the ground terminal or on the frame of the alternator. Put the ammeter around the positive output wire of the alternator.

2. Turn off all electrical accessories. Turn off the fuel to the engine. Crank the engine for 30 seconds. Wait for two minutes in order to cool the starting motor. If the electrical system appears to operate correctly, crank the engine again for 30 seconds.

   Note: Cranking the engine for 30 seconds partially discharges the batteries in order to do a charging test. If the battery has a low charge, do not perform this step. Jump start the engine or charge the battery before the engine is started.

3. Start the engine and run the engine at full throttle.

4. Check the output current of the alternator. The initial charging current should be equal to the minimum full load current or greater than the minimum full load current. Refer to Specifications, "Alternator and Regulator" for the correct minimum full load current.

Table 2

Fault Conditions And Possible Causes			
Current At Start-up	The Voltage Is Below Specifications After 10 Minutes.	The Voltage Is Within Specifications After 10 Minutes.	The Voltage Is Above Specifications After 10 Minutes.

Less than the specifications	Replace the alternator. Check the circuit of the ignition switch.	Turn on all accessories. If the voltage decreases below the specifications, replace the alternator.	-
Decreases after matching specifications	Replace the alternator.	The alternator and the battery match the specifications. Turn on all accessories in order to verify that the voltage stays within specifications.	Replace the alternator.
The voltage consistently exceeds specifications.	Follow the procedures that are in the Tool Operating Manual, SEHS7633 in order to test the battery. Test the alternator again.	The alternator operates within the specifications. Follow the procedures in the Tool Operating Manual, SEHS7633 in order to test the battery.	Replace the alternator. Inspect the battery for damage.

5. After approximately ten minutes of operating the engine at full throttle, the output voltage of the alternator should be 14.0 ± 0.5 volts. Refer to the Fault Conditions And Possible Causes in Table 3.

6. After ten minutes of engine operation, the charging current should decrease to approximately 10 amperes. The actual length of time for the charging current to decrease to 10 amperes depends on the following conditions:

    - The battery charge
    - The ambient temperature
    - The rpm of the engine

    Refer to the Fault Conditions And Possible Causes in Table 3.

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i01126605

Battery - Test

SMCS - 1401-081

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition. The wire and cable connections must be clean, and both components must be tight.

WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery.

NOTICE

The charging unit will be damaged if the connections between the battery and the charging unit are broken while the battery is being charged. Damage occurs because the load from the battery is lost and because there is an increase in charging voltage. High voltage will damage the charging unit, the regulator, and other electrical components.

See Special Instruction, SEHS7633, "Battery Test Procedure" for the correct procedures to use to test the battery. This publication also contains the specifications to use when you test the battery.

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i01964005

Electric Starting System - Test

SMCS - 1450-081

Use the multimeter in the DCV range to find starting system components which do not function.

Move the start control switch in order to activate the starting solenoids. The starting solenoid's operation can be heard as the pinion of the starting motor is engaged with the ring gear on the engine flywheel.

If a solenoid for a starting motor will not operate, it is possible that the current from the battery did not reach the solenoid. Fasten one lead of the multimeter to the connection (terminal) for the battery cable on the solenoid. Connect the other lead to a good ground. A zero reading indicates that there is a broken circuit from the battery. More testing is necessary when there is a voltage reading on the multimeter.

The solenoid operation also closes the electric circuit to the motor. Connect one lead of the multimeter to the solenoid connection (terminal) that is fastened to the motor. Connect the other lead to a good ground. Activate the starting solenoid and look at the multimeter. A voltage reading of the battery shows that the problem is in the motor. The motor must be removed for further testing. A zero reading on the multimeter shows that the solenoid contacts do not close. This indicates the need for repair to the solenoid, or to the clearance for the starter motor pinion.

Perform a test. Fasten one multimeter lead to the connection (terminal) for the small wire at the solenoid and fasten the other lead to the ground. Look at the multimeter and activate the starting solenoid. A voltage reading shows that the problem is in the solenoid. A zero reading indicates that the problem is in the start switch or the wires for the start switch.

Fasten one multimeter lead to the start switch at the connection (terminal) for the wire from the battery. Fasten the other lead to a good ground. A zero reading indicates a broken circuit from the battery. Check of the circuit breaker and wiring. If there is a voltage reading, the problem is in the start switch or in the wires for the start switch.

Starting motors that operate too slowly can have an overload due to excessive friction in the engine that is being started. Slow operation of the starting motors can also be caused by a short circuit, loose connections, and/or dirt in the motor.

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i02830900

Glow Plugs - Test

SMCS - 1412-081

Continuity Check of the Glow Plugs

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
237-5130	Digital Multimeter	1

The following test will check the continuity of the glow plugs.

1. Disconnect the power supply and the bus bar.
2. Set the **237-5130** Digital Multimeter to check continuity (resistance). Turn the audible signal on the digital multimeter ON.
3. Place one probe on the connection for the glow plug and the other probe to a suitable ground. The Digital Multimeter should make an audible sound. Replace the glow plug if there is no continuity.
4. Check the continuity on all the glow plugs.

Checking the Operation of the Glow Plug

Table 2

Required Tools		
Part Number	**Part Name**	**Qty**
231-5130	Digital Multimeter	1
225-8266	Ammeter	1

The following test will check the operation of the glow plugs.

1. Disconnect the power supply and the bus bar.
2. Connect the power supply to only one glow plug.
3. Place the **225-8266** Ammeter on the power supply wire.
4. Connect the **237-5130** Digital Multimeter to the terminal on the glow plug and to a suitable ground.
5. Turn the switch to the ON position in order to activate the glow plugs.
6. Check the reading on all of the glow plugs. Refer to Specifications, "Glow Plugs" for the values of the current for each glow plug.
7. If there is no reading on the ammeter check the electrical connections. If the readings on the ammeter are low replace the glow plugs. If there is still no reading replace the glow plugs.

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i02686950

Alternator - Test

SMCS - 1405-081

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
237-5130	Digital Multimeter	1
225-8266	Ammeter Tool Gp	1

1. Put the positive lead "+" of the multimeter on the "Bat" terminal of the alternator. Put the negative "-" lead on the ground terminal or on the frame of the alternator. Put the ammeter around the positive output wire of the alternator.

2. Turn off all electrical accessories. Turn off the fuel to the engine. Crank the engine for 30 seconds. Wait for two minutes in order to cool the starting motor. If the electrical system appears to operate correctly, crank the engine again for 30 seconds.

   Note: Cranking the engine for 30 seconds partially discharges the batteries in order to do a charging test. If the battery has a low charge, do not perform this step. Jump start the engine or charge the battery before the engine is started.

3. Start the engine and run the engine at full throttle.

4. Check the output current of the alternator. The initial charging current should be equal to the minimum full load current or greater than the minimum full load current. Refer to Specifications, "Alternator and Regulator" for the correct minimum full load current.

Table 2

Fault Conditions And Possible Causes			
Current At Start-up	The Voltage Is Below Specifications After 10 Minutes.	The Voltage Is Within Specifications After 10 Minutes.	The Voltage Is Above Specifications After 10 Minutes.

Less than the specifications	Replace the alternator. Check the circuit of the ignition switch.	Turn on all accessories. If the voltage decreases below the specifications, replace the alternator.	-
Decreases after matching specifications	Replace the alternator.	The alternator and the battery match the specifications. Turn on all accessories in order to verify that the voltage stays within specifications.	Replace the alternator.
The voltage consistently exceeds specifications.	Follow the procedures that are in the Tool Operating Manual, SEHS7633 in order to test the battery. Test the alternator again.	The alternator operates within the specifications. Follow the procedures in the Tool Operating Manual, SEHS7633 in order to test the battery.	Replace the alternator. Inspect the battery for damage.

5. After approximately ten minutes of operating the engine at full throttle, the output voltage of the alternator should be 14.0 ± 0.5 volts. Refer to the Fault Conditions And Possible Causes in Table 3.

6. After ten minutes of engine operation, the charging current should decrease to approximately 10 amperes. The actual length of time for the charging current to decrease to 10 amperes depends on the following conditions:

    - The battery charge
    - The ambient temperature
    - The rpm of the engine

    Refer to the Fault Conditions And Possible Causes in Table 3.

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i01126605

Battery - Test

SMCS - 1401-081

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition. The wire and cable connections must be clean, and both components must be tight.

WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery.

NOTICE

The charging unit will be damaged if the connections between the battery and the charging unit are broken while the battery is being charged. Damage occurs because the load from the battery is lost and because there is an increase in charging voltage. High voltage will damage the charging unit, the regulator, and other electrical components.

See Special Instruction, SEHS7633, "Battery Test Procedure" for the correct procedures to use to test the battery. This publication also contains the specifications to use when you test the battery.

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i01964005

Electric Starting System - Test

SMCS - 1450-081

Use the multimeter in the DCV range to find starting system components which do not function.

Move the start control switch in order to activate the starting solenoids. The starting solenoid's operation can be heard as the pinion of the starting motor is engaged with the ring gear on the engine flywheel.

If a solenoid for a starting motor will not operate, it is possible that the current from the battery did not reach the solenoid. Fasten one lead of the multimeter to the connection (terminal) for the battery cable on the solenoid. Connect the other lead to a good ground. A zero reading indicates that there is a broken circuit from the battery. More testing is necessary when there is a voltage reading on the multimeter.

The solenoid operation also closes the electric circuit to the motor. Connect one lead of the multimeter to the solenoid connection (terminal) that is fastened to the motor. Connect the other lead to a good ground. Activate the starting solenoid and look at the multimeter. A voltage reading of the battery shows that the problem is in the motor. The motor must be removed for further testing. A zero reading on the multimeter shows that the solenoid contacts do not close. This indicates the need for repair to the solenoid, or to the clearance for the starter motor pinion.

Perform a test. Fasten one multimeter lead to the connection (terminal) for the small wire at the solenoid and fasten the other lead to the ground. Look at the multimeter and activate the starting solenoid. A voltage reading shows that the problem is in the solenoid. A zero reading indicates that the problem is in the start switch or the wires for the start switch.

Fasten one multimeter lead to the start switch at the connection (terminal) for the wire from the battery. Fasten the other lead to a good ground. A zero reading indicates a broken circuit from the battery. Check of the circuit breaker and wiring. If there is a voltage reading, the problem is in the start switch or in the wires for the start switch.

Starting motors that operate too slowly can have an overload due to excessive friction in the engine that is being started. Slow operation of the starting motors can also be caused by a short circuit, loose connections, and/or dirt in the motor.

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i02830900

Glow Plugs - Test

SMCS - 1412-081

Continuity Check of the Glow Plugs

Table 1

Required Tools		
Part Number	**Part Name**	**Qty**
237-5130	Digital Multimeter	1

The following test will check the continuity of the glow plugs.

1. Disconnect the power supply and the bus bar.
2. Set the **237-5130** Digital Multimeter to check continuity (resistance). Turn the audible signal on the digital multimeter ON.
3. Place one probe on the connection for the glow plug and the other probe to a suitable ground. The Digital Multimeter should make an audible sound. Replace the glow plug if there is no continuity.
4. Check the continuity on all the glow plugs.

Checking the Operation of the Glow Plug

Table 2

Required Tools		
Part Number	**Part Name**	**Qty**
231-5130	Digital Multimeter	1
225-8266	Ammeter	1

The following test will check the operation of the glow plugs.

1. Disconnect the power supply and the bus bar.
2. Connect the power supply to only one glow plug.
3. Place the **225-8266** Ammeter on the power supply wire.
4. Connect the **237-5130** Digital Multimeter to the terminal on the glow plug and to a suitable ground.
5. Turn the switch to the ON position in order to activate the glow plugs.
6. Check the reading on all of the glow plugs. Refer to Specifications, "Glow Plugs" for the values of the current for each glow plug.
7. If there is no reading on the ammeter check the electrical connections. If the readings on the ammeter are low replace the glow plugs. If there is still no reading replace the glow plugs.

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Testing and Adjusting
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i04001426

General Information

SMCS - 7631

Cat® Electronic Key

The machine security system (MSS) uses a Cat® electronic key. The key contains an electronic chip that is embedded in the head of the key. This chip contains a unique identification number. No two keys have the same ID. The electronic key uses the same key cut as the standard Cat® key. The electronic key can be used to operate machines that are not equipped with the MSS. The head of the electronic key is gray or yellow in color.

The machine can be started when none of the valid keys are available. Any Cat® key and the access code for the MSS is required to enable this function.

A system disarm feature will allow a machine to operate with any key. Refer to the Testing and Adjusting, "System Disarm - Program" for additional information.

Security Management using Cat® Electronic Technician (Cat® ET)

The machine security system uses the Cat® Electronic Technician (Cat® ET) service tool to manage the settings of the system. There are restrictions on accessing the settings. The security management feature of the MSS controls the access to the settings.

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i02163387

Product Identification Number - Program

SMCS - 7631-591

This procedure allows you to input or change the Product Identification Number ("Product ID").

Note: If the correct "product ID" has not been entered into the MSS, you will be unable to obtain a factory password.

1. Connect a laptop computer with the Caterpillar ET to the machine via the communication adapter.
2. Place an electronic key with master level access in the key start switch.
3. Turn the electronic key to the "ON" position.
4. Start the Electronic Technician and establish communications with the MSS ECM.
5. Select the "Configuration" option from the "Service" Menu or press the "F5" key. This will display the "Configuration" screen.

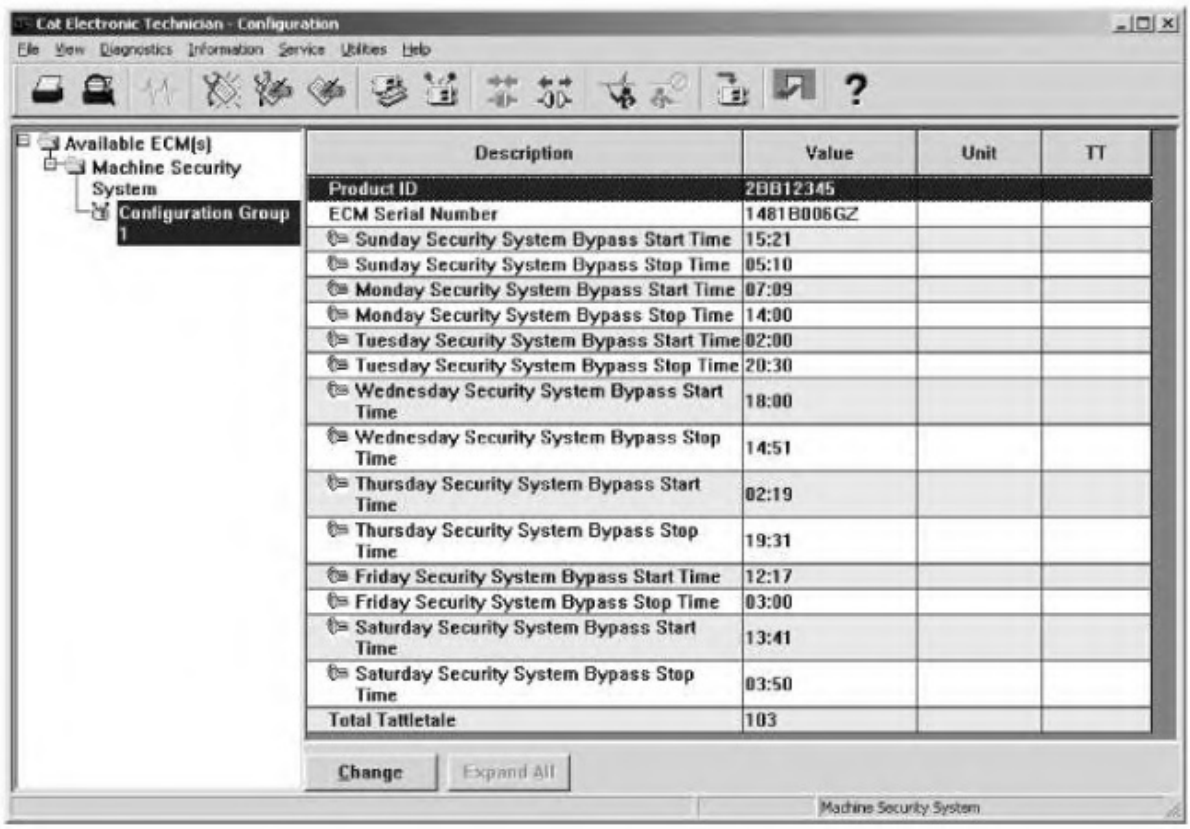


Illustration 1 g01097217

6. Select the "Product ID" selection that is displayed on the "Configuration" screen.
7. Click on the "Change" button that is located on the "Configuration" screen. This will display a dialog box.



Illustration 2 g01097232

8. Enter the "Product ID" of the machine. The "Product ID" must have 8 digits. The "Product ID" must be formatted as 3 alphanumeric characters and 5 numbers for a total of 8 digits. Refer to item (4) in Illustration 3.

   Note: Use the "Product ID" of MSS99999 for Non-Caterpillar machines.

Note: First Quarter 2001, the Caterpillar Product Identification Number (PIN) changed from 8 characters to 17 characters. The "Product ID" that is required by the Machine Security System is the last 8 digits. Refer to Item (4) in illustration 3.

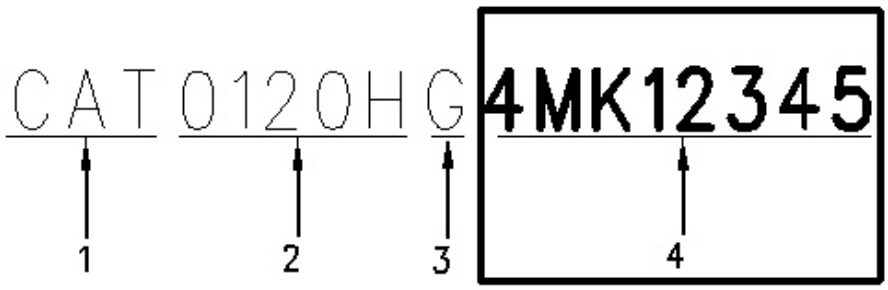


Illustration 3 g00860618

(1) Caterpillar's World Manufacturing Code (characters 1 - 3)

(2) Machine description (characters 4 - 8)

(3) Check character (character 9)

(4) Machine Indicator Section (MIS) or Product Sequence Number (characters 10 - 17). These characters were previously referred to as the Serial Number.

9. Click on the "OK" button. This will cause the ET to display the following message.



Illustration 4 g01097279

10. Click on the "Yes" button in order to change the "Product ID". Or you can click on the "No" button to cancel the change of the "Product ID".

    If you enter an invalid "product ID", The ET will display the following message.



Illustration 5 g01097220

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i02163982

Key - Program

SMCS - 7631-591

The MSS ECM may be programmed to accommodate a maximum of 255 keys. A new key is programmed into the MSS with the service tool.

Programming with a Service Tool

The "Security Management" function of the Caterpillar ET allows you to view information on the key currently in the key switch. You may also view a list of authorized keys. The authorized keys are the keys that have been programmed into the MSS.

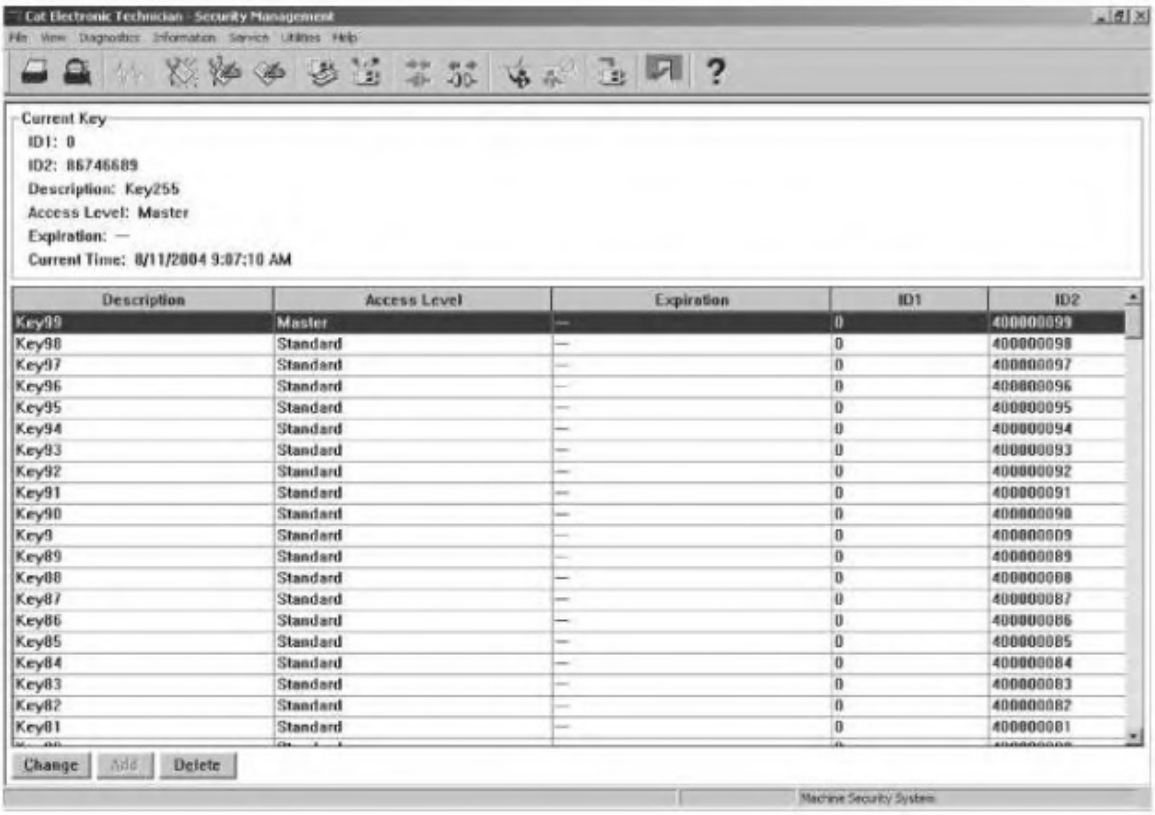


Illustration 1 g01101948

Connect a laptop computer with the Caterpillar ET to the machine that will be programmed. After the laptop computer is connected to the machine, start the ET. Select the "Security Management" option from "Service" menu. The "Security Management" screen will be displayed. Refer to Illustration 1.

Layout of the Screen

The "Security Management" screen has the following areas:

"Current Key Information" - The "Current Key Information" area displays information of the key currently in the keyswitch. If the "Description", "Access Level" and "Expiration" information was not entered for the current key, these areas will be blank.

"Display Area" - The "Security Management" display area has five columns: "Description", "Access Level", "Expiration", "ID1" and "ID2". The information in a column can be sorted by that column. Click on a column heading in order to sort by the information in that column. The "Description" column is the name for the key. The "Access Level" column displays the access level for the key. There are two access levels: Master and Standard. The Master Access Level gives the user the capability to modify information without a factory password. Standard Access Level requires factory passwords to add information on keys. A key can expire at a predetermined date and time. The "Expiration" column will show when the key is set to expire. Keys expire in 6 hour increments. "ID1" and "ID2" are the unique identification numbers for the key.

Push Buttons - The following push buttons are available in the "Security Management" screen: "Change", "Add" and "Delete".

Adding Key Information

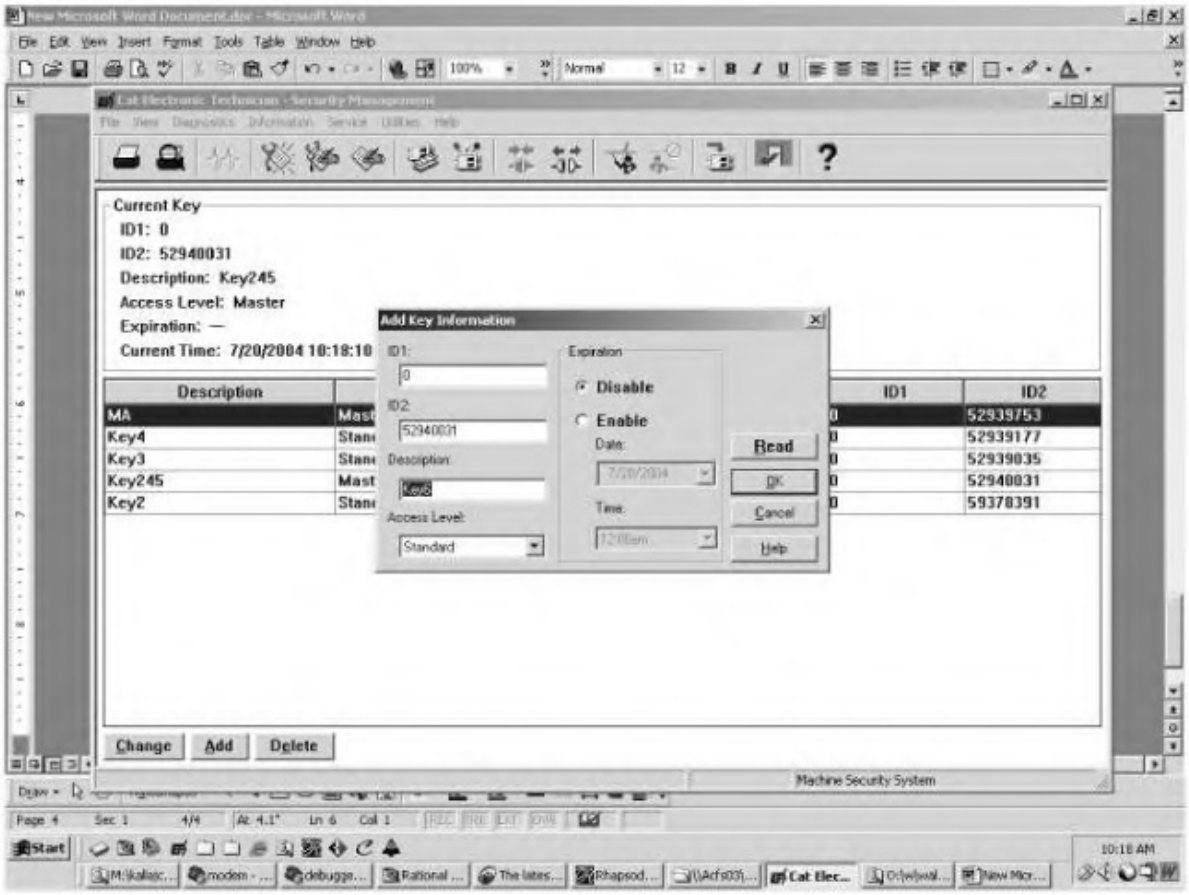


Illustration 2 g01097365

Add key information

The "Add" push button allows you to add a key to the list of Authorized Keys.

Note: When a function requires a factory password, the "Enter Factory Passwords" box is displayed.

To add a key, perform the following steps:

Note: Adding Keys requires a key with the master access level or a factory password.

1. Insert a master key for that machine in the key start switch. Turn the key to the ON position. If a master key is not used, then a factory password is required.

   Note: The MSS indicator should be green.

2. Turn the key to the OFF position.

   Note: The MSS indicator should remain green.

3. Insert the new key into the key start switch. This must be done within 30 seconds of step 4. Turn the key to the ON position before the MSS indicator turns off.

4. Connect a laptop computer with the Caterpillar Electronic Technician to the ECM on the machine. Select the" Machine Security System" from the menu in the ET.

5. Select the "Security Management Option" under the Service Menu in the ET.
6. Press the "Add" push button. The "Add Key Information" dialog box is displayed.
7. Press the "Read" push button. ID1 and ID2 will be filled with the information for the key that is in the ignition.

   Note: The "ID1" field may contain a "0".
8. Enter the name for the key in the "Description" box, if desired. As many as eleven characters may be used for the description. If no description is entered the description will default to"Key#". The # sign indicates a number. For example, "Key1", "Key2","Key...".

   Note: It is not advisable to make duplicate names for the keys in the list of keys.
9. Select the access level of the key from the "Access Level" menu.
10. Select an "Expiration" button: "Disable" or "Enable"

    "Disable" does not have an "Expiration Date". If "Enable" is selected, enter the "Expiration Date" and "Expiration Time" for that key.

    Note: Setting a Key with "Master Level Access" to the "Enable" status with an expiration date will cause the Key with "Master Level Access" to expire. If this occurs you will no longer be able to use the key as a Master Level Access Key.
11. Press the "OK" button in order to add the information for the key. The "Are you sure?" box is displayed. Press "OK" in order to add the key. Press "Cancel" in order to exit the "Add Key Information" dialog box without adding the information. Press "Help" to open on-line help for assistance.

Changing the Key Information

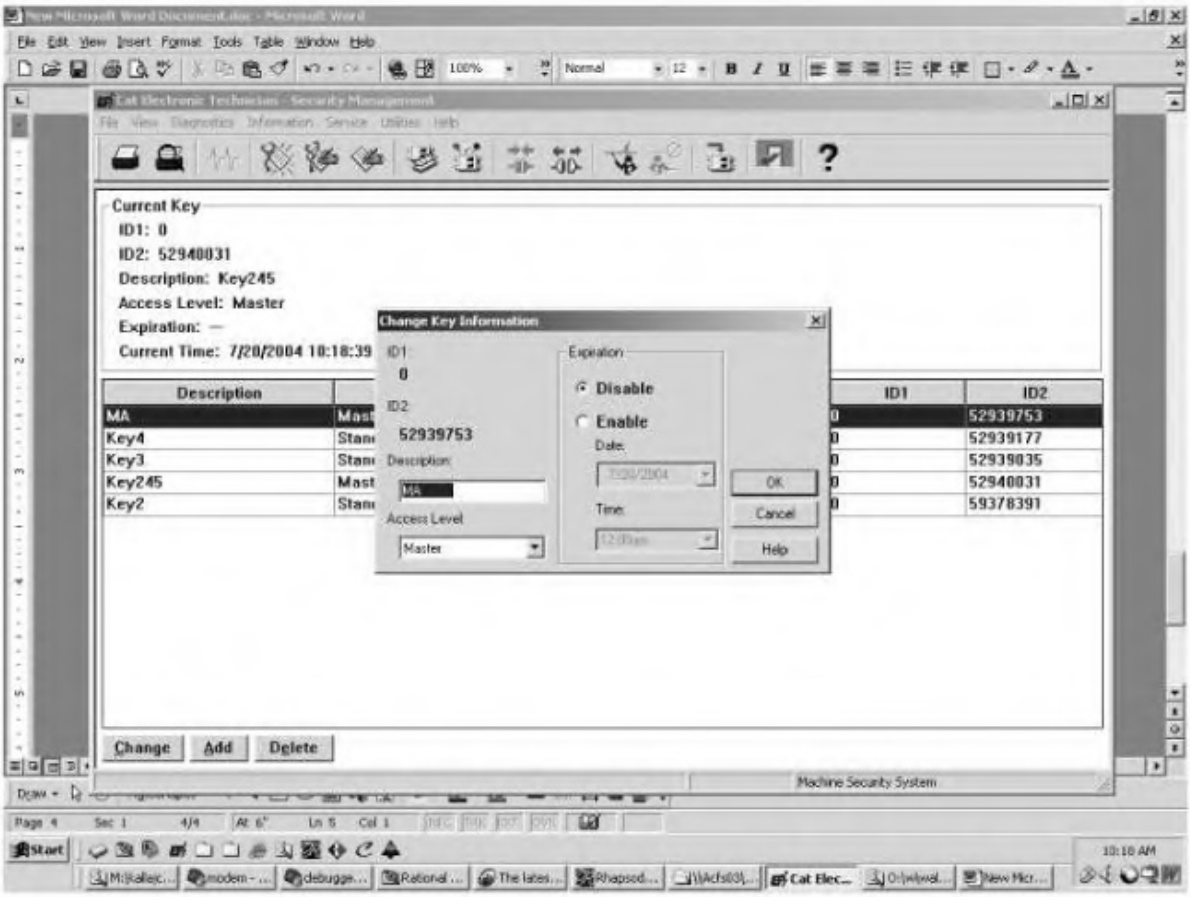


Illustration 3 g01097373

Change key information

The "Change" push button allows you to change the "Description", "Access Level" or "Expiration" of a key. ID1 and ID2 cannot be changed.

Note: The "Change" push button is disabled until a key is selected from the authorized list.

Note: When a function requires a factory level security password, the "Enter Factory Passwords" dialog box is displayed.

Note: Changing Keys requires a key with the master access level or a factory password.

Perform these steps in order to change the information regarding a particular key:

1. Choose a key and highlight that key in the list. Press the "Change" push button. The "Change Key Information" dialog box is displayed.

   OR

   Double click on the key you want to change. The "Change Key Information" dialog box is displayed.

2. Enter the changes in the key information. See "Adding Key Information" for more detail.

Deleting Key Information

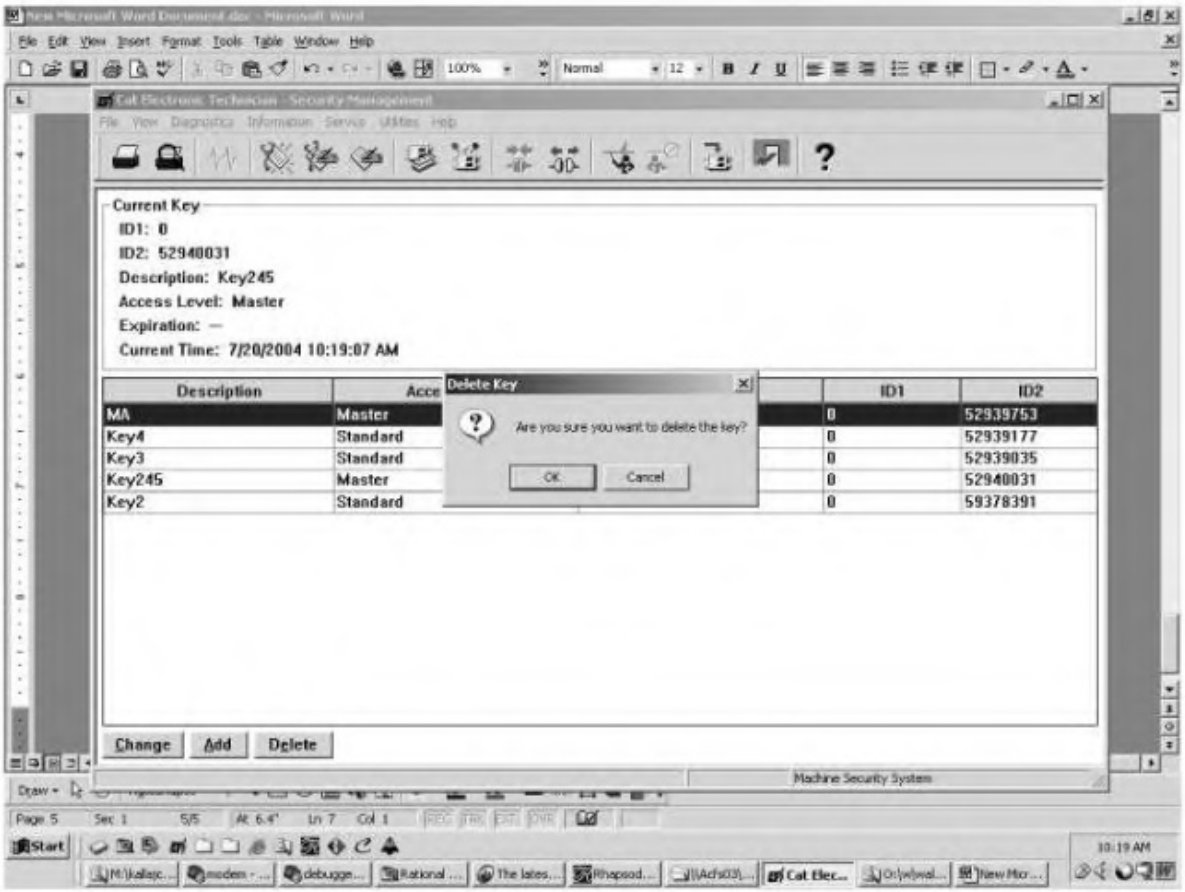


Illustration 4 g01097378

Delete Key

Note: You cannot delete the last Master key. An error message will display if deletion of the last master access level key is attempted.

Note: Deleting Keys requires a key with master access level or a factory password.

To delete a key:

1. Highlight the key you want to delete. Press the "Delete" push button. The "Are you sure?" box is displayed.
2. Press "OK" if you want to delete the key. Press "Cancel" if you do not want to delete the key. You automatically return to the "Security Management" screen.

Printing Key Information



Illustration 5 g01097385

The "Print Document" dialog box allows you to send a report to a file, to a printer, or to the screen. The report includes the following information:

- Source of data
- Time
- Date of report generation
- ECM connection
- List of parameter values
- Information that is unique to the function that you are printing

To print a report to a file:

1. Press the "Print" icon in the menu bar. The "Print Document" box is displayed.
2. Press the "Print to File" button. Press "OK" in order to print the report. Press "Cancel" in order to exit the "Print Document" box without saving the file.

   Note: If you do not have a file open, the "Printing" box asks you to open a file, create a new file, or cancel. Choose the appropriate button in order to continue.

   Open: Press the "Open" push button. The "Open File Dialog" box is displayed. Highlight a file and press the "Open" push button. The "Print New Document To File" box is displayed.

   New: Press the "New" push button. Enter a new file name into the "new file name" box. Press "OK". The "Print New Document To File" dialog box is displayed.

   Cancel: Press "Cancel" in order to exit the box. You return to the "Print Document" box.
3. In the "Print New Document To File", enter a name for the document. Press "OK". The "Print to File is complete" box is displayed. Press "OK" in order to return to the last active screen. Press "Cancel" in order to exit the "Print New Document To File" box.

To print a report to the printer:

1. Press the "Print" icon in the menu bar. The "Print Document" dialog box is displayed.
2. Press the "Print to Printer" button and then press "OK". The "Print to Printer is Complete" box is displayed. Press "OK" in order to return to the last active screen. Press "Cancel" in order to exit the "Print Document" box.

To print a report to the screen:

1. Press the "Print" icon in the menu bar. The "Print Document" box is displayed.

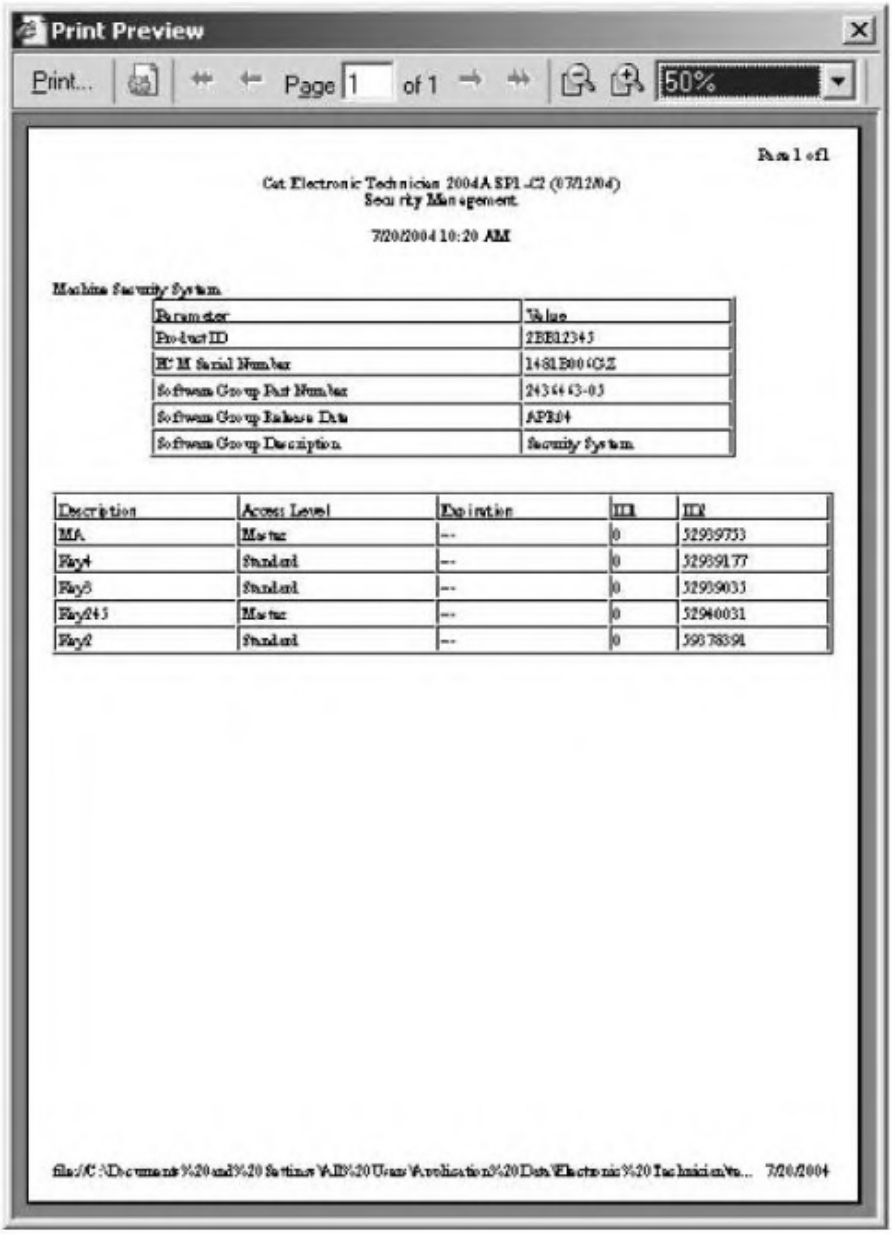


Illustration 6 g01097387

2. Press the "Print Preview" icon in the menu bar and then press "OK". The "Print Preview Screen" is displayed. Choose the appropriate push button to aid in viewing the document. "Print" prints the report to the printer. "Next Page" views the next page of the report. "Next Page" is disabled if you are on the last page of the report. "Prev Page" views the previous page of the report. "Prev Page" is disabled if you are on the first page of the report. "Two Page" displays two pages of the report. "Zoom In" magnifies the text. "Zoom In" is disabled when the text is fully magnified. "Zoom Out" decreases the size of the text. "Zoom Out" is disabled when the text is at normal size. "Close" will exit the preview.

"Fleet/Key Configuration"

The "Fleet/Key Configuration" function allows you to easily configure and manage a Machine Security System (MSS) enabled machine or set of machines. The function allows you to program, load, and save a set of configuration parameters and key information. The information can be loaded from or programmed to the MSS. This information can also be saved to or loaded from a file.

Once a file is saved in"Fleet/Key Configuration", File Management can be used to export the file as a *.MSS file. The exported *.MSS file can then be imported into the MSS Key Management Software program, for management of the "Fleet/Key" information.

Loading Data from the ECM

1. Connect the service tool to the Machine Security System ECM that you want to copy.
2. Select "Copy Configuration" from the "Service" menu, and then select "Fleet/Key Configuration" from the sub-menu.

   Note: Changing the "Fleet/Key Configuration" requires a key with master access level or a factory password.
3. If there is no recently loaded data available the "No data is available..." message box will display.
4. Press "Yes" to load data from the ECM. The "ECM Selector" dialog box displays.

   Press "No" if you do not want to load data. The "Fleet/Key Configuration blank screen" displays.

   Note: Pressing the "Load from ECM" push button from the "Fleet/Key Configuration" screen also displays the "ECM Selector" dialog box.
5. Highlight the Machine Security System ECM you wish to copy from and then press "OK". As the data is loading from the ECM, the "Please wait" message displays. Then, the "Loading data from ECM" progress bar displays.
6. Press "Cancel" to exit the "ECM Selector" dialog box. Press "Help" to open online help for assistance.

   You can cancel the loading process at any time, by pressing the "Cancel" push button. The "Are you sure..." message box displays. Press "Yes" to cancel loading the data or press "No" not to cancel loading the data.
7. When the data has been successfully loaded, "The data has been successfully loaded" message box displays.
8. Press "OK". The "Fleet/Key Configuration" screen displays with the "Program ECM" and the "Save to File" push buttons are enabled.

   Note: The data must be saved to a file before you disconnect from the service tool or the data is lost.

Saving the Configuration to a File

1. Press the "Save to File" push button. The "Print New Document to File" dialog box displays.

   Note: If you do not have a file open, the "Printing" dialog box asks you to open a file, create a new file, or cancel. Choose the appropriate button to continue.

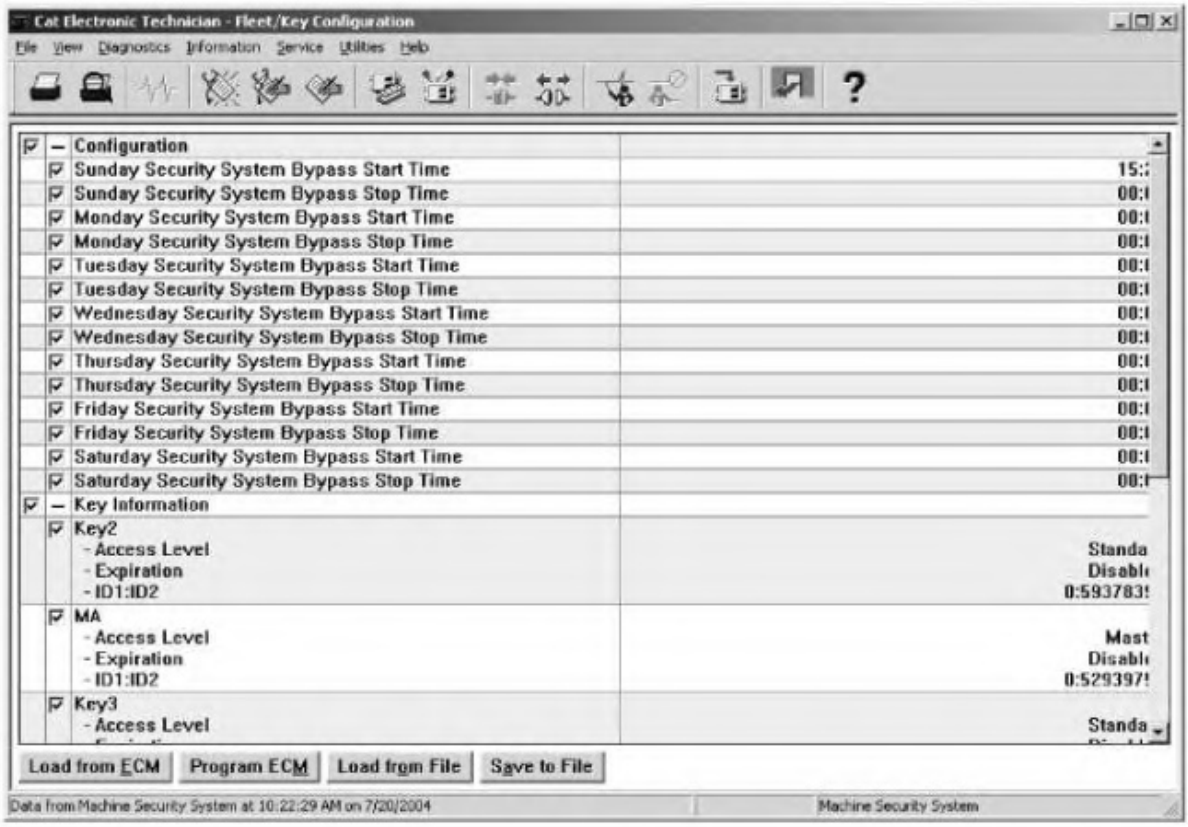


Illustration 7 g01097389

2. Enter a document name and description in the appropriate text boxes. Press the "OK"button. The "Fleet/Key Configuration saved successfully" message box displays. Press the "Cancel" push button to exit the "Print New Document To File" dialog box without saving the file. You will return to the "Fleet Configuration" dialog box.

3. Press "OK" to return to the "Fleet/Key Configuration" screen.

Loading Data from a File

1. Connect the service tool to the ECM to be programmed.

2. Select "Copy Configuration" from the "Service" menu, and then select "Fleet/Key Configuration" from the sub-menu.

   If there is no recently loaded data available the "No data is available..." message box displays.

3. Press "No" that you do not want to load data from the ECM. The "Fleet/Key Configuration screen" displays.

4. Press the "Load from File" push button. The "File Management" dialog box displays.

5. If you press the "Load from File" push button with unsaved data on the "Fleet/Key Configuration" screen, a message box displays asking if you want to save the changes.

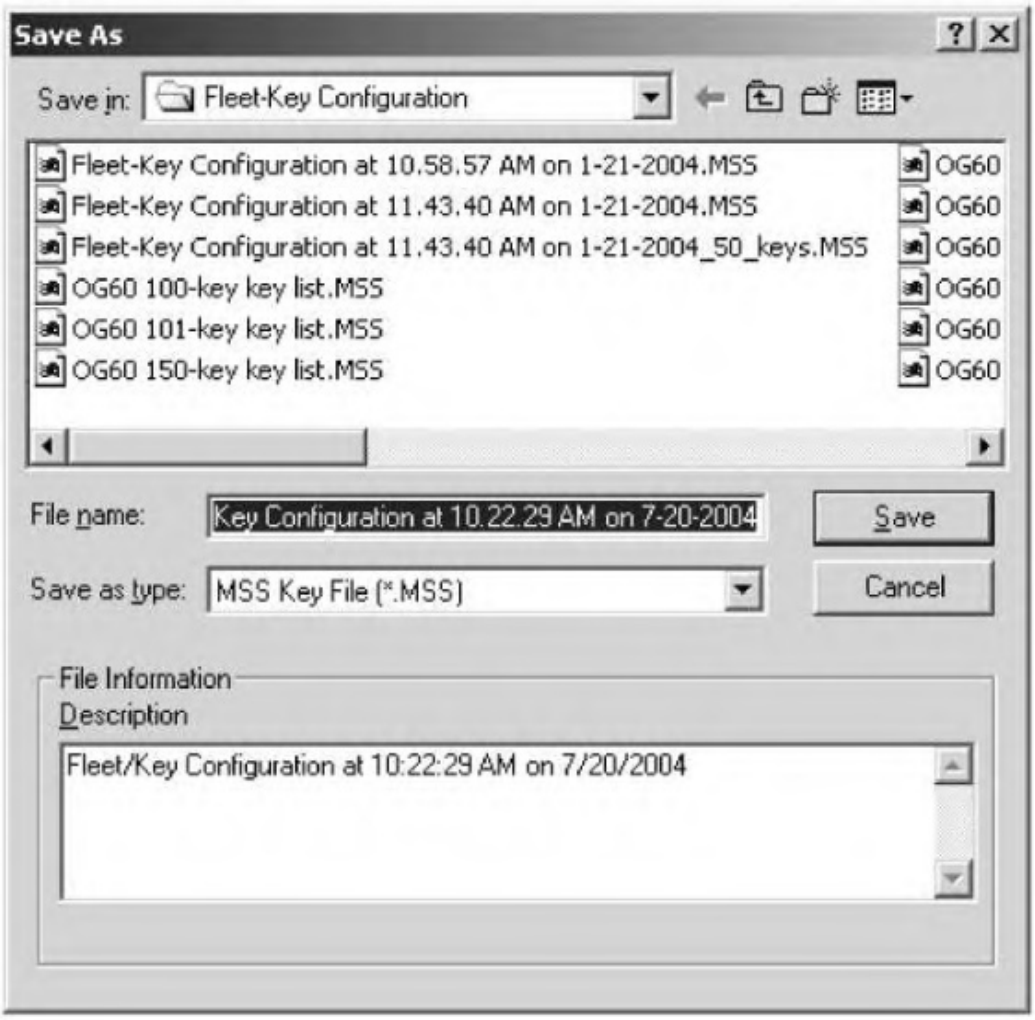


Illustration 8 g01097397

Save-As Screen

6. From the" File Management" dialog box, highlight the file from the "Files" list box, and then highlight the "Fleet/Key Configuration document" that you want to load from the "Documents" list box.

7. Open the document. As the data loads, a progress bar displays. Then, the "Fleet Configuration" message box displays.

8. Press "OK". The "Fleet/Key Configuration" screen displays with the file data.

Programming the ECM

Note: The data must be loaded from a file before you can program an ECM.

Note: Keys that are already programmed into the ECM can be unchecked from the "Fleet/Key Configuration" screen. This is only a time saving measure. If you do not uncheck the keys, the "Program ECM" message box displays. This message box lists all keys that were not programmed because the keys were already stored.

1. Press the "Program ECM" push button. The "ECM Selector" dialog box displays.

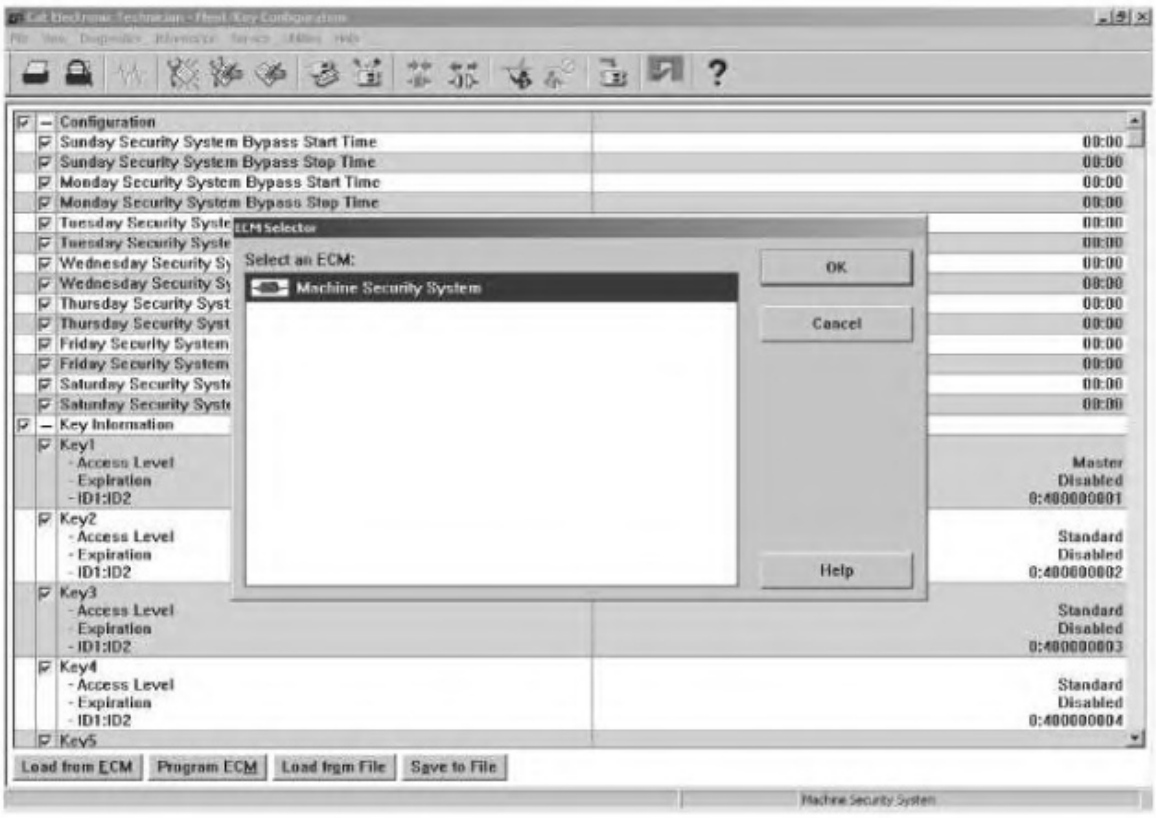


Illustration 9 g01101974

ECM Screen

2. Highlight an ECM and press "OK" The "Please wait" message box displays. Then the "Testing ECM" progress bar displays.

Note: You can cancel the uploading process at any time, by pressing the "Cancel" push button. The "Are you sure..." message box displays. Press "Yes" to cancel uploading the data or "No" not to cancel.

Refer to the following procedures when you "Append" or "Replace" the key list. Refer to the "Append" section to append the list. Refer to the "Replace" section to replace the list.

Append

1. Connect the service tool to the ECM to be programmed.
2. Start the Caterpillar Electronic Technician (ET)

   Note: This procedure requires Caterpillar Electronic Technician (ET) version 2004 SP1 or later.

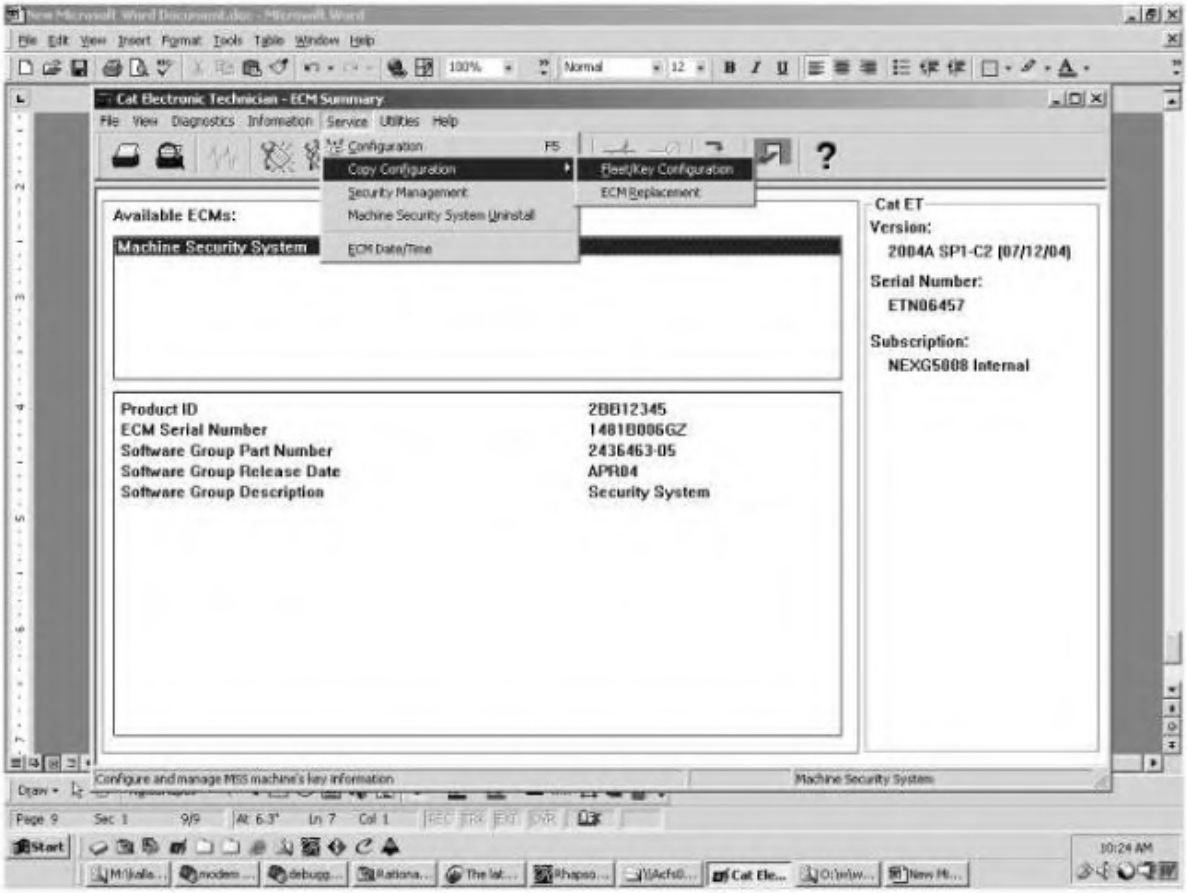


Illustration 10 g01097401

3. Select "Copy Configuration" from the "Service" menu, and then select "Fleet/Key Configuration" from the sub-menu.
4. Open the document. As the data loads, a progress bar displays. Then, the "Fleet Configuration" message box displays.
5. Press "OK". The "Fleet/Key Configuration" screen displays with the file data.
6. Click on the "Program ECM" button. This displays the Fleet key information box.



Illustration 11 g01097411

7. Click on the "Append" button.

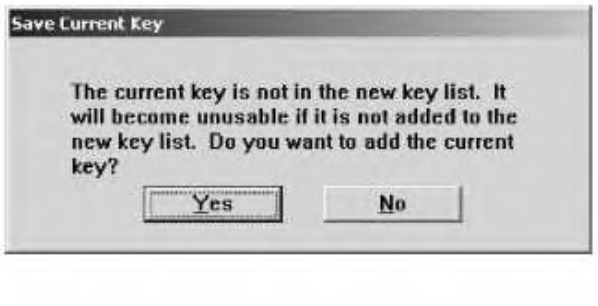


Illustration 12 g01097413

8. Click on the "Yes" button if you are prompted.

When the data has been successfully uploaded, the "Programming complete." message box displays. Press "OK"

Note: MSS can store a maximum number of 255 keys at one time. "Fleet/Key Configuration" determines the number of keys slots not programmed on the MSS. You can not program more keys than the maximum number allowed. A message box displays informing you of the number of key slots available or that there are no more key slots available. You must remove enough keys in order to add new key information.

STOP.

Replace

1. Connect the service tool to the ECM to be programmed.

   Note: This procedure requires Caterpillar Electronic Technician (ET) version 2004A SP1 or later.

2. Start the Caterpillar Electronic Technician (ET)

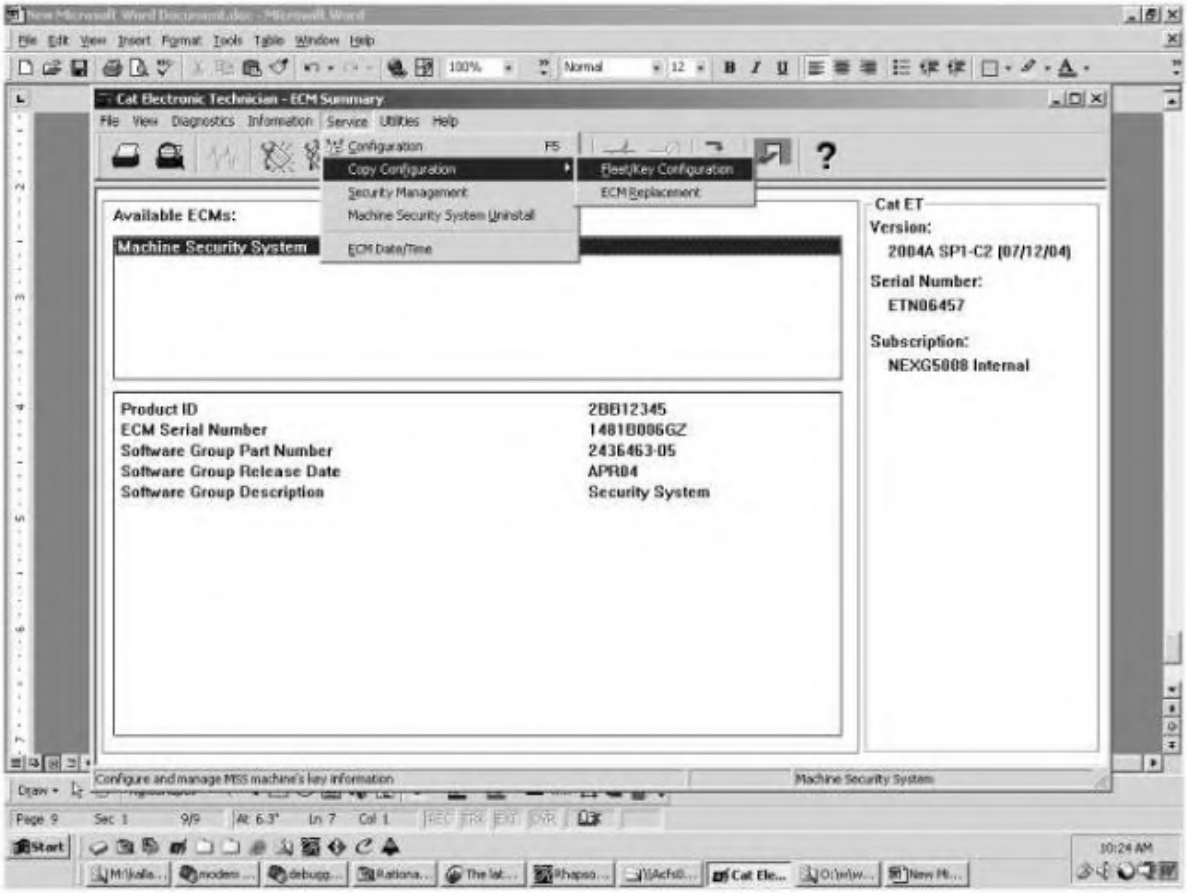


Illustration 13 g01097401

3. Select "Copy Configuration" from the "Service" menu, and then select "Fleet/Key Configuration" from the sub-menu.

4. From the" File Management" dialog box, highlight the file from the "Files" list box, and then highlight the "Fleet/Key Configuration document" that you want to load from the "Documents" list box.

5. Open the document. As the data loads, a progress bar displays. Then, the "Fleet Configuration" message box displays.

6. Press "OK". The "Fleet/Key Configuration" screen displays with the file data.

7. Click on the "Program ECM" button. The Fleet

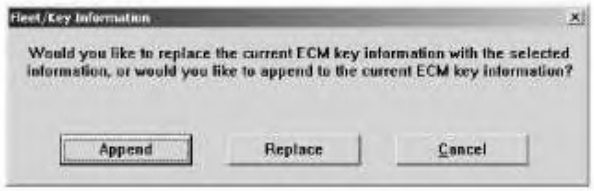


Illustration 14 g01097411

8. Click on the "Replace" button.

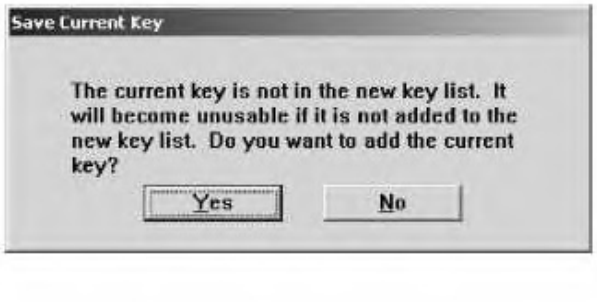


Illustration 15 g01097413

9. Click on the "No" button if you are prompted.

When the data has been successfully uploaded, the "Programming complete." message box displays. Press "OK"

Note: MSS can store a maximum number of 255 keys at one time. "Fleet/Key Configuration" determines the number of keys slots not programmed on the MSS. You cannot program more keys than the maximum number allowed. A message box displays informing you of the number of key slots available or that there are no more key slots available. You must remove enough keys in order to add new key information.

STOP.

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i02164922

System Disarm - Program - Security System Bypass

SMCS - 7631-591

Use the following procedure to change the Activation Periods of the Security System Bypass:

Note: Changing the MSS Bypass times requires you to use a key with master access level or a factory password.

1. Insert a key with Master Access Level in the key start switch and turn to the ON position.
2. Select "Service/Configuration" from the tool bar of the ET. This will bring up the Configuration screen.

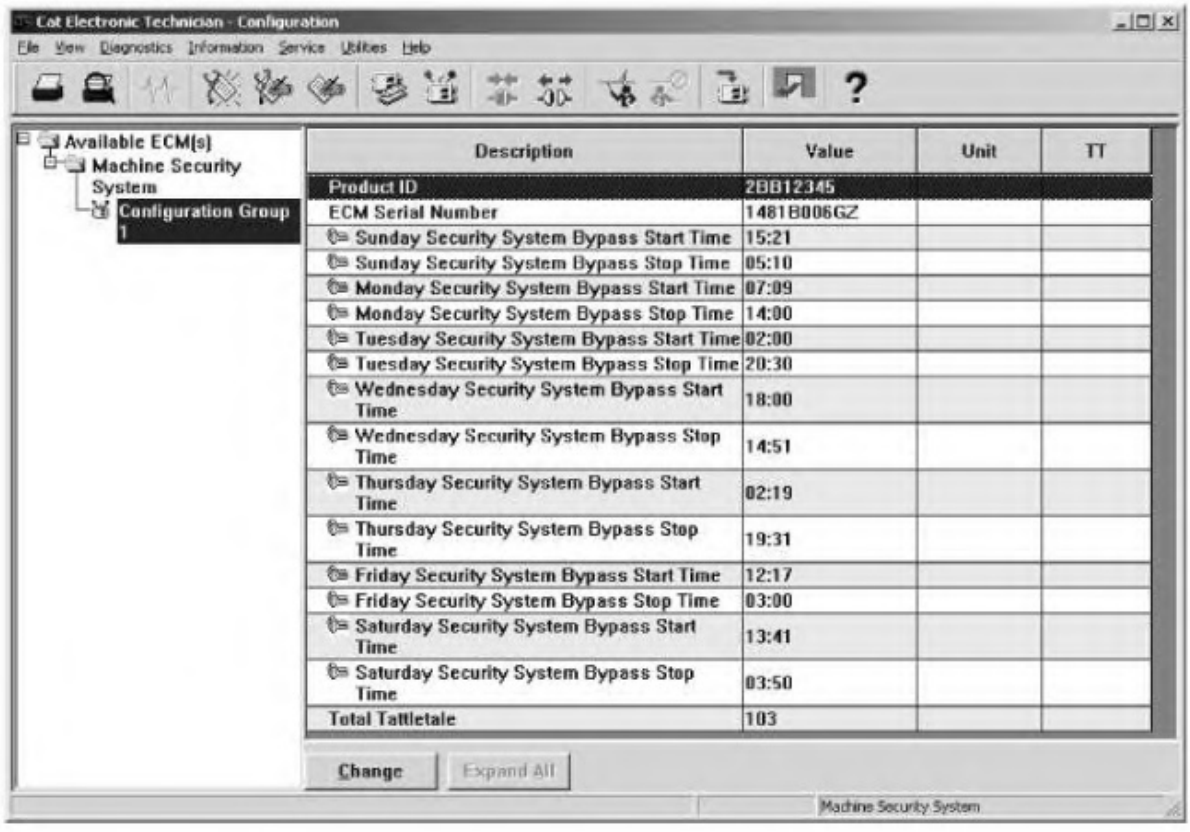


Illustration 1 g01097217

3. Highlight the "Security System Bypass Start Time" for the day that you want to setup. Press the "Change" push button at the bottom of the page. This will bring up the "Change Parameter Value" screen.

4. Enter the desired "start time" in the space that is provided. Then click on the "OK" button.

   All times are based on a 24 hour clock. If you want the desired start time to be 6:00 am then you must enter 06:00. If you want the desired start time to be 6:00 pm then you must enter 18:00. You must include the colon in the time setting or the MSS will not accept your entry.

5. Highlight the "Security System Bypass Stop Time" for the same day. Press the "Change" push button at the bottom of the page. This will bring up the "Change Parameter Value" screen. Enter the desired "stop time" in the space that is provided and click on the "OK" button.

6. Repeat Steps 3 and 5 for all days which should have Bypass Activation Times.

7. To have the MSS armed 24 hours a day, repeat Steps 3 and 5 entering 00:00 as the "Start time" and 00:00 as the "Stop time".

   Note: All times are based on a 24 hour clock. The Machine Security System automatically adjusts for Daylight Savings Time. If Daylight Savings Time is not observed in your area, you will need to reset the time in the MSS on the first Sunday in April and the last Sunday in October. If Daylight Savings Time changes on a different date in your area than in the United States, you will need to reset the time on that day. Refer to Testing and Adjusting, "Time - Set" for instructions on setting the date and the time of the MSS.

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Testing and Adjusting
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i04086689

Factory Password - Obtain

SMCS - 7631-554-XW

You may use the following methods to obtain a factory password. The first method is via the Factory Password System (FPS) via the Internet. The second method is via the telephone help line. The procedures for both methods are listed in the following sections.

Internet

1. The Factory Password System (FPS) is a secure web site and a password is required. Proceed to step 1.a if you do not have a "Login ID" and a "Password". Proceed to step 2 if you already have a "Login ID" and a "Password".

    a. Refer to the "Telephone Help Line" section or see your Caterpillar dealer in order to obtain the factory password.

2. Open your web browser. Enter the address for the Factory Password System (FPS) ("http://fps.cat.com") in the address bar of the web browser.

    Upon accessing FPS, the "Corporate Web Security" web site will appear.



Illustration 1 g01100010

Corporate web Security screen

3. Enter your "Login ID" and "Password" into the "Corporate Web Security" site. Refer to Illustration 1.



Illustration 2 g01100014

"Passwords"selection from the FPS screen

4. Select the "Password" option from the "FPS" menu. (Refer to Illustration 2) The Product Information Screen will now display.

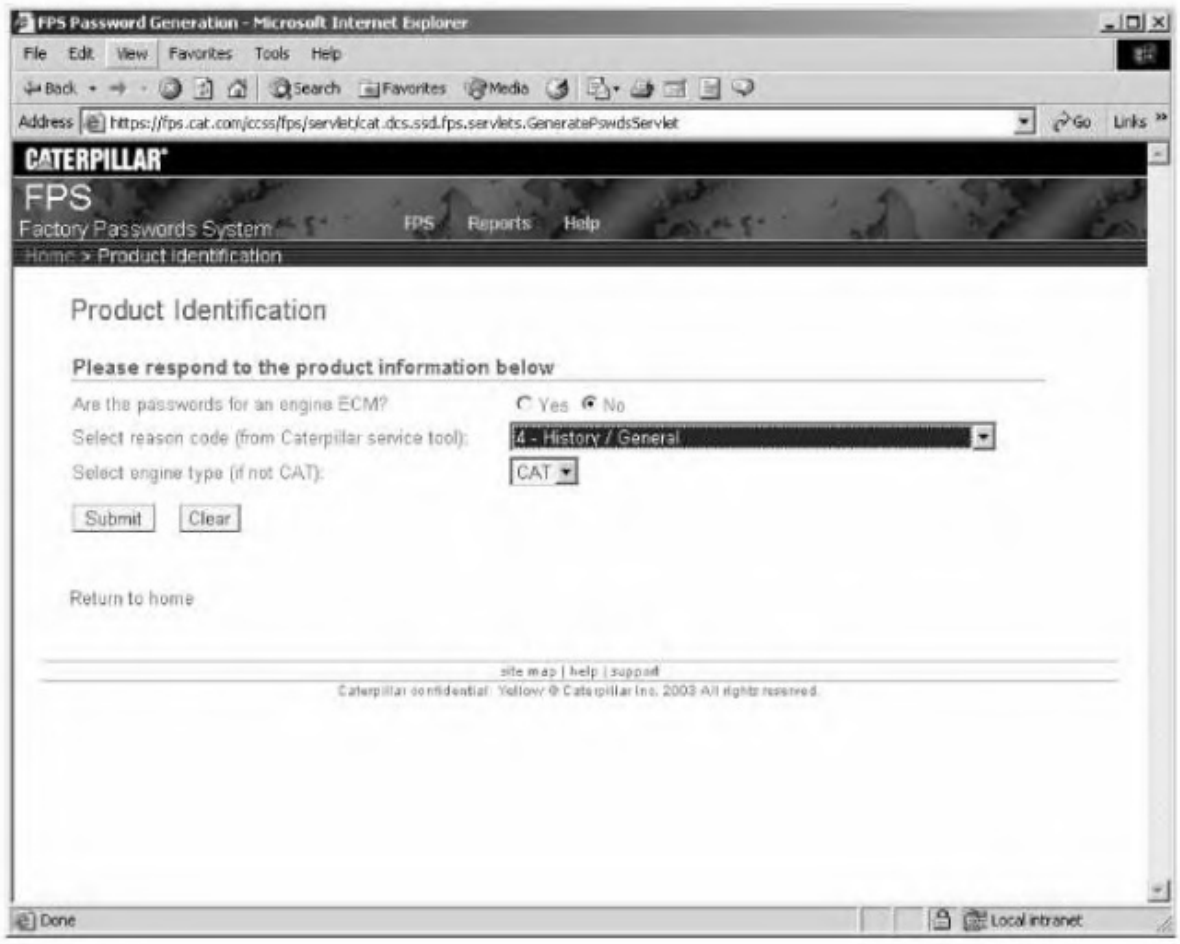


Illustration 3 g01100123

FPS Product Identification screen

5. Answer the questions and click the "Submit" button. The Factory Password Screen will now display.

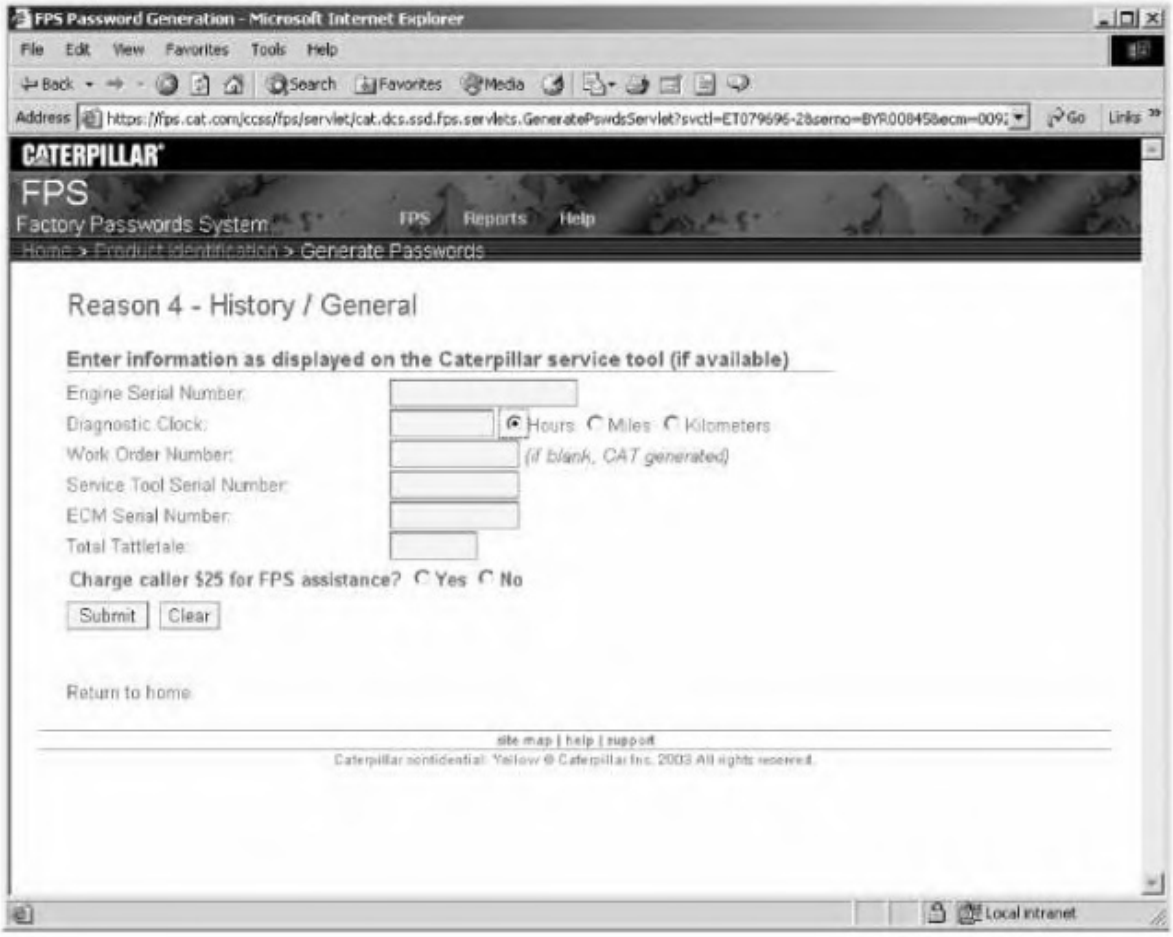


Illustration 4 g01100129

FPS History screen

6. Enter the following information:
   - "Product Serial Number"
   - "Engine Units"

   Note: Enter the hours that are displayed on the service hour meter in the "Engine Units" block. Select "Hours" as the unit.
   - "Service Tool Serial Number"
   - "ECM Serial Number"
   - "Total Tattletale Value"
   - "Reason Code"

   Note: The "Reason Code" is provided on the "Enter Factory Password" screen. Refer to Illustration 5.

   Note: The "Rerate" section is not used with the Machine Security System. Do NOT enter information in this section.

Note: The information that is listed above may be obtained from the "Enter Factory Passwords" screen in the Caterpillar Electronic Technician (ET). Refer to Illustration 5.

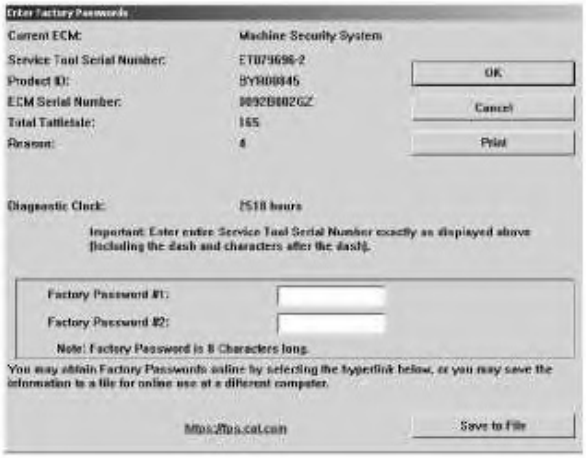


Illustration 5 g01097824

Enter Factory Passwords screen

7. Click on the "Submit" button. The passwords will then be generated.

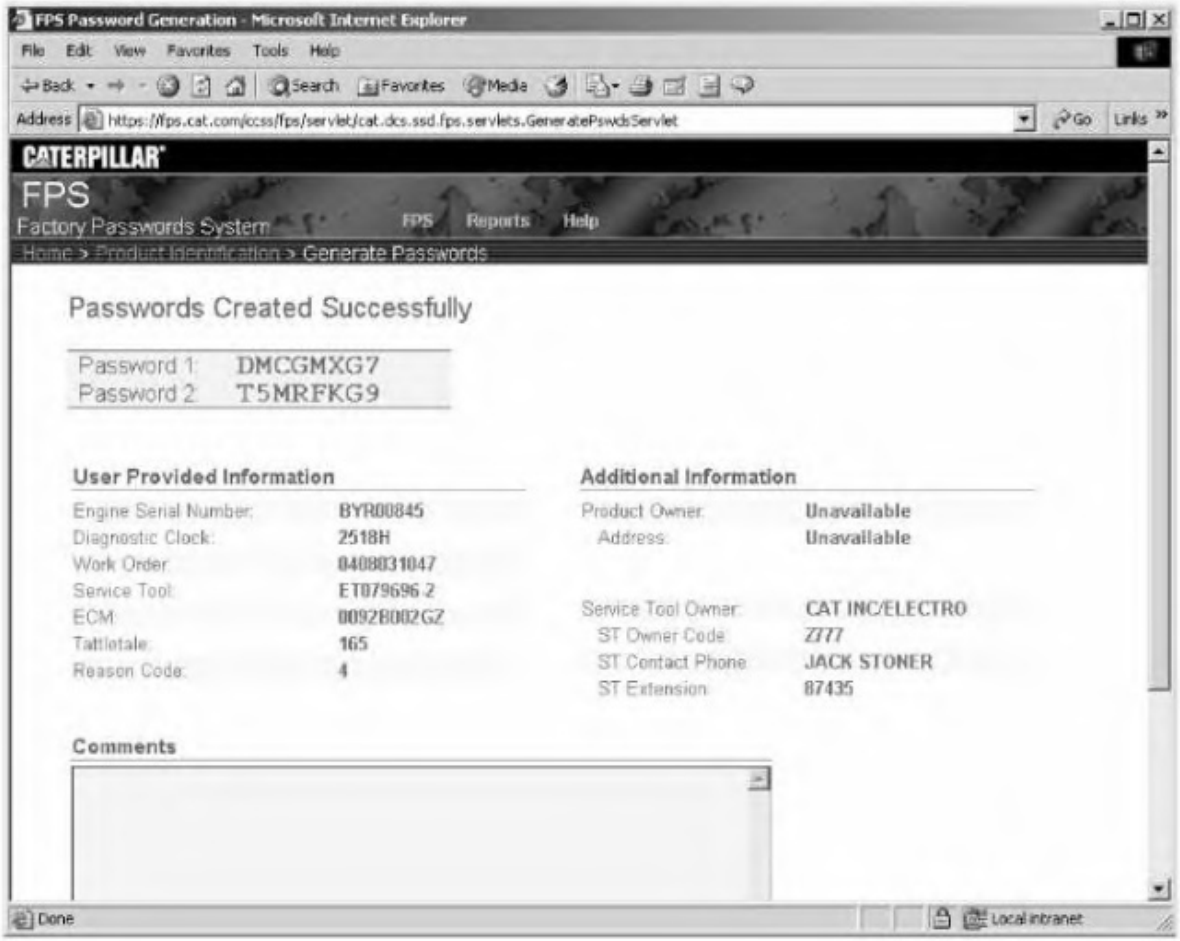


Illustration 6 g01100154

FPS Password Created confirmation screen

8. Record both of the factory passwords.



Illustration 7 g01100168

MSS Enter Factory Passwords screen

9. Refer to Illustration 7. Enter the factory password 1 in the "Factory Password #1" field and enter factory password 2 in the "Factory Password #2" field.

   Note: Both passwords are required in order to change any of the parameters of the Machine Security System.

Telephone Help Line

The Telephone Help line for obtaining a Factory Password is the same number assigned to the Dealer Solutions Network (DSN) and is listed below:

(309) 636-8500

You will need the information listed below, in order to obtain a Factory Password:

- "Product Serial Number"
- Service Meter Hours ("Engine Unit Block")
- Serial number of the Service Tool (Electronic Technician)
- Serial Number of the MSS ECM
- Total Tattletale Value
- Reason Code

Note: The information that is listed above may be obtained from the "Enter Factory Passwords" screen in the Caterpillar Electronic Technician (ET). Refer to Illustration 7.

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i02164488

Time - Set

SMCS - 7631-529

You must set the correct date and time for the Machine Security System. Use the following procedure to set the date and time.

Note: Changing the time on the MSS clock requires a key with the master access level or a factory password.

1. Connect the Cat ET to the service connector via the communication adapter.
2. Place the Master Access Level Key into the key start switch and turn the key to the ON position.
3. Start the Cat ET.
4. Click on the "Connect" icon in the menu bar of the Cat ET.
5. Once the Cat ET has established communications with the MSS ECM, select the "ECM date/time" option from the "Service" menu. This will cause the Cat ET to display the following screen.

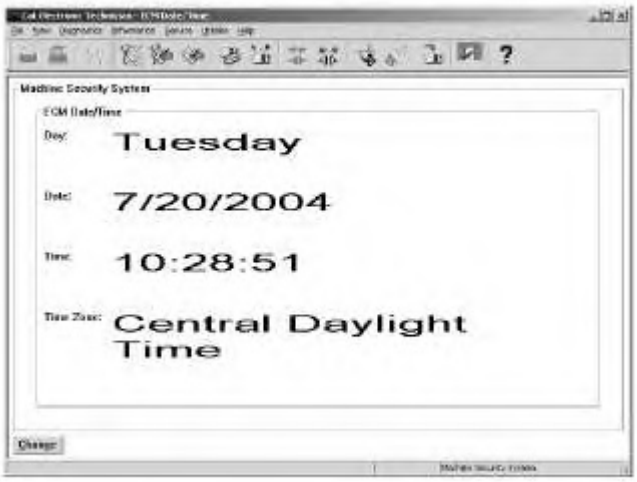


Illustration 1 g01097846

6. Press the "Change" button. This will launch the "Date and Time" dialog box.

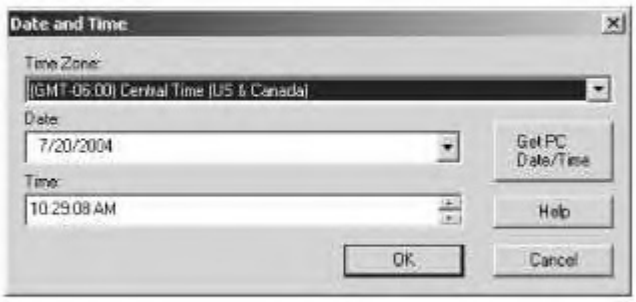


Illustration 2 g01097850

7. Select the local time zone from the drop down list.



Illustration 3 g01097851

8. Enter the local date and time. Use an accurate reference to set the time.

   Note: Laptop clocks are not accurate and may have a different time than the local time.



Illustration 4 g01097852

9. Then press the "OK" button. The Cat ET will display the following message.

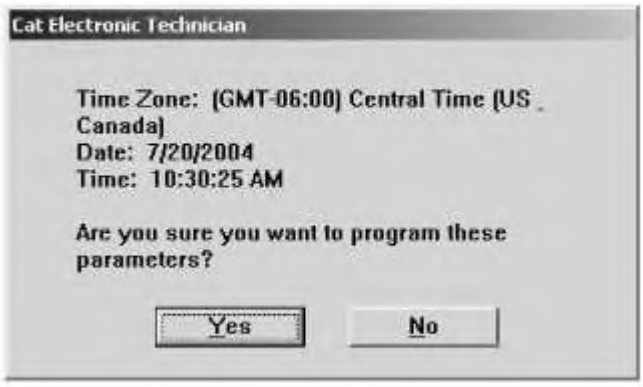


Illustration 5 g01097853

10. Click on the "Yes" button in order to change the date and time or click on the "No" button in order to cancel the change. The Cat ET will display the new time on a 24 hour clock.

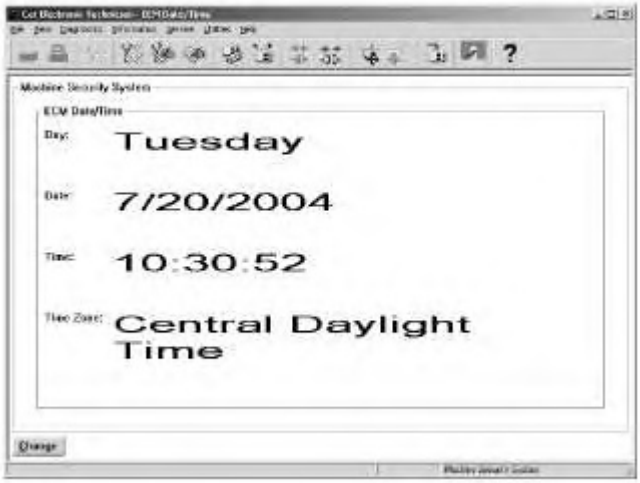


Illustration 6 g01097855

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Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i02164837

Software - Uninstall - "Immobilizer" Feature

SMCS - 7631-011

The "Uninstall" feature of the Machine Security System (MSS) allows the user to uninstall the Immobilizer feature from other electronic control modules.

The MSS ECM should be removed after the immobilizer software has been successfully uninstalled. If the MSS ECM is not removed, the LED for the status of the MSS will give a false indication.

The "Uninstall" screen for the Machine Security System consists of the areas that are listed below:

"Status Line" - The "status line" displays messages regarding the process of this function.

Display Area - The "Uninstall" display for the Machine Security System consists of two columns. The two columns are the "ECM" column and the "Security System Status" column. The "ECM" column lists every ECM that is installed on the machine with the immobilizer feature. The "Security System Status" column lists the status of the immobilizer feature of the Machine Security System. The status of the immobilizer feature is either "Installed" or "Not Installed".

"Uninstall Button" - The "Uninstall" button starts the "Uninstall" process.

Perform the steps that are listed below in order to uninstall the Machine Security System:

Note: You will need to obtain a factory password in order to perform this procedure. A master electronic key will not allow the user to uninstall the Machine Security System. Refer to the Testing and Adjusting, "Factory Password - Obtain" section of this manual for information on obtaining a factory password.

1. Connect a laptop Computer with the Caterpillar ET to the machine via the communication adapter.
2. Place a key in the key start switch.
3. Turn the key to the "ON" position.
4. Start the Electronic Technician and establish communications with the MSS ECM.
5. Obtain a factory password. Refer to the Testing and Adjusting, "Factory Password - Obtain" section of this manual for information on obtaining a factory password.
6. Select the "Machine Security System Uninstall" option from the "Service" menu. This will cause the ET to display the message that is shown in Illustration 1.

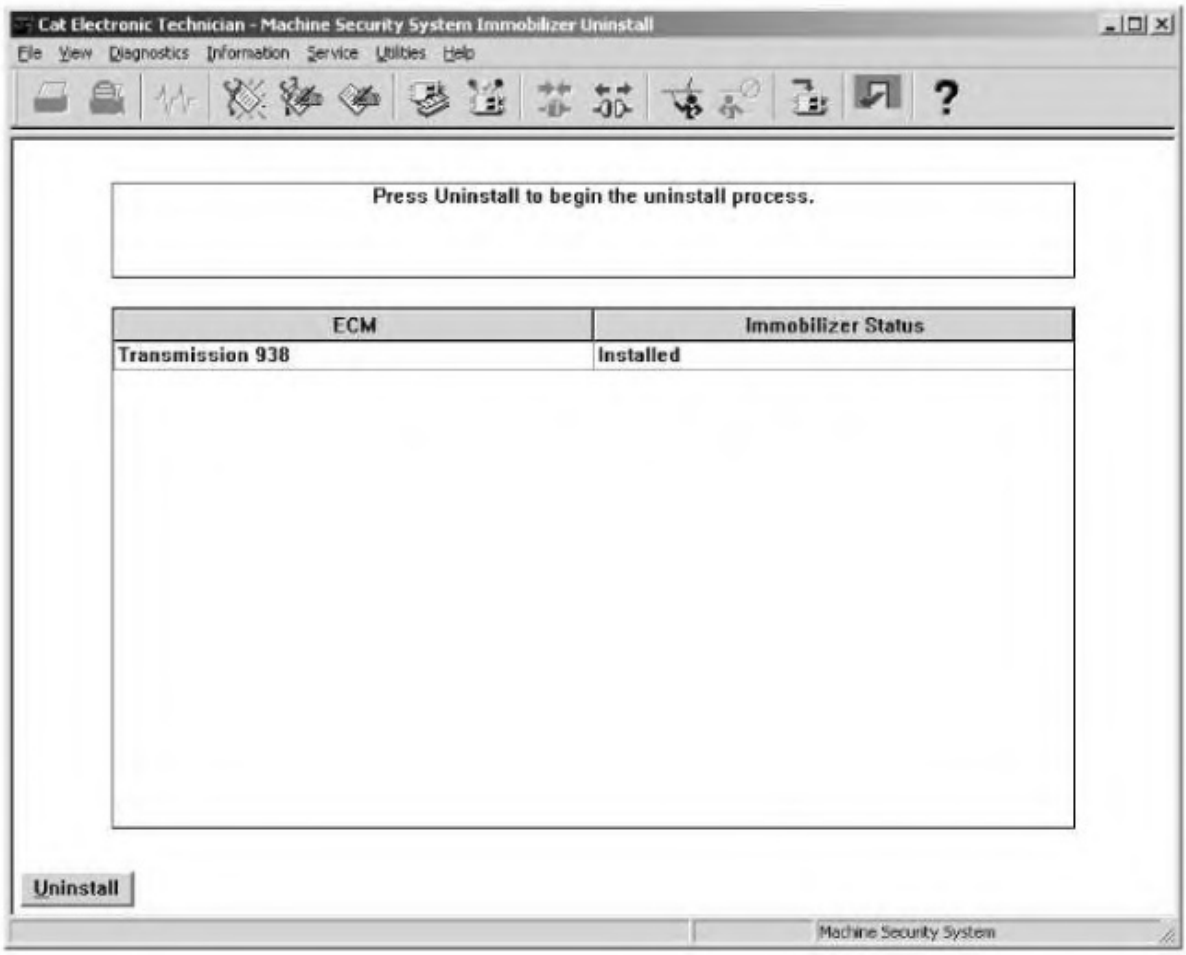


Illustration 1 g01097964

Machine Security System Uninstall screen

7. Click on the "Uninstall" button that is located at the lower left hand corner of the "Machine Security System Uninstall" screen. This will cause the ET to display the" Factory Password Screen" that is shown in Illustration 2.

   Note: A factory password is required to perform the "Machine Security System Uninstall". A master electronic key will not allow you to uninstall the Machine Security System. Refer to the Testing and Adjusting, "Factory Password - Obtain" section of this manual for information on obtaining a factory password.



Illustration 2 g01097965

Factory Password screen

8. The factory passwords are provided by the Factory Password System. Enter the factory passwords in the dialog boxes that are provided on the "Enter Factory Password" screen. Once the ET accepts the passwords, the screen shown in Illustration 3 will be displayed.

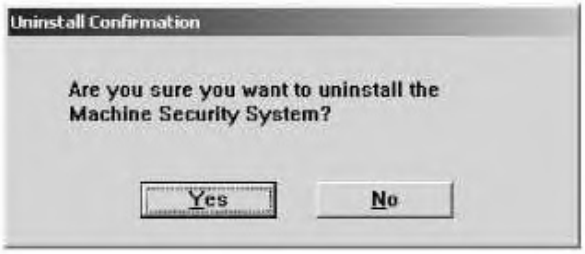


Illustration 3 g01097989

Uninstall Confirmation screen

9. Press the "Yes" button if you want to proceed with the "uninstall" of the Machine Security System. This will cause the ET to display the message that is shown in Illustration 4.

   Note: Pressing the "No" button aborts the "uninstall" of the Machine Security System.



Illustration 4 g00831242

Process in Progress screen

Note: Once the Machine Security System has been successfully uninstalled, the ET will display the message that is shown in Illustration 5.

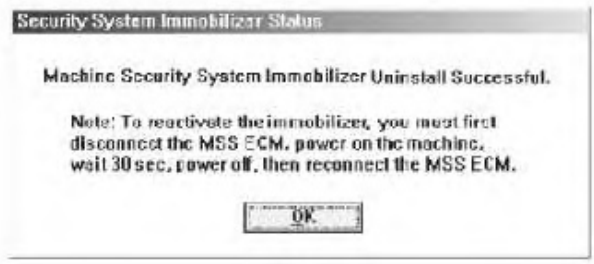


Illustration 5 g00916867

Uninstall Successful screen

10. Press the "OK" button in order to return to the "Machine Security System Uninstall" screen.

    Note: If the Machine Security System has not been successfully uninstalled, the ET will display the message that is shown in Illustration 6.

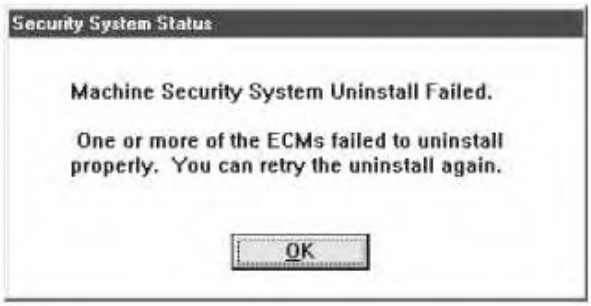


Illustration 6 g00921613

Uninstall Failed screen

11. Press the "OK" button in order to return to the "Machine Security System Uninstall" screen. The "Uninstall" button that is located on the "Machine Security System Uninstall" screen will be labelled "Retry". Press the "Retry" button in order to restart the uninstall.
12. Turn the key switch to the OFF position.
13. Remove the MSS ECM from the machine.

Note: If the MSS ECM is configured to control other devices (start relay and/or main power relay) you must reconnect those devices in accordance with the machine's Electrical Schematic.

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i04008550

Electrical Connector - Inspect

SMCS - 7553-040-WW

ReferenceSpecial Instruction, SEHS9615, "Servicing DT Connectors".

ReferenceSpecial Instruction, REHS0148, "Listing Of Deutsch Connector Components"

ReferenceSpecial Instruction, SEHS9065, "Use Of CE Connector Tools".

ReferenceService Magazine, SEPD034227 January 97, "Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)".

ReferenceService Magazine, SEPD037128 July 97, "Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications".

ReferenceService Magazine, SEPD047324 May 99, "New DT Connector Plugs With Improved Seal Retention".

ReferenceService Magazine, SEPD054509 October 00, "Dielectric Grease Should Not Be Used In Electrical Connectors".

ReferencePocket Guide, SEBD0402, "Guidelines For Routing And Installing Wire Harness Assemblies".

This information will assist in detecting problems with connectors and with wiring. If a problem is found, correct the condition and verify that the problem is resolved.

Disconnecting and reconnecting connectors sometimes resolve intermittent electrical problems. Check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Important Safety Information

Work safely. Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs.

A person must be alert to potential hazards. This person should also have the necessary training, skills, and tools to perform these functions properly.

Safety precautions and warnings are provided in this instruction and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons. Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard.

Therefore, the warnings in this publication and the warnings that are on the product are not all inclusive. If any of the following are not recommended by Caterpillar, but are used, ensure the safety of all people involved:

- A tool
- A procedure
- A work method
- An operating technique

Ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance, or the repair procedures that are used.

Guidelines

- Use a **1U-5804** Crimp Tool (12-GA TO 18-GA) to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to Tool Operating Manual, SEHS9615, "Servicing Deutsch HD and DT Style Connectors".
- Use a **147-6456** Wedge Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire to access to a circuit for measurements.
- If a wire is cut, install a new terminal for the repair.

Tests

Check Connectors for Moisture and Corrosion

Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. This deformation will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.



Illustration 1 g01960167

(1) Former seal design

(2) Current seal design

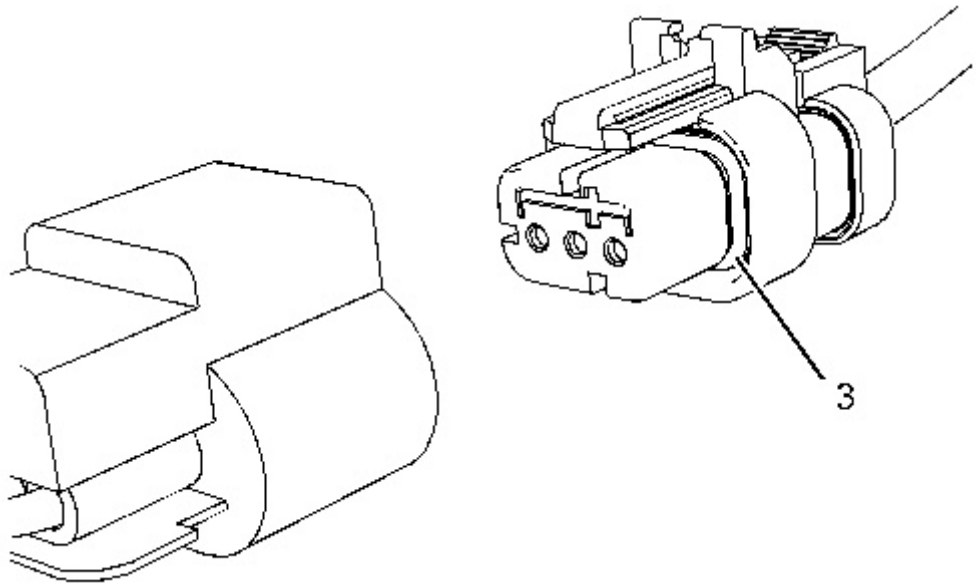


Illustration 2 g01960176

(3) Seal for a three-pin connector (typical example)

The plug end of the DT connector has a seal at the end of the connector. This seal has been improved on black connectors to help prevent slipping. Additionally, this seal is replaceable. This improvement will help keep moisture and dirt from entering the connector.

The current seal design (2) is not interchangeable with the former design (1). The receptacle has also changed to the new colors.

1. Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. This deformation will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

2. Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector.

3. Thoroughly inspect the connectors for evidence of moisture entry.

   Some minor seal abrasion on connector seals is normal. Minor seal abrasion will not allow the entry of moisture. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and repaired. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path:

   - Missing seals
   - Improperly installed seals
   - Nicks in exposed insulation
   - Improperly mated connectors

Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector harness for damage. Also check other connectors that share the harness for moisture.

Expected Result

The harness wiring, connectors, and seals are in good condition. There is no evidence of moisture in the connectors.

Results

OK - The harness wiring, connectors, and seals are in good condition. Proceed to "Check the Wires for Damage to the Insulation".

Not OK - A problem has been found with the harness or the connectors.

Repair

Repair the connectors or the wiring, as required. Ensure that all of the seals are properly in place. Ensure that the connectors have been reattached. If corrosion is evident on the pins, sockets or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, replacing the wires may be necessary. Verify that the repair eliminates the problem.

STOP

Check the Wires for Damage to the Insulation

1. Carefully inspect each wire for signs of abrasion, of nicks, and of cuts. Inspect the wires for the following conditions:
    - Exposed insulation
    - Rubbing of a wire against the chassis
    - Rubbing of a wire against a sharp point
2. Check all of the wiring harness fasteners to verify that the harness is properly secured. Also check all of the fasteners to verify that the harness is not compressed. Pull back the harness sleeves to check for a flattened portion of wire. A fastener that has been overtightened will flatten the harness. This damages the wires that are inside the harness.

Expected Result

The wires are free of abrasion, of nicks, and of cuts and the harness is properly clamped.

Results

OK - The harness is OK. Proceed to "Inspect the Connector Terminals".

Not OK - There is damage to the harness.

Repair

Repair the wires or replace the wires, as required. Verify that the repair eliminates the problem.

STOP

Inspect the Connector Terminals

A. Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are properly aligned in the connector and verify that the terminals are properly located in the connector.

Expected Result

The terminals are properly aligned and the terminals appear undamaged.

Results

OK - The terminals are OK. Proceed to "Perform a Pull Test on Each Wire Terminal Connection".

Not OK - The terminals of the connector are damaged.

Repair

Repair the terminals and/or replace the terminals, as required. Verify that the repair eliminates the problem.

STOP

Perform a Pull Test on Each Wire Terminal Connection

1. Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly. Refer to Illustration 2.

2. Perform the 45 N (10 lb) pull test on each wire.

   Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.

Expected Result

Each terminal and each connector can withstand 45 N (10 lb) of pull and each wire remains in the connector body.

Results

OK - All terminals pass the pull test. Proceed to "Check Individual Pin Retention into the Socket".

Not OK - A wire has been pulled from a terminal or a terminal has been pulled from the connector.

Repair

Use the **1U-5804** Crimp Tool (12-GA TO 18-GA) to replace the terminal. Replace damaged connectors, as required. Verify that the repair eliminates the problem.

STOP

Check Individual Pin Retention into the Socket

A. Verify that the sockets provide good retention for the pins. Disconnect the harness and insert a new pin into each socket of the mating plug. Insert the pins one at a time. Check for a good grip on the pin by the socket.

Expected Result

The sockets provide good retention for the new pin.

Results

OK - The terminals are OK. Proceed to "Check the Locking Mechanism of the Connectors".

Not OK - Terminals are damaged.

Repair

Use a calibrated **1U-5804** Crimp Tool (12-GA TO 18-GA) to replace the damaged terminals. Verify that the repair eliminates the problem.

STOP

Check the Locking Mechanism of the Connectors

1. Ensure that the connectors lock properly. After locking the connectors, ensure that the two halves cannot be pulled apart.
2. Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.

Expected Result

The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

Results

OK - The connectors are in good repair. Proceed to "Perform the Wiggle Test on the Caterpillar Electronic Technician (Cat ET) service tool".

Not OK - The locking mechanism of the connector is damaged or missing.

Repair

Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem.

STOP

Perform the Wiggle Test on the Cat® Electronic Technician (Cat® ET) Service Tool

1. Select the "Wiggle Test" from the diagnostic tests on the Cat® ET.
2. Choose the appropriate group of parameters to monitor.
3. Press the "Start" button. Wiggle the wiring harness to reproduce intermittent problems.

   If an intermittent problem exists, the status will be highlighted and an audible beep will be heard.

Expected Result

No intermittent problems were indicated during the wiggle test.

Results

OK - No intermittent problems were found. The harness and connectors appear to be OK. If another procedure recommended this test, return to that procedure and continue testing. If the problem has been resolved, return the machine to service.

STOP

Not OK - At least one intermittent problem was indicated.

Repair

Repair the harness or the connector. Verify that the repair eliminates the problem.

STOP

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i04001417

Electronic Control Module (ECM) - Flash Program

SMCS - 7610-591-MCH

Perform the following procedure to flash program the ECM. The ECM is flashed to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (Cat ET) service tool contains the program WinFlash. WinFlash is used to load software into the ECM. The following procedure is used to flash software into the MSS ECM.

Procedure

1. Connect the data-link cable between the communication adaptor and the Cat ET service tool.
2. Connect the data-link cable between the communication adaptor and the diagnostic connector of the machine.
3. Use WinFlash to load the software.

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i04001395

Electronic Control Module (ECM) - Replace

SMCS - 7610-510-MCH

Follow this procedure to replace the MSS ECM without deleting the original configuration and/or the information from the key database.

Note: This procedure assumes that the failed MSS ECM is able to communicate via the communication adapter with the Caterpillar Electronic Technician (Cat ET) service tool.

1. Turn the disconnect switch to the ON position.
2. Connect the communications adapter between the machine and the PC.
3. Use a master access level key to turn the keyswitch to the ON position. Verify the status LED is green.
4. Start the Cat ET service tool. Allow Cat ET service tool to connect with the Cat data-link. If the Cat ET service tool detects more than one ECM, select the ECM for the machine security system.
5. From the menu bar of the Cat ET service tool, select the following: "Service", "Copy Configuration", and then Fleet/Key Configuration from the submenu. If there is no recently loaded data available, the "No data is available..." message box displays. Click on the "Yes" button to load the data from the ECM. The "ECM Selector" dialog box is displayed. If necessary, highlight the Machine Security System ECM and Click on "OK". As the data is loading from the ECM, the "Please wait." message is displayed. Then, the "Loading data from ECM." progress bar is displayed. When the data has been successfully loaded from the ECM, the "The data has been successfully loaded." message is displayed. Click on "OK". The "Fleet/Key Configuration" screen displays with the "Program ECM" and "Save to File" push buttons are enabled.

   Note: The data must be saved to a file before you disconnect from the service tool or the data will be lost.

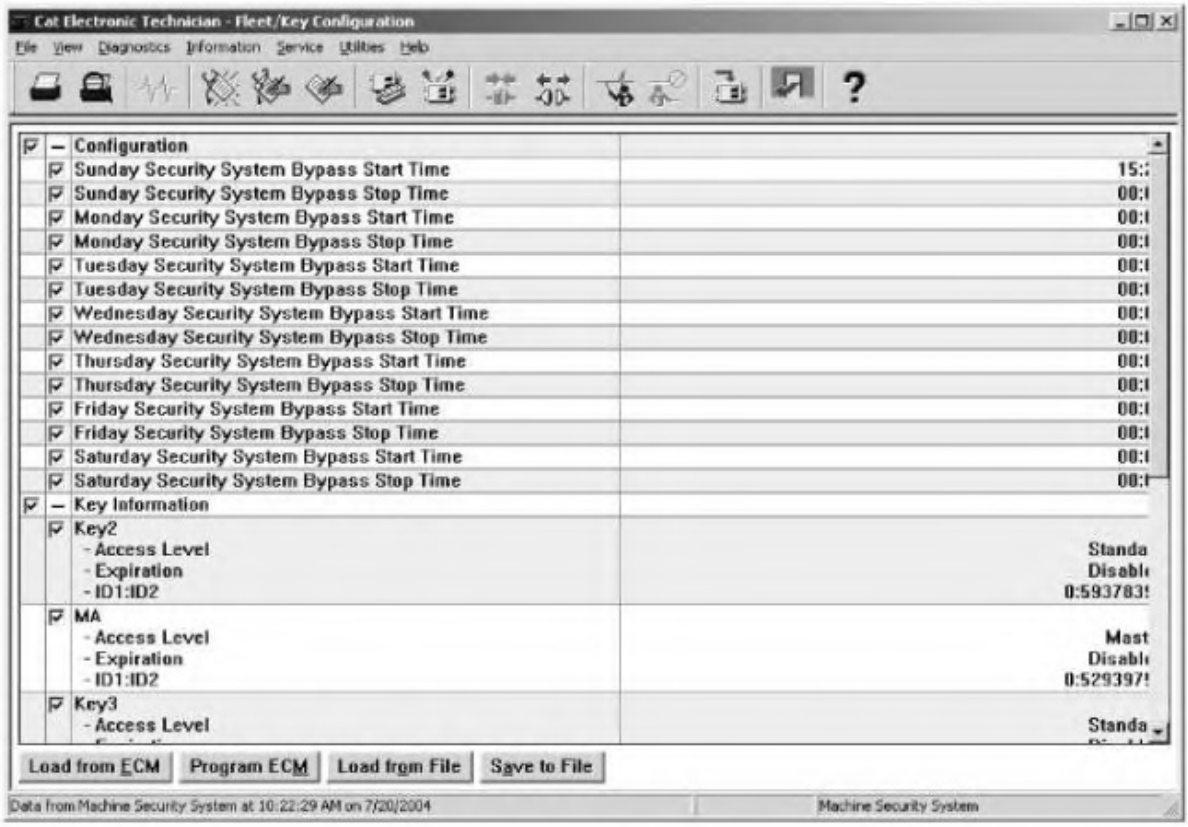


Illustration 1 g01097389

6. Click on the "Save to File" push button. The "Print New Document to File" dialog box is displayed. If you do not have a file open, a dialog box will ask you to choose one of the following options: open a file, create a file and cancel. Choose the "New" button to continue. Enter a document name and description in the appropriate text boxes. Click on "OK". The "Fleet/Key Configuration saved successfully" message box should display. Click on "OK". You will return to the "Fleet Configuration" screen. Record the saved file name in the space provide below as the file will be used in Step 14.

Table 1

Filename	

7. Select the "Machine Security System Uninstall" option from the "Service" menu. This option will cause the Cat ET service tool to display the message that is shown in Illustration 2.

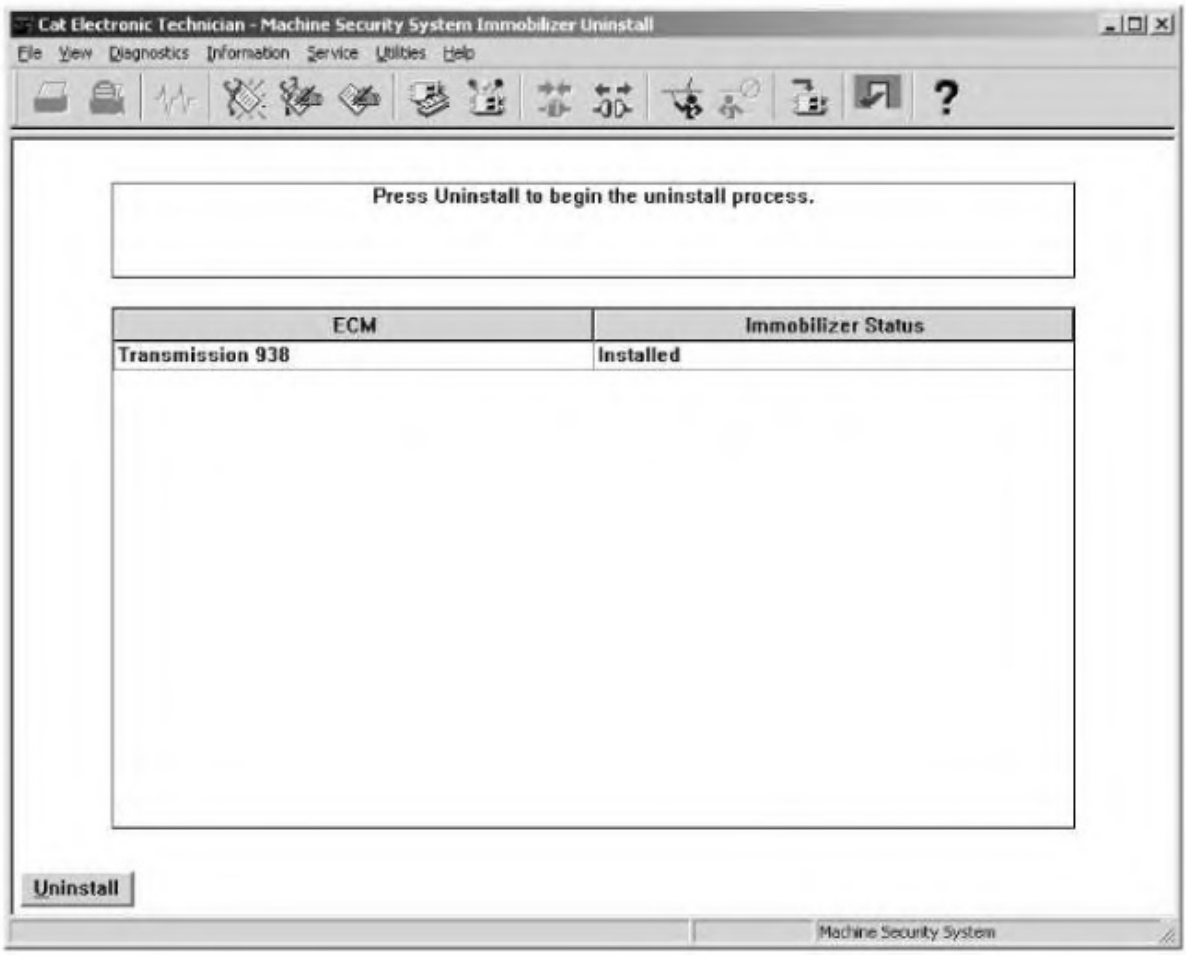


Illustration 2 g01097964

8. Click on the "Uninstall" button that is located at the lower left-hand corner of the "Machine Security System Uninstall" screen. This action will cause the Cat ET to display the message that is shown in Illustration 3.

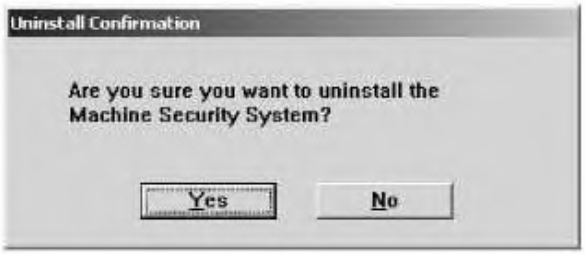


Illustration 3 g01097989

9. Click on the "Yes" button if you want to proceed with the "uninstall" of the Machine Security System.

Note: Pressing the "No" button aborts the "uninstall" of the Machine Security System.

10. Turn the keyswitch and disconnect switch to the "OFF" position. If the machine does not have a disconnect switch, remove the ground cable from the battery.

11. Remove and retain the tagged master keys from the new ECM. Replace the original MSS ECM with the new ECM supplied in the kit.

12. Turn the disconnect switch to the "ON" position or reattach the ground cable to the battery. Using one of the two new MASTER keys, turn the keyswitch to the "ON" position. Verify the status LED is green. If necessary, re-establish communication between the service tool and the MSS ECM.

13. Select "Copy Configuration" from the "Service" menu, and then select "Fleet/Key Configuration" from the submenu.

14. Open the document. As the data loads, a progress bar displays. Then, the "Fleet Configuration" message box displays.

15. Press "OK". The "Fleet/Key Configuration" screen displays with the file data.

16. Click on the "Program ECM" button. This action displays the fleet key information box.

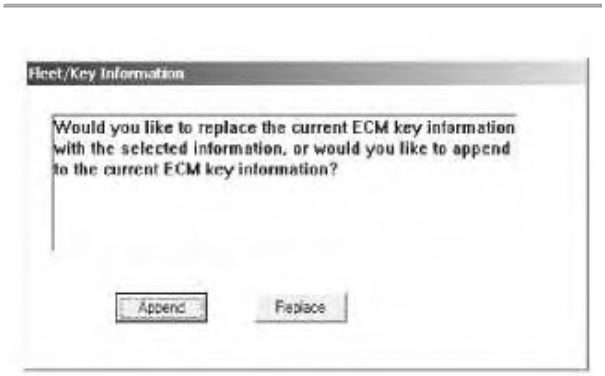


Illustration 4 g00921871

17. Click on the "Append" button.

Note: Replacing the key list adds the current master access level key to key list. The additional master access level key supplied will not be added. Appending the list adds both master access level keys that came with the MSS ECM to the key list that copied to the MSS ECM.

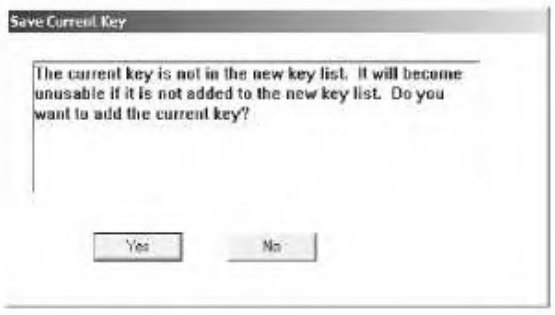


Illustration 5 g00921879

18. Click on the "Yes" button if you are prompted.

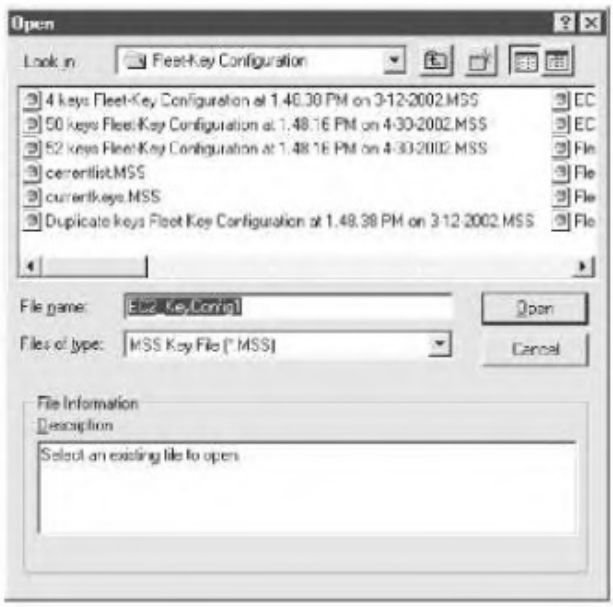


Illustration 6 g00921601

Note: MSS has a maximum of 255 keys that can be stored at one time. The replacement ECM has two master access level keys pre-programmed into the ECM. Fleet/Key Configuration determines the number of keys slots not programmed on the MSS. You cannot program more keys than the maximum number allowed. If more than 253 keys from the saved file, a message box displays informing you of the number of key slots available.

19. Perform the following steps:

    a. On the main menu bar, select "Service"

    b. Select "Configuration".

    c. Enter the serial number of the machine in the "Product ID field".

    d. To enter the "PID", highlight the" Product ID bar".

    e. Enter the correct value by clicking the "Change" button in the lower left-hand corner of the screen. If this machine has one of the newer 17 character "PID's", use the last eight (8) characters.

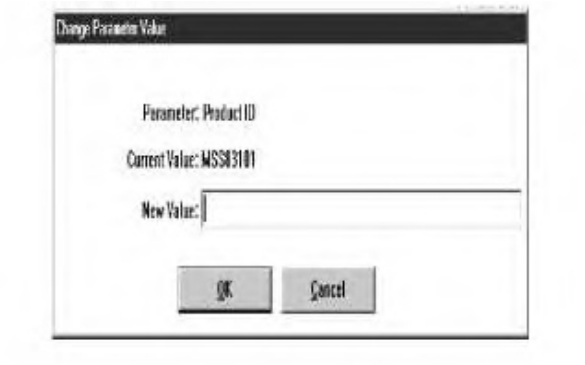


Illustration 7 g00827548

20. On the main menu bar, select "Service" and then "ECM Date/Time". Verify that correct date, time, and time zone are displayed for your location. Click on the "Change" button to adjust the settings.

21. Check the bypass times to ensure that the times are set correctly.

22. The ECM replacement procedure is now complete. You may choose to remove the two pre-installed master access level keys from the key list. To remove these keys, select "Service" and then "Security Management" from the menu bar. The list of keys will be displayed. In the "Description" field, located and highlight (one at a time) keys M1 and M2. Click on the "Delete" button. Confirm the "Are you sure." by clicking "OK".

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i01792812

Glossary of Terms

SMCS - 7631

Armed - This is a state of the security system when the machine is disabled.

Disarmed - This is a state of the security system when the machine is able to operate normally.

Electronic Control Module - The portion of the MSS that contains the microprocessor and memory

EID - Event Identifier

Exciter Coil - The exciter coil is a small coil of fine wire. The wire is molded into the bezel of a keyswitch with harness wiring. The exciter coil provides a path of communication. The electronic key and the electronic control module communicate via radio frequency.

Immobilizer - The Machine Security System Immobilizer is a feature within another ECM (engine and/or transmission) that restricts the operation of the machine until the Machine Security System disarms.

Master Access Level - Keys that are programmed for this level of access permit the operation of the machine and the key allows the user to add new keys. Also, keys that are already programmed can be modified.

MSS - Machine Security System

PID - A parameter identifier is used to identify specific parameters that are used by the MSS.

Product ID - The Product ID is an 8 digit alphanumeric number that identifies the machine.

Programming - Programming refers to the process of storing information in the memory of the control module.

Standard Access Level - Keys that are programmed for this level of access permit the operation of the machine.

Tattletale - The tattletale is a counter in the ECM that is used as part of the calculation for the factory password. The tattletale is incremented after a factory password is used. The affected parameter will have an increase in the specific parameter of the tattletale and the total tattletale

will reflect the increase as well. Once you use the factory password the factory password will no longer be valid. To make a change on the same ECM at a later date, another password will be required.

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i04008179

System Schematic

SMCS - 7566

Refer to the corresponding schematic of the machine or Special Instruction.

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Testing and Adjusting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490315

Electronic Control Module (ECM) - Flash Program

SMCS - 7610-591

Perform the following procedure in order to flash program the PL522 and 523. The PL522 and 523 is flashed in order to upgrade the software. Flash programming of the PL522 and 523 must also be done if the PL522 and 523 have been replaced. The Caterpillar Electronic Technician (Cat ET) contains the program WinFlash®. WinFlash® is used in order to load software into the PL522 and 523.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration" in order to configure the PL522 and 523.

Note: The Communication Adapter II is available in order to flash program the electronic control modules.

The Communications Adapter II hardware is connected between the service connector of the machine and the PC serial port or the PC parallel port. The Cat ET "Communications Interface Device" is configured for "Caterpillar Communications Adapter II (RP1210)".

Flash Program the PL522 AND 523

WinFlash® is used in order to load the software. The following steps explain the process in order to flash program the PL522 and 523.



Illustration 1 g02173443

1. Select the "Utilities" and "Winflash".

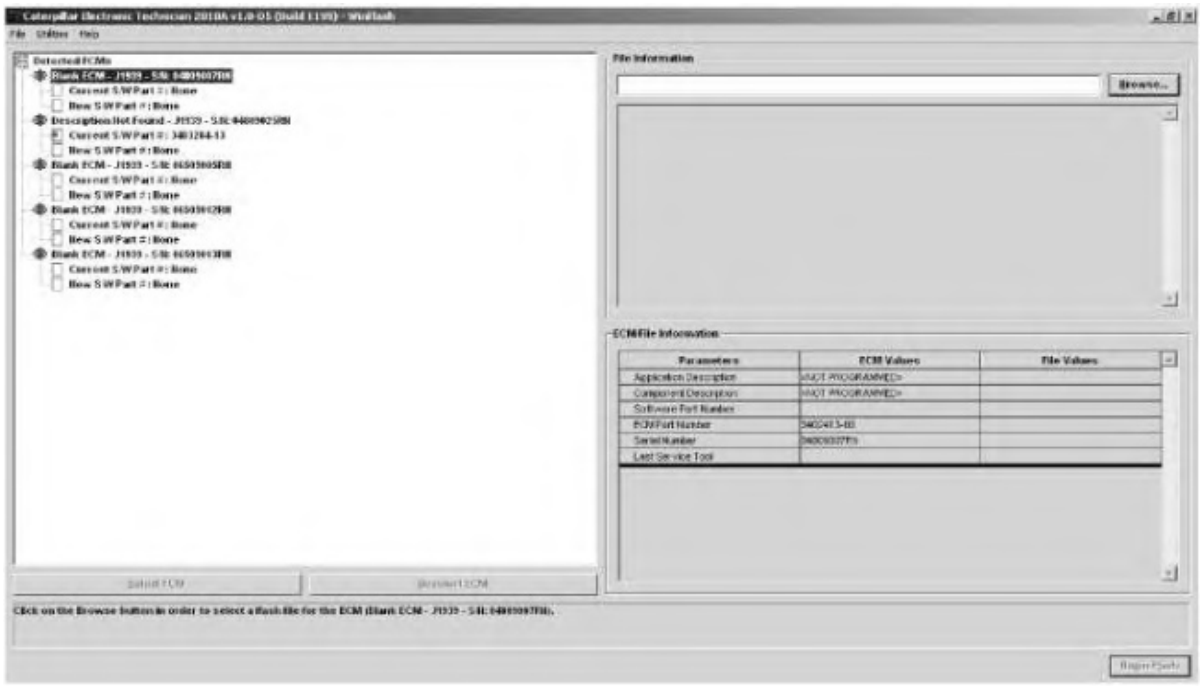


Illustration 2 g02173445

2. To flash the gateway board within the PL522 and 523, select the "Blank ECM" with the matching serial number of the PL522 or 523 from the list of detected ECMs. Refer to Illustration 2.

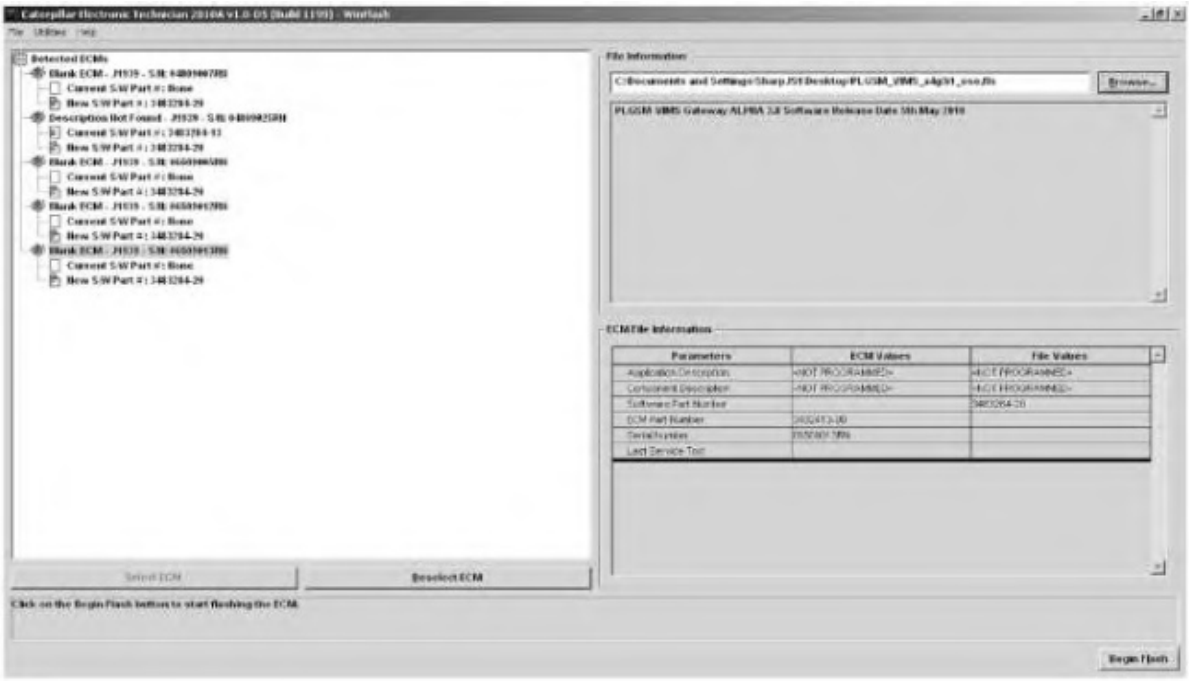


Illustration 3 g02173446

3. Select the file. Refer to Illustration 3.
4. Click "Begin Flash".

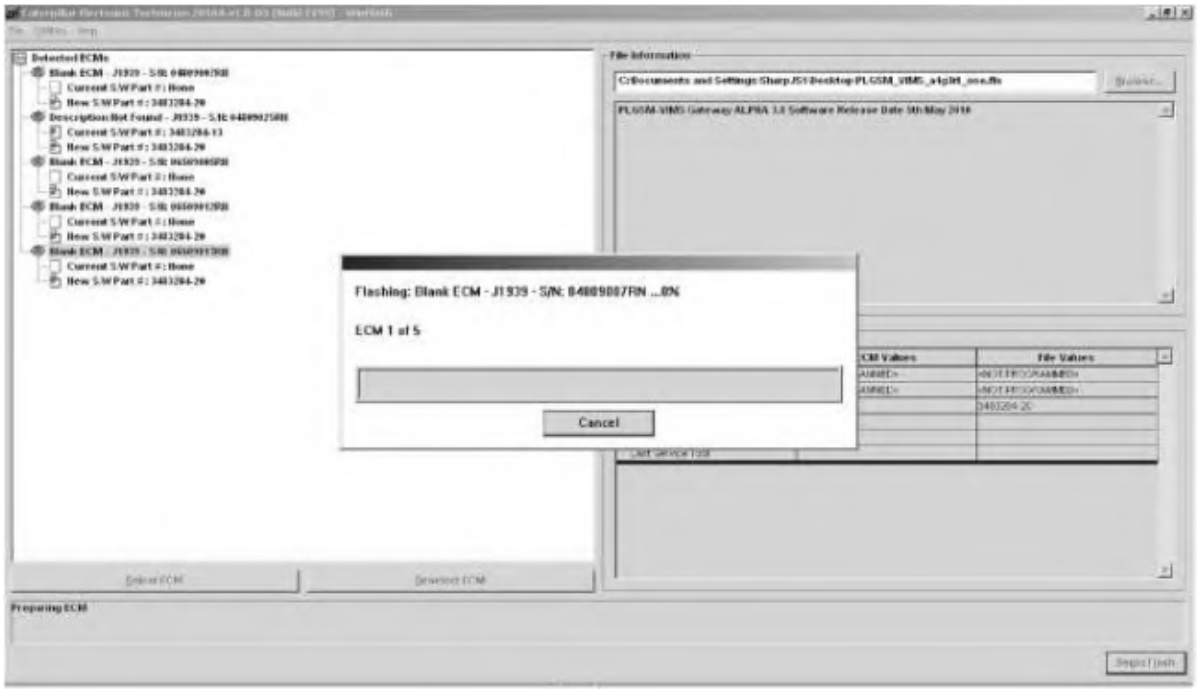


Illustration 4 g02173595

5. The progress bar should appear while the program is being loaded. Refer to Illustration 4.

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Testing and Adjusting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i03995041

Electronic Control Module (ECM) - Replace

SMCS - 7610-510

Before the PL522 or 523 is replaced, ensure that replacement is necessary. The PL522 or 523 is seldom the cause of a fault. Always check that power is available to the PL522 or 523. Battery voltage is required between contacts 1 and 2 of the machine harness connector for the PL522 or 523. Continue ONLY if all other attempts to isolate the problem have failed. Always consult your dealerships Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce the time that is required for a repair.

1. Turn the disconnect switch and the key start switch to the OFF position. Disconnect the machine harness from the PL522 or 523.
2. Remove the PL522 or 523.
3. Ensure that the replacement PL522 or 523 kit is the correct part number.
4. Install the replacement PL522 or 523 system according to the Special Instructions that are included in the installation kits.
5. Flash the software to the new module in order to ensure that the latest version of the software is on the system.

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Testing and Adjusting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i03995042

Electrical Connector - Inspect

SMCS - 7553-040-WW

ReferenceSpecial Instruction, SEHS9615, "Servicing DT Connectors".

ReferenceSpecial Instruction, REHS0148, "Listing Of Deutsch Connector Components"

ReferenceSpecial Instruction, SEHS9065, "Use Of CE Connector Tools".

ReferenceService Magazine, SEPD034227 January 97, "Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)".

ReferenceService Magazine, SEPD037128 July 97, "Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications".

ReferenceService Magazine, SEPD047324 May 99, "New DT Connector Plugs With Improved Seal Retention".

ReferenceService Magazine, SEPD054509 October 00, "Dielectric Grease Should Not Be Used In Electrical Connectors".

ReferencePocket Guide, SEBD0402, "Guidelines For Routing And Installing Wire Harness Assemblies".

Use this procedure under the following situation:

Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been corrected.

The following background information is related to this procedure:

Many of the operational procedures and the diagnostic code procedures in this troubleshooting guide will instruct you to check a specific electrical connector.

Intermittent electrical problems are often caused by poor connections. Always check for an active diagnostic code before breaking any connections. Also, always check for an active diagnostic code after the connector is reconnected in order to verify that the problem disappears.

Simply disconnecting the connectors and then reconnecting the connectors can temporarily solve a problem at times. If reconnecting the connectors solves the problem, likely causes are loose

terminals, bent terminals, improperly crimped terminals, corrosion, or harness routing that is improper.

The original source of the problem must then be identified in order to ensure that the problem does not reoccur.

Follow this procedure to inspect the connectors in order to determine if the connectors are the cause of the problem.

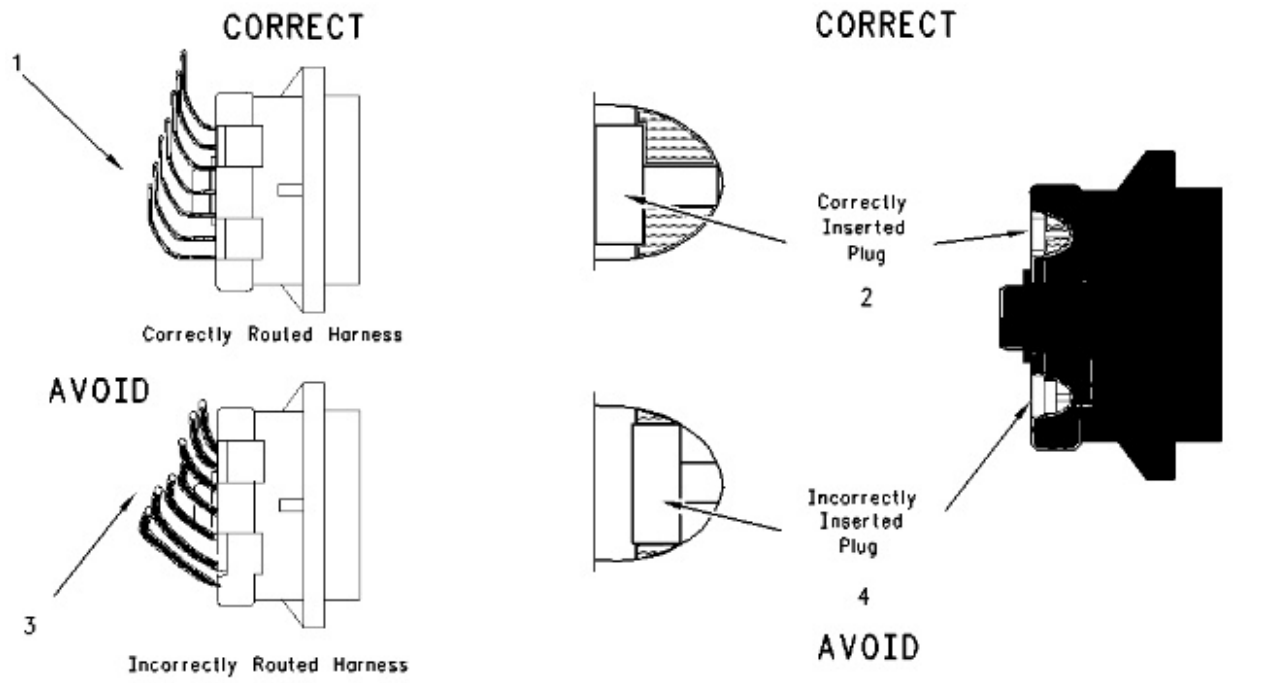


Illustration 1 g00820688

(1) Correctly Routed Harness

(2) Correctly Inserted Plug

(3) Incorrectly Routed Harness

(4) Incorrectly Inserted Plug

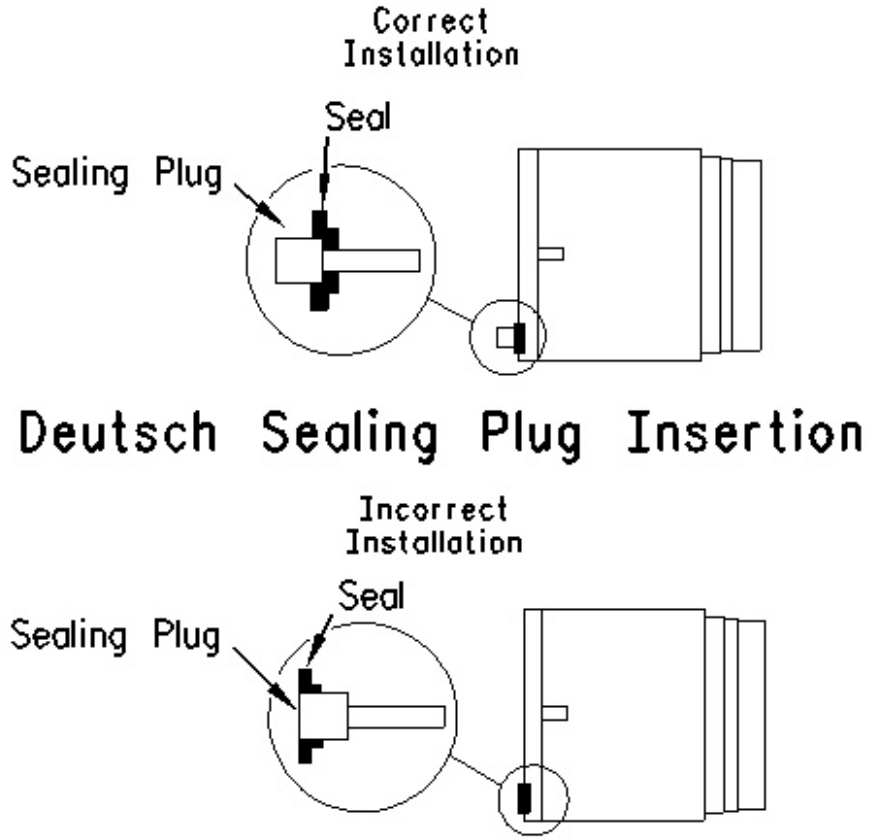


Illustration 2 g00690571

Proper Installation of Plug

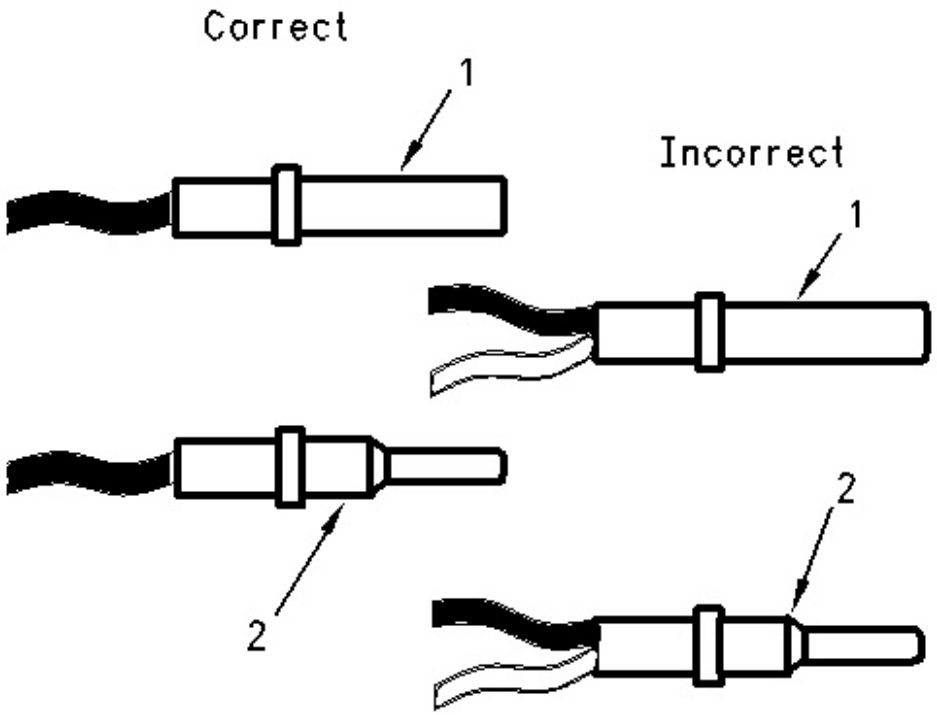


Illustration 3 g00828600

DT Type sealing plug

The 8T-8729 Connector Pin (2) and the 8T-8730 Connector Socket (1) is designed to accept only one 16/18 AWG wire. Do not insert multiple wires of a smaller wire size. An incorrect method would be using two 24 AWG wires. The 9W-0852 Connector Pin and the 9W-0844 Connector Socket are designed to accept only one 14 AWG wire. Do not insert multiple wires of a smaller wire size. An example of an incorrect method is the use of two 20 AWG wires.

1. **CHECK THE CONNECTORS.**

   a. Ensure that the connector is properly locked. Also, ensure that the two halves of the connector cannot be pulled apart.

   b. Verify that the latch tab of the connector is properly latched. Verify that the latch tab of the connector is fully latched.

      Expected Result: The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

      Results:

      OK - The connector will securely lock. The connector and the locking mechanism are without cracks or breaks. Proceed to test step 2.

      NOT OK - A problem exists with the connector.

      Repair: Repair the connector or replace the connector, as required.

      STOP.

2. **CHECK THE ALLEN HEAD SCREW ON THE HARNESS CONNECTOR OF THE ECM.**

   a. Ensure that the connector bolt is properly tightened. Be careful not to tighten the bolt too much. The bolt may break.

   b. Do not exceed 6.0 N·m (53.0 lb in) of torque on the connector bolt of the harness when the connector is being installed on the ECM.

      Expected Result: The harness connector is secure and the connector bolt of the ECM is properly torqued.

      Results:

      OK - The harness connector is secure and the connector is properly torqued. Proceed to test step 3.

      NOT OK - A problem exists with the connector.

      Repair: Secure the harness connector of the ECM. Ensure that the connector bolt is properly torqued.

      STOP.

3. **PERFORM A PULL TEST ON EACH CONNECTOR CONTACT.**

   a. Each connector contact should withstand 45 N (10 lb) of pull. Each wire should remain in the connector body. This test checks whether the wire was properly crimped in the contact and whether the contact was properly inserted into the connector.

   b. The DT connectors use an orange wedge to lock the terminals in place.

   c. Check in order to ensure that the orange wedge is not missing and that the orange wedge is installed properly on the DT connectors.

      Note: A Crimp Tool should ALWAYS be used in order to crimp wires on connector contacts. Do not solder the terminals. Use the proper Crimp Tool.

      Expected Result: Each connector contact should withstand 45 N (10 lb) of pull. Each wire remains in the connector body.

      Results:

      OK - Each connector contact withstands 45 N (10 lb) of pull. Each wire remains in the connector body. Proceed to test step 4.

      NOT OK - A problem exists with the connector.

      Repair: Repair the wiring or replace the connector contact.

      STOP.

4. **CHECK THE WIRES FOR NICKS OR ABRASIONS IN THE INSULATION.**

   a. Carefully inspect each wire for signs of abrasion, nicks, or cuts.

      The following areas are locations that should be checked:

- Exposed insulation
- Points of rubbing wire

b. Check all of the hold down clamps for the harness in order to verify that the harness is properly clamped. Also check all of the hold down clamps for the harness in order to verify that the harness is not compressed by the clamp. Pull back the harness sleeves in order to check for a flattened portion of wire. The flattened portion of wire is caused by the clamp that holds the harness.

Expected Result: The wires are free of abrasion, nicks, or cuts and the harness is properly clamped.

Results:

OK - The wires are free of abrasion, nicks, or cuts and the harness is properly clamped. Proceed to test step 5.

NOT OK - A problem exists with the wiring.

Repair: Repair the wires or replace the wires, as required.

STOP.

5. **CHECK THE CONNECTORS FOR MOISTURE OR CORROSION.**

a. Ensure that the connector seals and the white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal or plug. If necessary, replace the connector.

b. Check all of the wiring harnesses in order to verify that the harness does not make a sharp bend out of a connector. Sharp bends will deform the connector seal and will create a path for the entrance of moisture. See Illustration 1.

Note: Minor seal abrasion is normal on the ECM connector seals. Minor seal abrasion will not allow the entry of moisture.

c. Thoroughly inspect ECM connectors for evidence of moisture entry. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found. Also, the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will reoccur. Simply drying the connector will not fix the problem. Likely paths for the entrance of moisture are from missing seals, improperly installed seals, nicks in exposed insulation, and improperly mated connectors.

Note: Moisture can also travel from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector.

Note: If corrosion is evident on the contacts or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. Do not use cleaners that contain trichloroethylene because trichloroethylene may damage the connector.

Expected Result: All of the connectors must be coupled and all of the seals must be inserted. The harness and the wiring should be free of corrosion, moisture, abrasion, and pinch points.

Results:

OK - All of the connectors are coupled and all of the seals are inserted. The harness and the wiring are free of corrosion, moisture, abrasions, and pinch points. Proceed to test step 6.

NOT OK - A problem exists with the connector, the wiring, or the wiring harness. Moisture is present.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are coupled. Verify that the repair eliminates the problem by operating the machine for several minutes and by checking again for moisture.

STOP.

6. **INSPECT THE CONNECTOR CONTACTS.**

   a. Verify that the contacts are not damaged. Verify that the contacts are properly aligned in the connector and verify that the contacts are properly located in the connector.

   Expected Result: The contacts are properly aligned and the contacts appear undamaged.

   Results:

   OK - The contacts are properly aligned and the contacts appear undamaged. Proceed to test step 7.

   NOT OK - A problem exists with the connector contacts.

   Repair: Repair the contacts and wiring and/or replace the contacts and wiring.

   STOP.

7. **CHECK THE FIT OF THE CONTACTS.**

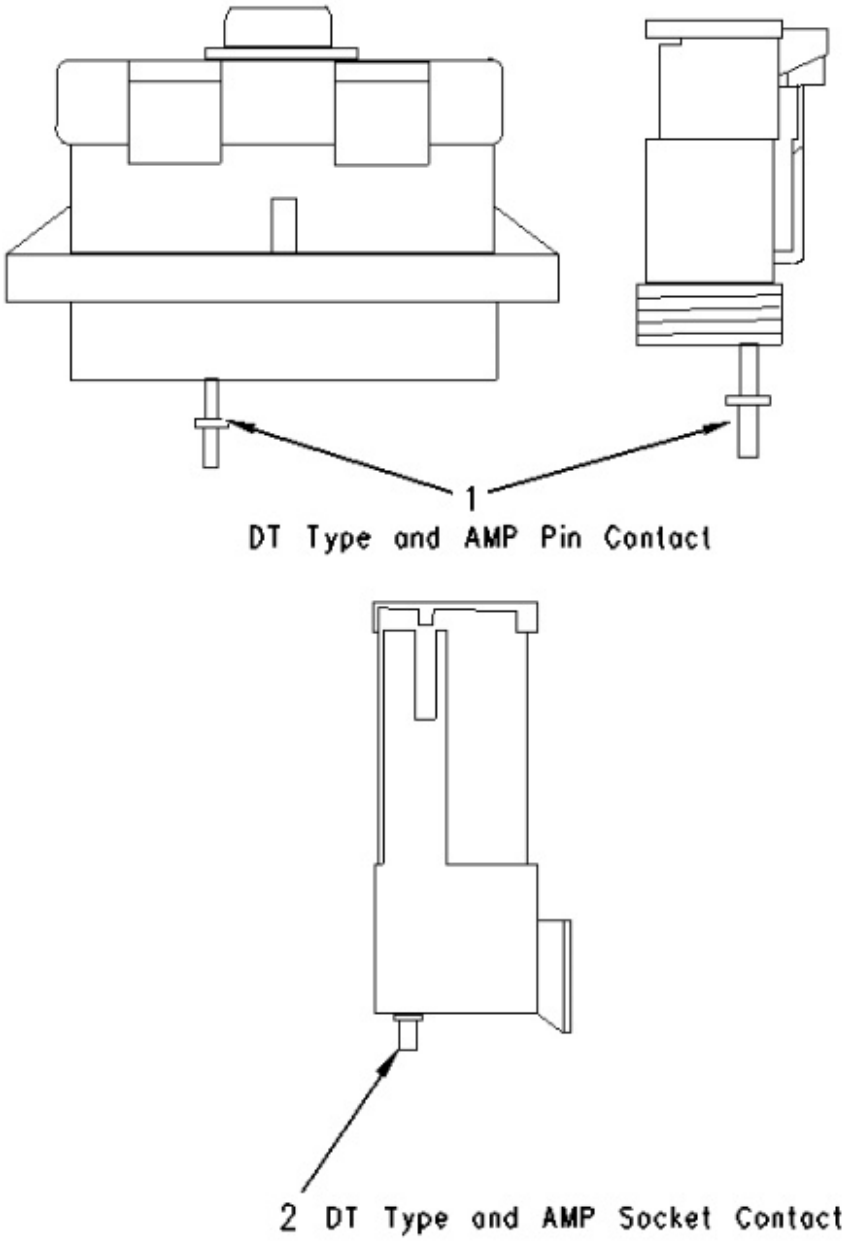


Illustration 4 g00838765

Retention of the Connector

(1) Pin Contact

(2) Socket Contact

Note: Contact is especially important for intermittent problems.

a. Use a new pin contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact.

b. Use a new socket contact. Insert the pin contact into each socket contact one at a time. Check for a good grip on the pin contact by the socket contact. The pin contacts are located on the mating side of the connector.

c. The connector contact should stay connected when the connector is held in the position shown in Illustration 4. The connector contact is the pin contact or the socket contact.

Expected Result: The pin contacts and the socket contacts appear to be OK.

Results:

OK - The pin contacts and the socket contacts appear to be OK. **STOP.**

NOT OK - A problem exists with the connector terminal.

Repair: Replace the connector contact.

STOP.

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Testing and Adjusting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i03995056

Wiring Harness (Open Circuit) - Test

SMCS - 1408-081

An open is a failure of an electrical circuit that results in no flow of electrical current. An open circuit can be caused by failed electrical wires or a poor connection of electrical connectors. If an electrical wire or a connection is broken, the flow of electrical current through the circuit is interrupted. A normally closed circuit will have less than 5 ohms of resistance. The following procedure explains the test for an open circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR AN OPEN CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.

5. At the other connector of the machine harness, use a multimeter to measure the resistance from the contact of the suspect wire to frame ground.

   Expected Result: The resistance is less than 5 ohms.

   OK - The resistance is less than 5 ohms. The harness circuit is correct.

   Stop.

   NOT OK - The resistance is greater than 5000 ohms. There is an open in the machine harness.

   Repair: Repair the machine harness or replace the machine harness.

   Stop.

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Testing and Adjusting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i03995057

Wiring Harness (Short Circuit) - Test

SMCS - 1408-081

A short circuit is a failure of an electrical circuit that results in undesired electrical current. Usually, a short circuit is a bypass of the circuit across a load. A short across the wires in a circuit produces too much current in the wires. The resistance in a normal circuit can vary, but the resistance between a particular circuit and other unrelated circuits is always greater than 5000 ohms. The following procedure explains the test for a short circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR A SHORT CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At the machine harness connector for the ECM, place one of the multimeter probes on the contact of the suspect wire.

5. Use the other multimeter probe to check the resistance across all other contacts in the connectors of the ECM and frame ground.

   Expected Result: The resistance is greater than 5000 ohms for all the measurements.

   OK - The resistance is greater than 5000 ohms for all the measurements. The harness circuits are correct.

   Stop.

   NOT OK - The resistance is less than 5 ohms. There is a short in the machine harness. The short is between the suspected wire and the wire with the lowest resistance measurement.

   Repair: Repair the machine harness or replace the machine harness.

Stop.

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Specifications

SMCS - 7606

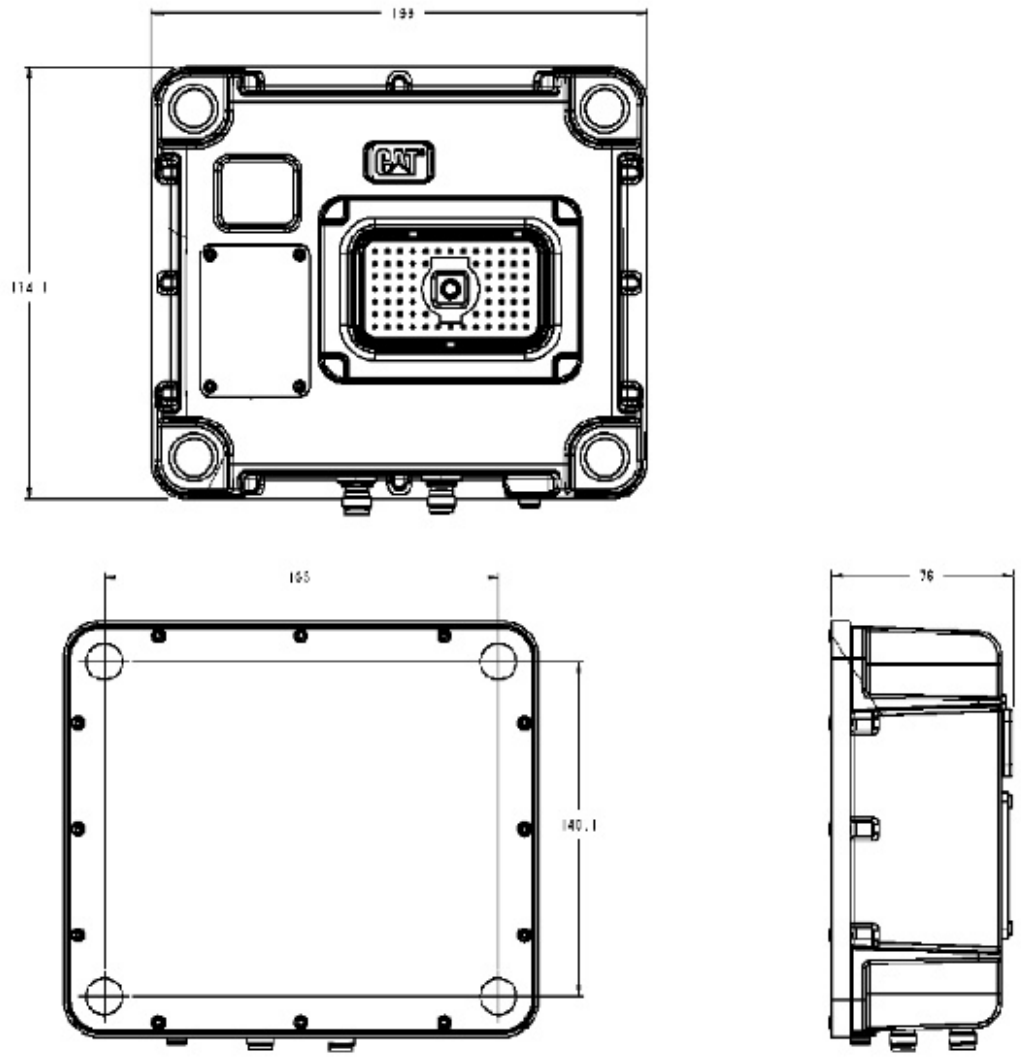


Illustration 1 g02173473

PL522 and 523 ECM

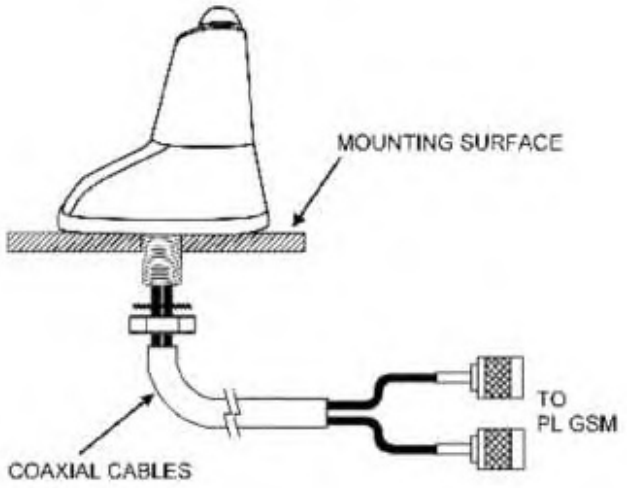


Illustration 2 g02173475

"Sharkin" antenna

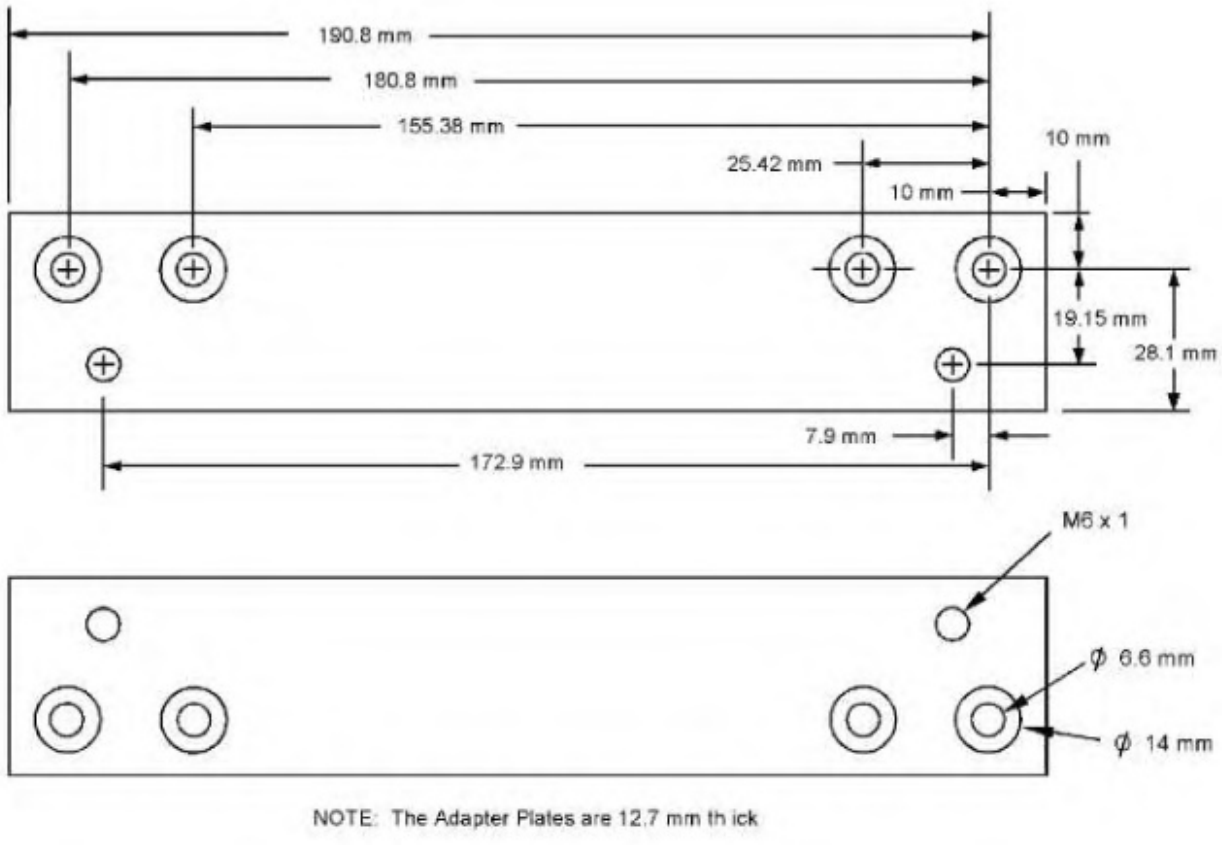


Illustration 3 g02173478

Adapter plates for the ECM

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i05373503

System Schematic

SMCS - 7566

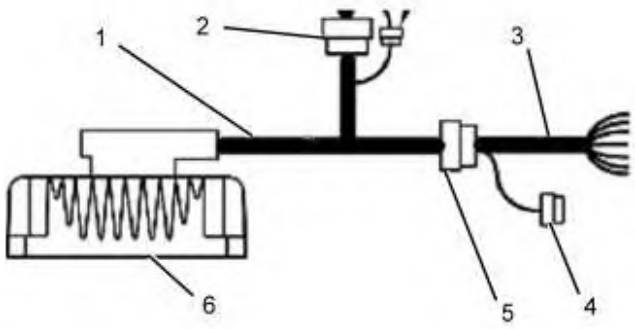


Illustration 1 g02173500

Overview of the connection of the PL522 or 523 legacy field installation group

(1) 256-6804 Control Harness As

(2) 12 pin connector

(3) 257-9364 Radio Harness As

(4) Serial service connector

(5) 12 pin receptacle connector

(6) PL52 or 523 ECM

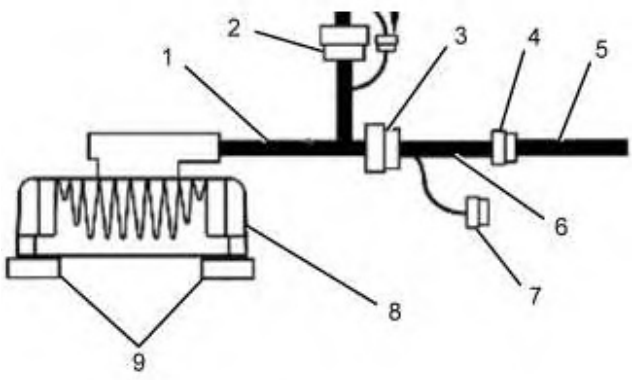


Illustration 2 g02173503

Overview of the connection of the PL522 or 523 field installation group (conversion)

(1) 256-6804 Control Harness As

(2) 12 pin connector

(3) 12 pin receptacle connector

(4) 6 pin Product Link connector

(5) Machine harness

(6) 257-9163 Adapter

(7) Serial service connector

(8) PL522 or 523 ECM

(9) 256-0501 Plate

Legacy Harness for Caterpillar Machines

Table 1

Legacy Harness Connections			
P1 Connector Pin Number	**Harness Wire**	**Description**	**Connection Point for the Machine**
1	125-RD	Batt +	Fused (5 amp) unswitched power circuit (1)
2	200-BK	Batt -	Machine Ground
3	308-YL	Keyswitch On	Circuit that provides battery voltage only when the keyswitch is turned to the ON position
4	403-GN	R-terminal	Alternator R-terminal circuit (2)
5	N957-PK	RS-232 Port 1-TXD	-
7	N960-OR	RS-232 Port 1-RXD	-

8	N979-GN	RS-232 Port 1-GND	-
9	N970-YL	RS-232 Port 1-DTR	-
10	N973-BR	RS-232 Port 1-DCD	-

(1) The supply voltage must be 12 VDC or 24 VDC.

(2) If an R-terminal input is not available, a DC voltage that goes high when the engine is running may be used.

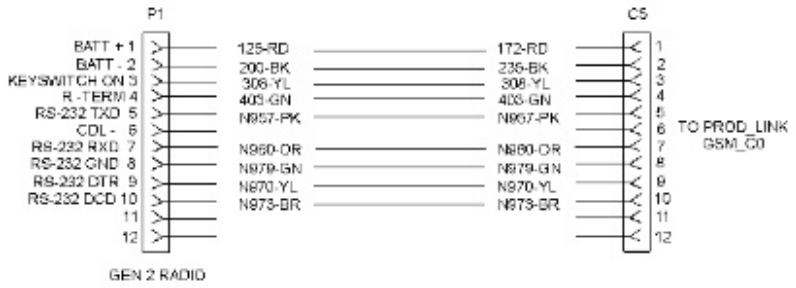


Illustration 3 g03404339

Legacy harness schematic

Conversion Harness for Caterpillar Machines

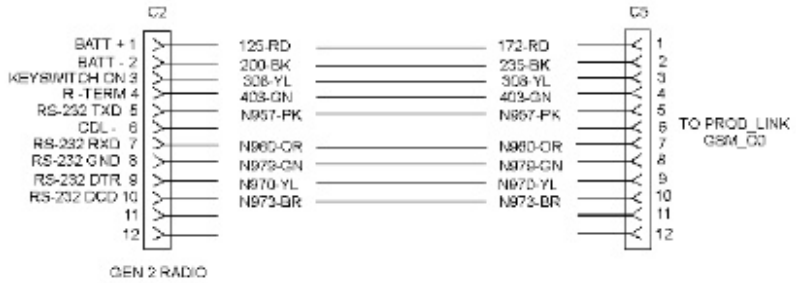


Illustration 4 g03404340

Conversion harness schematic

PL522 or 523 System Harness Wiring

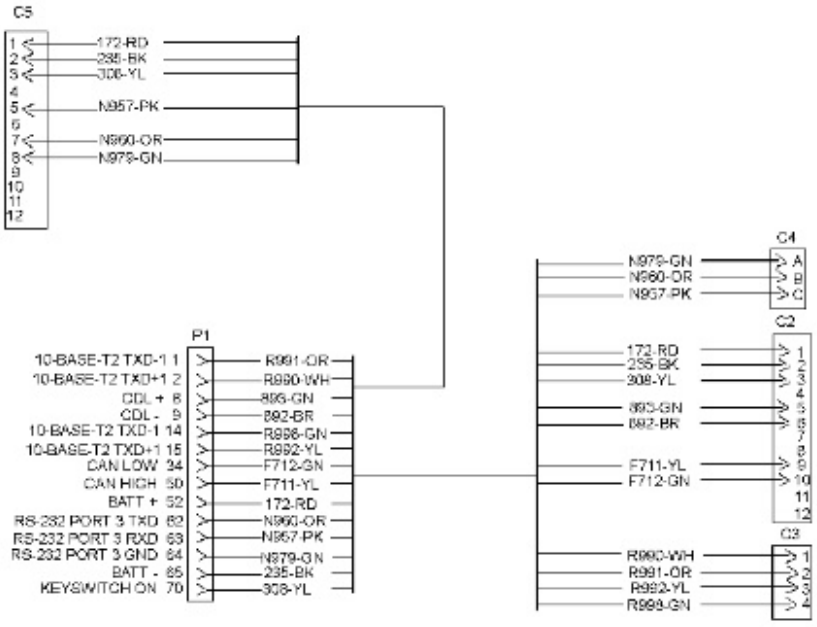


Illustration 5 g03404341

PL522 or 523 harness schematic

Note: Connectors "P2" and "P3" are not used in a PL522 or 523 installation and should be capped.

PL522 or 523 Digital Inputs

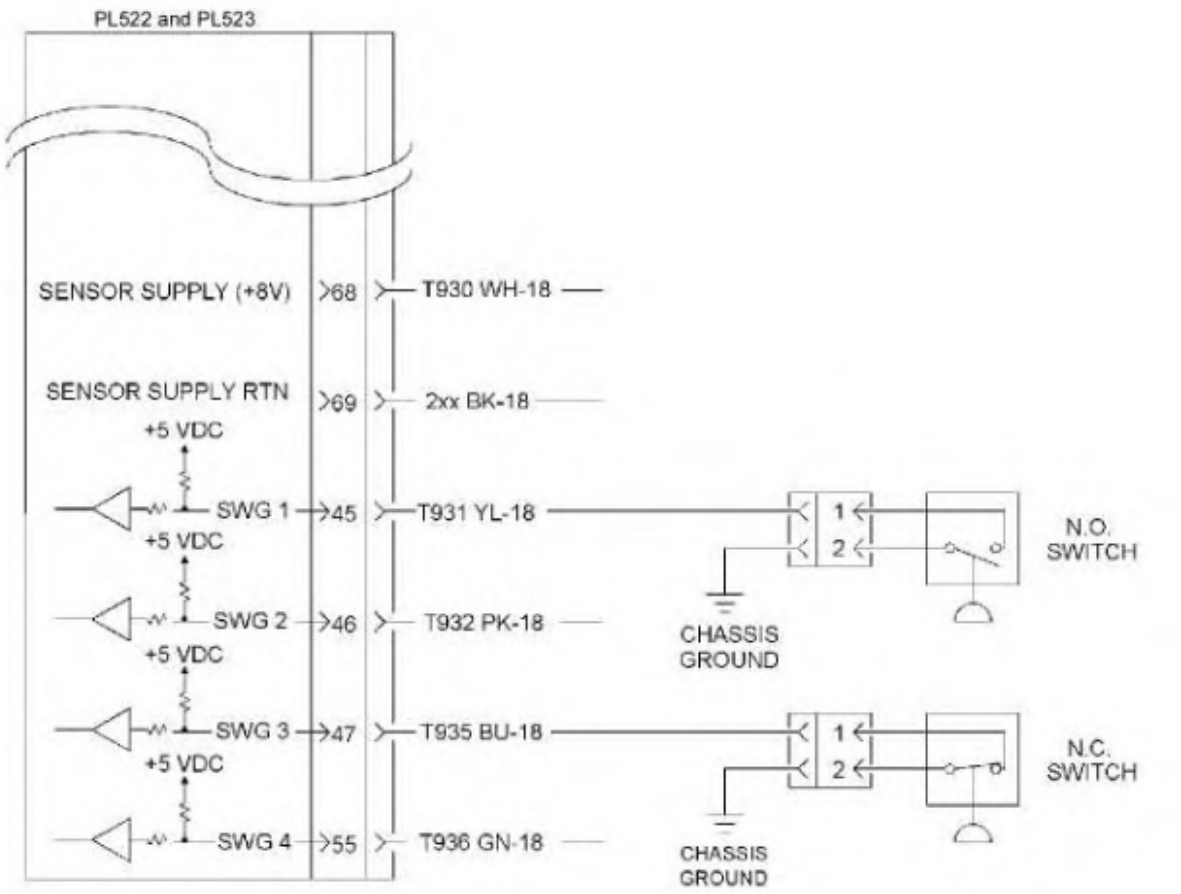


Illustration 6 g02173530

For a list of switches that may be used, refer to Special Instruction, REHS2365.

System Level Schematic

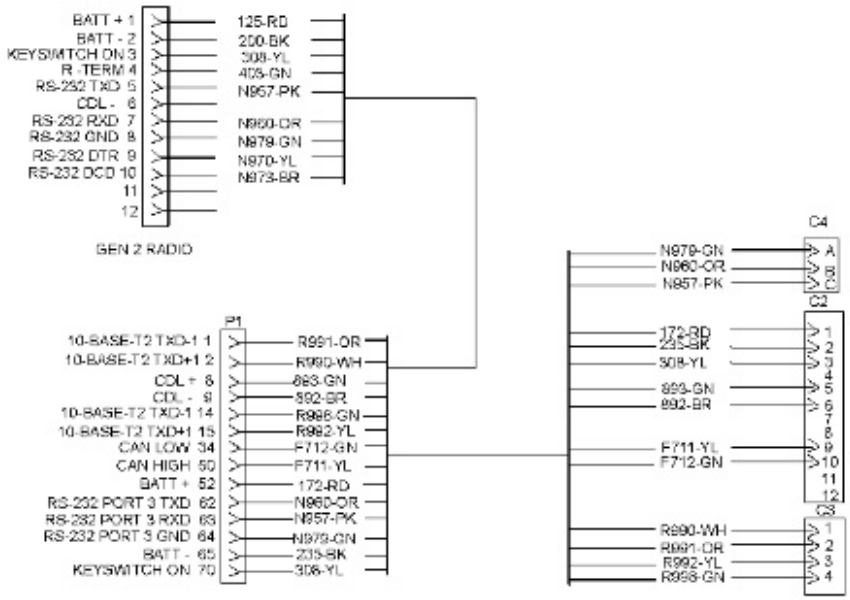


Illustration 7 g03404343

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Testing and Adjusting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04907011

Electronic Control Module (ECM) - Flash Program

SMCS - 7610-591

Perform the following procedure in order to flash program Product Link. Product Link is flashed in order to upgrade the software. Flash programming of Product Link must also be done if Product Link has been replaced. The Caterpillar Electronic Technician (Cat ET) contains the program WinFlash®. WinFlash is used in order to load software into Product Link.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Configuration" in order to configure the following products:

- PL121SR
- PL300

Note: Two communications adapters are available in order to flash program the electronic control modules. The **7X-1700** Communications Adapter can be used, or the **171-4400** Communication Adapter II can be used.

PL321SR - The **171-4400** Caterpillar Communications Adapter II hardware is connected between the service connector for the machine and the PC serial port or the PC parallel port. The Cat ET "Communications Interface Device" is configured for "Caterpillar Communications Adapter II (RP1210)".

PL121SR - The **245-7310** Serial Service cable is to be used only for the configuration of the PL121SR radio system.

Note: Only the **171-4400** Caterpillar Communications Adapter II is to be used for the PL321SR (PL121SR plus PL300) system configurations.

Note: DO NOT USE the **171-4400** Caterpillar Communications Adapter II for the PL121SR system.

Note: DO NOT USE the **245-7310** Serial Service cable for the PL321SR system.

PL121SR System

Flash Program the PL121SR Radio Module

The following steps explain the flash procedure for the PL121SR. **RADIO ONLY** system

1. **Procedure to connect a laptop computer to the machine**
    a. Connect the **245-7310** Serial Service cable between the laptop computer and the serial service connector on the wiring harness of the machine.

2. Select "Utilities" on the menu bar.
3. From the drop-down list, select "Preference".



Illustration 1 g01138570

4. If the "Communications" tab has not been automatically selected, select the "Communications" tab. Click on the drop-down menu in order to expand the menu. Select "Caterpillar Embedded Communication Adaptor".

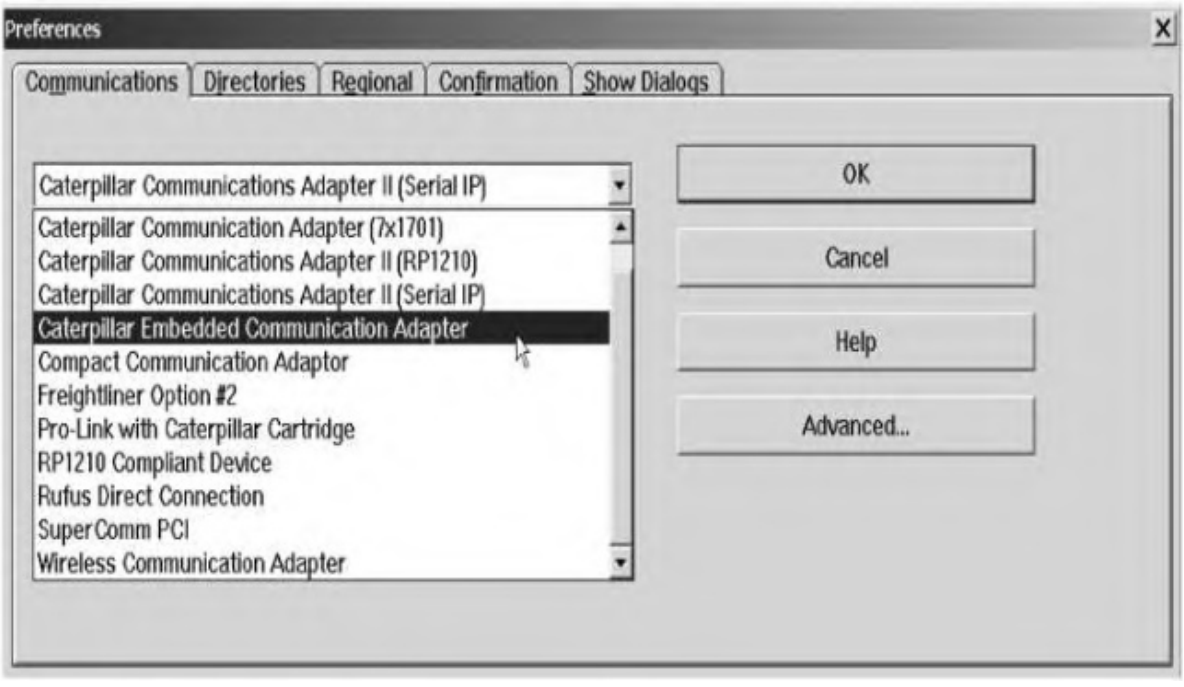


Illustration 2 g01138571

5. Select "Service" on the menu bar. Select "Product Link Flash" from the drop-down menu.

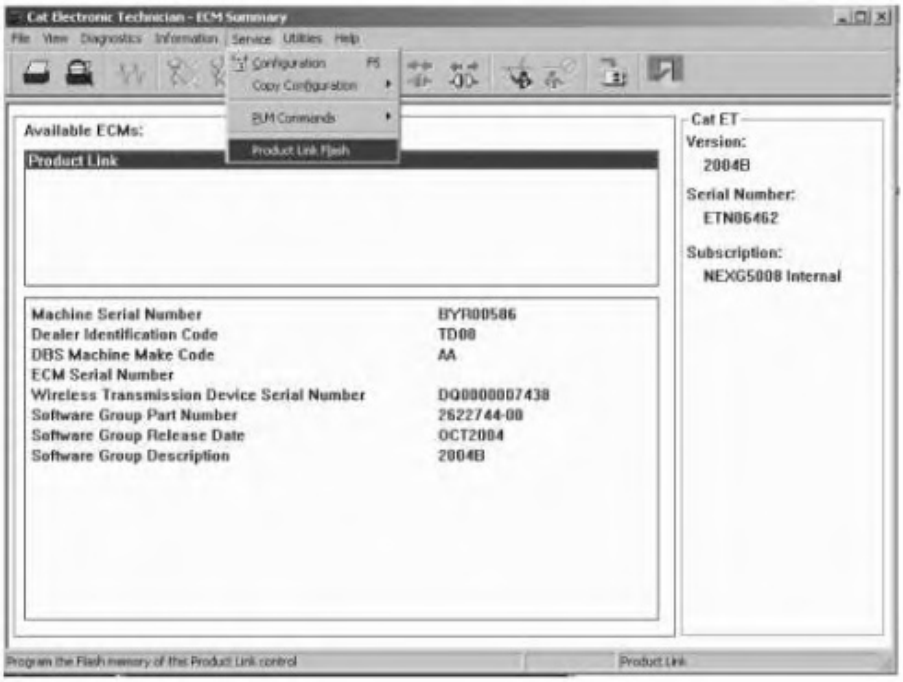


Illustration 3 g01134115

"Product Link Flash" Screen

6. After the following screen appears, click "Browse".



Illustration 4 g01134116

7. Click on the appropriate file.

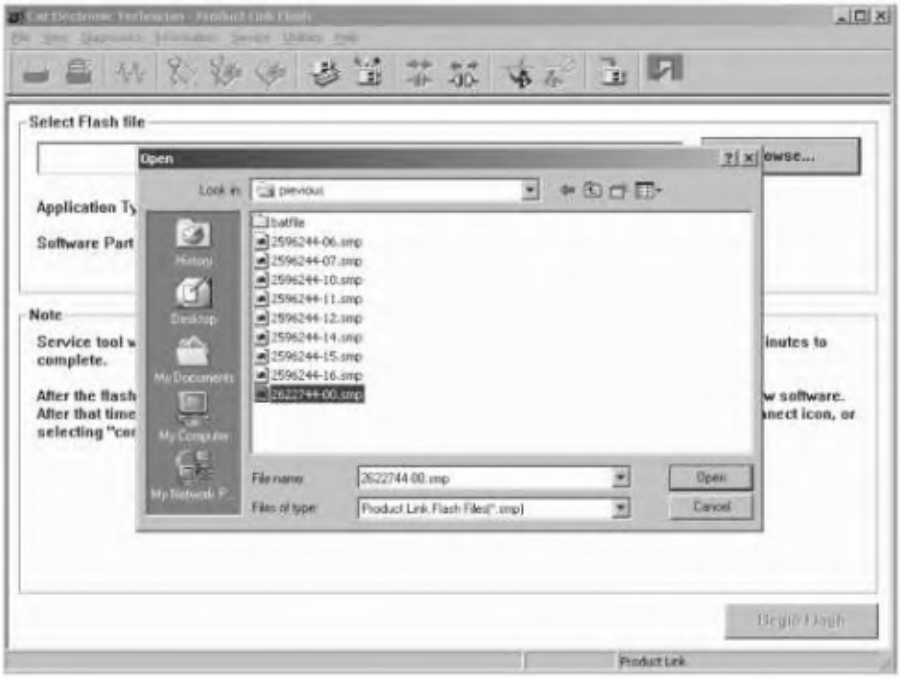


Illustration 5 g01134117

"File Screen"

8. Click "Begin Flash".

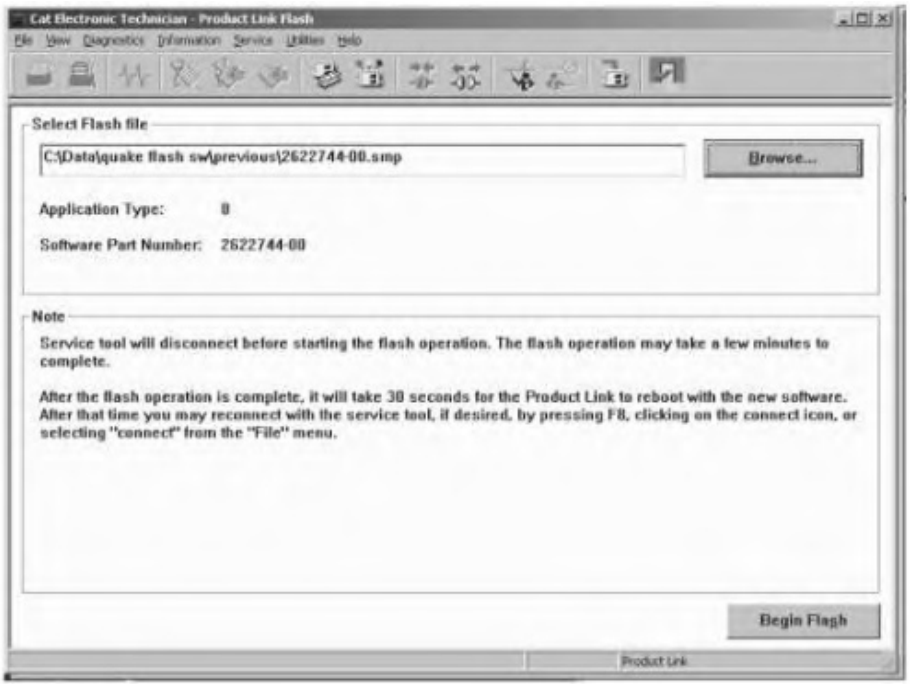


Illustration 6 g01134118

9. The following screen will appear.

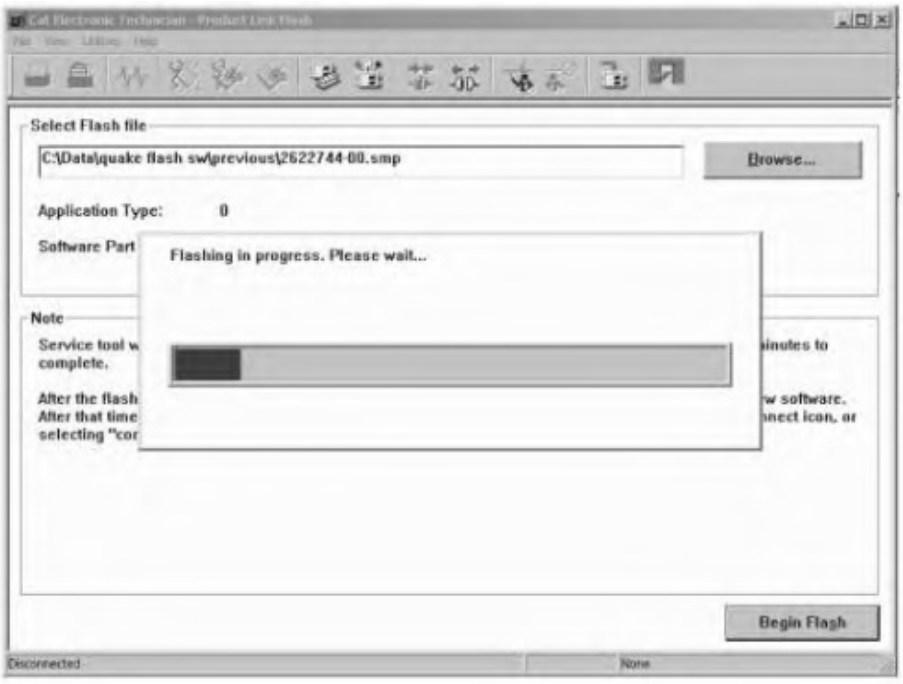


Illustration 7 g01134121

10. The following screen should appear once program "flashing" is complete.

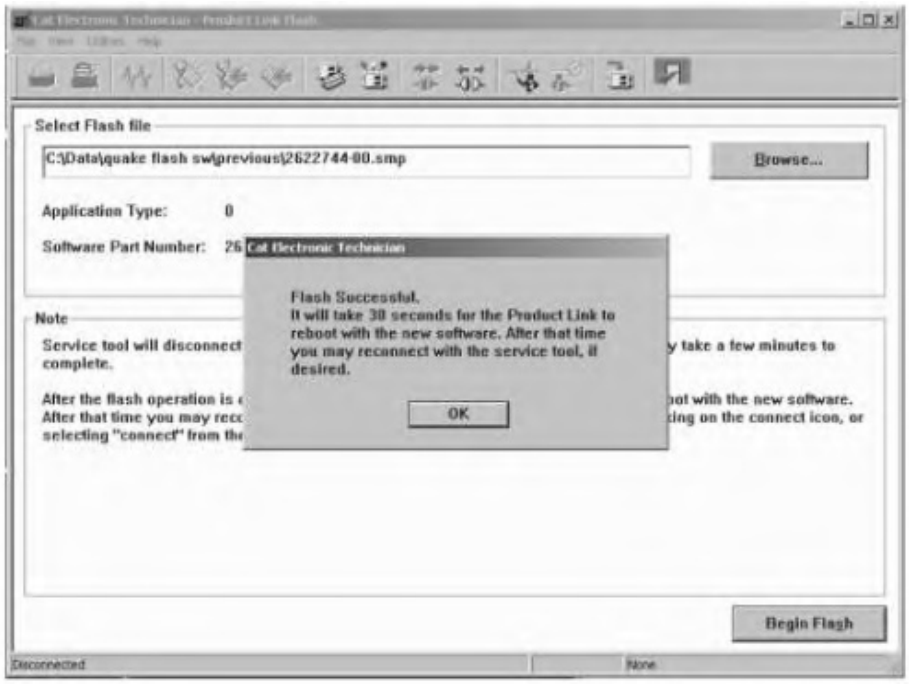


Illustration 8 g01134122

11. Click "OK".
12. The "Connect" icon should change from being grayed out to active. Click the "Connect" icon on the tool bar in order to return to Cat ET. Refer to the arrow in Illustration 9. (You may also select "File" on the menu bar, then click "Connect" from the drop-down menu.)

PL321SR System

Flash Program the PL121 Radio Module

WinFlash is used in order to load the software. The following steps explain the process in order to flash program the PL300.

1. Select the "ECM Summary"Screen.

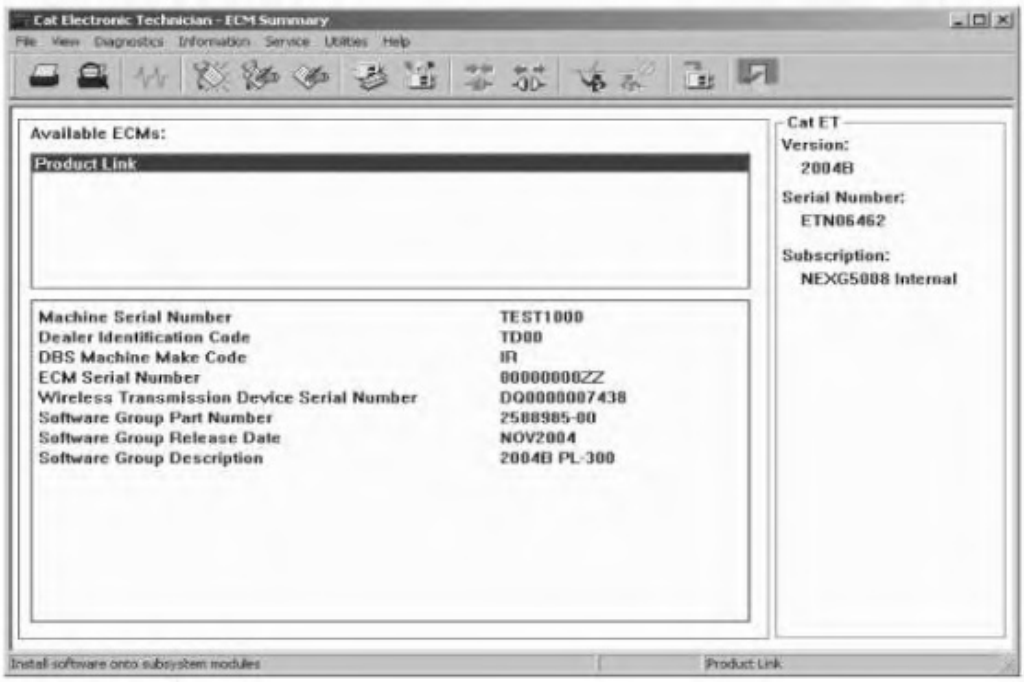


Illustration 9 g01133998

PL300 "System ECM Summary" Screen

2. In a PL321 system, in order to flash the PL121SR (radio) by using the PL300 ECM, select "Service" menu bar and then select "Subsystem Module Programming".

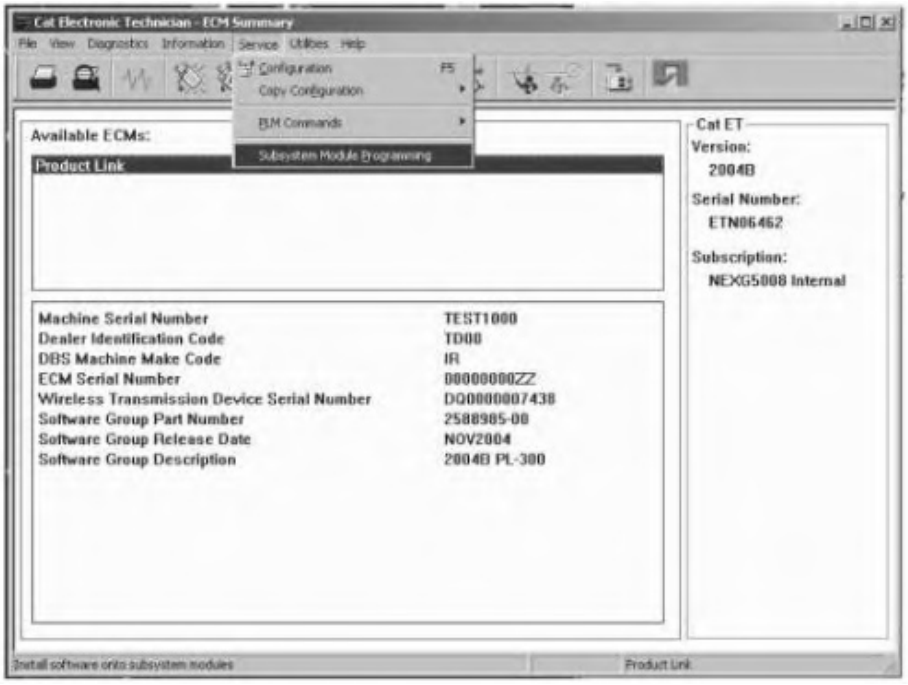


Illustration 10 g01134106

"Subsystem Module Programming" Screen

3. The "Subsystem Module Programming" screen should appear.



Illustration 11 g01134107

4. Click on "Submodule".

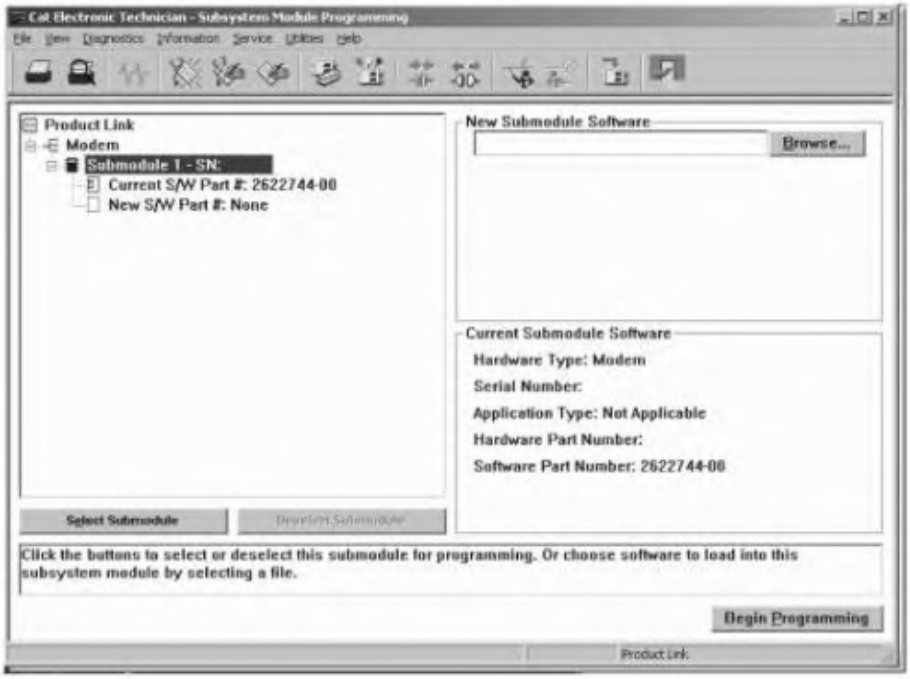


Illustration 12 g01134109

5. Click on the correct flash file for the PL121SR to load.

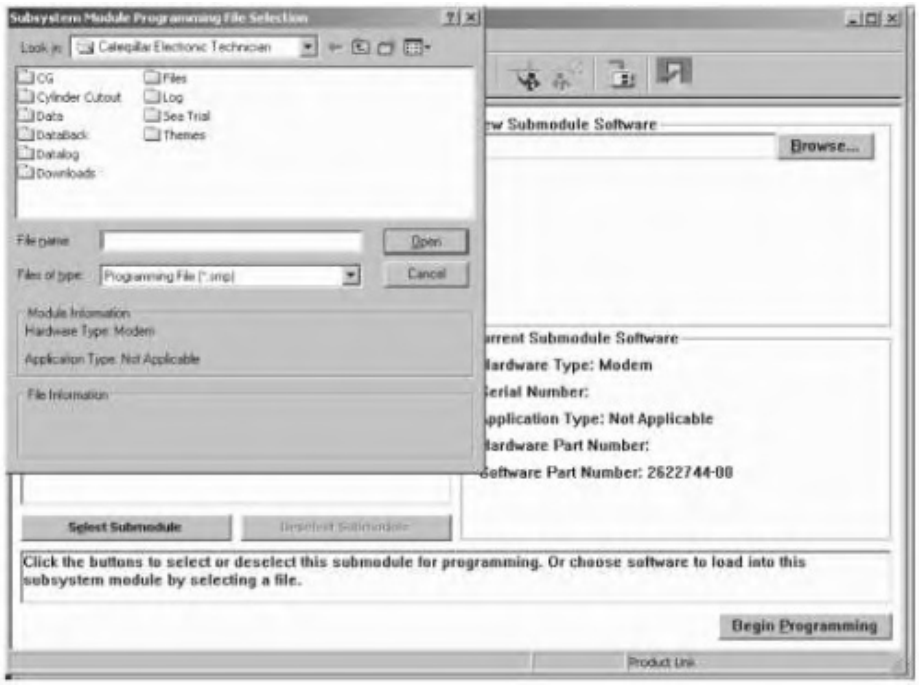


Illustration 13 g01134110

"File Select" Screen

6. Click the "Begin Progamming" button that is located on lower right side of screen.

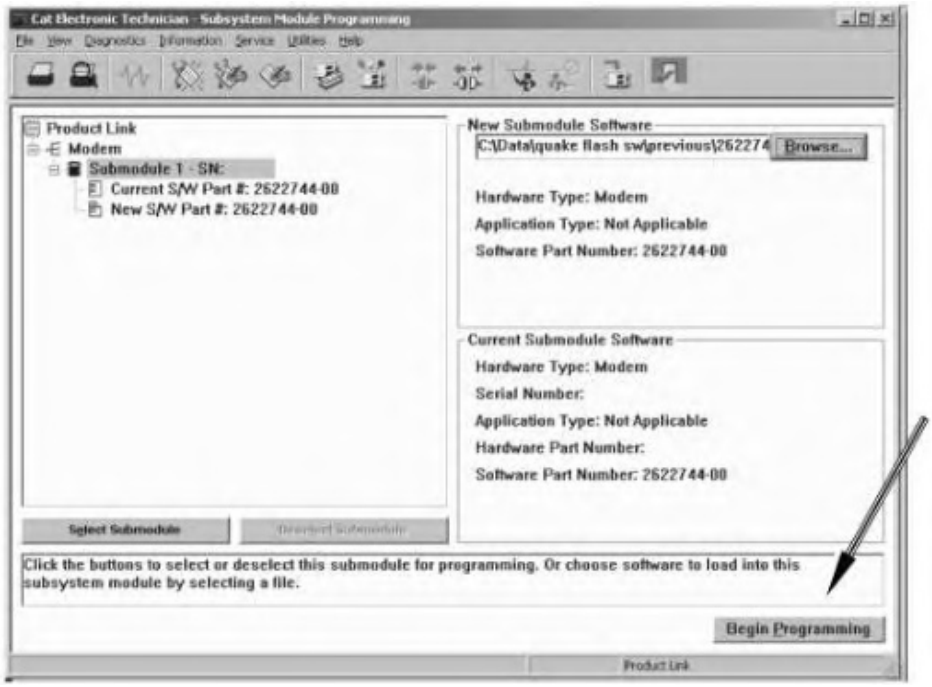


Illustration 14 g01134111

7. The following screen should appear while "flashing" is in progress.

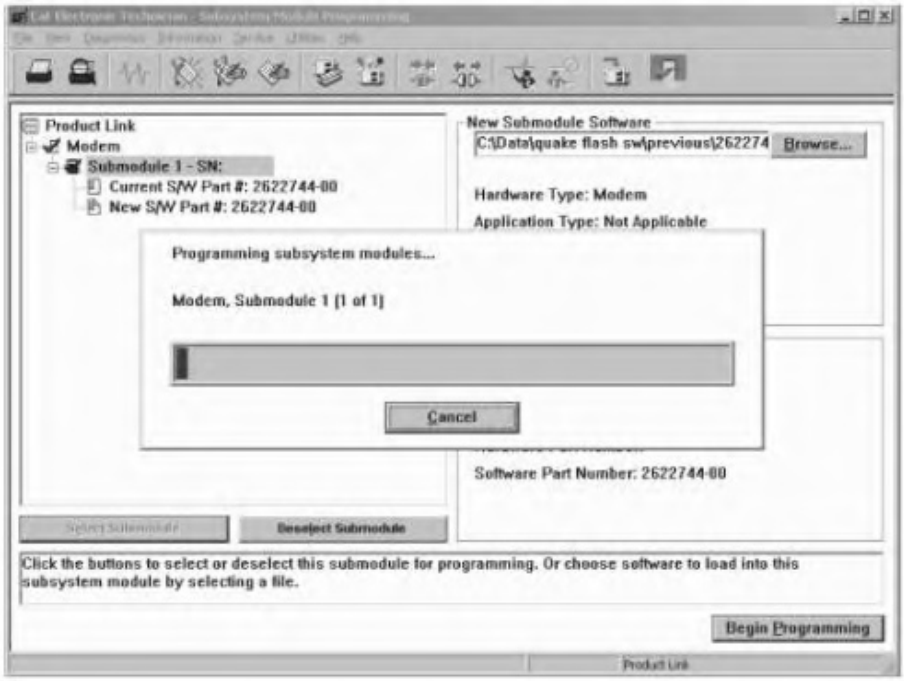


Illustration 15 g01134112

8. The following screen should appear once program "flashing" is complete.

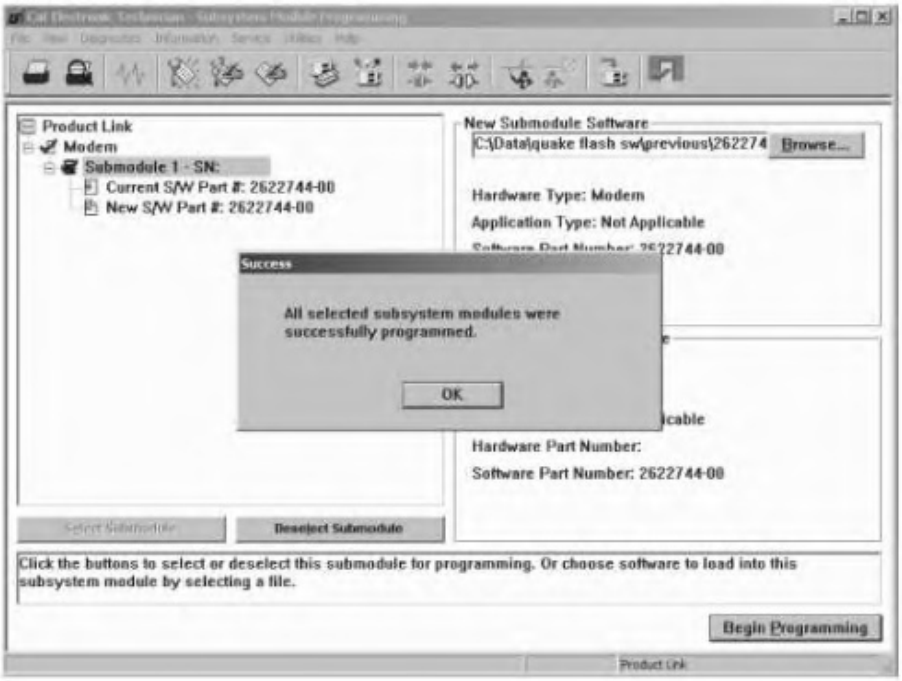


Illustration 16 g01134113

9. Click "OK" in order to acknowledge.

Flash the PL300 ECM

1. In order to flash the PL300 ECM in a PL321 system, select the ECM.

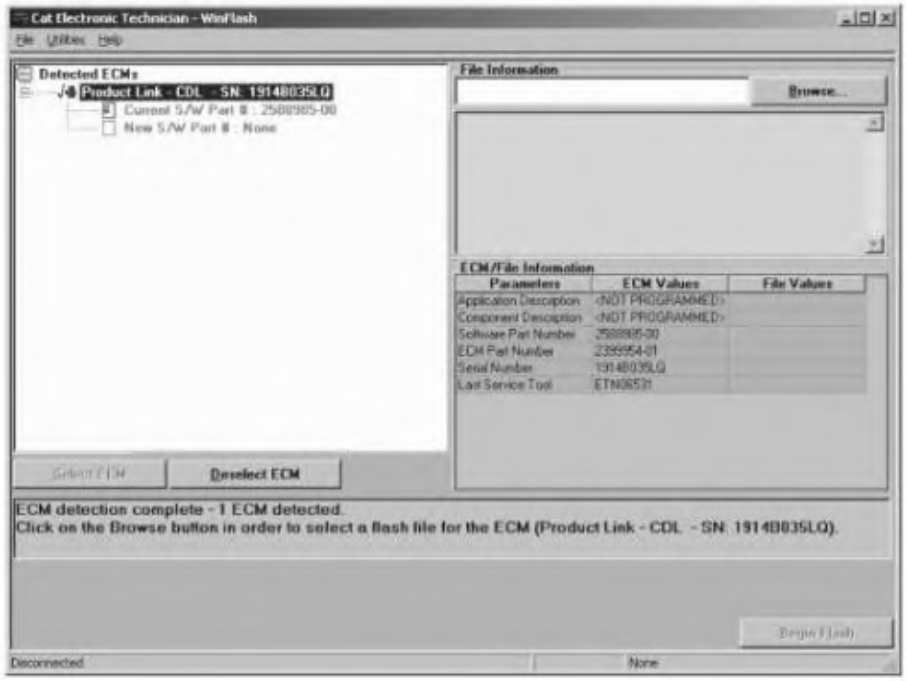


Illustration 17 g01134819

2. Select the file.

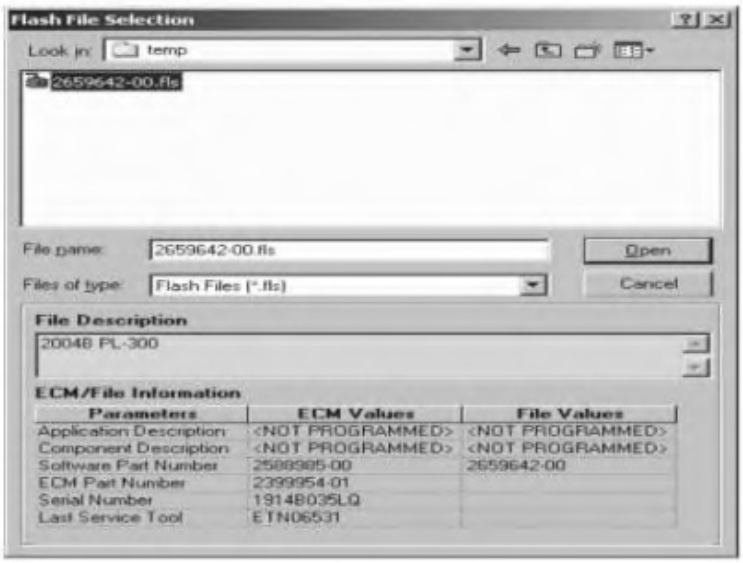


Illustration 18 g01134820

3. Click "Begin Flash"

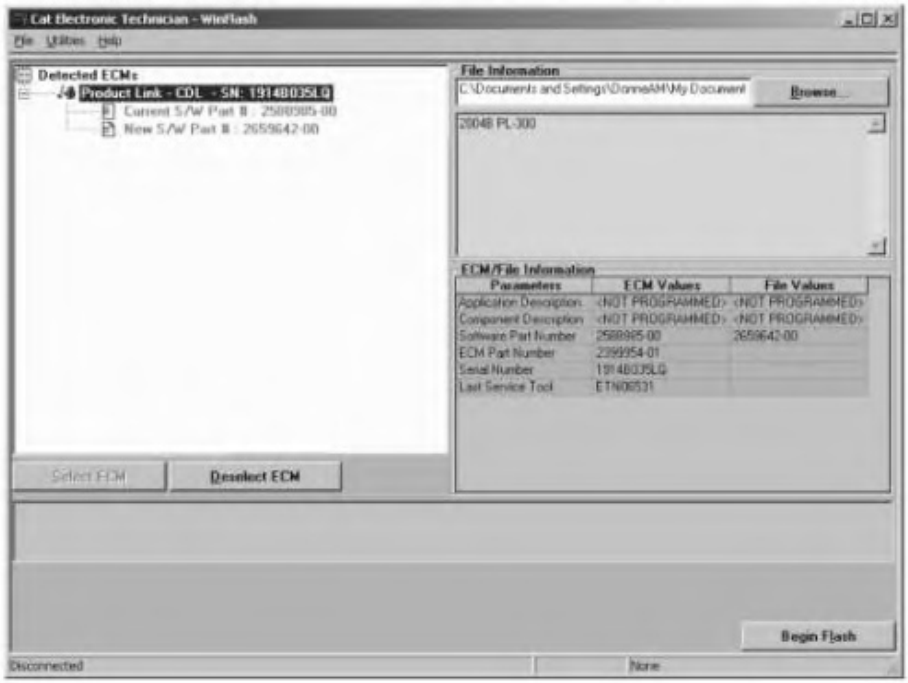


Illustration 19 g01134821

4. The following screen should appear while the program is being loaded.

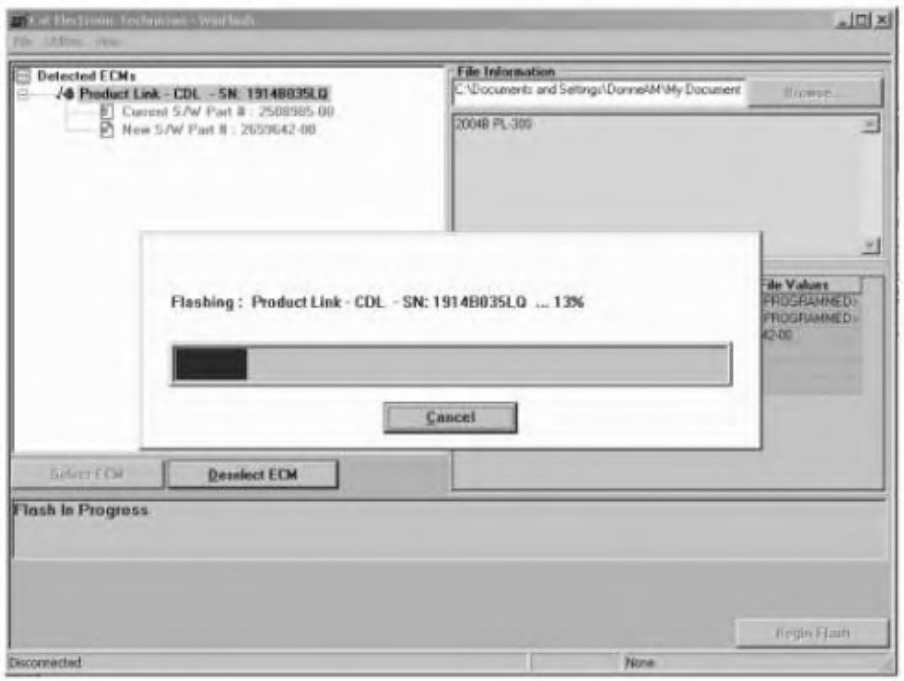


Illustration 20 g01134822

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i04905817

Electronic Control Module (ECM) - Replace

SMCS - 7610-510

Before Product Link is replaced, ensure that replacement is absolutely necessary. Product Link is seldom the cause of a fault. Always check that power is available to Product Link. Battery voltage is required between contacts 1 and 2 of the machine harness connector for Product Link. Continue ONLY if all other attempts to isolate the problem have failed. Always consult your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce the time that is required for a repair.

1. Turn the disconnect switch and the key start switch to the OFF position. Disconnect the machine harness from Product Link.
2. Remove Product Link.
3. Ensure that the replacement Product Link kit is the correct part number.
4. Install the replacement Product Link system according to the Special Instructions that are included in the installation kits.
5. Flash the software to the new module in order to ensure that the latest version of the software is on the system.

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i04905737

Electrical Connector - Inspect

SMCS - 7553-040-WW

ReferenceSpecial Instruction, SEHS9615, "Servicing DT Connectors".

ReferenceSpecial Instruction, REHS0148, "Listing Of Deutsch Connector Components"

ReferenceSpecial Instruction, SEHS9065, "Use Of CE Connector Tools".

ReferenceService Magazine, SEPD034227 January 97, "Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)".

ReferenceService Magazine, SEPD037128 July 97, "Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications".

ReferenceService Magazine, SEPD047324 May 99, "New DT Connector Plugs With Improved Seal Retention".

ReferenceService Magazine, SEPD054509 October 00, "Dielectric Grease Should Not Be Used In Electrical Connectors".

ReferencePocket Guide, SEBD0402, "Guidelines For Routing And Installing Wire Harness Assemblies".

Use this procedure under the following situation:

Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been corrected.

The following background information is related to this procedure:

Many of the operational procedures and the diagnostic code procedures in this troubleshooting guide will instruct you to check a specific electrical connector.

Intermittent electrical problems are often caused by poor connections. Always check for an active diagnostic code before breaking any connections. Also, always check for an active diagnostic code after the connector is reconnected in order to verify that the problem disappears.

Simply disconnecting the connectors and then reconnecting the connectors can temporarily solve a problem at times. If this occurs, likely causes are loose terminals, bent terminals, improperly crimped terminals, corrosion, or harness routing that is improper.

The original source of the problem must then be identified in order to ensure that the problem does not reoccur.

Follow this procedure to inspect the connectors thoroughly, in order to determine if the connectors are the cause of the problem.

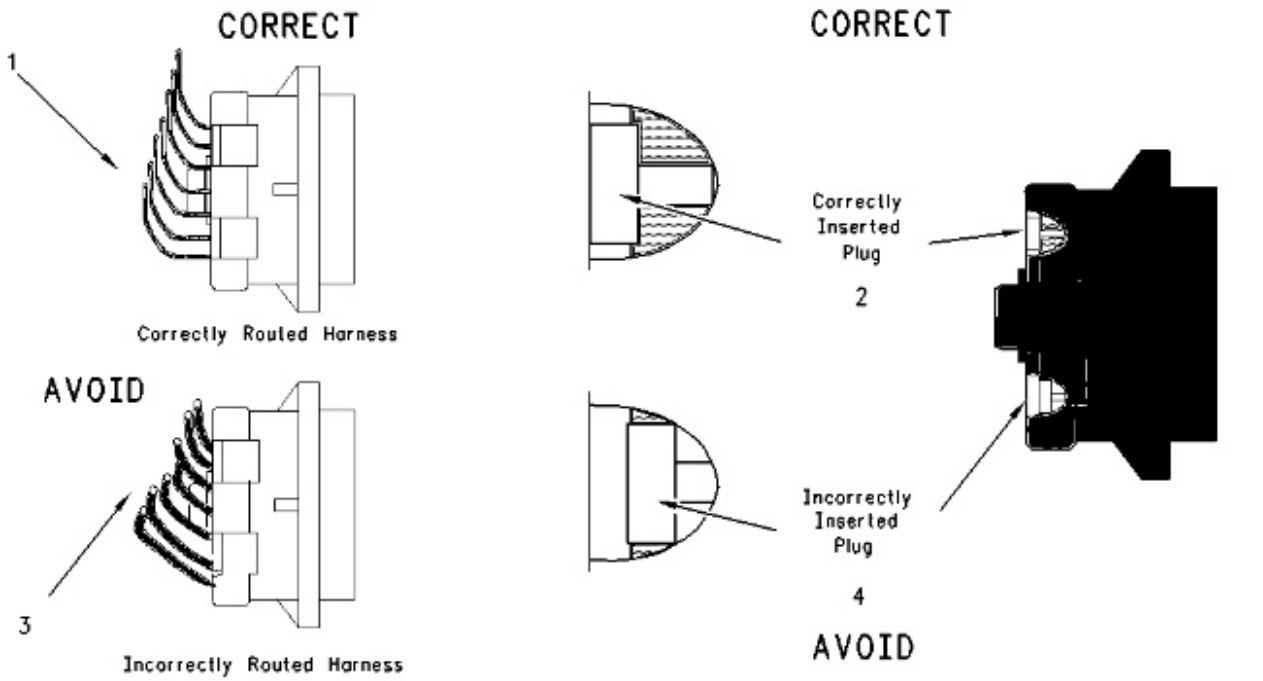


Illustration 1 g00820688

(1) Correctly Routed Harness

(2) Correctly Inserted Plug

(3) Incorrectly Routed Harness

(4) Incorrectly Inserted Plug

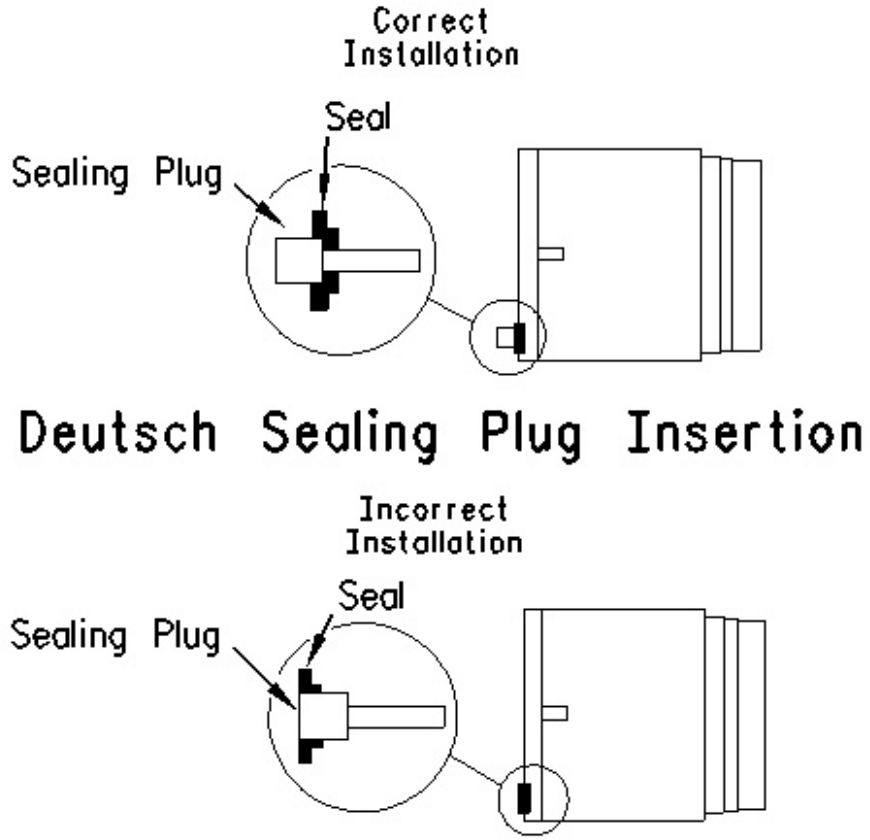


Illustration 2 g00690571

Proper Installation of Plug

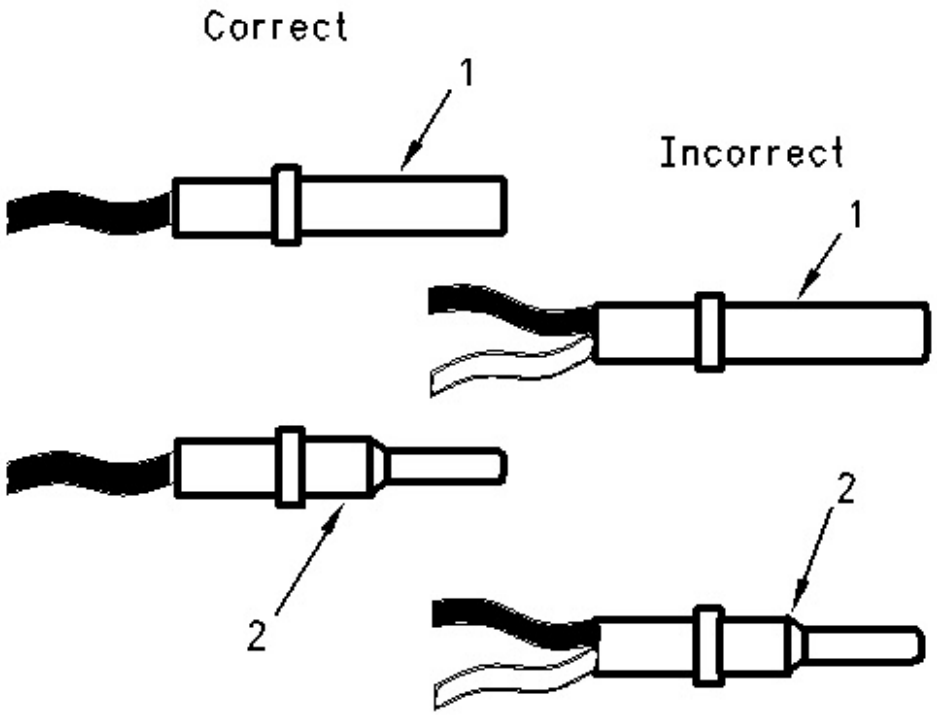


Illustration 3 g00828600

DT Type sealing plug

The 8T-8729 Connector Pin (2) and the 8T-8730 Connector Socket (1) is designed to accept only one 16/18 AWG wire. Do not insert multiple wires of a smaller wire size. An incorrect method would be using two 24 AWG wires. The 9W-0852 Connector Pin and the 9W-0844 Connector Socket are designed to accept only one 14 AWG wire. Do not insert multiple wires of a smaller wire size. An example of an incorrect method is the use of two 20 AWG wires.

1. **CHECK THE CONNECTORS.**

   a. Ensure that the connector is properly locked. Also, ensure that the two halves of the connector cannot be pulled apart.

   b. Verify that the latch tab of the connector is properly latched. Verify that the latch tab of the connector is fully latched.

      Expected Result: The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

      Results:

      OK - The connector will securely lock. The connector and the locking mechanism are without cracks or breaks. Proceed to test step 2.

      NOT OK - A problem exists with the connector.

      Repair: Repair the connector or replace the connector, as required.

      STOP.

2. **CHECK THE ALLEN HEAD SCREW ON THE HARNESS CONNECTOR OF THE ECM.**

   a. Ensure that the connector bolt is properly tightened. Be careful not to tighten the bolt too much. The bolt may break.

   b. Do not exceed 6.0 N·m (53.0 lb in) of torque on the connector bolt of the harness when the connector is being installed on the ECM.

      Expected Result: The harness connector is secure and the connector bolt of the ECM is properly torqued.

      Results:

      OK - The harness connector is secure and the connector is properly torqued. Proceed to test step 3.

      NOT OK - A problem exists with the connector.

      Repair: Secure the harness connector of the ECM. Ensure that the connector bolt is properly torqued.

      STOP.

3. **PERFORM A PULL TEST ON EACH CONNECTOR CONTACT.**

   a. Each connector contact should withstand 45 N (10 lb) of pull. Each wire should remain in the connector body. This test checks whether the wire was properly crimped in the contact and whether the contact was properly inserted into the connector.

   b. The DT connectors use an orange wedge to lock the terminals in place.

   c. Check in order to ensure that the orange wedge is not missing and that the orange wedge is installed properly on the DT connectors.

      Note: A Crimp Tool should ALWAYS be used in order to crimp wires on connector contacts. Do not solder the terminals. Use the proper Crimp Tool.

      Expected Result: Each connector contact should withstand 45 N (10 lb) of pull. Each wire remains in the connector body.

      Results:

      OK - Each connector contact withstands 45 N (10 lb) of pull. Each wire remains in the connector body. Proceed to test step 4.

      NOT OK - A problem exists with the connector.

      Repair: Repair the wiring or replace the connector contact.

      STOP.

4. **CHECK THE WIRES FOR NICKS OR ABRASIONS IN THE INSULATION.**

   a. Carefully inspect each wire for signs of abrasion, nicks, or cuts.

      The following areas are locations that should be checked:

- Exposed insulation
- Points of rubbing wire

b. Check all of the hold down clamps for the harness in order to verify that the harness is properly clamped. Also check all of the hold down clamps for the harness in order to verify that the harness is not compressed by the clamp. Pull back the harness sleeves in order to check for a flattened portion of wire. The flattened portion of wire is caused by the clamp that holds the harness.

Expected Result: The wires are free of abrasion, nicks, or cuts and the harness is properly clamped.

Results:

OK - The wires are free of abrasion, nicks, or cuts and the harness is properly clamped. Proceed to test step 5.

NOT OK - A problem exists with the wiring.

Repair: Repair the wires or replace the wires, as required.

STOP.

5. **CHECK THE CONNECTORS FOR MOISTURE OR CORROSION.**

a. Ensure that the connector seals and the white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal or plug. If necessary, replace the connector.

b. Check all of the wiring harnesses in order to verify that the harness does not make a sharp bend out of a connector. A sharp bend will deform the connector seal and will create a path for the entrance of moisture. See Illustration 1.

Note: It is normal to see some minor seal abrasion on the ECM connector seals. Minor seal abrasion will not allow the entry of moisture.

c. Thoroughly inspect ECM connectors for evidence of moisture entry. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will reoccur. Simply drying the connector will not fix the problem. Likely paths for the entrance of moisture are from missing seals, improperly installed seals, nicks in exposed insulation, and improperly mated connectors.

Note: Moisture can also travel from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector.

Note: If corrosion is evident on the contacts or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. Do not use cleaners that contain trichloroethylene because trichloroethylene may damage the connector.

Expected Result: All of the connectors should be coupled completely and all of the seals should be inserted completely. The harness and the wiring should be free of corrosion, moisture, abrasion, or pinch points.

Results:

OK - All of the connectors are coupled completely and all of the seals are inserted completely. The harness and the wiring are free of corrosion, moisture, abrasions, or pinch points. Proceed to test step 6.

NOT OK - A problem exists with the connector, the wiring, or the wiring harness. Moisture is present.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are coupled completely. Verify that the repair eliminates the problem by operating the machine for several minutes and by checking again for moisture.

STOP.

6. **INSPECT THE CONNECTOR CONTACTS.**

   a. Verify that the contacts are not damaged. Verify that the contacts are properly aligned in the connector and verify that the contacts are properly located in the connector.

   Expected Result: The contacts are properly aligned and the contacts appear undamaged.

   Results:

   OK - The contacts are properly aligned and the contacts appear undamaged. Proceed to test step 7.

   NOT OK - A problem exists with the connector contacts.

   Repair: Repair the contacts and wiring and/or replace the contacts and wiring.

   STOP.

7. **CHECK THE FIT OF THE CONTACTS.**

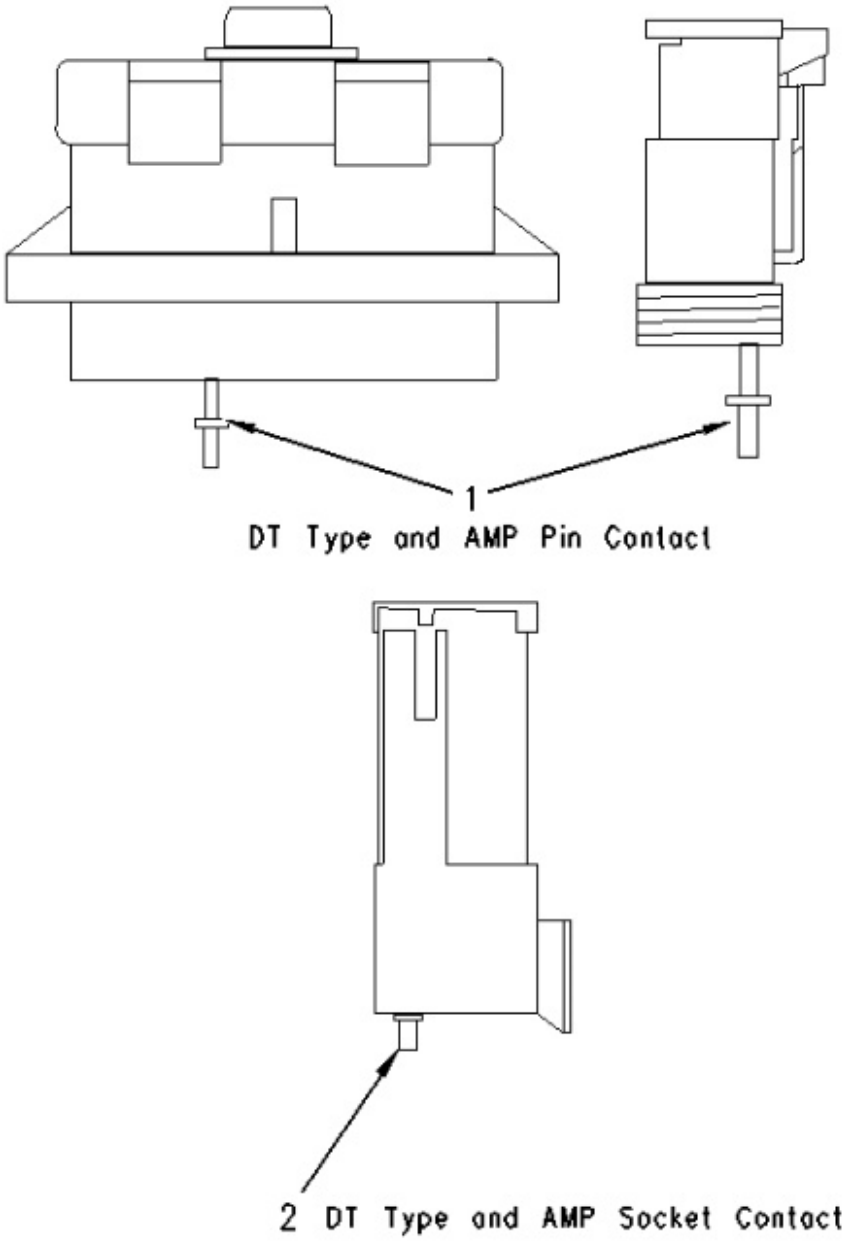


Illustration 4 g00838765

Retention of the Connector

(1) Pin Contact

(2) Socket Contact

Note: This is especially important for intermittent problems.

a. Use a new pin contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact by the socket contact.

b. Use a new socket contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact by the socket contact. The pin contact is located on the mating side of the connector.

c. The connector contact should stay connected when the connector is held in the position shown in Illustration 4. The connector contact is the pin contact or the socket contact.

Expected Result: The pin contacts and the socket contacts appear to be OK.

Results:

OK - The pin contacts and the socket contacts appear to be OK. **STOP.**

NOT OK - A problem exists with the connector terminal.

Repair: Replace the connector contact.

STOP.

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Testing and Adjusting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905743

Wiring Harness (Open Circuit) - Test

SMCS - 1408-081

An open is a failure of an electrical circuit that results in no flow of electrical current. An open circuit is usually caused by failed electrical wires or a poor connection of electrical connectors. If an electrical wire or a connection is broken, the flow of electrical current through the circuit is interrupted. A normally closed circuit will have less than 5 ohms of resistance. The following procedure explains the test for an open circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR AN OPEN CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.

5. At the other connector of the machine harness, use the multimeter probes to measure the resistance from the contact of the suspect wire to frame ground.

   Expected Result: The resistance is less than 5 ohms.

   OK - The resistance is less than 5 ohms. The harness circuit is correct.

   Stop.

   NOT OK - The resistance is greater than 5000 ohms. There is an open in the machine harness.

   Repair: Repair the machine harness or replace the machine harness.

   Stop.

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Testing and Adjusting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905744

Wiring Harness (Short Circuit) - Test

SMCS - 1408-081

A short circuit is a failure of an electrical circuit that results in undesired electrical current. Usually, a short circuit is a bypass of the circuit across a load. For example, a short across the wires in a circuit for a lamp produces too much current in the wires but no current is felt at the lamp. The lamp is shorted out. The resistance in a normal circuit can vary, but the resistance between a particular circuit and other unrelated circuits is always greater than 5000 ohms. The following procedure explains the test for a short circuit:

ReferenceFor a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR A SHORT CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At the machine harness connector for the ECM, place one of the multimeter probes on the contact of the suspect wire.

5. Use the other multimeter probe to check the resistance across all other contacts in the connector(s) of the ECM and frame ground.

   Expected Result: The resistance is greater than 5000 ohms for all the measurements.

   OK - The resistance is greater than 5000 ohms for all the measurements. The harness circuits are correct.

   Stop.

   NOT OK - The resistance is less than 5 ohms. There is a short in the machine harness. The short is between the suspected wire and the wire with the lowest resistance measurement.

   Repair: Repair the machine harness or replace the machine harness.

Stop.

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i04905818

Specifications

SMCS - 7606

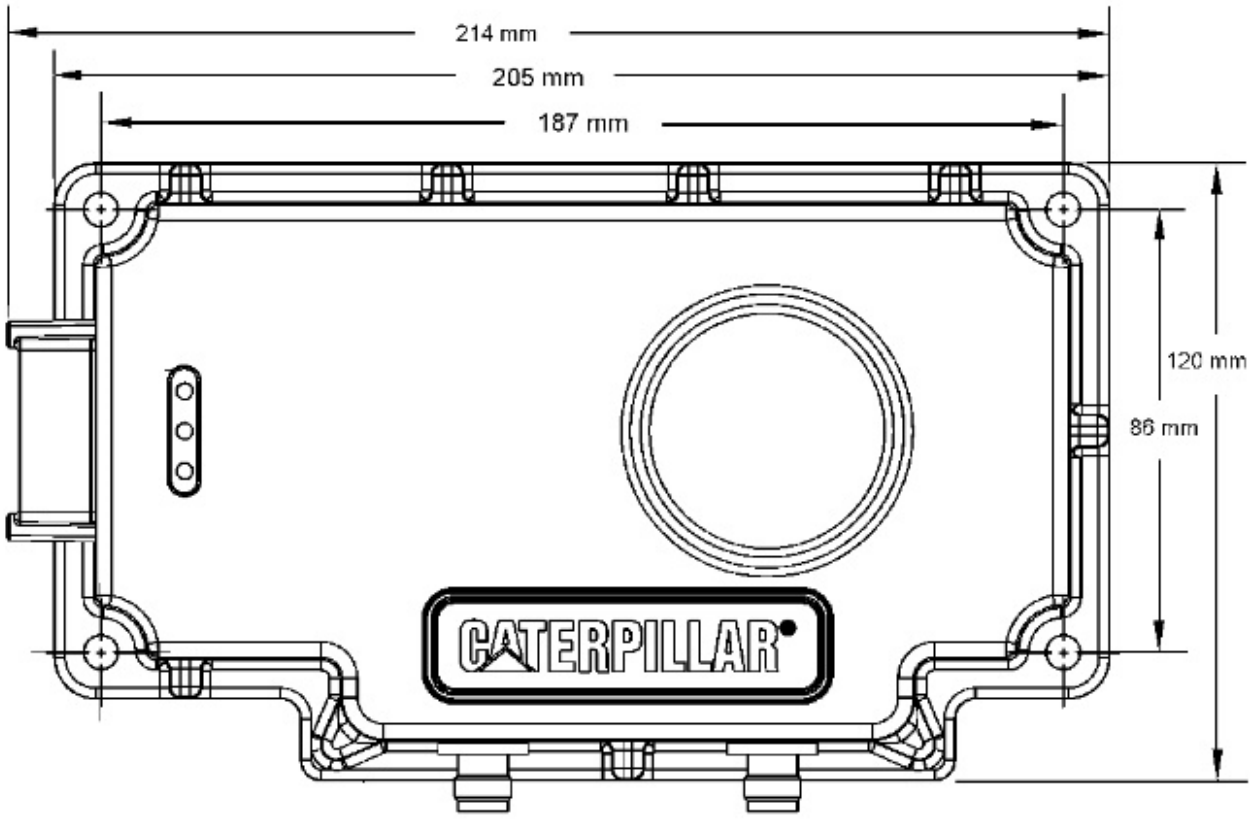


Illustration 1 g01130001

PL121SR Radio

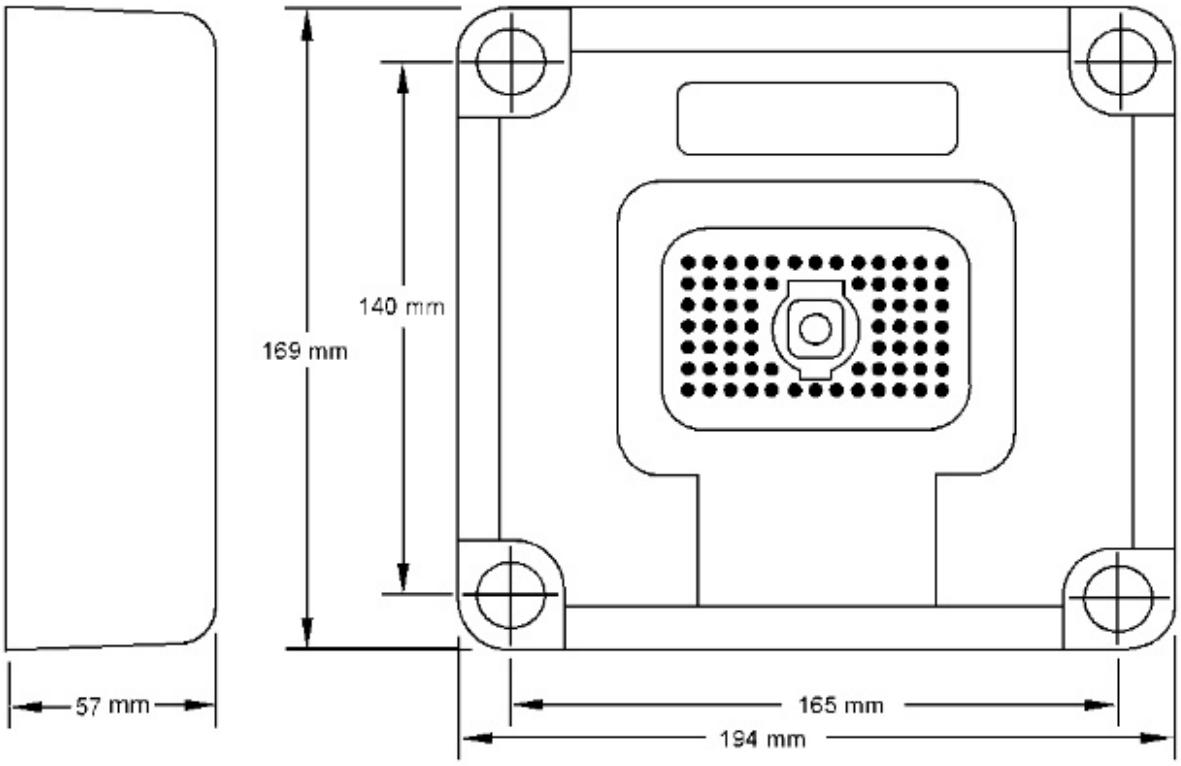


Illustration 2 g01103287

PL300 ECM

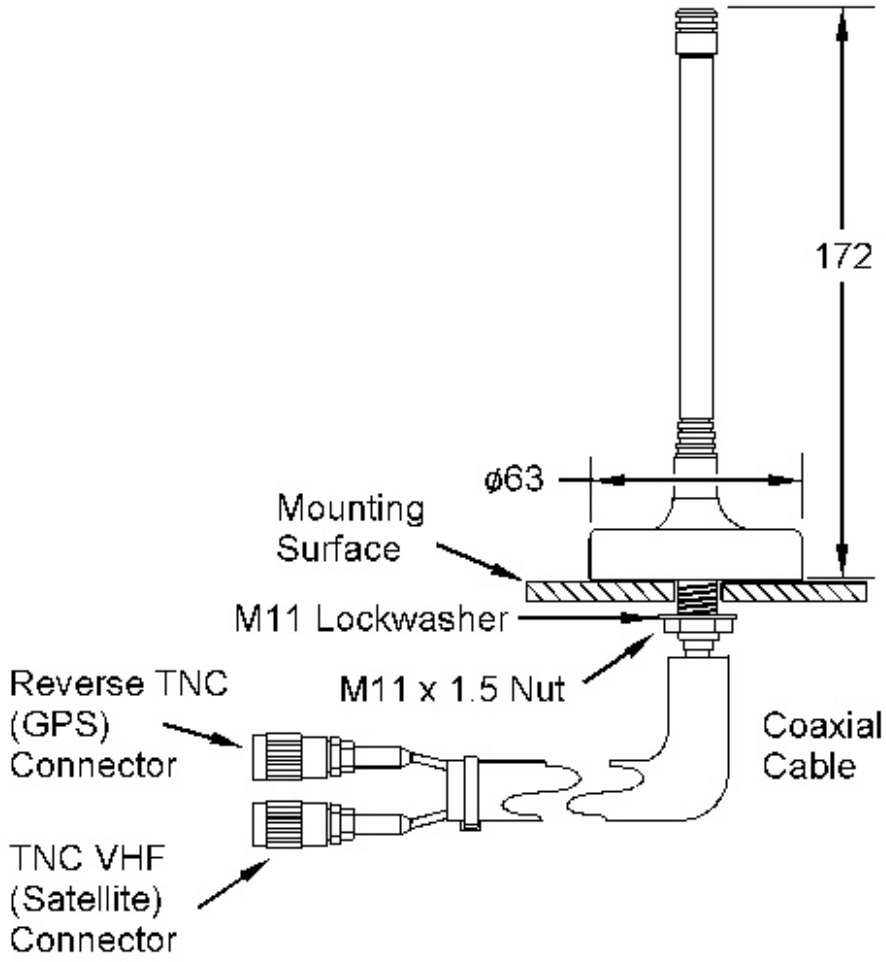


Illustration 3 g01130025

"Hard Mount" Antenna

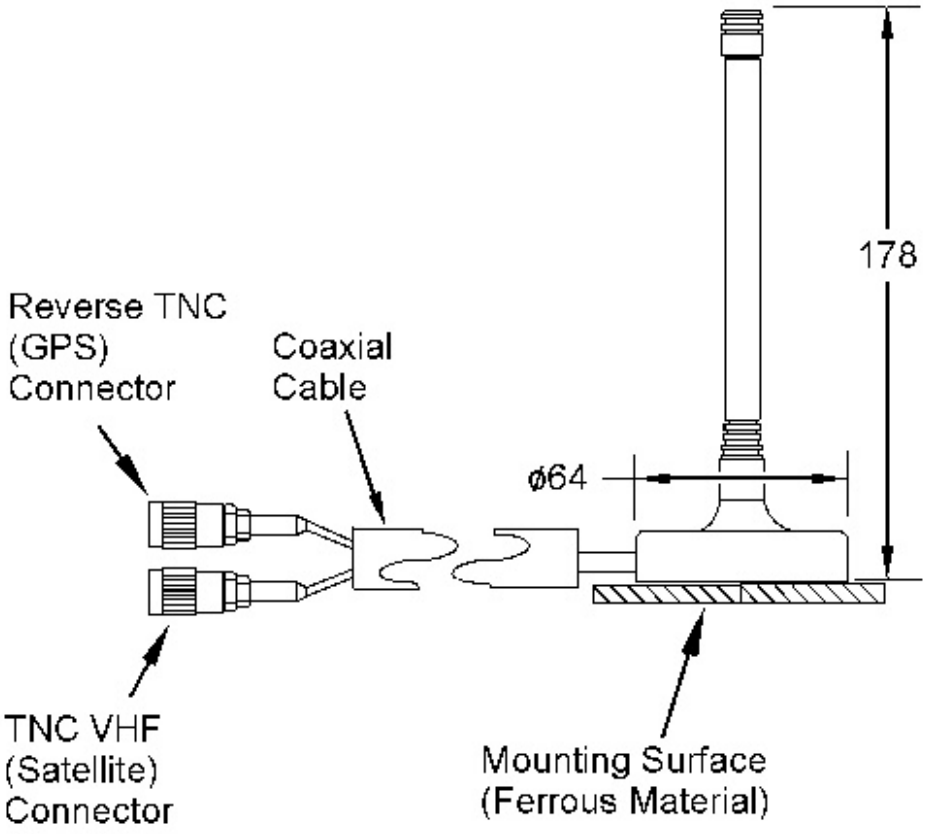


Illustration 4 g01130028

"Magnetic Mount" Antenna

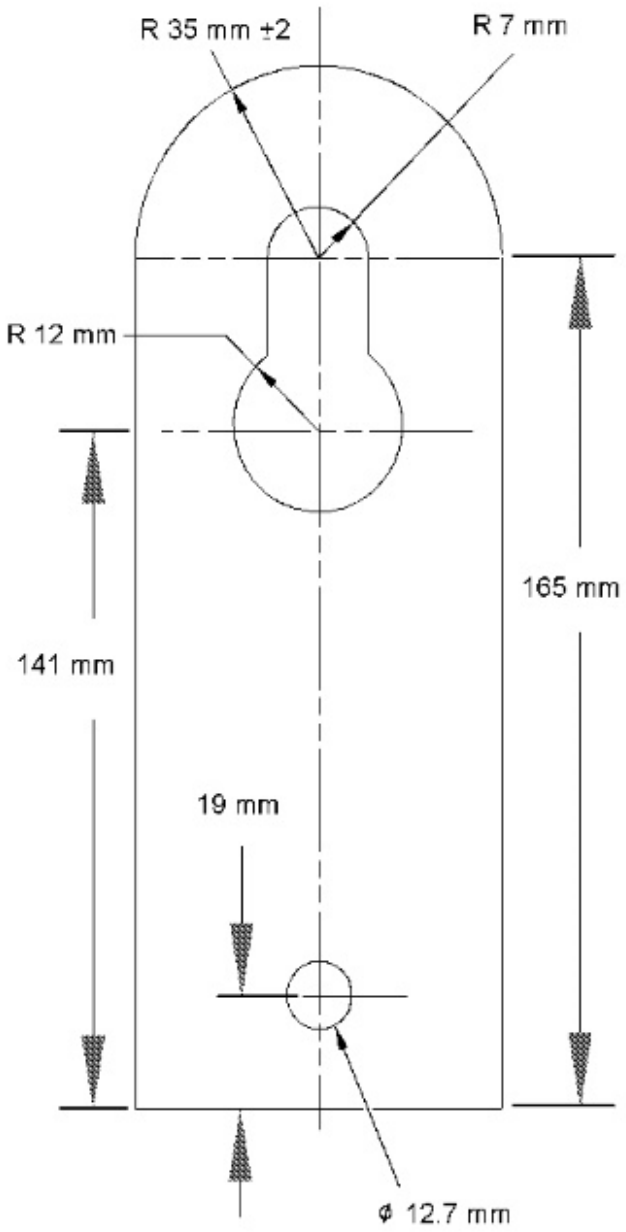


Illustration 5 g01130030

Optional Bracket for the Antenna

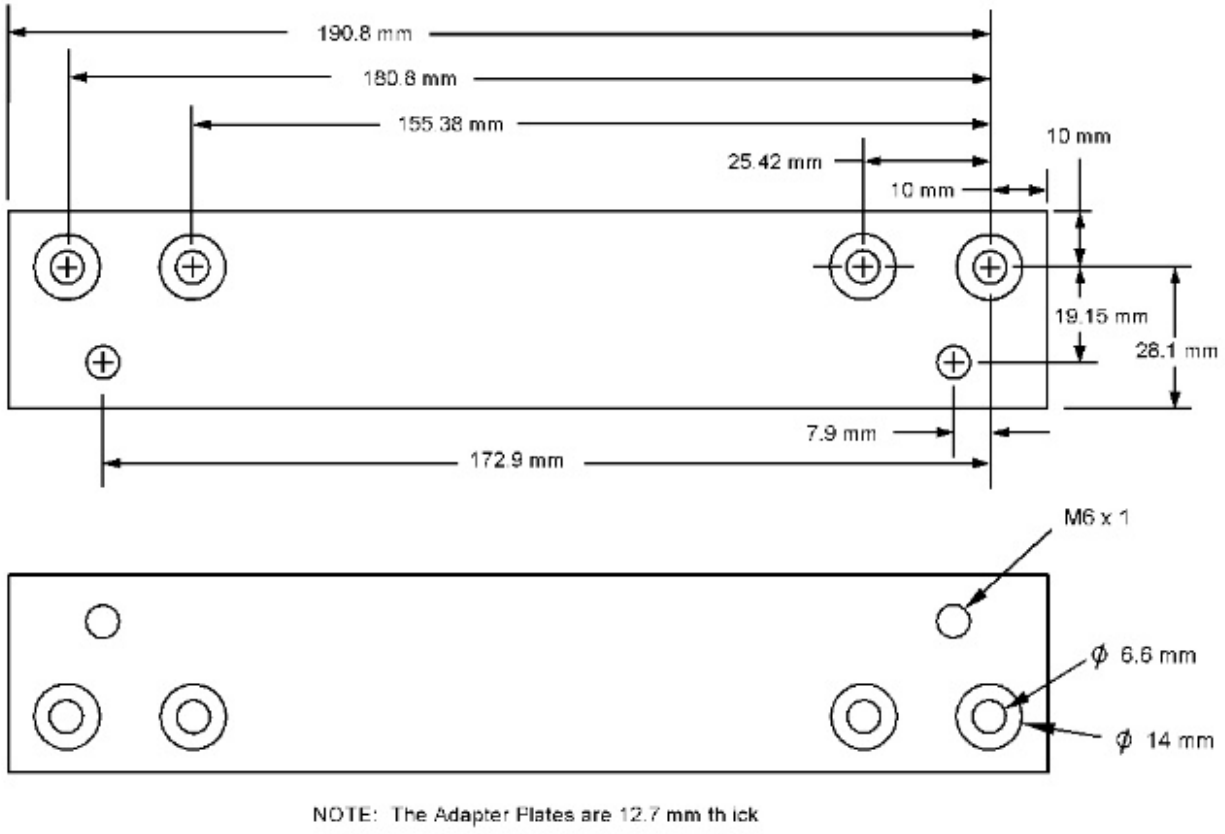


Illustration 6 g01130129

PL300 Adapter Plates for the ECM

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995791

General Information

SMCS - 6700-EK2

There are no diagnostic indicators for the auxiliary hydraulic electronic control module (ECM). When there is a problem with the system there will be some operational symptom that will be present. The Caterpillar® ET must be used in order to retrieve any diagnostic information.

Troubleshooting the ECM may require additional information from the machine Service Manual. The following items may be required.

- Electrical System Schematic
- Parts Manual
- Operation and Maintenance Manual

As a guide, a simplified system schematic is at the end of this manual. For a complete electrical system schematic, see the Electrical System Schematic, RENR6419.

When the troubleshooting procedure instructs you to REPAIR THE HARNESS, use the Electrical System Schematic in the machine Service Manual in order to trace the circuit. Perform continuity checks at the connectors in order to locate harness failures. At component connectors, always check the ground circuit. Less than five ohms of resistance is required between the connector ground contacts and frame ground. Resistance that is greater than five ohms can cause an incorrect diagnosis of problems.

During troubleshooting, inspect all component and harness connections before any component is replaced. If these connections are not clean and tight the connections can cause electrical problems. The problems may be permanent or intermittent. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before any other tests are made.

Repairs of the machine harness should be performed with the wire of the same size. All joints should be soldered. All joints should be tightly taped or all joints should be covered with shrink sleeving. Use **1P-0810** Electrical Tape .

Failure of an electrical component can cause the failure of one or more components. Always attempt to find the cause of a problem and correct the problem before replacing a component.

Use the single screw in the center of the harness in order to remove the harness from the ECM.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01514961

Service Tools

SMCS - 0785

The following service tools should be used to aid in troubleshooting the electrical system.

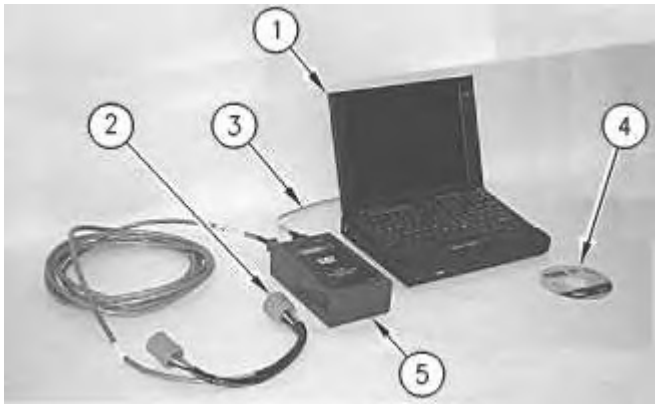


Illustration 1 g00280782

Connections for the Electronic Technician (ET)

Table 1

Service Tools	
Part Number	**Part**
NEXG 4523 or	(1) Use the IBM-Compatible Computer with the (4) Caterpillar Electronic Technician (ET) Software
139-4166 or 7X-1570	(2) Data Link Cable

7X-1425 or 4C-6805	(3) Adapter
7X-1700	(5) Communication Adapter Tool
6V-7070 or 9U-7330 or 146-4080	Digital Multimeter
7X-1710	Multimeter Probe Group
8T-8726	(Cable Assembly)
6V-3000	Connector Repair Kit (Sure Seal)
9U-7246	Connector Repair Kit (Deutsch DT Type)
4C-3406	Connector Repair Kit (Deutsch)

In order to use the CAT® ET, order the following literature:

- Special Publication, JERD2124, "ET Single Use Program License"
- Special Publication, JEHP1026, "Information and Requirements Sheet"
- Special Publication, JERD2129, "ET Engine and Machine Data Subscript"
- Special Publication, JEBD3003, "ET Software - Getting Started Book"
- Special Publication, JERD2142, "Data Subscription"
- Special Publication, JEHP1026, "Information and Requirements Sheet"

See Testing And Adjusting, "Using Caterpillar Electronic Technician" for more information on the ET.

Use the digital multimeter for making continuity checks or for measuring voltage. For instructions about the use of the **6V-7070** Digital Multimeter, see Special Instruction, SEHS7734. The **7X-1710** Probe Cable Group is used to measuring voltage at the connectors without needing to disconnect the connectors. The probe cables are pushed into the back of the connector along the wire. The **8T-8726** Adapter Cable has a 3 pin breakout. The adapter cable is used for measurements in the sensor circuits.

Note: Except for harness tests, using continuity testers such as the **8T-0500** Continuity Tester or voltage testers such as the **5P-7277** Voltage Tester is not recommended for today's Caterpillar electrical circuits.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01402195

Electrical Component and Connector Locations

SMCS - 1408-546-CY; 7553-546

The auxiliary hydraulic ECM is located under the floor panel. Access is gained by removing the floor panel.

The Electrical System Schematic, Parts Manual and the Operation and Maintenance Manual are needed in order to locate the electrical components and connectors.

The following information is a guide for reading the Harness Connector and Component Location charts that are found on the back of the Electrical System Schematic.

The harness connector and the component location charts use white circles as location labels in the views of the machine. Numbers in the machine location columns of the charts represent the numbers in the white circles. The white circles are placed on a top view and a side view of the machine. The location of the white circles is representing the location of the connectors or the components. Connectors that are attached directly to components are not located separately from the component.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01696137

Diagnostic Capabilities

SMCS - 6700-EK2

The Caterpillar Electronic Technician (ET)



Illustration 1 g00777826

The Caterpillar Electronic Technician (ET) is a software program that is used to access data. The service technician can use the ET in order to perform maintenance on the machine. Some of the options that are available with the Caterpillar Electronic Technician are listed below:

- View diagnostic codes. See Troubleshooting, "Using the Caterpillar Electronic Technician to Determine Diagnostic Codes".

- Viewing active event codes and logged event codes
- View the status of parameters.
- Clear active diagnostic codes and clear logged diagnostic codes
- Perform calibration of machine systems.
- Program the ECM (Flash). This is done with the "WINflash" program. See Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program".
- Print reports.

The following list contains some of the diagnostic functions and programming functions that are performed by the service tools.

- The failures of the ECM system are displayed.
- The status of most of the inputs and the outputs are displayed.
- The settings for the ECM are displayed.
- Display the status of the input and output parameters in real time.
- Display the clock hour of the internal diagnostic clock.
- The number of occurrences and the clock hour of the first occurrence and the last occurrence is displayed for each logged diagnostic code.
- The definition for each logged diagnostic code and each event is displayed.
- Load new FLASH software.

See Troubleshooting, "Diagnostic Code List" for the list of diagnostic codes for the ECM.

- Active diagnostic codes
- Logged diagnostic codes

Event Codes

Logged Event Codes

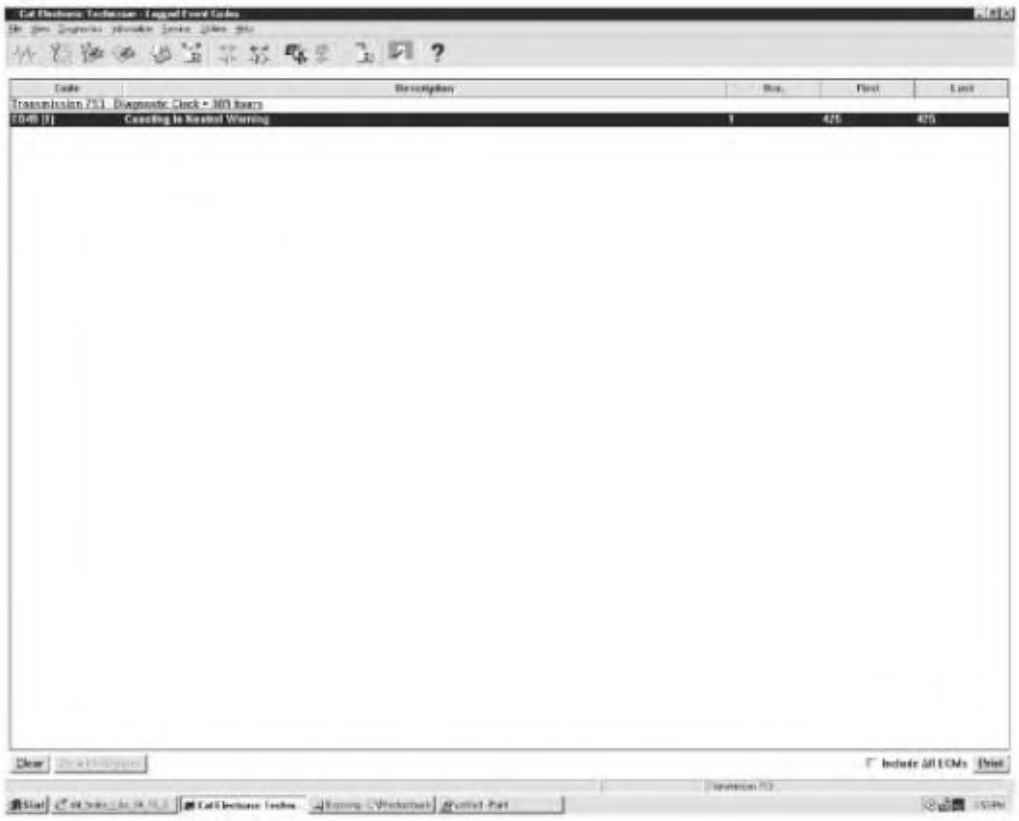


Illustration 2 g00803746

An indicator for logged events is provided. The indicator allows the service technician to keep track of event codes that are intermittent. The data for the logged event will include the following information:

- An event identifier (EID)
- A text description of the problem
- The number of occurrences of the problem
- A time stamp will display the first occurrence of the problem.
- A time stamp will display the last occurrence of the problem.

Status Groups For The Electronic Technician

The Status groups are lists of machine parameters. The status of the parameters are shown in real time.

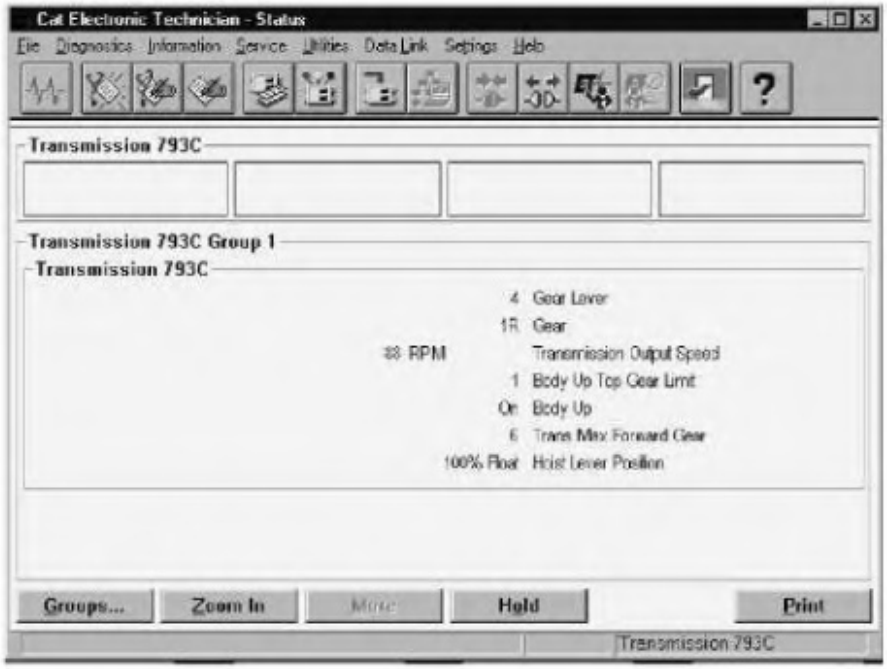


Illustration 3 g00496395

Typical ET Status Screen

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Troubleshooting

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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03938629

Diagnostic Code List

SMCS - 7569

Diagnostic Codes Table

Table 1

Service Codes For The Auxiliary Hydraulic ECM [1]	
When troubleshooting diagnostic codes is necessary, see the procedure with the same diagnostic code.	
CID-FMI	**Description**
CID 0070 Switch (Parking Brake)	
FMI 04	Voltage below normal
CID 0168 Electrical System Voltage	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 598 Solenoid Valve (Two Speed)	
FMI 03	Voltage above normal
FMI 05	Current below normal
CID 1180 Modulating Valve (Auxiliary Hydraulics)(A1)	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 1181 Modulating Valve (Auxiliary Hydraulics)(A2)	

FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 1184 Solenoid Supply (Auxiliary Hydraulics)	
FMI 03	Voltage above normal
FMI 06	Current above normal
CID 1187 Switch (Continuous Flow)	
FMI 04	Voltage below normal
CID 1188 Switch (Interlock Override)	
FMI 04	Voltage below normal
CID 1189 Switch (Auxiliary) or Position Sensor (Auxiliary)	
FMI 00	Data above normal operating range (2)
FMI 01	Data below normal operating range (2)
FMI 04	Voltage below normal (3)
FMI 08	Abnormal frequency, pulse width, or period (2)
CID 1190 Switches (Armrest/Seat switch)	
FMI 04	Voltage below normal
CID 1694 Solenoid Supply (Two Speed)	
FMI 03	Voltage above normal
FMI 06	Current above normal
CID 1695 Switches (Two Speed)	
FMI 04	Voltage below normal
CID 1931 Solenoid (Auxiliary Circuit Flow)	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 1935 Switch (Auxiliary Hydraulic Mode Select)	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 1940 Solenoid (Auxiliary Hydraulic Boost Flow Diverter)	
FMI 03	Voltage above normal

FMI 06	Current above normal
CID 1939 Solenoid (Auxiliary Hydraulic Boost Flow Supply)	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 1942 Pressure Switch (Tool Detection)	
FMI 04	Voltage below normal

(1) For the Auxiliary Hydraulic ECM, the MID is No. 106. This table pertains only to faults with a MID of No. 106.

(2) Position sensor only

(3) Switches only

Note: This table shows the service codes for the auxiliary hydraulic ECM only. The service codes for the ECM are shown on the display area of the Caterpillar® ET. The information of the service code for the ECM is transferred via the CAT® Data Link to the Caterpillar® ET. The module identifier (MID) tells the service person the ECM that is sending the service code. The MID for the auxiliary hydraulic ECM is No. 106. This Service Manual is used only for service codes with a MID of 106.

Detailed FMI Explanations

The FMI information for the auxiliary hydraulic ECM is explained in the following list.

FMI 00 - Operating Range Is Above Normal. Every electronic control system sets a high limit for the expected operating range of the signal. The limit includes signals that are above the expected range. A sensor that is still working but sending a signal above the expected limit will cause an FMI 00 to be stored.

Some possible causes of FMI 00 are listed here:

- Signal above normal (High pressure or high temperature)
- Calibration is needed. FMI 13 is the preferred code.

For example, a certain PWM sensor is expected to generate a valid signal over 80 percent duty cycle. If the sensor generates a signal of 81 percent duty cycle, the sensor is still working but the signal is above the expected signal limits.

FMI 01 - Operating Range Is Below Normal. Every electronic control system sets a low limit for the expected operating range of the signal. The limit includes signals that are under the expected range. A low engine oil pressure signal from a working sensor could produce this FMI. A sensor that is still working but sending a signal below the expected limit will cause an FMI 01 to be stored.

Some possible causes of FMI 01 are listed here:

- The signal is below normal. (The voltage, pressure, or temperature is low.)
- Timing is retarded.

For example, a certain PWM sensor is not expected to generate a PWM signal below 5 percent duty cycle even with zero air pressure. If the sensor generates a signal of 4 percent duty cycle with the engine shutdown, the sensor is still working but the signal is below the expected signal limits.

FMI 02 - Data Is Erratic, Intermittent Or Incorrect. Signal data that is received from a component is valid. The data that is received from the component has become intermittent or erratic. Data can be correct sometimes and the data may be incorrect at other times. The communication that occurs between electronic controls also relates to this condition.

Some possible causes of FMI 02 are listed here:

- Loose connections in switches, harness, etc.
- Intermittent/erratic signal
- Programmed data has changed.
- Noisy signal
- The signal is out of the expected range. FMI 00 or FMI 01 is the preferred code.
- A failed power or ground connection to the ECM
- Failed ECM

FMI 03 - "Voltage Above Normal Or Shorted High". The voltage that is received from a component is higher than the expected value that is identified by the CID. FMI 03 most often relates to a signal circuit.

Some possible components that can cause an FMI 03 are listed here:

- The sensor (switch)
- The harness
- The related electronic control

FMI 03 - "Voltage Above Normal Or Shorted High". The voltage that is received from a component is higher than the expected value that is identified by the CID. FMI 03 most often relates to a signal circuit.

Some possible components that can cause an FMI 03 are listed here:

- The sensor (switch)
- The harness
- The related electronic control

Some possible causes of an FMI 03 are listed here:

- A sensor output that is not related to the duty cycle is stuck at the maximum output of the sensor.

- A harness that has the sensor signal wire shorted to any voltage that is greater than the voltage of the sensor power supply.
- A sensor signal wire is open in the machine harness between the sensor and the control. When a sensor has been disconnected from an electronic control, the input circuit voltage is normally pulled up to a positive level.
- A sensor signal contact of a failed control that is internally shorted to a positive voltage source
- A failed control believes that a failure exists in a circuit that is working correctly. This is unlikely.

FMI 04 - "Voltage Below Normal Or Shorted Low". The voltage that is received from a component is lower than the expected value that is identified by the CID. FMI 04 most often relates to a signal circuit. FMI 04 is very similar to FMI 06. FMI 04 is sometimes used in the place of FMI 06.

Some possible causes of FMI 04 are listed here:

- The sensor
- The harness
- The related electronic control

Some possible cause of FMI 04 are listed here:

- A sensor output that is not related to the duty cycle is stuck at the minimum output of the sensor.
- The signal wire is shorted to ground in the harness.
- Electronic control has an internal short to ground on the connector contact of the signal input.

FMI 05 - "Current Below Normal Or Open Circuit". The current of the monitored circuit is below normal. This usually results from an open circuit. FMI 05 is generally related to an output of a driver circuit.

Some possible causes of FMI 05 are listed here:

- Open circuit or poor harness connection
- High resistance circuit in a component (relay coil)
- Component in the open position (switch)

FMI 06 - "Current Above Normal Or Grounded Circuit". The current of the monitored circuit is above normal. This code is most commonly caused by a circuit that is shorted to ground. This is very similar to an FMI 04. FMI 06 is sometimes used in the place of FMI 04. FMI 06 is generally related to an output of a driver circuit.

Some possible causes of FMI 06 are listed here:

- A short to ground in the harness
- Low resistance (failure) in component coil (relay)
- Electronic control has an internal short to ground on the connector contact of signal input.

FMI 08 - The Frequency, The Pulse Width Or The Period Is Abnormal. The frequency of the signal or the width of a given signal pulse is not in the expected range. This code can also relate to a failed output circuit of a sensor or an open output circuit of a sensor.

Note: The period is the time in seconds for one cycle at a given frequency.

Some possible causes of FMI 08 are listed here:

- Intermittent connection of a signal circuit
- Misfire.
- Noisy signals that are caused by a nearby radio or magnetic field

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233065

MID 106 - CID 0168 - FMI 03

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the system voltage is greater than 20 VDC. The FMI 03 means that the ECM determined that the voltage is above normal.

Test Step 1. CHECK FOR DIAGNOSTIC CODE

A. Turn the key start switch to the OFF position.

B. Occupy the seat.

C. Place the armrest in the DOWN position.

D. Start the engine.

E. Run the engine at high idle for several minutes.

F. Check the Caterpillar ET for the active diagnostic code of CID 0168 FMI 03.

Expected Result:

The diagnostic code of CID 0168 FMI 03 should not be active.

Results:

- **OK -** The diagnostic code of CID 0168 FMI 03 is not active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The diagnostic code of CID 0168 FMI 03 is active. Proceed to Test Step 2.

Test Step 2. CHECK THE SYSTEM VOLTAGE

Note: The following steps are performed with the engine at high idle.

A. Check the system voltage that is displayed on the Caterpillar ET.

B. Measure the voltage at the battery posts.

Expected Result:

The voltage readings should be less than 20 VDC.

Results:

- **OK -** The voltage readings are less than 20 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The voltage readings are greater than 20 VDC.

  Repair: The charging system is charging at an excessive voltage. Check the charging system. See Service Manual, REHS0354, "Starting System Troubleshooting".

  Stop.

- **NOT OK -** Voltage readings above 20 VDC are displayed on the ET. Proceed to Test Step 3.

Test Step 3. CHECK THE VOLTAGE AT THE ECM

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the auxiliary hydraulic ECM.

C. Disconnect the wire harness from the ECM.

D. Start the engine and run the engine at high idle.

E. Measure the voltage from contact 1 to contact 3 of the wire harness connector.

Expected Result:

The voltage should be less than 20 VDC.

Results:

- **OK -** The voltage is less than 20 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine

configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The voltage is greater than 20 VDC.

  Repair: The charging system is charging at an excessive voltage. Check the charging system. See Service Manual, REHS0354, "Starting System Troubleshooting".

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233069

MID 106 - CID 0168 - FMI 04

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the system voltage is below 9 VDC. The FMI 04 means that the ECM determined that the voltage is below normal.

Test Step 1. CHECK FOR DIAGNOSTIC CODE

A. Turn the key start switch to the OFF position.

B. Occupy the seat.

C. Place the armrest in the DOWN position.

D. Start the engine.

E. Run the engine at high idle for several minutes.

F. Check the Caterpillar ET for the active diagnostic code of CID 0168 FMI 04.

Expected Result:

The diagnostic code of CID 0168 FMI 04 should not be active.

Results:

- **OK -** The diagnostic code of CID 0168 FMI 04 is not active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The diagnostic code of CID 0168 FMI 04 is active. Proceed to Test Step 2.

Test Step 2. CHECK THE SYSTEM VOLTAGE

Note: The following steps are performed with the engine at high idle.

A. Check the system voltage that is displayed on the Caterpillar ET.

B. Measure the voltage at the battery posts.

Expected Result:

The voltage readings should be greater than 9 VDC.

Results:

- **OK -** The voltage readings are greater than 9 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The voltage readings are less than 9 VDC.

  Repair: The charging system has failed. Check the charging system. See Service Manual, REHS0354, "Starting System Troubleshooting".

  Stop.

- **NOT OK -** A voltage reading below 9 VDC is displayed on the Caterpillar ET. Proceed to Test Step 3.

Test Step 3. CHECK THE WIRE HARNESS

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Start the engine and run the engine at high idle.

D. Measure the voltage from contact 1 to contact 3 of the wire harness connector.

Expected Result:

The voltage should be greater than 9 VDC.

Results:

- **OK -** The voltage is greater than 9 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still

exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The voltage is less than 9 VDC.

  Repair: The wire harness has a bad wire or a connector has a bad connection. Inspect the wire harness and connectors. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03885304

MID 106 - CID 1180 - FMI 03

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A1). The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

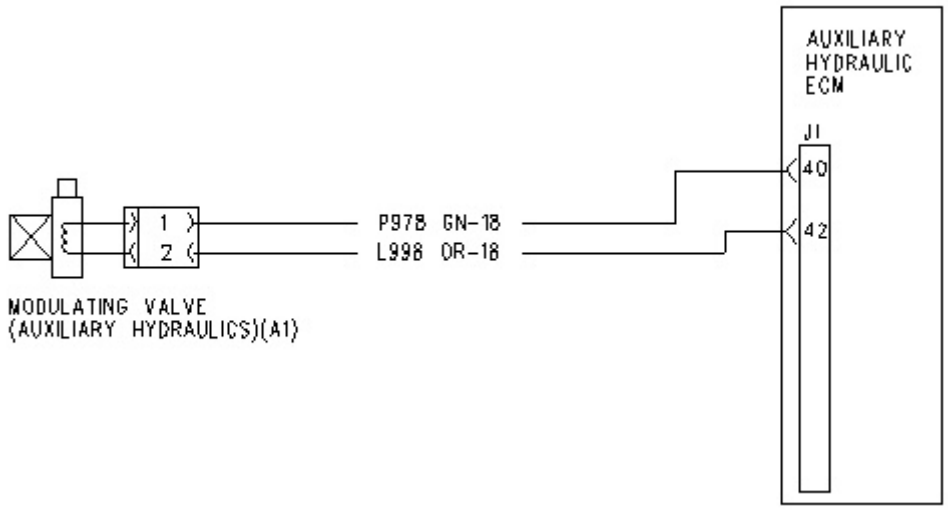


Illustration 1 g00738823

Schematic of the modulating valve for the auxiliary hydraulics (A1)

Test Step 1. CHECK FOR A SHORT TO + BATTERY IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. At the harness connector for the Aux Hydaulic controlfor the Machine ECM, measure the resistance from the sensor signal contact (wire P978-GN) to all of the other contacts that are used on the Aux Hydaulic connectors for the ECM .

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03885302

MID 106 - CID 1180 - FMI 05

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A1). The FMI 05 means that the ECM determined that the current is below normal. An open circuit will cause this code.

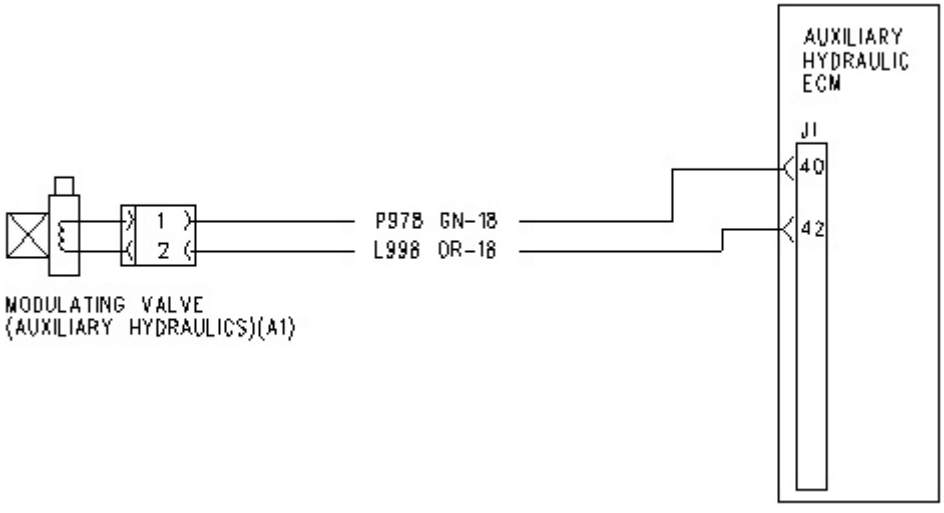


Illustration 1 g00738823

Schematic of the modulating valve for the auxiliary hydraulics (A1)

Test Step 1. CHECK FOR AN OPEN WINDING IN THE SOLENOID (A1)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the modulating valve (A1).

D. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.2 Ohms at 25 C.

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is considerably greater than 2.4 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 2. CHECK FOR AN OPEN IN THE WIRE HARNESS

A. Reconnect the connector for the modulating valve (A1).

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 40 (wire P978-GN) to contact 42 (wire L998-OR) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistance was considerably greater than 3 Ohms.

  Repair: There is an open in the wire harness or a bad connection in a connector. Locate the open wire. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233110

MID 106 - CID 1180 - FMI 06

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A1). The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

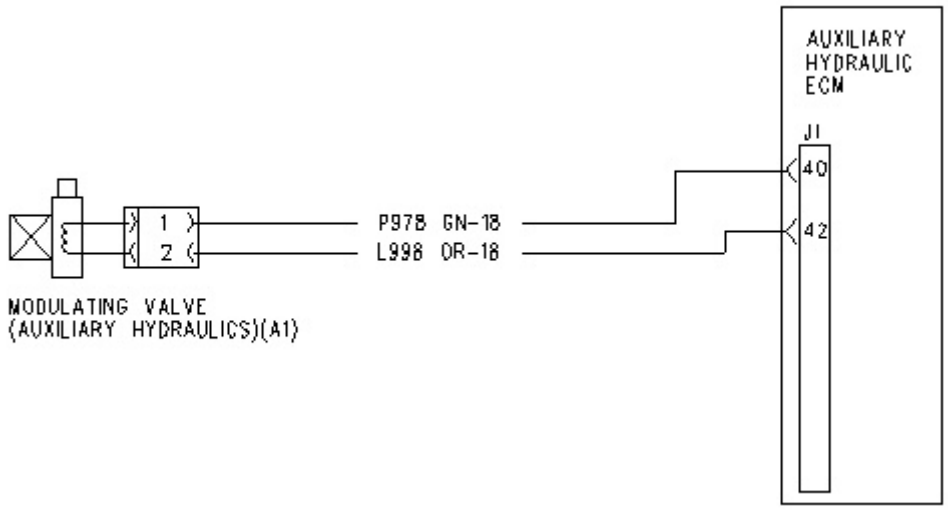


Illustration 1 g00738823

Schematic of the modulating valve for the auxiliary hydraulics (A1)

Test Step 1. CHECK FOR A SHORT TO GROUND IN THE SOLENOID (A1)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the modulating valve (A1).

D. Measure the resistance from each of the coil wires to the machine frame.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 2. CHECK FOR A SHORTED WINDING IN THE SOLENOID (A1)

A. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.5 Ohms.

Results:

- **OK -** The resistance is approximately 2.5 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is less than 1.5 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 3. CHECK FOR A SHORT IN THE WIRE HARNESS

A. Reconnect the connector for the modulating valve (A1).

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 40 (wire P978-GN) to contact 42 (wire L998-OR) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is less than 1.5 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 4. CHECK FOR A SHORT TO GROUND IN THE WIRE HARNESS

A. Measure the resistance from contact 40 (wire P978-GN) and contact 42 (wire L998-OR) of the wire harness to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03884471

MID 106 - CID 1181 - FMI 03

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A2). The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

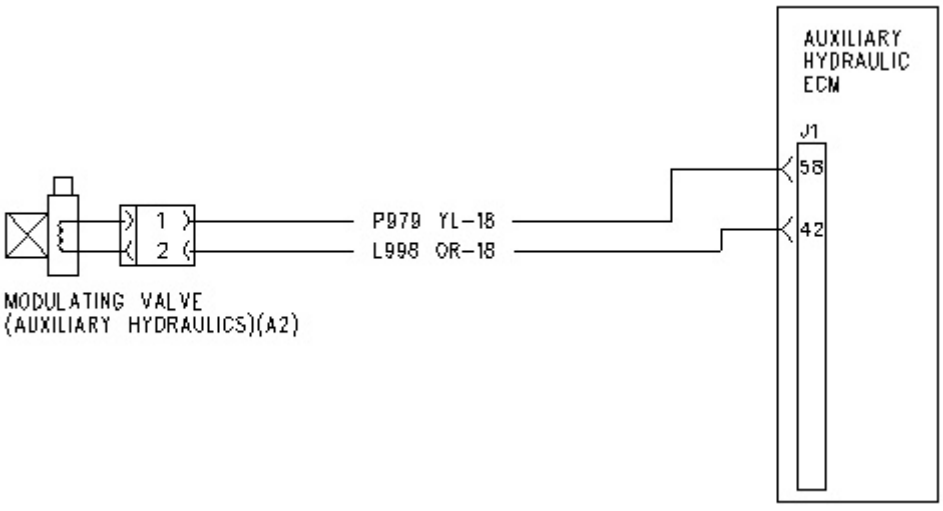


Illustration 1 g00739076

Schematic of the modulating valve for the auxiliary hydraulics (A2)

Test Step 1. CHECK FOR A SHORT TO + BATTERY IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Disconnect the harness connector from the solenoid connector.

E. At the harness connector for the Aux Hydaulic controlfor the Machine ECM, measure the resistance from the sensor signal contact (wire P978-GN) to all of the other contacts that are used on the Aux Hydaulic connectors for the ECM .

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233118

MID 106 - CID 1181 - FMI 05

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A2). The FMI 05 means that the ECM determined that the current is below normal. An open circuit will cause this code.

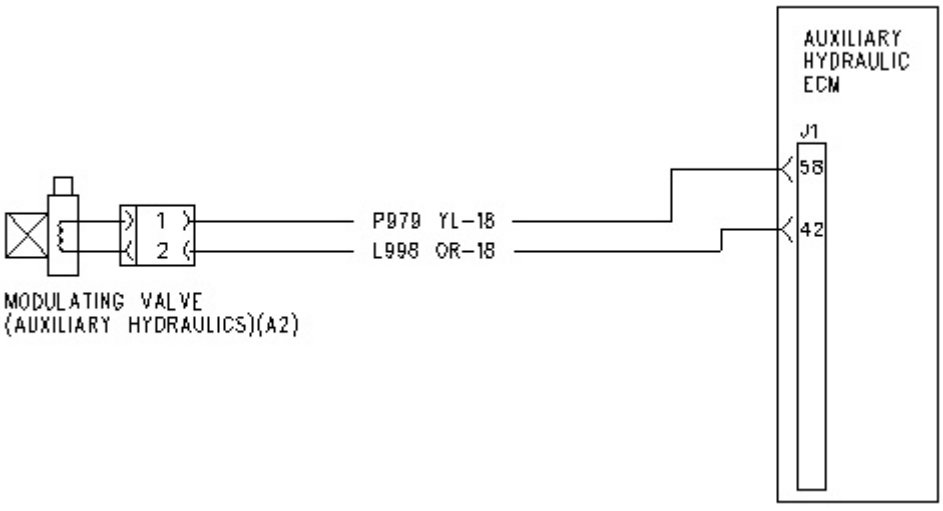


Illustration 1 g00739076

Schematic of the modulating valve for the auxiliary hydraulics (A2)

Test Step 1. CHECK FOR AN OPEN WINDING IN THE SOLENOID (A2)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the modulating valve (A2).

D. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.5 Ohms.

Results:

- **OK -** The resistance is approximately 2.5 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is considerably greater than 2.5 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 2. CHECK FOR AN OPEN IN THE WIRE HARNESS

A. Reconnect the connector for the modulating valve (A2).

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 58 (wire P979-YL) to contact 42 (wire L998-OR) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was considerably greater than 3 Ohms.

  Repair: There is an open in the wire harness or a bad connection in a connector. Locate the open wire. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02233121

MID 106 - CID 1181 - FMI 06

SMCS - 3139-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the modulating valve for the auxiliary hydraulics (A2). The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

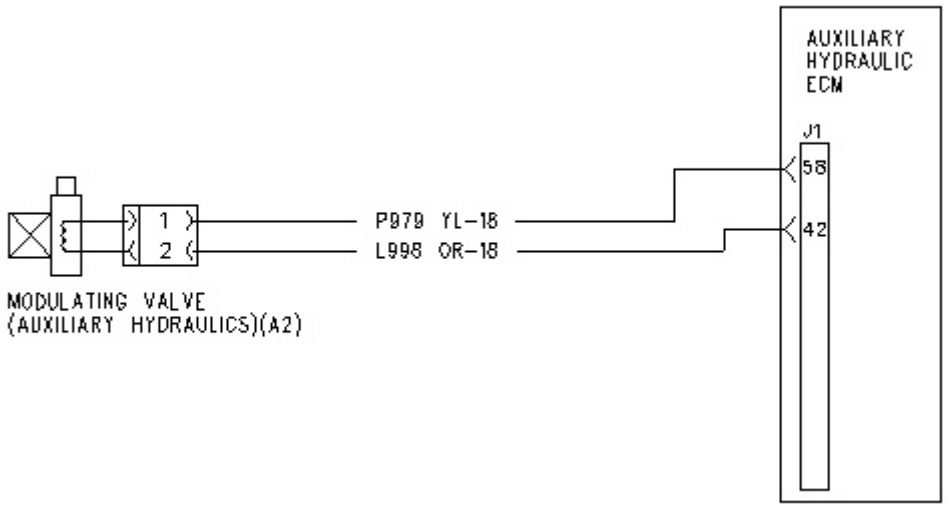


Illustration 1 g00739076

Schematic of the modulating valve for the auxiliary hydraulics (A2)

Test Step 1. CHECK FOR A SHORT TO GROUND IN THE SOLENOID (A2)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the modulating valve (A2).

D. Measure the resistance from each of the coil wires to the machine frame.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 2. CHECK FOR A SHORTED WINDING IN THE SOLENOID (A2)

A. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.5 Ohms.

Results:

- **OK -** The resistance is approximately 2.5 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is less than 1.5 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 3. CHECK FOR A SHORT IN THE WIRE HARNESS

A. Reconnect the connector for the modulating valve (A2).

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 58 (wire P979-YL) to contact 42 (wire L998-OR) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is less than 1.5 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 4. CHECK FOR A SHORT TO GROUND IN THE WIRE HARNESS

A. Measure the resistance from contact 58 (wire P979-YL) and contact 42 (wire L998-OR) of the wire harness to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234238

MID 106 - CID 1184 - FMI 03

SMCS - 5479-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the supply voltage for the modulating valves for the auxiliary hydraulics. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

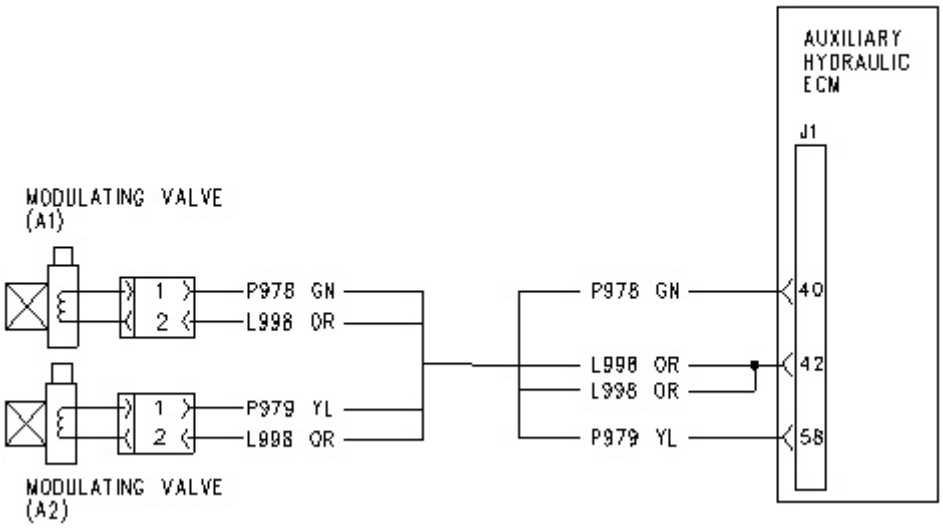


Illustration 1 g00778617

Schematic of the modulating valve for the auxiliary hydraulics

Test Step 1. CHECK FOR A SHORT IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 42 (wire L998-OR) to the following contacts of the wiring harness: contact 1, contact 5, contact 24, contact 26, contact 45 and contact 47.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 2. CHECK FOR VOLTAGE ON THE CIRCUIT

A. Turn the key start switch to the ON position.

B. Measure the voltage from contact 42 (wire L998-OR) to contact 3 of the wiring harness.

Expected Result:

The voltage should be near 0 volts.

Results:

- **OK -** The voltage is near 0 volts.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The voltage is greater than 0 volts.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i04058093

MID 106 - CID 1184 - FMI 06

SMCS - 5479-038-AX

Conditions Which Generate This Code:

This diagnostic code is associated with the supply voltage for the modulating valves for the auxiliary hydraulics. The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

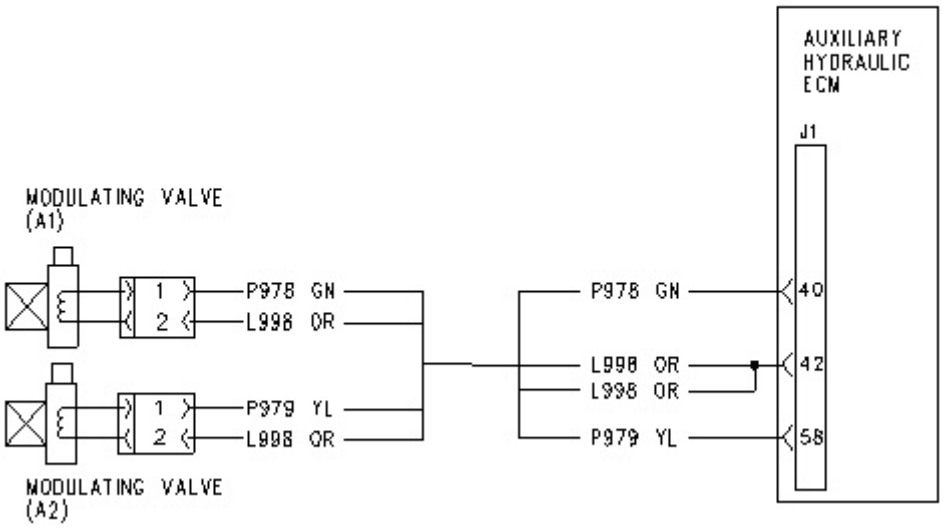


Illustration 1 g00778617

Schematic of the modulating valve for the auxiliary hydraulics

Test Step 1. CHECK FOR A SHORT TO GROUND IN THE MODULATING VALVE(A1)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the modulating valve (A1).

D. Measure the resistance from each of the coil wires (A1) to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 2. CHECK FOR A SHORTED WINDING IN THE MODULATING VALVE (A1)

A. Measure the resistance of the coil (A1).

Expected Result:

The resistance should be approximately 2.2 Ohms at 25° C (77° F).

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is less than 2.0 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 3. CHECK FOR A SHORT TO GROUND IN THE MODULATING VALVE (A2)

A. Disconnect the connector for the modulating valve (A2).

B. Measure the resistance from each of the coil wires (A2) to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

Repair: The solenoid coil has failed. Replace the coil.

STOP

Test Step 4. CHECK FOR A SHORTED WINDING IN THE MODULATING VALVE (A2)

A. Measure the resistance of the coil (A2).

Expected Result:

The resistance should be approximately 2.2 Ohms at 25 C.

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 5.
- **NOT OK -** The resistance is less than 2.0 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 5. CHECK FOR A SHORT TO GROUND IN THE MODULATING VALVE (PRESSURE RELEASE)

If the machine is not equipped with a solenoid valve (pressure release), press the "SKIP" button.

A. Disconnect the connector for the solenoid valve (pressure release).

B. Measure the resistance from each of the coil wires (pressure release) to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **SKIP -** The machine is not equipped with a solenoid valve (pressure release). Proceed to Test Step 7.
- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 6.
- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 6. CHECK FOR A SHORTED WINDING IN THE MODULATING VALVE (PRESSURE RELEASE)

A. Measure the resistance of the coil (pressure release).

Expected Result:

The resistance should be approximately 2.2 Ohms at 25 C.

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 7.
- **NOT OK -** The resistance is less than 2.0 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 7. CHECK FOR A SHORT IN THE CIRCUIT (A1) OF THE WIRE HARNESS

A. Do not reconnect the connectors for the valves.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 40 (wire P978-GN) to contact 42 (wire L998-OR) of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 8.
- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  STOP

Test Step 8. CHECK FOR A SHORT IN THE CIRCUIT (A2) OF THE WIRE HARNESS

A. Measure the resistance from contact 42 (wire L998-OR) to contact 58 (wire P979-YL) of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 9.
- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  STOP

Test Step 9. CHECK FOR A SHORT TO GROUND IN THE CIRCUIT

A. Measure the resistance from contact 42 (wire L998-OR) to contact 3 of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234253

MID 106 - CID 1187 - FMI 04

SMCS - 7332-038-FW

Conditions Which Generate This Code:

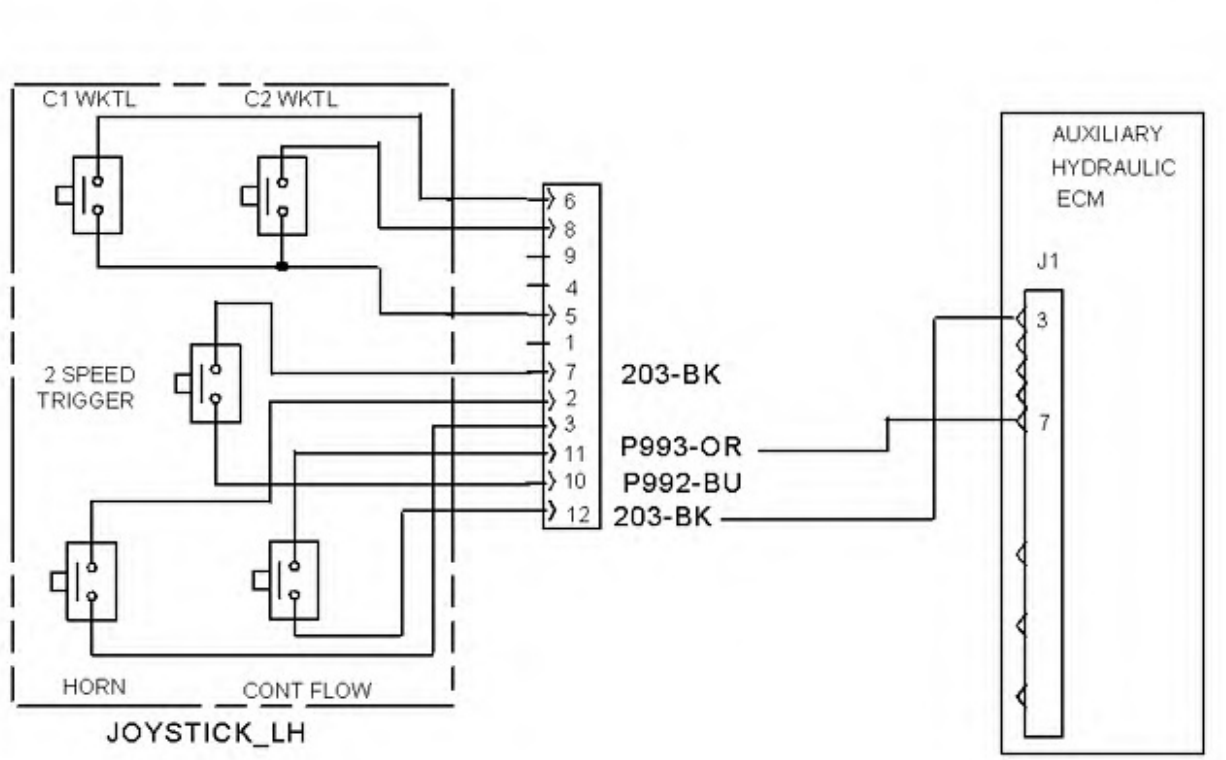


Illustration 1 g01035064

Schematic of the continuous flow switch

This diagnostic code is recorded when the ECM sees the input of the switch as grounded for more than 30 seconds.

The possible causes of the diagnostic code are listed:

- A short to ground
- The switch has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK FOR A SHORT TO GROUND.

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Turn the key start switch to the OFF position.

D. At the J1 machine harness connector, measure the resistance from contact J1-7 to all sources of ground.

Expected Result:

The resistance measurement should be greater than 5000 ohms for each measurement.

Results:

- **OK -** The resistance measurement is greater than 5000 ohms. Proceed to test step 2.
- **NOT OK -** The resistance measurement is not 5000 ohms.

  Repair: Repair the harness or replace the harness. Verify that the problem has been corrected.

  Stop.

Test Step 2. CHECK THE RESISTANCE OF THE SWITCH.

A. Press the continuous flow switch on the left joystick handle.

B. At the J1 machine harness connector, measure the resistance from contact J1-3 to J1-7.

Expected Result:

The resistance measurement should be less than 5 ohms.

Results:

- **OK -** The resistance measures less than 5 ohms. The switch is correct.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not less than 5 ohms.

  Repair: The switch has failed. The switch is internal to the handle. Replace the handle.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234286

MID 106 - CID 1694 - FMI 03

SMCS - 6700-038-EK2

Conditions Which Generate This Code:

This diagnostic code is associated with the supply voltage for the solenoid valves for the auxiliary hydraulics. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

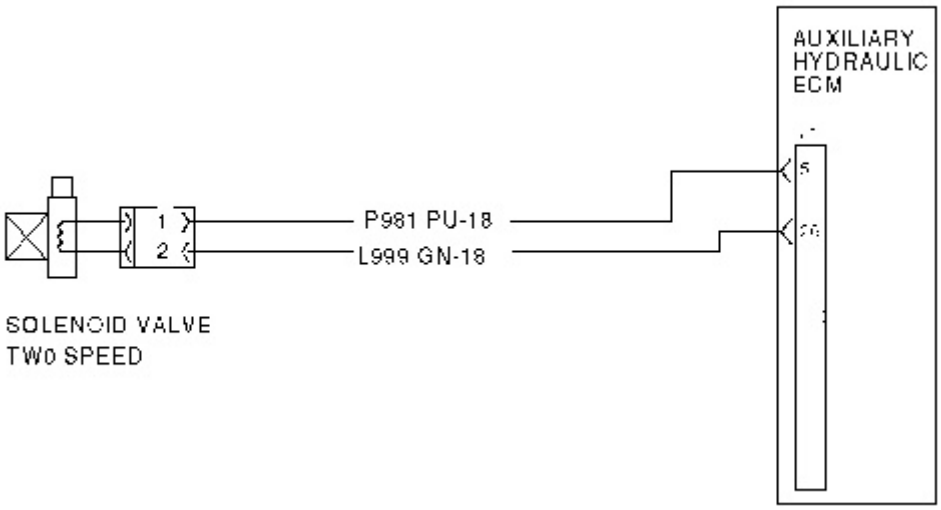


Illustration 1 g01037835

Schematic of the two speed solenoid valve for the auxiliary hydraulics

Test Step 1. CHECK FOR A SHORT IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 26 (wire L999-GN) to the following contacts of the wiring harness: contact 1, contact 5, contact 24, contact 42, contact 45 and contact 47.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 2. CHECK FOR VOLTAGE ON THE CIRCUIT

A. Turn the key start switch to the ON position.

B. Measure the voltage from contact 26 (wire L999-GN) to contact 3 of the wiring harness.

Expected Result:

The voltage should be near 0 volts.

Results:

- **OK -** The voltage is near 0 volts.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The voltage is greater than 0 volts.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234288

MID 106 - CID 1694 - FMI 06

SMCS - 6700-038-EK2

Conditions Which Generate This Code:

This diagnostic code is associated with the supply voltage for the solenoid valves for the auxiliary hydraulics. The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

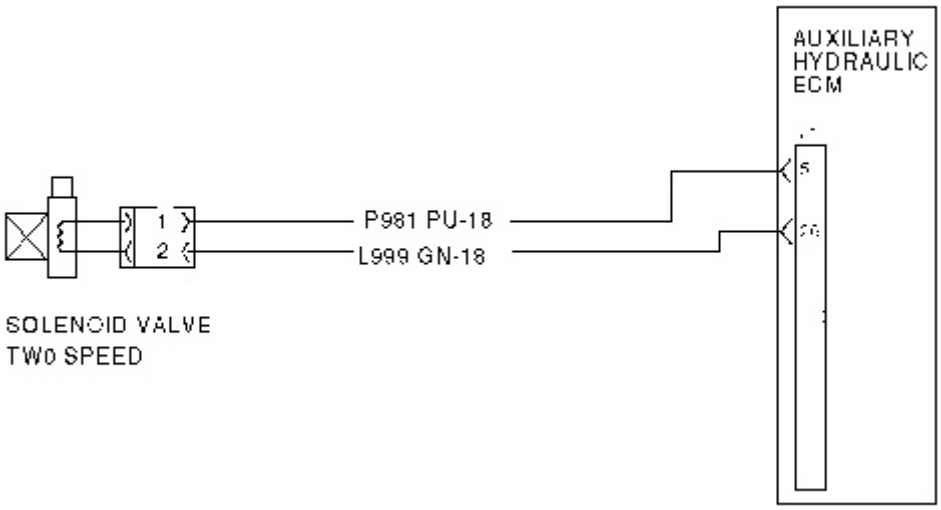


Illustration 1 g01037835

Schematic of the two speed solenoid valve for the auxiliary hydraulics

Test Step 1. CHECK FOR A SHORT TO GROUND IN THE SOLENOID

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the connector for the solenoid valve.

D. Measure the resistance from each of the coil wires to the machine frame.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 2. CHECK FOR A SHORTED WINDING IN THE SOLENOID

A. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.2 Ohms.

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is less than 2 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 3. CHECK FOR A SHORT IN THE WIRE HARNESS

A. Reconnect the connector for the solenoid valve.

B. Disconnect the wire harness from the ECM.

C. Measure the resistance from contact 5 (wire P981-PU) to contact 26 (wire L999-GN) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms. Proceed to Test Step 4.

- **NOT OK -** The resistance is less than 2 Ohms.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 4. CHECK FOR A SHORT TO GROUND IN THE WIRE HARNESS

A. Measure the resistance from contact 5 (wire P981-PU) and contact 26 (wire L999-GN) of the wire harness to the machine frame or to contact 3.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted in the wire harness. Locate the shorted wires. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234291

MID 106 - CID 1931 - FMI 03

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the circuit for the auxiliary hydraulics control flow solenoid. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

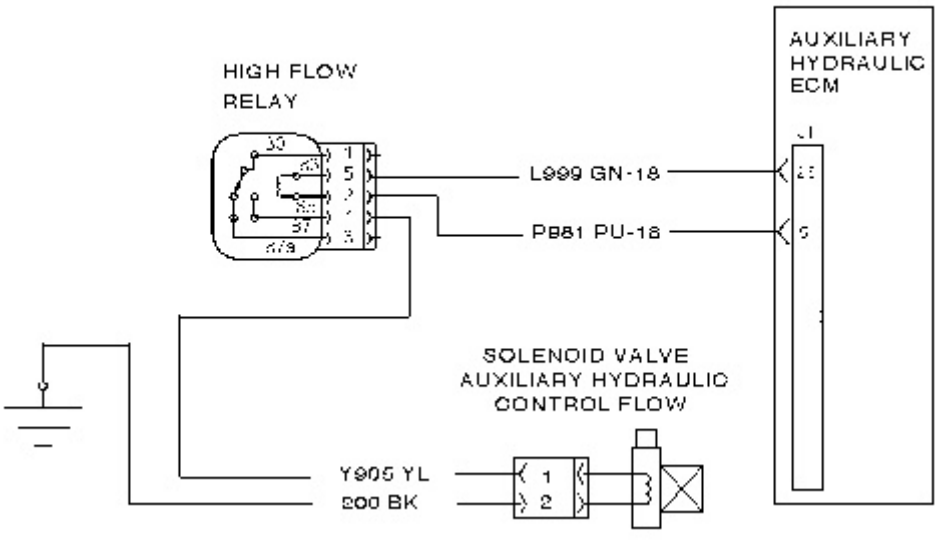


Illustration 1 g01042001

Schematic for the auxiliary hydraulics control flow solenoid circuit

The possible causes of the diagnostic code are listed:

- The relay has failed.
- The energizer circuit of the relay is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1931 FMI 03 is active before performing this procedure.**

Note: Use the **146-4080** Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE ENERGIZER CIRCUIT OF THE RELAY FOR A SHORT TO THE +BATTERY CIRCUIT.

A. Turn the key start switch to the OFF position.

B. Disconnect the machine harness connectors from the relay and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J1-5 (wire P981-PU) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **OK -** Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- **NOT OK -** Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-5 (P981-PU) and the circuit that has a low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Determine if the CID 1931 FMI 03 is active.

Expected Result:

The CID 1931 FMI 03 is active.

Results:

- **YES -** The CID 1931 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1931 FMI 03 is not active. The problem does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234294

MID 106 - CID 1931 - FMI 05

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the circuit for the auxiliary hydraulics control flow solenoid. The FMI 05 means that the ECM determined that the current is below normal. An open circuit will cause this code.

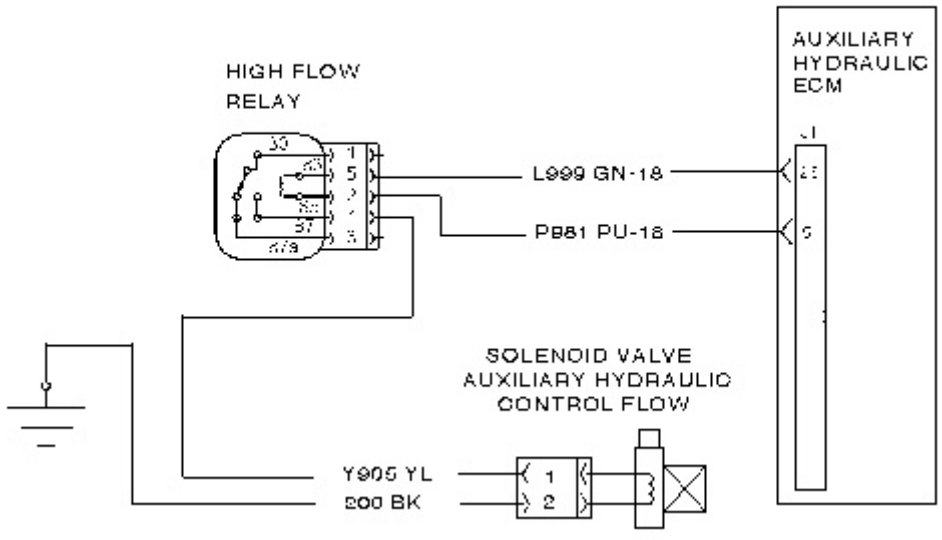


Illustration 1 g01042001

Schematic of the auxiliary hydraulics control flow solenoid circuit

The possible causes of this diagnostic code are listed below:

- The energizer circuit of the relay is open.
- The return circuit of the relay is open.
- The relay has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1931 FMI 05 is active before performing this procedure.**

Note: Use the **146-4080** Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE RELAY.

A. Turn the key start switch to the ON position. Do not start the engine.

B. Disconnect the relay with the active diagnostic code from the machine harness.

C. At the machine harness connector for the relay, place a jumper wire from contact 5 (wire P981-PU) to contact 2 (wire L999-GN).

D. Observe the status of the CID 1931 FMI 05.

Expected Result:

The CID 1931 FMI 05 remains active. The FMI has not changed and the "05" is still active.

Results:

- **YES -** The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- **NO -** The diagnostic is no longer active. The relay has failed.

  Repair: The relay has failed. Repeat this Test Step "CHECK THE RELAY" in order to verify the failure of the relay. Replace the relay. Verify that the new relay corrects the problem.

  Stop.

Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous test remains in place.

D. At the machine harness connector, measure the resistance from signal contact J1-5 (wire P981-PU) to contact J1-26 (wire L999-GN).

Expected Result:

The resistance is less than 5.0 ohms.

Results:

- **OK -** The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- **NOT OK -** The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  Repair: The open is in wire P981-PU or in wire L999-GN of the machine harness. Repair the machine harness or replace the machine harness.

  Stop.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1931 FMI 05.

Expected Result:

The CID 1931 FMI 05 is active.

Results:

- **YES -** The CID 1931 FMI 05 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1931 FMI 05 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234296

MID 106 - CID 1931 - FMI 06

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the auxiliary hydraulics control flow solenoid. The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

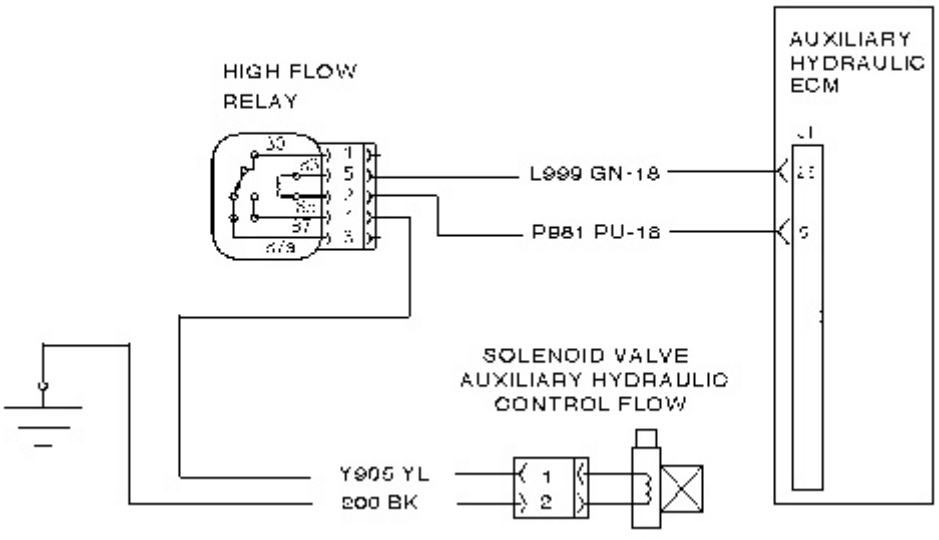


Illustration 1 g01042001

Schematic of the auxiliary hydraulics control flow solenoid

The possible causes of this diagnostic code are listed:

- The energizer circuit of the relay is shorted to ground.
- The relay has failed.
- The ECM has failed. This is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1931 FMI 03 is active before performing this procedure.**

Note: Use the **146-4080** Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE RELAY.

A. Turn the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the relay with the active diagnostic code from the machine harness.

Expected Result:

CID 1931 FMI 06 changes to CID 1931 FMI 05 when the relay is disconnected.

Results:

- **YES -** CID 1931 FMI 06 changes to CID 1931 FMI 05 when the relay is disconnected. The circuit is correct.

  Repair: The relay has failed. Repeat this test "CHECK THE RELAY" in order to verify the failure of the relay. Replace the relay.

  Stop.

- **NO -** CID 1931 FMI 06 remains active. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZER CIRCUIT OF THE RELAY FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The relay remains disconnected from the machine harness.

C. Disconnect the machine harness connector(s) from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-5 (wire P981-PU) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **OK -** Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- **NOT OK -** Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-5 (wire P981-PU) and the circuit with the low resistance measurement.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1931 FMI 06.

Expected Result:

The CID 1931 FMI 06 is active.

Results:

- **YES -** The CID 1931 FMI 06 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1931 FMI 06 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234322

MID 106 - CID 1942 - FMI 04

SMCS - 1435-038

Conditions Which Generate This Code:

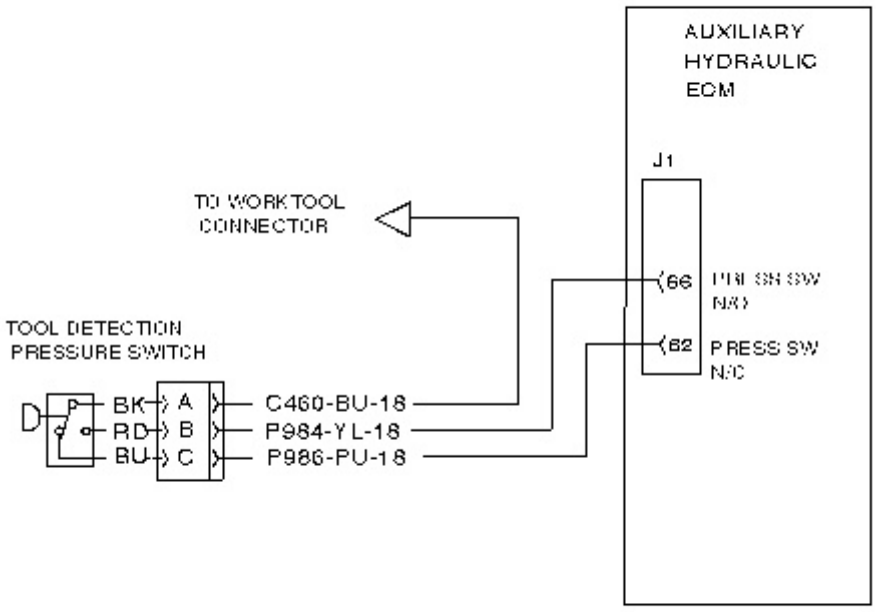


Illustration 1 g01044423

Schematic of the Pressure Switch for the tool detection

This diagnostic code is associated with the parking brake pressure switch. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 04 means that the ECM has determined that the "Normally Open" and "Normally Closed" circuits are grounded.

Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1942 FMI 04 is active before performing this procedure.**

Test Step 1. CHECK THE HARNESS

A. Turn the disconnect switch and the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-62 (wire P986-PKU) and J1-66 (wire P984-YL) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **YES -** Each resistance measurement is greater than 5000 ohms. Proceed to Test Step 2.
- **NO -** One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-62 (wire P986-PU) and the circuit with the lowest resistance or the short is between J1-66 (wire P984-YL) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  Stop.

Test Step 2. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact A of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact B of the harness connector for the switch.

D. Measure the resistance between contact A and contact B. Note the resistance.

E. Disconnect the lead from contact B and connect the lead to contact C.

F. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact (A) to contact B is greater than 5000 ohms.

Results:

- **YES -** The resistance from contact A to contact C is less than 5 ohms, and the resistance from contact A to contact B is greater than 5000 ohms. Proceed to Test Step 3.
- **NO -** The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  Stop.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact A of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact B of the harness connector for the switch.

E. Measure the resistance between contact A and contact B. Note the resistance.

F. Disconnect the lead from contact B and connect the lead to contact C.

G. Measure the resistance between contact A and contact C.

Expected Result:

The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact A to contact C is greater than 5000 ohms.

Results:

- **YES -** The resistance from contact A to contact B is less than 5 ohms, and the resistance from contact Aand contact C is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 4.
- **NO -** The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  Stop.

Test Step 4. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 1942 FMI 04 is present.

Expected Result:

The CID 1942 FMI 04 is active.

Results:

- **YES -** The CID 1942 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1942 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01996301

Power Supply Circuit of Electronic Control Module

SMCS - 1417-038-EK2; 1420-038-EK2

System Operation Description:

A fuse is blown out or the circuit breaker is tripped as a result of an overloaded circuit. For example, the +battery connection is shorted to ground. If the fuse is blown out or the circuit breaker is tripped on a supply circuit for the ECM, no diagnostic code will be recorded. A power supply circuit that has failed will cause a diagnostic code of CID 0168 to be logged for MID 106.

Test Step 1. CHECK THE FUSES/CIRCUIT BREAKER

Whenever the machine's electronic components fail to function and no diagnostic code is available, check the appropriate fuses/circuit breaker for that component.

A. Check all fuses and circuit breakers.

Expected Result:

All fuses and circuit breakers are correct.

Results:

- **YES -** All fuses and circuit breakers are correct. Exit this procedure and repeat this procedure. **Stop.**
- **NO -** All fuses and circuit breakers are not correct.

  Repair: Replace the blown fuse or reset the circuit breaker.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234410

Auxiliary Hydraulic Does Not Function in One Direction

SMCS - 5005-038-EA

System Operation Description:

Press the switch (A1) in order to enable the auxiliary hydraulics (A1). Press the switch (A2) in order to enable the auxiliary hydraulics (A2).

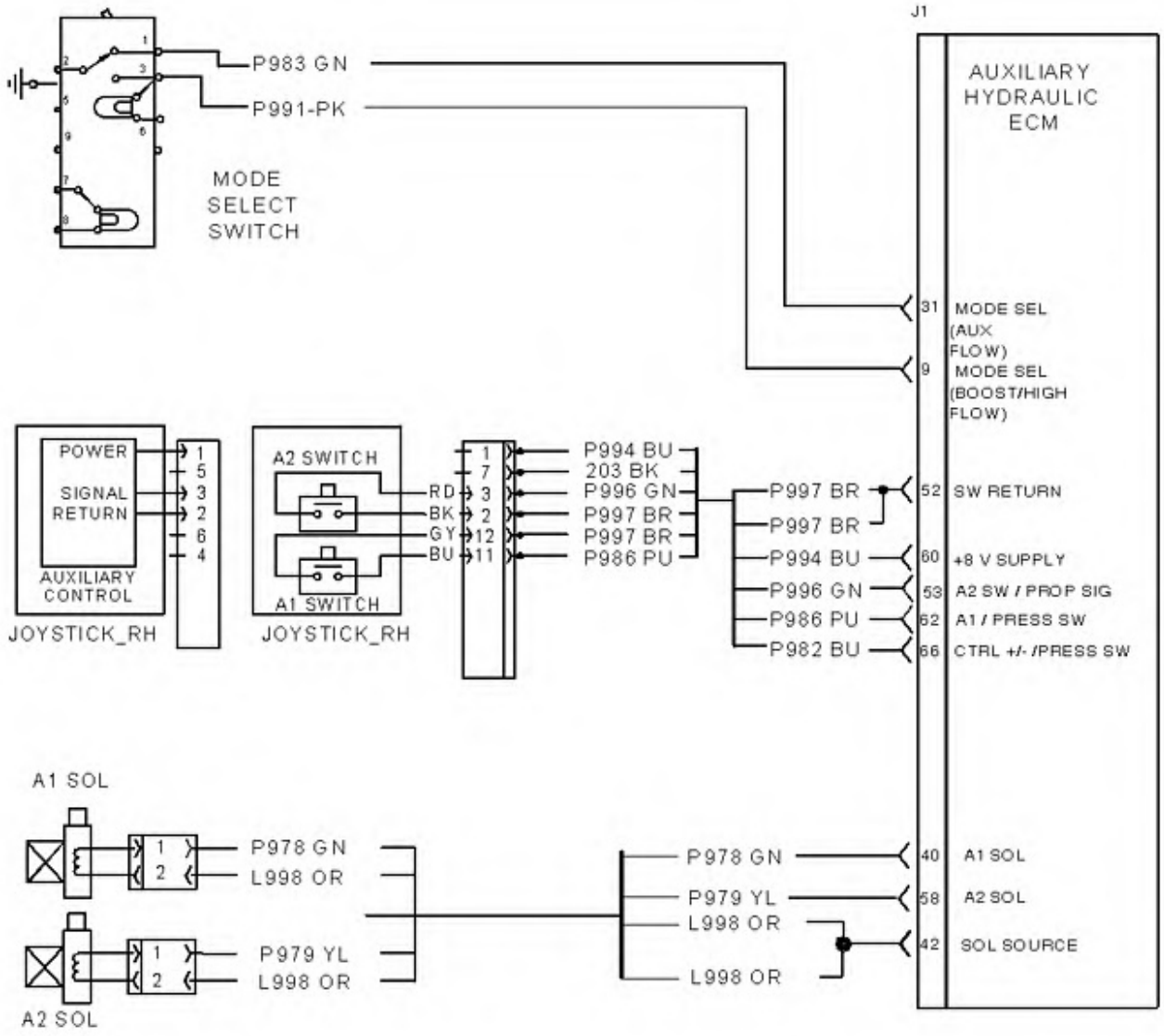


Illustration 1 g01037121

Schematic of the auxiliary/high flow circuit

Note: Check for any related diagnostic codes that are displayed on the Caterpillar ET before performing the following Test Steps.

Test Step 1. CHECK FOR PUSH BUTTON SWITCHES

A. Check the work tool joystick control for the type of control.

Expected Result:

The work tool joystick control should have push button switches for A1 and A2.

Results:

- **OK -** The work tool joystick control uses push button switches for A1 and A2. Proceed to Test Step 2.

- **NOT OK -** The work tool joystick control uses an auxiliary control in order to operate A1 and A2. Proceed to Test Step 10.

Test Step 2. CHECK FOR PROPER OPERATION FOR A1

A. Enable the machine.

B. Press the switch (A1) .

Expected Result:

The auxiliary hydraulics (A1) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1) are active. Proceed to Test Step 3.
- **NOT OK -** The auxiliary hydraulics (A1) are not active. Proceed to Test Step 4.

Test Step 3. CHECK FOR PROPER OPERATION FOR A2

A. Release the A1 switch.

B. Press the switch (A2).

Expected Result:

The auxiliary hydraulics (A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A2) are not active. Proceed to Test Step 7.

Test Step 4. CHECK THE STATUS OF THE SWITCH

A. Press the switch (A1).

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 5.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 6.

Test Step 5. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P978-GN and L998-OR coming out of the ECM.

C. Enable the machine.

D. Press the switch (A1) .

E. Measure the voltage from wire P978-GN to wire L998-OR. Measure the voltage on the back side of a connector or by penetrating the wire insulation.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 6. CHECK THE SWITCH CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch (A1).

E. Measure the resistance from contact 52 to contact 53 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance was less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 7. CHECK THE STATUS OF THE SWITCH

A. Press the switch (A2).

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 8.
- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 9.

Test Step 8. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P979-YL and L998-OR coming out of the ECM.

C. Enable the machine.

D. Press the switch (A2).

E. Use a **7X-1710** Multimeter Probe in order to measure the voltage from wire P979-YL to wire L998-OR.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 9. CHECK THE SWITCH CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch (A2).

E. Measure the resistance from contact 52 to contact 62 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance was less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 10. CHECK THE STATUS OF THE AUXILIARY CONTROL

A. Actuate the auxiliary control.

B. Observe the status for the auxiliary hydraulics on the Caterpillar ET.

Expected Result:

The amperes for the auxiliary hydraulic status should be displaying values that are greater than "0.00".

Results:

- **OK -** The reading is displaying values that are greater than "0.00".

  Repair: If there are no diagnostic codes that are present, the problem does not appear to be an electrical problem.

  Stop.

- **NOT OK -** The reading is displaying "0.00" amperes.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234437

Auxiliary Hydraulic Does Not Function in Either Direction

SMCS - 5005-038-EA

System Operation Description:

Press the switch (A1) in order to enable the auxiliary hydraulics (A1). Press the switch (A2) in order to enable the auxiliary hydraulics (A2).

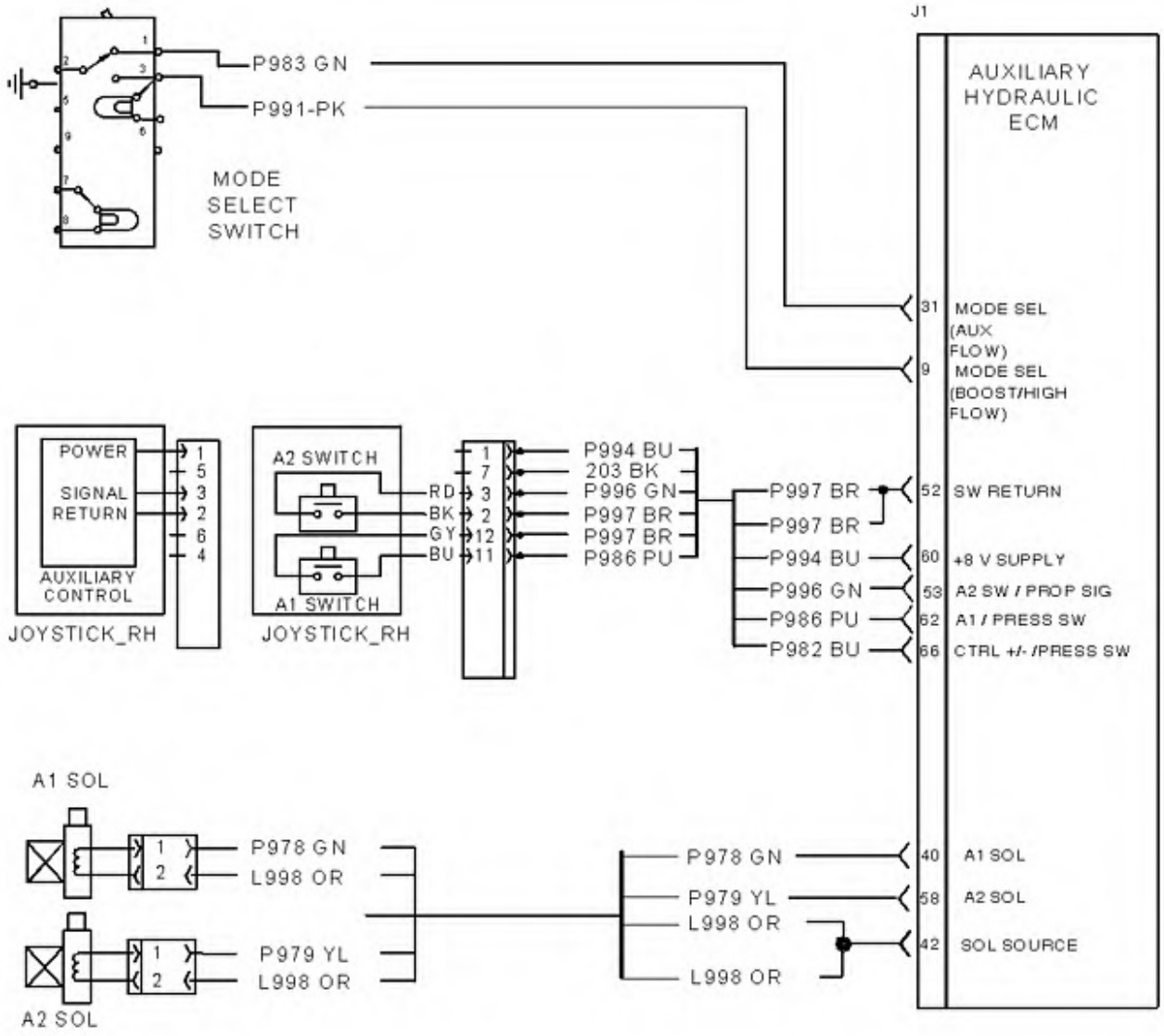


Illustration 1 g01037121

Schematic of the auxiliary/high flow circuit

Note: Check for any related diagnostic codes that are displayed on the Caterpillar ET before performing the following Test Steps.

Test Step 1. CHECK FOR PROPER OPERATION FOR A1

A. Enable the machine.

B. Press the switch (A1) .

Expected Result:

The auxiliary hydraulics (A1) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1) are active. Proceed to Test Step 2.

- **NOT OK -** The auxiliary hydraulics (A1) are not active. Proceed to Test Step 6.

Test Step 2. CHECK FOR PROPER OPERATION

A. Enable the machine.

B. Push down on either the A1 switch or the A2 switch.

Expected Result:

The auxiliary hydraulics (A1 or A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1 or A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A1 or A2) are not active. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE SWITCH

A. Press and release the auxiliary hydraulic switch (A1).

B. Observe the status on the Caterpillar ET.

C. Press and release the auxiliary hydraulic switch (A2).

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 4.
- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status on both A1 and A2. Proceed to Test Step 5.
- **NOT OK -** The status of either A1 or A2 did not change from the "CLOSED" status to the "OPEN" status.

  Repair: See Troubleshooting, "Auxiliary Hydraulics Does Not Function In One Direction".

  Stop.

Test Step 4. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P978-GN and L998-OR coming out of the ECM.

C. Enable the machine.

D. Push down on the A1 switch.

E. Measure the voltage from wire P978-GN to wire L998-OR. Measure the voltage on the back side of a connector or by penetrating the wire insulation.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 5. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Press the switch (A1).

D. Measure the resistance from contact 52 to contact 62 of the wire harness connector.

E. Press the switch (A2).

F. Measure the resistance from contact 52 to contact 53 of the wire harness connector.

Expected Result:

The resistances should be less than 5 Ohms on both of the readings.

Results:

- **OK -** The resistances were less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration

screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistances were greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 6. CHECK THE STATUS OF THE AUXILIARY CONTROL

A. Actuate the auxiliary control.

B. Observe the status for the auxiliary hydraulics on the Caterpillar ET.

Expected Result:

The amperes for the auxiliary hydraulic status should be displaying values that are greater than "0.00".

Results:

- **OK -** The ampere for the auxiliary hydraulic status is displaying a value that is greater than "0.00".

  Repair: If there is no diagnostic codes that are present, the problem does not appear to be an electrical problem.

  Stop.

- **NOT OK -** The ampere for the auxiliary hydraulic status is displaying "0.00".

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234444

High Flow Does Not Function in One Direction

SMCS - 5005-038-EA

System Operation Description:

Press the switch (A1) in order to enable the auxiliary hydraulics (A1). Press the switch (A2) in order to enable the auxiliary hydraulics (A2).

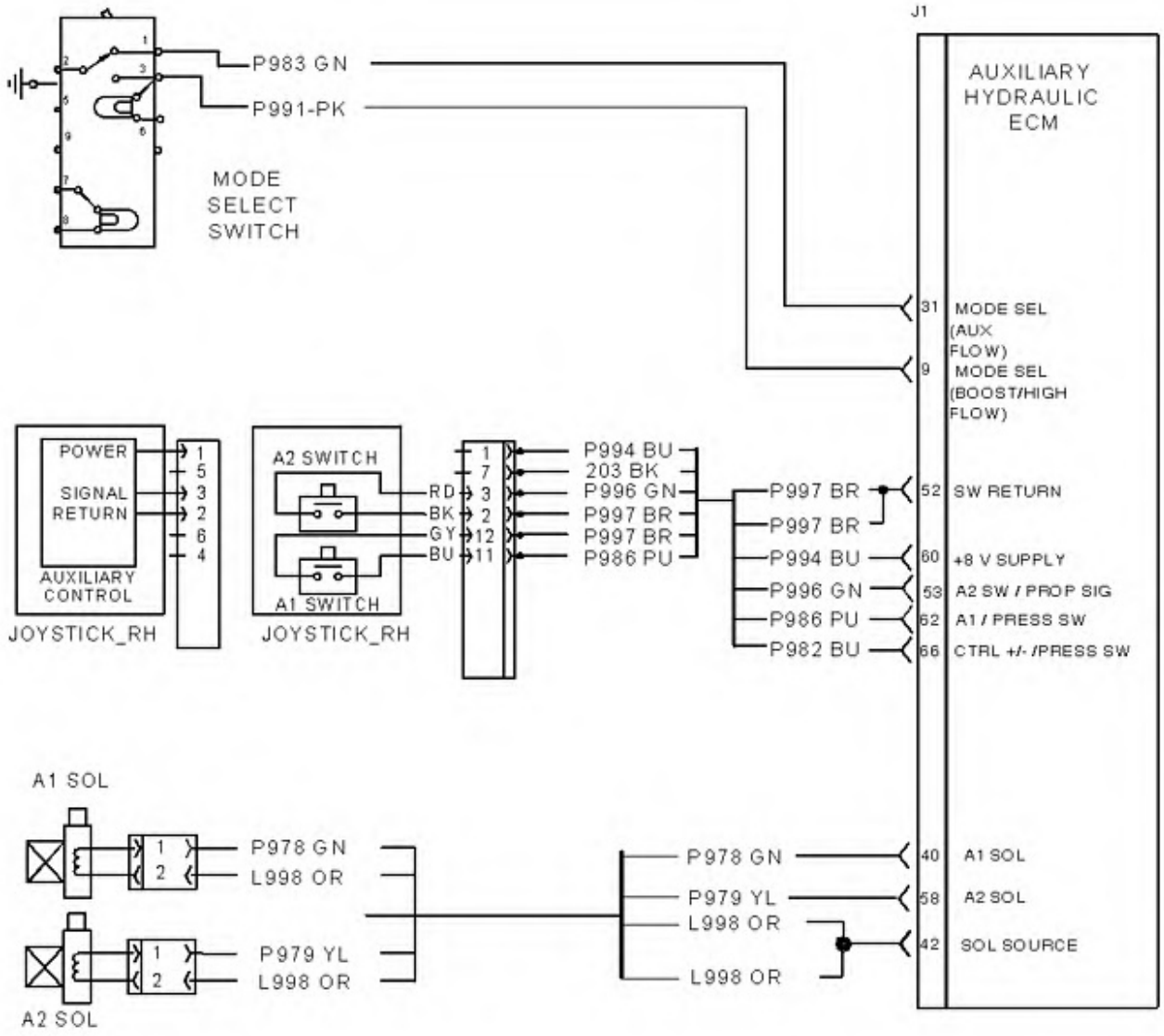


Illustration 1 g01037121

Schematic of the high flow circuit

Note: Check for any related diagnostic codes that are displayed on the Caterpillar ET before performing the following Test Steps.

Test Step 1. CHECK FOR PUSH BUTTON SWITCHES

A. Check the work tool joystick control for the type of control.

Expected Result:

The work tool joystick control should have push button switches for A1 and A2.

Results:

- **OK -** The work tool joystick control uses push button switches for A1 and A2. Proceed to Test Step 2.

- **NOT OK -** The work tool joystick control uses an auxiliary control in order to operate A1 and A2. Proceed to Test Step 10.

Test Step 2. CHECK FOR PROPER OPERATION FOR A1

A. Enable the machine.

B. Press the switch (A1) .

Expected Result:

The auxiliary hydraulics (A1) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1) are active. Proceed to Test Step 3.
- **NOT OK -** The auxiliary hydraulics (A1) are not active. Proceed to Test Step 4.

Test Step 3. CHECK FOR PROPER OPERATION FOR A2

A. Release the A1 switch.

B. Press the switch (A2).

Expected Result:

The auxiliary hydraulics (A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A2) are not active. Proceed to Test Step 7.

Test Step 4. CHECK THE STATUS OF THE SWITCH

A. Press the switch (A1).

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 5.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 6.

Test Step 5. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P978-GN and L998-OR coming out of the ECM.

C. Enable the machine.

D. Press the switch (A1) .

E. Measure the voltage from wire P978-GN to wire L998-OR. Measure the voltage on the back side of a connector or by penetrating the wire insulation.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 6. CHECK THE SWITCH CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch (A1).

E. Measure the resistance from contact 52 to contact 62 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance was less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 7. CHECK THE STATUS OF THE SWITCH

A. Press the switch (A2).

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 8.
- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 9.

Test Step 8. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P979-YL and L998-OR coming out of the ECM.

C. Enable the machine.

D. Press the switch (A2).

E. Use a **7X-1710** Multimeter Probe in order to measure the voltage from wire P979-YL to wire L998-OR.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 9. CHECK THE SWITCH CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch (A2).

E. Measure the resistance from contact 52 to contact 53 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance was less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 10. CHECK THE STATUS OF THE AUXILIARY CONTROL

A. Actuate the auxiliary control.

B. Observe the status for the auxiliary hydraulics on the Caterpillar ET.

Expected Result:

The amperes for the auxiliary hydraulic status should be displaying values that are greater than "0.00".

Results:

- **OK -** The reading is displaying values that are greater than "0.00".

  Repair: If there are no diagnostic codes that are present, the problem does not appear to be an electrical problem.

  Stop.

- **NOT OK -** The reading is displaying "0.00" amperes.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234446

High Flow Does Not Function in Either Direction

SMCS - 5005-038-EA

System Operation Description:

Press the switch (A1) in order to enable the auxiliary hydraulics (A1). Press the switch (A2) in order to enable the auxiliary hydraulics (A2).

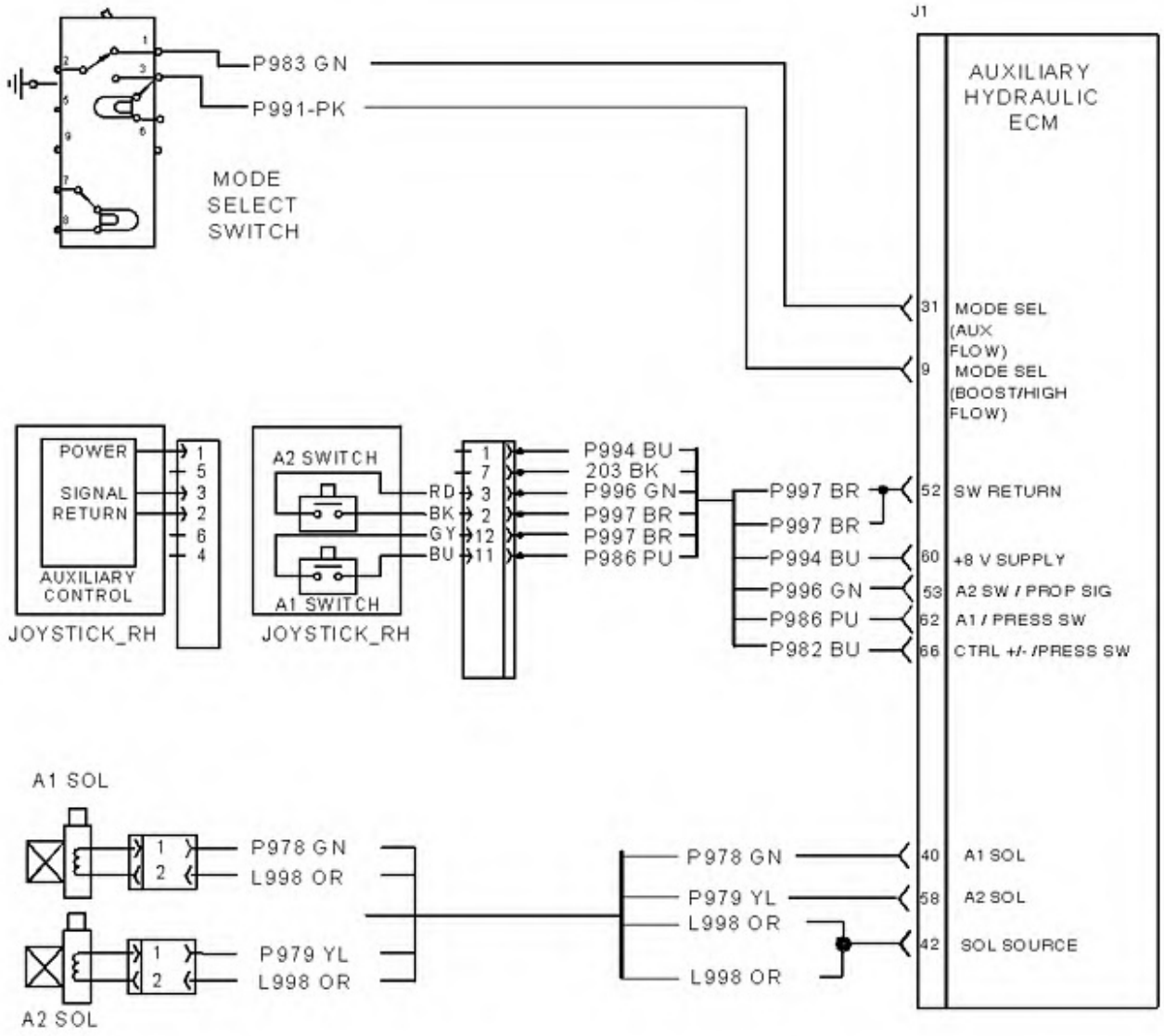


Illustration 1 g01037121

Schematic of the the high flow circuit

Note: Check for any related diagnostic codes that are displayed on the Caterpillar ET before performing the following Test Steps.

Test Step 1. CHECK FOR PROPER OPERATION FOR A1

A. Enable the machine.

B. Press the switch (A1) .

Expected Result:

The auxiliary hydraulics (A1) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1) are active. Proceed to Test Step 2.

- **NOT OK -** The auxiliary hydraulics (A1) are not active. Proceed to Test Step 6.

Test Step 2. CHECK FOR PROPER OPERATION

A. Enable the machine.

B. Push down on either the A1 switch or the A2 switch.

Expected Result:

The auxiliary hydraulics (A1 or A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1 or A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A1 or A2) are not active. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE SWITCH

A. Press and release the auxiliary hydraulic switch (A1).

B. Observe the status on the Caterpillar ET.

C. Press and release the auxiliary hydraulic switch (A2).

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The switch status changed from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 4.
- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status on both A1 and A2. Proceed to Test Step 5.
- **NOT OK -** The status of either A1 or A2 did not change from the "CLOSED" status to the "OPEN" status.

  Repair: See Troubleshooting, "Auxiliary Hydraulics Does Not Function In One Direction".

  Stop.

Test Step 4. CHECK THE OUTPUT OF THE ECM

A. Remove the floorplate in order to get to the ECM.

B. Locate the wires P978-GN and L998-OR coming out of the ECM.

C. Enable the machine.

D. Push down on the A1 switch.

E. Measure the voltage from wire P978-GN to wire L998-OR. Measure the voltage on the back side of a connector or by penetrating the wire insulation.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The voltage should be greater than 10 VDC.

Results:

- **OK -** The voltage is greater than 10 VDC.

  Repair: The problem does not appear to be electrical.

  Stop.

- **NOT OK -** The voltage is less than 10 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

Test Step 5. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Press the switch (A1).

D. Measure the resistance from contact 52 to contact 53 of the wire harness connector.

E. Press the switch (A2).

F. Measure the resistance from contact 52 to contact 62 of the wire harness connector.

Expected Result:

The resistances should be less than 5 Ohms on both of the readings.

Results:

- **OK -** The resistances were less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration

screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistances were greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 6. CHECK THE STATUS OF THE AUXILIARY CONTROL

A. Actuate the auxiliary control.

B. Observe the status for the auxiliary hydraulics on the Caterpillar ET.

Expected Result:

The amperes for the auxiliary hydraulic status should be displaying values that are greater than "0.00".

Results:

- **OK -** The ampere for the auxiliary hydraulic status is displaying a value that is greater than "0.00".

  Repair: If there is no diagnostic codes that are present, the problem does not appear to be an electrical problem.

  Stop.

- **NOT OK -** The ampere for the auxiliary hydraulic status is displaying "0.00".

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01506256

General Information

SMCS - 7630

There are two diagnostic indicators that are associated with the interlock electronic control module (ECM). The indicators that are used are the parking brake indicator and the armrest indicator. The indicators will flash when there is a fault in the system.

Troubleshooting the ECM may require additional information from the machine Service Manual. The following items may be required.

- Electrical System Schematic
- Parts Manual
- Operation and Maintenance Manual

As a guide, a simplified system schematic is at the end of this manual. For a complete electrical system schematic, see the Electrical System Schematic in the machine Service Manual.

When the troubleshooting procedure instructs you to REPAIR THE HARNESS, use the Electrical System Schematic in the machine Service Manual in order to trace the circuit. Perform continuity checks at the connectors in order to locate harness failures. At component connectors, always check the ground circuit. Less than five ohms of resistance is required from the connectors to frame ground. Resistance that is greater than five ohms can cause an incorrect diagnosis of problems.

During troubleshooting, inspect all component and harness connections before any component is replaced. If these connections are not clean and tight the connections can cause electrical problems. The problems may be permanent or intermittent. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before any other tests are made.

Repairs of the machine harness should be performed with the wire of the same size. All joints should be soldered. All joints should be tightly taped or all joints should be covered with shrink sleeving. Use **1P-0810** Electrical Tape .

Failure of an electrical component can cause the failure of one or more components. Always attempt to find the cause of a problem and correct the problem before replacing a component.

Use the screw in the center of the connector in order to remove the connector from the ECM.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01410386

Service Tools

SMCS - 0785

The following service tools should be used in order to aid in troubleshooting the electrical system.

- **6V-7070** Digital Multimeter
- **9U-7330** Digital Multimeter
- **7X-1710** Multimeter Probe
- **8T-8726** Adapter Cable
- **6V-3000** Sure Seal Repair Kit
- **4C-3406** Deutsch Connector Repair Kit

Use the digital multimeter for making continuity checks or voltage measurements. For instruction on the use of the **6V-7070** Digital Multimeter, see Special Instruction, SEHS7734 for more information. The **7X-1710** Multimeter Probe is used in order to make measurements at the connectors without disconnecting the connectors. The probes are pushed in the back of the connector alongside the wire. The **8T-8726** Adapter Cable is a 3 pin breakout cable that is used in order to make measurements in sensor circuits.

Note: Do not use the **8T-0500** Continuity Light or **5P-7277** Voltage Tester on electrical circuits. These tools can be used for harness tests.

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247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

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i01995522

Electrical Component and Connector Locations

SMCS - 1408-546-CY; 7553-546



Illustration 1 g01032312

Access to the interlock ECM

The interlock ECM is located beneath the floor plate on the left side of the machine.

The Electrical System Schematic, Parts Manual and the Operation and Maintenance Manual are needed in order to locate the electrical components and connectors.

The following information is a guide for reading the Harness Connector and Component Location charts that are found on the back of the Electrical System Schematic.

The harness connector and the component location charts use white circles as location labels in the views of the machine. Numbers in the machine location columns of the charts represent the numbers in the white circles. The white circles are placed on a top view and a side view of the machine. The location of the white circles is representing the location of the connectors or the components. Connectors that are attached directly to components are not located separately from the component.

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247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01503943

Initial Troubleshooting Procedure

SMCS - 7569

Begin troubleshooting the interlock ECM by observing the machine operation and the two diagnostic indicators. These two indicators are located in the left headliner. The two diagnostic indicators are listed below.

- flashing parking brake indicator
- flashing armrest indicator



Illustration 1 g00731194

(1) Indicator (parking brake)

(2) Indicator (armrest)

If ANY fault occurs with the ECM or system components, one or both of the diagnostic indicators will flash.

Reference: See System Operation Section, "Diagnostic Operation" for more information.

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i01995530

Engine Does Not Crank

SMCS - 1453-038; 7630-038

System Operation Description:

The engine will not crank when the key start switch is in the START position.

Test Step 1. CHECK ARMREST INDICATOR



Illustration 1 g00731194

(1) Indicator (parking brake)

(2) Indicator (armrest)

A. Occupy the seat.

B. Lower the armrest.

C. Turn the key start switch to the ON position.

D. Check the status of the armrest indicator and the parking brake indicator.

Expected Result:

The armrest indicator should be off and the parking brake indicator should be on.

Results:

- **OK -** The armrest indicator is not illuminated and the parking brake indicator is illuminated. Proceed to Test Step 3.
- **NOT OK -** The armrest indicator and the parking brake indicator are off. Proceed to Test Step 2.
- **NOT OK -** The armrest indicator is illuminated or flashing.

  Repair: See Troubleshooting, "Armrest Indicator is Flashing".

  Stop.
- **NOT OK -** The parking brake indicator is flashing.

  Repair: See Troubleshooting, "Parking Brake Indicator is Flashing".

  Stop.

Test Step 2. CHECK THE FUSE FOR THE KEY START SWITCH



Illustration 2 g01032879

Fuse panel

A. Locate the fuse for the key start switch. Refer to Illustration 2.

B. Check for a blown fuse.

Expected Result:

The fuse should be good.

Results:

- **OK -** The fuse is good.

  Repair: See Troubleshooting, "Parking Brake Indicator and Armrest Indicator Do Not Function Correctly".

  Stop.

- **NOT OK -** The fuse is bad.

  Repair: Replace the fuse. See Operation and Maintenance Manual, "Circuit Breakers and Fuses - Reset/Replace".

  Stop.

Test Step 3. CHECK FOR VOLTAGE AT THE START RELAY

When the key start switch is in the START position, battery voltage is applied to the interlock ECM. The ECM sends power to the start relay.

A. Locate wire 306-GN and wire 202-BK on the start relay.

   Note: On machines that are equipped with the machine security system (MSS), locate wires A346-BU and M732-OR.

B. Turn the key start switch to the START position.

   Note: Two people will need to perform this procedure. One person will need to sit in the seat with the armrest down holding the key start switch in the START position.

C. Measure the voltage across the start relay coil from wire 306-GN to 202-BK.

   Note: On machines that are equipped with the machine security system (MSS), measure the voltage from wire A346-BU to wire M732-OR.

Expected Result:

The voltage should be equal to or greater than 10 DCV.

Results:

- **OK -** The voltage is equal to or greater than 10 DCV. Proceed to Test Step 4.
- **NOT OK -** The voltage is less than 10 DCV. Proceed to Test Step 8.

Test Step 4. CHECK FOR + BATTERY AT THE START RELAY

A. Measure the voltage at wire 109-RD on the start relay.

Expected Result:

The voltage should be equal to or greater than 10 DCV.

Results:

- **OK -** The voltage is equal to or greater than 10 DCV. Proceed to Test Step 5.
- **NOT OK -** The voltage is less than 10 DCV. Proceed to Test Step 7.

Test Step 5. CHECK THE OUTPUT OF THE START RELAY

A. Turn the key start switch to the START position.

   Note: Two people will need to perform this procedure. One person will need to sit in the seat with the armrest down holding the key start switch in the START position.

B. Measure the voltage at wire 304-WH on the start relay.

Expected Result:

The voltage should be equal to or greater than 10 DCV.

Results:

- **OK -** The voltage is equal to or greater than 10 DCV. Proceed to Test Step 6.
- **NOT OK -** The voltage is less than 10 DCV.

  Repair: The start relay has failed. Replace the start relay.

  Stop.

Test Step 6. CHECK THE VOLTAGE AT THE STARTING MOTOR

A. Locate wire 304-WH on the starting motor.

B. Turn the key start switch to the START position.

   Note: Two people will need to perform this procedure. One person will need to sit in the seat with the armrest down holding the key start switch to the START position.

C. Measure the voltage on wire 304-WH on the starting motor.

Expected Result:

The voltage should be equal to or greater than 10 DCV.

Results:

- **OK -** The voltage is equal to or greater than 10 DCV.

  Repair: The problem is in the starting motor. Check for loose connections. Repair the starting motor or replace the starting motor.

  Stop.

- **NOT OK -** The voltage is less than 10 DCV.

  Repair: The harness or the connectors from the start relay to the starting motor has failed. Repair the starting motor or replace the starting motor.

Stop.

Test Step 7. CHECK THE CIRCUIT BREAKER

A. Locate the main circuit breaker in the engine compartment on the left side.

B. Check for an open circuit breaker.

C. Check for voltage on both sides of the circuit breaker.

Expected Result:

The circuit breaker should be closed.

Results:

- **OK -** The circuit breaker is closed.

  Repair: There is a problem with battery voltage. See Diagnostic Function, "Electrical System".

  Stop.

- **NOT OK -** The circuit breaker is open.

  Repair: Reset the circuit breaker.

  Stop.

Test Step 8. CHECK THE KEY START SWITCH

A. Access the wiring for the key start switch.

B. Unplug the key start switch.

C. With the switch in the START position, check the resistance from terminal 3 to terminal 4.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms. Proceed to Test Step 9.
- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The key start switch has failed. Replace the key start switch.

  Stop.

Test Step 9. CHECK THE INPUT TO THE INTERLOCK ECM

A. Turn the key start switch to the OFF position.

B. Locate the interlock ECM.

C. Remove the harness from the interlock ECM.

D. Jumper contact 64 to contact 62 of the wire harness connector.

E. Turn the key start switch to the START position.

Expected Result:

The engine should crank.

Results:

- **OK -** The engine cranks.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The engine did not crank.

  Repair: If the machine is equipped with a machine security system (MSS), refer to the manual for the MSS .The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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i01995730

Solenoid Valve (Parking Brake) Does Not Function Correctly

SMCS - 5479-038-BRK

System Operation Description:

The parking brake solenoid has no diagnostics for checking for faults in the system. The solenoid will NOT be energized when there is an open circuit or a short to ground. If the parking brake solenoid is shorted to the +battery the solenoid will be ON all the time.

Test Step 1. CHECK FOR HYDROSTATIC OPERATION

A. Occupy the seat.

B. Lower the armrest.

C. Turn the key start switch to the ON position.

D. Press and release the parking brake switch.

Expected Result:

The hydrostatic system should energize.

Results:

- **OK -** The hydrostatic system energizes. Proceed to Test Step 2.
- **NOT OK -** The hydrostatic system does NOT energize.

  Repair: See Troubleshooting, "Switch (Parking Brake)".

  Stop.

Test Step 2. CHECK VOLTAGE AT THE SOLENOID VALVE WITH KEY SWITCH OFF

A. Turn the key start switch to the OFF position.

B. Locate the parking brake solenoid under the cab.

C. Disconnect the parking brake solenoid from the electrical connector.

D. Measure the voltage across the two contacts of the harness connector (A958-WH and G939-YL).

Expected Result:

The voltage should be less than 2 DCV.

Results:

- **OK -** The voltage is less than 2 DCV. Proceed to Test Step 3.
- **NOT OK -** The voltage is greater than 2 DCV.

  Repair: The wire harness is shorted to a + battery circuit. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 3. CHECK VOLTAGE AT THE SOLENOID VALVE WITH KEY SWITCH ON

A. Turn the key start switch to the ON position.

B. Measure the voltage across the two contacts of the harness connector (A958-WH and G939-YL).

Expected Result:

Voltage should be less than 2 DCV.

Results:

- **OK -** The voltage is less than 2 DCV. Proceed to Test Step 4.
- **NOT OK -** The voltage is greater than 2 DCV. Proceed to Test Step 6.

Test Step 4. CHECK THE VOLTAGE AT THE SOLENOID VALVE WHILE THE KEY SWITCH IS ON AND THE PARKING BRAKE IS RELEASED

A. Turn the key start switch to the ON position. Press and release the parking brake switch.

   Note: Two people will need to perform this procedure. One person will need to be sitting in the seat with the armrest in the DOWN position.

B. Measure the voltage across the two contacts of the harness connector (A958-WH and G939-YL).

Expected Result:

The voltage should be greater than 10 DCV.

Results:

- **OK -** The voltage is greater than 10 DCV. Proceed to Test Step 5.

- **NOT OK -** The voltage is less than 10 DCV. Proceed to Test Step 7.

Test Step 5. CHECK RESISTANCE OF THE SOLENOID

A. Measure the resistance between the two wires of the parking brake solenoid.

Expected Result:

The resistance should be 10 ± 2 Ohms.

Results:

- **OK -** The resistance is 10 ± 2 Ohms.

  Repair: The problem does NOT appear to be electrically related.

  Stop.

- **NOT OK -** The resistance is NOT 10 ± 2 Ohms.

  Repair: The solenoid has failed. Replace the solenoid.

  Stop.

Test Step 6. CHECK THE WIRE HARNESS FOR A SHORT CIRCUIT

A. Locate the Interlock ECM.

B. Disconnect the wire harness.

C. Turn the key start switch to the ON position.

D. Check the resistance from contact 13 of the wire harness to the following contacts: contact 1, contact 11, contact 24, contact 29, contact 62 and contact 70.

Expected Result:

The resistances should be above 2 Ohms.

Results:

- **OK -** The resistance readings are above 2 Ohms.

  Repair: The ECM is unlikely to fail. Terminate this procedure and restart the procedures. Verify all the readings.

  Stop.

- **NOT OK -** One or more resistance readings are below 2 Ohms.

  Repair: The wire harness has failed. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 7. CHECK THE WIRE HARNESS FOR CONTINUITY

A. Turn the key start switch to the OFF position.

B. Connect a jumper wire between wires A958-WH and G939-YL on the wire harness at the end of the parking brake solenoid.

C. Locate the Interlock ECM.

D. Disconnect the wire harness.

E. Check the resistance between pin 13 and pin 66 of the wire harness.

Expected Result:

The resistance should be less than 2 Ohms.

Results:

- **OK -** The resistance is less than 2 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is greater than 2 Ohms.

  Repair: The wire harness has failed. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting
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Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995723

Work Tool Does Not Function

SMCS - 6700-038; 7630-038

System Operation Description:

The Interlock ECM will NOT engage the work tool pilot solenoid if problems exist with the parking brake switch or the work tool pilot solenoid.

Note: Use a jumper wire on machines that do NOT use a lockout switch for the work tool. The jumper wire is **165-0312** Wire Assembly. This jumper wire is fastened to the harness in place of the switch. The jumper must be connected in order to allow both the primary work tool and the auxiliary work tool to operate.

Test Step 1. CHECK THE FAULT INDICATORS

A. Occupy the seat.

B. Lower the armrest.

C. Turn the key start switch to the ON position.

D. Press and release the parking brake switch.

Expected Result:

The armrest indicator and the parking brake indicator should be off.

Results:

- **OK -** The armrest indicator and the parking brake indicator are off. Proceed to Test Step 2.
- **NOT OK -** The parking brake indicator remains on.

  Repair: See Troubleshooting, "Switch (Parking Brake)".

  Stop.

Test Step 2. CHECK THE CIRCUIT OF THE WORK TOOL PILOT SOLENOID

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 24 to contact 68 (wire P988-OR to wire 975-WH) of the wire harness connector.

Expected Result:

The resistance should be approximately 6 Ohms.

Results:

- **OK -** The resistance is approximately 6 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not approximately 6 Ohms. Proceed to Test Step 3.

Test Step 3. CHECK THE RESISTANCE OF THE WORK TOOL PILOT SOLENOID

A. Locate the work tool pilot solenoid.

B. Disconnect the wire harness from the work tool pilot solenoid.

C. Measure the resistance of the two wires on the work tool pilot solenoid.

Expected Result:

The resistance should be approximately 10.5 Ohms.

Results:

- **OK -** The resistance is approximately 10.5 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is not approximately 10.5 Ohms.

  Repair: The solenoid has failed. Replace the coil.

  Stop.

Test Step 4. CHECK THE RESISTANCE OF THE WORK TOOL DETENT COIL

A. Locate the work tool detent coil. The detent coil is located beneath the right hand joystick. Remove the access panel in order to get to the connector.

B. Disconnect the wire harness from the work tool detent coil .

C. Measure the resistance of the two wires on the work tool detent coil.

Expected Result:

The resistance should be approximately 10.5 Ohms.

Results:

- **OK -** The resistance is approximately 10.5 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The resistance is not approximately 10.5 Ohms.

  Repair: The work tool detent coil has failed. Replace the the work tool detent coil.

  Stop.

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Troubleshooting
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Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01395060

Electrical System

SMCS - 1406-038; 1408-038

System Operation Description:

The Interlock ECM has no operation or the Interlock ECM has intermittent operation.

The Interlock ECM is not able to diagnose problems with the electrical system voltage. System under voltages will result in intermittent operation as the voltage drops below the solenoid pull-in voltage or the solenoid hold-in voltage.

If the machine is equipped with auxiliary hydraulics use the troubleshooting procedure that is provided for the auxiliary hydraulics in order to minimize the effort.

Test Step 1. CHECK THE BATTERY VOLTAGE

A. Start the engine and run at high idle for several minutes.

B. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be greater than 12 DCV.

Results:

- **OK -** The voltage is greater than 12 DCV. Proceed to Test Step 1.
- **NOT OK -** The voltage is less than 12 DCV.

  Repair: The charging system has failed. Check the charging system for the problem.

  Stop.

Test Step 2. CHECK THE SYSTEM VOLTAGE AT THE INTERLOCK ECM

A. Locate the Interlock ECM.

B. Remove the wire harness from the ECM.

C. Measure the voltage between pin 1 and pin 3 (wire 126-PK and wire 201-BK).

Expected Result:

The voltage should be greater than 12 DCV.

Results:

- **OK -** The voltage is greater than 12 DCV.

  Repair: The Interlock ECM is very unlikely to fail. Check all connectors for tightness. Verify the problem before replacing the ECM.

  Stop.

- **NOT OK -** The voltage is less than 12 DCV.

  Repair: The wire harness and/or a connector has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Charging System

SMCS - 1406-038

System Operation Description:

Table 1

Alternator Specifications		
	Peak Current Rating (Amps)	**Minimum Peak Current (Amps)**
12 V Alternators		
8C-5535	32	28
7N-4784 , OR-5201	40	36
6T-1396 , 7T-2096 , 8C-5908 , OR-3654	51	46
9W-2648 , 9W-2949 , 8T-9700 , 105-2811 (IG), OR-4327 (IG), 105-2812 (IG), OR-9273 (IG), 34-3268 , 68-4139 , 3E-7295 (D+), 7T-2876 (D+), 100-8223	55	49
7G-7889	60	54
8C-5510 (I), OR5200	61	55
8N-2268	75	68
3E-7892 , OR-3616	85	77
105-2813 (IG), OR-9274 (IG), 105-2814 (IG), OR-4328 (IG), 149-2064 (REG), OR-9410 (REG), 9X-0341 (D+)	90	81
8C-6163 , OR-1699 , 107-2519	105	95
167-7816	110	99

9X-6796 , 9X-9096 , 121-4134 , 121-4136 , OR-3527	115	104
3E-8827 , 121-4135 , 117-1379 (I)	130	117
152-8746	135	122
125-9597 , OR-8332	145	131
24 V Alternators		
2P-1204 , 3Y-8200	19	17
2Y-8310	21	19
6T-1395 , 7T-2095 , OR-3653	33	30
6N-9294 , OR-5217 , OR-3482	35	32
5N-5692 , OR-2698	45	41
5S-9088 , 100-5047 , 112-5041 , 3E-7578 , OR-5206 , OR-3667 , OR-3668	50	45
109-2362 , 9W-3043 , OR-3652 (D+), 112-8032	55	50
3E-7772 (IG), OR-9437 (IG), 105-3132 (IG), 4N-3986 , OR-5203	60	54
155-7434 , 132-2156 (I), 107-7977 (I), OR-8279 (I)	70	63
169-4319 , 167-7812	75	67.5
107-7976 , 114-2401 , OR-8997 , 3E-7577 , OR-3615	75	68
165-5140	100	90
9X-7803 , OR-3749	100	90
Parts-Service Only Discontinued 12 V Alternators		
6T-1193	18	16
7N-6118 , 6N-5460 , 4N-4540	40	36
6T-1195	42	38
7X-1340	45	41
9G-6079 , 6T-1194	63	57
Parts-Service Only Discontinued 24 V Alternators		
9G-6081 , 6T-1196	40	36
D+ - Diode trio output. Alternator requires external excitation.		
REG - Regulator Terminal. Alternator requires external excitation.		
I - Ignition Terminal. Alternator can be externally excited through this terminal.		

IG - Ignition Terminal. System voltage must be supplied to this terminal to turn on the alternator. Some of these alternators use the IG terminal as a sense terminal.

Often when problems with the charging system are being investigated, the alternator is not the problem. If a low battery condition is present test the batteries first. See Special Instruction, SEHS7633, "Battery Test Procedure" for more information. If the engine cranks slowly, then test the starting system. See Service Magazine, SEPD0020, "Testing The Starter On The Engine" for more information. If a warning indicator for the charging system is ON, see Service Magazine, SEBD1751, "Difference Between Alternator Indicator In Electronic Monitoring System (EMS) And Low Voltage Indicator In Operating Monitoring System (OMS)".

Note: Severely discharged batteries can cause low system voltage. Severely discharged batteries can occur even while the engine is running above idle, and the alternator is working properly. Proper low engine idle is also important.

Test Step 1. DETERMINE THE ALTERNATOR EXCITATION METHOD.

A. Check the rear of your alternator in order to determine the method of excitation. See table 1 in order to verify the proper alternator excitation.

Expected Result:

Test method 1. These alternators have a "1", "REG", or "D+" terminal. Test method 2. These alternators are self-excited. Test method 3. These alternators have a "IG" terminal.

Results:

- **Method 1 -** The alternator has a "1", "REG", or "D+" terminal. Proceed to test step 2.
- **Method 2 -** The alternator is self-excited. Proceed to test step 4.
- **Method 3 -** The alternator has an "IG" terminal. Proceed to test step 3.

Test Step 2. CHECK THE RESISTANCE IN THE EXCITATION CIRCUIT.

A. Turn the key start switch to the ON position.

B. Verify voltage at the excitation terminal. Connect the red lead from a multimeter to the excitation terminal. Connect the black lead to a ground source (alternator case ground).

C. Read the voltage that is shown on the multimeter.

Expected Result:

The voltage reads at least .2 volts.

Results:

- **YES -** The voltage reads .2 volts or more. The excitation circuit is correct. Proceed to test step 4.
- **NO -** The voltage is less than .2 volts. There is a problem in the wiring harness to the alternator or there is a poor electrical connection. Correct the problem and operate the generator set. Watch for a recurrence of the problem.**STOP**

Test Step 3. CHECK THE RESISTANCE IN THE EXCITATION CIRCUIT (CONTINUED).

Note: This step is only for alternators with external excitation when the terminal for excitation is labeled: "IG".

A. Turn the key start switch to the ON position.

B. Verify voltage at the excitation terminal. Connect the red lead from a multimeter to the excitation terminal. Connect the black test lead to a ground source (alternator case ground).

Note: For G3B, K3A, and L3A alternators, Insert a **7X-1710** Multimeter Probe Group into the rear of the middle wire in the connector. See figure 1 below. Insert the probes spoon lead between the seal and the wire that surrounds the wire and the outer shell of the connector. Do not insert the probe between the wire insulation and the black seal. This terminal (IG) is the terminal for excitation.



Illustration 1 g00496660

Special wire probe technique for G3B, K3A, L3A alternators.

C. Read the voltage that is shown on the multimeter.

Expected Result:

The voltage measurement is within .5 volts of the battery voltage.

Results:

- **YES -** The voltage reads battery voltage. The excitation circuit is correct. 4
- **NO -** The voltage that is measured is more than a .5 volt less than the battery voltage. There is a problem in the wiring harness to the alternator or there is a poor electrical connection.

Correct the problem and operate the generator set. Watch for a recurrence of the problem.**STOP**

Test Step 4. CHECK THE SYSTEM VOLTAGE.

A. Before you start the generator set, connect a voltmeter between the "B+" terminal and the case of the alternator. Turn OFF all electrical loads.

B. Turn the key to the ON position but do not start the engine. Read the voltage on the voltmeter. Make a note of the voltage that was measured.

Expected Result:

This voltage should be approximately system voltage.

Results:

- **YES -** The voltage is approximately system voltage. Proceed to test step 5.
- **NO -** The voltage is less than system voltage. Proceed to test step 7.

Test Step 5. CHECK THE OPERATION OF THE ALTERNATOR.

A. The voltmeter remains connected between the "B+" terminal and the case of the alternator.

B. Start the generator set. Set the throttle to at least 75 percent. Read the voltage on the voltmeter. Make a note of the voltage that was measured.

Expected Result:

The voltage measurement is greater than the voltage that was recorded in the previous test step "Check The System Voltage".

Results:

- **VOLTAGE HIGHER -** The voltage measurement is greater than the voltage that was observed in the previous test step "Check The System Voltage". The voltage is also less than the maximum voltage that is listed in the specifications for the alternator. The alternator is partially charging the battery. Proceed to test step 6.
- **VOLTGE TOO HIGH -** The voltage measurement is greater than the voltage that was observed in the previous test step "Check The System Voltage". The voltage is also greater than the maximum voltage that is listed in the specifications for the alternator. The alternator is over charging. Proceed to test step 19.
- **VOLTAGE LOWER -** The voltage is not higher than the voltage that was observed in the previous test step. Proceed to test step 7.

Test Step 6. TEST THE ALTERNATOR OUTPUT.

Note: For the proper output current, refer to table 1.

A. Ensure that the batteries are NOT fully charged.

Note: A fully charged battery may have open circuit voltage above 12.5 V on 12 V systems. 24 V systems may be as high as 25 V.

B. If the batteries are fully charged, then crank the engine for 30 seconds. This action reduces the battery voltage. Operate the lights for 10 minutes while the engine is off as an alternative.

C. Connect the **9U-5795** Current Probe to a DMM (digital multimeter) or use the **225-8266** Ammeter Tool Gp . The multimeter must have a peak hold feature. Clamp the probe around the alternator output wire "B+". Before you clamp the probe around the wire, ensure that the probe is "zeroed".

D. Set the digital multimeter to "peak hold" or "max mode" on the "mV" scale.

E. Turn on all electrical accessories: lights, air conditioning and radio.

F. Start the generator set, and immediately set the throttle to at least 75%. The peak current will appear on the voltmeter in "peak hold" or "max" mode.

Expected Result:

The current reading should be at least 90% of the specified peak output.

Results:

- **YES -** The current is at least 90% of the specified peak output. Proceed to test step 13.
- **NO -** The current is less than 90% of the specified peak output. Proceed to test step 7.

Test Step 7. CHECK THE DRIVE SYSTEM OF THE ALTERNATOR.

A. Check the condition of the alternator drive belt. Clean the pulley and replace the drive belt if the drive belt is oily. Dry the drive belt if the belt is wet. Replace the drive belt, if the belt is worn.

B. Check the tension of the alternator drive belt. Adjust the drive belt to the correct tension.

C. Check the nut on the alternator pulley. Tighten the nut if the nut is loose.

Expected Result:

The drive system of the alternator is functioning correctly. No corrections to the drive system were necessary.

Results:

- **YES -** The drive system of the alternator is functioning correctly. No corrections were necessary. Proceed to test step 8.
- **NO -** The drive system of the alternator was not functioning correctly. Corrections were necessary.

  Repair: Ensure that the problems have been corrected. Exit this procedure and retest the alternator charging system.

STOP

Test Step 8. TEST THE CHARGING CIRCUIT.

A. Verify that the nut on the "B+" alternator terminal is tight. Also, verify that the wire has a good connection to the "B+" terminal.

B. Start the engine and set the throttle to at least 75 percent. Turn ON all electrical accessories for the remainder of this test step. Allow the engine to run for at least 3 minutes before continuing.

C. Measure the voltage between the "B+" alternator terminal and the alternator case ground. Make a note of the measured voltage. Perform the next measurement immediately.

D. Measure the voltage across the battery. Put the red lead on the battery positive terminal, and put the black lead on the battery negative terminal. Make a note of the voltage that was measured.

Expected Result:

The voltage at the battery should be less than the voltage at the alternator. The difference in voltages should not be more than 1 V on 12 V systems. The difference should not be more than 2 V on 24 V systems.

Results:

- **YES -** The voltage at the battery is less than the voltage at the alternator. Also, the difference in voltages is less than 1 V for 12 V systems and the difference is less than 2 V for 24 V systems. The wiring that is related to the alternator is correct at this time.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

  STOP

- **NO -** The voltage at the battery is less than the voltage at the alternator. However, the difference in voltages is greater than 1 V for 12 V systems and the difference is greater than 2 V for 24 V systems. Proceed to test step 9.

Test Step 9. TEST THE POSITIVE SIDE OF THE CHARGING CIRCUIT.

A. Measure the voltage between the frame ground and the "B+" alternator terminal. Make a note of the voltage that was measured. Perform the next measurement immediately.

B. Measure the voltage between the frame ground and the + battery post. Make a note of the voltage that was measured.

Expected Result:

The voltage difference does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- **YES -** The voltage difference does not exceed the tolerance. The positive circuit is good. Proceed to test step 10.

- **NO -** The voltage difference exceeds the tolerance.

  Repair: There is high resistance in the positive side of the charging circuit that is caused by one of the following conditions:

  - An electrical connection has loosened.
  - An electrical connection has corroded.
  - The main relay has failed.
  - A circuit breaker has failed.

  Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP

Test Step 10. TEST THE NEGATIVE SIDE OF THE CHARGING CIRCUIT.

A. Check the voltage between the negative battery post and the alternator case ground.

Expected Result:

The voltage does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- **YES -** The voltage difference does not exceed the tolerance. The negative circuit is good. Proceed to test step 11.
- **NO -** The voltage difference exceeds the tolerance.

  Repair: There is high resistance in the negative side of the charging circuit that is caused by one of the following conditions:

  - An electrical connection has loosened.
  - The alternator ground has loosened.
  - The engine ground has opened.

  Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP

Test Step 11. TEST THE CIRCUIT OF THE "R" TERMINAL.

A. Start the engine and set the throttle to at least 75%.

B. Connect a voltmeter between the "B+" terminal and the alternator case ground.

C. Disconnect the wire from the "R" terminal. Select "YES" if the "R" terminal is not used on the generator set.

Expected Result:

The voltage does not change.

Results:

- **YES -** The voltage does not change. Proceed to test step 12.
- **NO -** The voltage rises and the alternator begins charging.

  Repair: The wire to the "R" terminal is shorted. Repair the wiring or replace the wiring. Exit this procedure and retest the alternator charging system.

  STOP

Test Step 12. RESTORE THE RESIDUAL MAGNETISM OF THE ROTOR.

A. Connect one end of a jumper wire to the "B+" terminal (D+ terminal for the K1, N1, and N3 Series alternators) of the alternator.

B. Connect the other end of the jumper wire to the "R" terminal of the alternator for 2 seconds.

Expected Result:

The voltage output rises on the "B+" terminal. The residual magnetism of the rotor has been restored.

Results:

- **YES -** The voltage output rises. The residual magnetism of the rotor has been restored. The alternator is now charging.

  Repair: Exit this procedure and retest the alternator charging system.

  STOP

- **NO -** The voltage output does not rise.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

  STOP

Test Step 13. TEST FOR UNDESIRABLE CURRENT FLOW IN THE ALTERNATOR CHARGING SYSTEM.

A. Turn off all of the accessories. Turn the keyswitch to the OFF position.

B. Clamp a **9U-5795** Current Probe or a **225-8266** Ammeter Tool Gp around the main ground cable. Clamp the tool with the positive side away from the battery. Reset the probe (zero) before you clamp the probe around the wire. Read the current on the meter. Make a note of the current that was measured.

Expected Result:

The current is below 2 A. The "YES" selection is dependent on the presence of a main disconnect switch on the generator set that is being tested.

Results:

- **YES - WITH DISCONNECT SWITCH -** The current is below 2 A. For generator sets with a main disconnect switch, proceed to test step 14.
- **YES - WITHOUT DISCONNECT SWITCH -** The current is below 2 A. For generator sets without a main disconnect switch, proceed to test step 15.
- **NO -** The current is above 2 A. There is a current draw in the system. Proceed to test step 16.

Test Step 14. MEASURE THE CURRENT OF THE SYSTEM BY USING THE MAIN DISCONNECT SWITCH.

A. Turn the disconnect switch to the ON position.

B. Connect a multimeter across the disconnect switch terminals. Connect the red lead to the terminal on the frame side. Connect the black lead to the terminal on the battery side. Use the 10A connections in order to avoid damage.

C. Turn the disconnect switch to the OFF position and read the current. Make a note of the measured current.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. Contact a Caterpillar dealer for more information.

Expected Result:

The current is below 0.050 A (50 mA).

Results:

- **YES -** The current is below 0.050 A. The charging system is functioning properly at this time. The failure is possibly an intermittent draw in the system. The batteries may have failed. Ensure that NO accessories were ON during the test. Exit this procedure and retest the alternator charging system.**STOP**
- **NO -** The current is above 0.050 A. There is a draw in the system. Proceed to test step 16.

Test Step 15. MEASURE THE CURRENT OF THE SYSTEM BY REMOVING THE NEGATIVE BATTERY CABLE.

A. Disconnect the ground cable from the negative battery post. There may be more than one battery that is connected to ground. Disconnect all of the batteries that are connected to ground. Do not disconnect cables that are between batteries that are connected in series.

B. Connect a multimeter between the disconnected battery ground cable and one of the negative battery terminals. Connect the red positive lead of the multimeter to the cable. The negative lead should be connected to the battery terminal. Use the 10 A connections in order to avoid damage.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. Contact a Caterpillar dealer for more information.

Expected Result:

The current is below .050 amperes (50 mA).

Results:

- **YES -** The current is below 0.050 A. The charging system is currently good. The problem is a possible intermittent current draw in the system. The batteries may have failed. Check that NO accessories were ON during the test.**STOP**
- **NO -** The current is above 0.050 A. There is excessive current flow in the system. Proceed to test step 16.

Test Step 16. TEST THE CURRENT OF THE ALTERNATOR OUTPUT BELOW 2 AMPERES.

A. Turn the keyswitch to the OFF position.

B. Connect the **9U-5795** Current Probe to a DMM (digital multimeter) or use the **225-8266** Ammeter Tool Gp . Clamp the probe around the "B+" wire of the alternator. Before you clamp the probe around the wire, ensure that the probe is "zeroed".

C. Read the current on the meter. Make a note of the current that was measured.

Expected Result:

The current is under 2 A.

Results:

- **YES -** The current is under 2 A. Proceed to test step17.
- **NO -** The current is over 2 A.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP

Test Step 17. TEST THE OUTPUT CURRENT OF THE ALTERNATOR BELOW 0.015 AMPERES.

A. Disconnect the wire from the "B+" terminal of the alternator. Set the multimeter on the 10 amp scale. Connect the red lead of the multimeter to the wire that was disconnected. Connect the black lead of the multimeter to the "B+" terminal of the alternator. Make a note of the current that was measured.

Expected Result:

The current is less than 0.015 A.

Results:

- **YES -** The current is under 0.015 A. The alternator is operating correctly. There may be a current draw on the generator set. Proceed to test step 18.
- **NO -** The current is over 0.015 A.

  Repair: There is an internal problem with the alternator. Repair or replace the alternator.

STOP

Test Step 18. IDENTIFY THE SOURCE OF EXCESSIVE CURRENT DRAW.

A. Make sure that every electrical component is turned OFF. Make sure that the keyswitch is turned OFF. Make sure that the dome lights are OFF.

B. Clamp a **9U-5795** Current Probe or a **225-8266** Ammeter Tool Gp around the main ground cable. Clamp the tool with the positive side away from the battery. Reset the probe (zero) before clamping the probe around the wire. Use the current probe if the draw is above approximately 2 A. Use the Ammeter if the draw is below approximately 2 A.

C. Remove the fuses or open the circuit breakers one at a time. Check the current after each fuse has been removed or each circuit breaker has been opened. After observing the current, reinstall the fuse or close the circuit breaker. Start with the main circuits first, and proceed to smaller circuits.

D. Check if any components on the circuit are ON.

E. If everything is OFF, then disconnect electrical components on the circuit one at a time. Monitor the current after each component is disconnected.

F. All of the components in the circuit should be disconnected. If the problem still exists, then check the wiring in the circuit. There may be circuit leakage through corrosion or circuit leakage through a short.

Note: The standard acceptable current draw is 50 mA. A current draw above 50 mA usually indicates a problem. Contact a Caterpillar dealer for more information.

Expected Result:

The source of the excessive current draw was determined.

Results:

- **YES -** The source of the excessive current draw was determined.

  Repair: Repair the problem or replace any component that has failed. Exit this procedure and retest the alternator charging system.

  STOP

- **NO -** The source of the excessive current draw was not determined.

  Repair: Exit this procedure and retest the alternator charging system.

  STOP

Test Step 19. TEST FOR AN OVERCHARGING CONDITION FROM THE ALTERNATOR.

A. Verify that the nut on the "B+" alternator terminal is tight. Also, verify that the wire has a good connection to the "B+" terminal.

B. Start the engine and set the throttle to at least 75 percent. Turn ON all electrical accessories for the remainder of this test step. Allow the engine to run for at least 3 minutes before continuing.

C. Measure the voltage between the "B+" terminal of the alternator and the case of the alternator. Make a note of the voltage that was measured. Perform the next measurement immediately.

D. Measure the voltage across the battery. Put the red lead on the positive terminal of the battery, and put the black lead on the negative terminal of the battery. Make a note of the voltage that was measured.

Expected Result:

The voltage at the battery should be less than the voltage at the alternator. On systems that are 12 V, the difference in voltages should not be more than 1 V. On systems that are 24 V, the difference should not be more than 2 V.

Results:

- **YES -** The voltage at the battery is less than the voltage at the alternator. Also, the difference in voltages is less than 1 V for 12 V systems and the difference is less than 2 V for 24 V systems. The wiring that is related to the alternator is correct at this time.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP

- **NO -** The voltage at the battery is less than the voltage at the alternator. However, the difference in voltages is greater than 1 V for 12 V systems and the difference is greater than 2 V for 24 V systems. Proceed to test step 20.

Test Step 20. TEST THE POSITIVE SIDE OF THE CHARGING CIRCUIT.

A. Measure the voltage between the frame of the generator set and the "B+" terminal of the alternator. Make a note of the voltage that was measured. Perform the next measurement immediately.

B. Measure the voltage between the frame of the generator set and the positive terminal of the battery. Make a note of the voltage that was measured.

Expected Result:

The voltage difference does not exceed 1 V on 24 V systems or 0.5 V on 12 V systems.

Results:

- **VOLTAGE OK - ALT. WITHOUT IG/S TERM. -** The voltage difference does not exceed the tolerance. The positive circuit is good.

  Repair: There is an internal problem with the alternator. Repair or Replace the alternator.

  STOP

- **VOLTAGE EXCESSIVE - ALL ALT. -** The voltage difference exceeds the tolerance.

Repair: There is high resistance in the positive side of the charging circuit that is caused by one of the following conditions:

- An electrical connection has loosened.
- An electrical connection has corroded.
- The main relay has failed.
- A circuit breaker has failed.

Correct the problem. Exit this procedure and retest the alternator charging system.

STOP

- **VOLTAGE OK - ALT. WITH IG/S TERM. -** The voltage difference does not exceed the tolerance. The positive circuit is good. Proceed to test step 21.

Test Step 21. ALTERNATOR OVERCHARGING TEST.

A. Start the engine and set the throttle to at least 75 percent.

B. Measure the voltage between the sense terminal (S) and/or the "IG" terminal to the case of the alternator.

Expected Result:

The voltage at the "S" terminal and/or "IG" terminal is above the specification.

Results:

- **YES -** The measured voltage exceeds the specification. There is an internal malfunction in the alternator. See the appropriate service manual for the alternator in order to test the internal components and connections.**STOP**
- **NO -** The measured voltage is below the measurement that was taken in the initial tests (B+ to alternator case). The sense circuit in the generator set has high resistance. Correct the problem. Exit this procedure and retest the alternator charging system.**STOP**

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General Information

SMCS - 7631

Failure of an electrical component can cause the failure of other components. Also, failure of an electrical component can be caused by the failure of other components. Always attempt to correct the cause of an electrical system failure before you replace a component.

Note: If you suspect that there is a problem with the Machine Security System, ensure that the machine's starting system is working properly. Use the electrical system schematic to troubleshoot the starting circuit.

Note: Electronic control modules seldom fail. Perform the troubleshooting procedures that are provided in the Troubleshooting, "Symptom Procedures" section of this manual, before you replace an ECM.

Test procedures progress from the most likely points of failure to the least likely points of failure. The procedures normally proceed in the following order:

- A component is bad.
- Wiring or connectors are bad.
- An electronic module is bad.

Each procedure assumes the following data:

- No previous troubleshooting has been performed on the system.
- The system has not been altered.

Assume for repair:

- The batteries are fully charged and the charging system is operating properly.
- Caterpillar Electronic Technician (ET) is available and the technician is trained on the operation of Cat ET. See Troubleshooting, "Service Tools".

During troubleshooting, inspect all connections before any component is replaced. If the connections are not clean and tight, permanent electrical problems or intermittent electrical

problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

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Service Tools

SMCS - 0785

Standard Caterpillar tools should be adequate for service. The following tools are needed to troubleshoot the Machine Security System:

Table 1

Service Tools	
Part Number	**Description**
9U-7246	Connector Repair Kit
7X-1710	Multimeter Probe
8T-5318	Wire Removal Tool
6V-7070	Digital Multimeter
4C-4911	Battery Load Tester

In addition to the tools that are listed in Table 1, a laptop computer with the Caterpillar Electronic Technician (ET) and the communication adapter are required.

The Caterpillar Electronic Technician 2004 SP1 or later is required to use the full security management potential of the Machine Security System.

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Troubleshooting
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

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Electrical Component and Connector Locations

SMCS - 1408-546-CY; 7553-546

The locations of the components of the MSS will vary between machines. If the MSS was installed by a Caterpillar dealer, consult the installation instructions for component locations. If the MSS was an attachment that was installed at the factory, consult the electrical schematic for that machine.

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Symptom Troubleshooting

SMCS - 7000-035

Use the following guidelines as you troubleshoot a symptom:

Know the Machine

Understand the operation of the machine. Know if the symptom is a characteristic of normal operation or if the symptom is a failure.

Use Available Service Literature

Read the systems operation information in order to understand the systems of the machine. Understand the interaction of the machine systems.

Use all available service literature to understand the systems of the machine and perform troubleshooting. Troubleshooting the machine security system (MSS) system may require additional information from the Service Manual of the machine. Following is a list of books that may be useful:

- Electrical Schematic
- Systems Operation / Testing and Adjusting
- Troubleshooting / Systems Operation / Testing and Adjusting
- Systems Operation / Testing and Adjusting

Understand the Symptom

Speak with the operator about the symptom. Acquire the following Information:

- The performance of the machine prior to the failure
- First occurrence of the symptom
- The operating conditions at the time of the failure

- The sequence of events prior to the failure (order of the occurrences)
- The troubleshooting steps that have been taken
- The history of repairs of the machine
- The preventive maintenance of the machine
- Related service information about current problems that affect the serial number of the machine
- Inspect the Machine. Look for problems. Notice any unusual odors in the air. Listen for unusual noises.

Verify the Symptom

When possible, attempt to duplicate the symptom. Operate the machine and repeat the conditions that caused the failure. Check the gauges inside the cab. Notice any unusual odors in the air. Listen for unusual noises.

Determine if the electronic control module (ECM) has detected any faults. A diagnostic code is used to specify each detected fault.

Determine Possible Causes

Use the information from the operator and your inspection. Attempt to identify a common cause if there is more than one symptom.

Test and Repair the System

Use the tests and procedures in this manual to verify the cause of the symptom. Once the cause has been identified, repair the failure. Then, test the system again to verify that the symptom is resolved.

Provide Feedback to Caterpillar

Share your troubleshooting information. Provide Caterpillar feedback after the correct repair has been performed. Use the form in SISweb or CBT feedback to write a brief description about the symptom, testing, and repair of the machine. Include your phone number or your e-mail address so that you can be contacted. This feedback information helps Caterpillar improve service information.

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Machine Security System
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i04008493

Emerging Symptom Information

SMCS - 7000-035

This space is for new information for this product.

Note: Use the Service Information System (SIS) on the Web to find the most up-to-date information.

To share your knowledge of symptoms: please use the form in SISweb or CBT feedback to write a brief description about the symptom, testing, and repair of the machine. Your feedback information will help Caterpillar improve the service information for this product.

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Lost Key

SMCS - 7631-038-KEY

Lost Key

1. Use another valid key to start the machine.
2. Program another key into the control module. Refer to the Testing and Adjusting, "Key - Program" section of this manual for additional information.
3. Contact your Caterpillar dealer.

Note: If a key is lost, the key should be deleted from the list of authorized keys.

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Engine Does Not Crank and Status Indicator Is Green

SMCS - 7631-038

System Operation Description:

The green LED of the status indicator informs the operator that the machine security system (MSS) ECM has recognized a valid key. The problem may be unrelated to the MSS. The source of the problem that is preventing an engine start can come from several sources. Ensure that all of the standard requirements for starting the machine have been met. A few examples of the requirements are listed here:

- Interlocks in the operator seat
- Hydraulic interlocks
- Gear of the machine
- Fuel level

This troubleshooting procedure will eliminate the MSS as a source of the starting problem.

Note: The wires that are identified in this procedure are not present on every machine. If the wire that is identified in this procedure is not present, proceed to the next Test Step.

Test Step 1. CHECK THE CAT DATA-LINK.

A. Connect the Caterpillar Electronic Technician (Cat ET) service tool to the machine.

B. Use a valid key to turn the keyswitch to the ON position.

C. Use the Cat ET service tool to determine the status of the Cat data-link.

Expected Result:

The Cat data-link is communicating with all the ECMs that are installed on the machine.

Note: Some machines are equipped with only the MSS ECM.

Results:

- **YES -** The Cat data-link is communicating with all the ECMs that are installed on the machine. Proceed to Test Step 2.
- **NO -** The Cat data-link is not communicating with all the ECMs that are installed on the machine. The Cat data-link has failed.

  Repair: Repair the Cat data-link circuits in the harness.

  STOP

Test Step 2. CHECK THE SYSTEM VOLTAGE AT THE MSS ECM.

A. Measure the voltage between pin 1 and pin 3 of the MSS ECM.

Expected Result:

The voltage is approximately system voltage.

Results:

- **YES -** The voltage is approximately system voltage. Proceed to Test Step 3.
- **NO -** The voltage is not approximately system voltage.

  Repair: Check the battery and the associated wiring in the machine harness.

  STOP

Test Step 3. CHECK THE VOLTAGE FROM THE KEY SWITCH TO THE DRIVER (INPUT No. 1) OF THE ECM.

A. Turn the keyswitch to the ON position.

B. Measure the voltage between pin 9 and pin 3 if the wires are present. Record the reading.

C. Measure the voltage between pin 24 and pin 3 and record the reading.

D. Measure the voltage between pin 64 and pin 3 if the wires are present. Record the reading.

Expected Result:

Voltage should be present for all of the measurements. The voltage should be within 10% of the machine battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. The ECM is receiving voltage. Proceed to Test Step 4.
- **NO -** The voltage was not correct, or no voltage was present.

  Repair: Check the harness for signs of damage. Repair or replace the harness.

  STOP

Test Step 4. CHECK THE VOLTAGE FROM THE KEY SWITCH TO THE DRIVER (INPUT No. 2) OF THE ECM.

A. Turn and hold the keyswitch in the START position.

B. Measure the voltage between pin 18 and pin 3 with the wires present. Record the reading.

C. Measure the voltage between pin 31 and pin 3 and record the reading.

Expected Result:

Voltage should be present for all measurements. The voltage should be within 10% of the battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. The ECM is receiving voltage. Proceed to Test Step 5.
- **NO -** The voltage was not correct, or no voltage was present.

  Repair: Check the harness for signs of damage. Repair or replace the harness.

  STOP

Test Step 5. CHECK THE DRIVER (OUTPUT No. 1) VOLTAGE.

Note: The output drivers of the MSS ECM are protected from excessive electrical current. Excessive electrical current is usually the result of a wire or a component that is shorted to ground. If the MSS ECM detects an excessive amount of electrical current, the MSS ECM will disable the output driver.

A. Place the keyswitch in the ON position. With **7X-1710** Multimeter Probes check for voltage between pin 58 and pin 11 with the wires present. Do not disconnect the connector from the MSS ECM.

Expected Result:

Voltage should be present. The voltage should be within 10% of the machine battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. Proceed to Test Step 6.
- **NO -** The voltage was not correct. Proceed to Test Step 7.

Test Step 6. CHECK THE DRIVER (OUTPUT No. 2) VOLTAGE.

Note: The output drivers of the MSS ECM are protected from excessive electrical current. Excessive electrical current is usually the result of a wire or a component that is shorted to ground. If the MSS ECM detects an excessive amount of electrical current, the MSS ECM will disable the output driver.

A. With the keyswitch in the START position, check for voltage between pin 52 and pin 5 with the wires present.

Expected Result:

Voltage should be present. The voltage should be within 10% of the machine battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. The ECM is sending voltage to the driven components that will start the machine.

  Repair: The MSS has not caused the problem. Verify that the driven components are receiving voltage by measuring at the component. Consult the troubleshooting manual for the engine.

  STOP

- **NO -** The voltage was not correct. Proceed to Test Step 9.

Test Step 7. CHECK FOR A FAILED COMPONENT ON OUTPUT DRIVER (No. 1).

A. Turn the keyswitch and the disconnect switch to the OFF position. If the machine is not equipped with a disconnect switch, remove the negative wire from the battery.

B. Disconnect the harness connector from the solenoid or the relay that is controlled by the output driver (No. 1).

C. Turn the disconnect switch and the keyswitch to the ON position. If the machine is not equipped with a disconnect switch, reconnect the negative wire to the battery.

D. Place the keyswitch in the ON position. With **7X-1710** Multimeter Probes check for voltage between pin 58 and pin 11 with the wires present. Do not disconnect the connector from the MSS ECM.

Expected Result:

Voltage should be present. The voltage should be within 10% of the machine battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. The solenoid or the relay have failed.

  Repair: Replace the solenoid or relay.

  STOP

- **NO -** The voltage was not correct. Proceed to Test Step 8.

Test Step 8. CHECK THE WIRES IN THE CIRCUIT OF OUTPUT DRIVER (No. 1).

A. Turn the keyswitch and the disconnect switch to the OFF position. If the machine is not equipped with a disconnect switch, remove the negative wire from the battery.

B. Verify that the harness connector remains disconnected from the solenoid or the relay that is controlled by the output driver (No. 1).

C. Disconnect the 70-pin connector from the MSS ECM.

D. Measure the resistance between pin 58 and frame ground, with the wires present.

E. Measure the resistance between pin 11 and frame ground, with the wires present.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- **YES -** The resistance is greater than 5000 ohms. The ECM may have failed, however, ECM failure is unlikely.

  Repair: Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the technical communicator at your Caterpillar dealer. If the ECM must be replaced, refer to the, "Electronic Control Module (ECM) - Replace" section of this manual.

  STOP

- **NO -** The resistance was not correct.

  Repair: There is a problem in the wiring. Check the harness for signs of damage. Repair or replace the harness.

  STOP

Test Step 9. CHECK FOR A FAILED COMPONENT ON OUTPUT DRIVER (No. 2).

A. Turn the keyswitch and the disconnect switch to the OFF position. If the machine is not equipped with a disconnect switch, remove the negative wire from the battery.

B. Disconnect the harness connector from the solenoid or the relay that is controlled by the output driver (No. 2).

C. Turn the disconnect switch and the keyswitch to the ON position. If the machine is not equipped with a disconnect switch, reconnect the negative wire to the battery.

D. Place the keyswitch in the START position. With **7X-1710** Multimeter Probes check for voltage between pin 52 and pin 5 with the wires present. Do not disconnect the connector from the MSS ECM.

Expected Result:

Voltage should be present. The voltage should be within 10% of the machine battery voltage.

Results:

- **YES -** The voltage is present and the voltage level is correct. The solenoid or the relay has failed.

  Repair: Replace the solenoid or the relay.

  STOP

- **NO -** The voltage was not correct. Proceed to Test Step 10.

Test Step 10. CHECK THE WIRES IN THE CIRCUIT OF THE OUTPUT DRIVER (No. 2).

A. Turn the keyswitch and the disconnect switch to the OFF position. If the machine is not equipped with a disconnect switch, remove the negative wire from the battery.

B. The harness connector remains disconnected from the solenoid or the relay that is controlled by the output driver (No. 2).

C. Disconnect the 70-pin connector from the MSS ECM.

D. Measure the resistance between pin 52 and frame ground, with the wires present.

E. Measure the resistance between pin 5 and frame ground, with the wires present.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- **YES -** The resistance is greater than 5000 ohms. The ECM may have failed, however, ECM failure is unlikely.

  Repair: Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the technical communicator at your Caterpillar dealer. If the ECM must be replaced, refer to the, "Electronic Control Module (ECM) - Replace" section of this manual.

  STOP

- **NO -** The resistance was not correct.

  Repair: There is a problem in the wiring. Check the wiring harness for signs of damage. Repair or replace the harness.

  STOP

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i02164890

Engine Does Not Start and Status Indicator Is Continuously Red

SMCS - 7631-038

System Operation Description:

A solid red LED in the status indicator indicates that the MSS has not recognized a valid electronic key for that machine. This condition can be caused by several problems. One or more of the problems that are listed here could be responsible for this condition. If the electronic key has been damaged, the MSS will not disarm and the machine will not start. If a problem exists in the exciter coil, the MSS will be unable to read the electronic key. If the wiring for the exciter coil is damaged, the MSS will be unable to read the electronic key.

Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If there is more than one electronic key near the exciter coil, the MSS ECM will not be able to read the key and the machine will not start.

Test Step 1. CHECK THE KEY.

A. Connect the Caterpillar Electronic Technician (ET) to the Service Connector.

B. Insert a valid electronic key for the machine in the key start switch.

C. Turn the key switch to the ON position.

D. Go to the "Service/Security Management" screen. Check the "Current Key Information".

E. Check the "ID1" and "ID2" for the key that is in the key start switch.

Expected Result:

The MSS reads the ID1 code and the ID2 code as 0.

Results:

- **YES -** The MSS reads the ID1 code and the ID2 code as 0. The key may have failed or the problem may exist in the exciter coil. Proceed to Test Step 2.

- **NO -** The MSS reads the ID1 code and the ID2 code correctly. The key has been read by the MSS ECM, but the MSS is still armed. This indicates that the key in the key start switch is not authorized for that machine.

  Repair: Program that key into the MSS ECM or use a different key.

  Stop.

Test Step 2. CHECK THE EXCITER COIL.

A. Disconnect the exciter coil from the wiring harness.

B. Measure the resistance on the leads of the exciter coil.

Expected Result:

The resistance is approximately 1 ohm.

Results:

- **YES -** The resistance is approximately 1 ohm. Proceed to Test Step 3.
- **NO -** The resistance is greater than approximately 1 ohm. The exciter coil has failed.

  Repair: Replace the exciter coil.

  Stop.

Test Step 3. CHECK THE WIRING OF THE MACHINE HARNESS FOR AN OPEN CIRCUIT.

A. The exciter coil remains disconnected from the wiring harness.

B. On the harness side of the connector for the exciter coil, install a jumper wire between pin 1 and pin 2 .

C. Disconnect the wiring harness connector from the MSS ECM.

D. Measure the resistance between pin 7 and pin 53 of the connector for the MSS ECM.

Expected Result:

The resistance is less than 5 ohms.

Results:

- **YES -** The resistance is less than 5 ohms between pin 7 and pin 53. The wiring for the exciter coil is correct. Proceed to Test Step 4.
- **NO -** The resistance is greater than 5 ohms between pin 7 and pin 53. There is a problem in the wiring for the exciter coil.

  Repair: Check the wiring harness for signs of damage. Repair the machine harness or replace the machine harness.The "ferrite coil" assembly is wired in series with the harness of the exciter coil. Locate the "ferrite coil" assembly. The "ferrite coil" assembly is located

near the 70-pin connector of the MSS ECM. Continuity should exist through the coil assembly.

Stop.

Test Step 4. CHECK THE WIRING OF THE MACHINE HARNESS FOR A SHORT TO GROUND.

Note: The output drivers of the MSS ECM are protected from excessive electrical current. Excessive electrical current is usually the result of a wire or a component that is shorted to ground. If the MSS ECM detects an excessive amount of electrical current, the MSS ECM will disable the output driver.

A. The wiring harness connector for the MSS ECM and the exciter coil remain disconnected.

B. The jumper wire remains installed.

C. Measure the resistance between pin 7 of the MSS ECM and frame ground.

D. Measure the resistance between pin 53 of the MSS ECM and frame ground.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- **YES -** The resistance is greater than 5000 ohms. The resistance is correct. Proceed to Test Step 5.
- **NO -** The resistance is less than 5 ohms. The wiring harness is shorted to ground.

  Repair: Check the wiring harness for signs of damage. Repair the machine harness or replace the machine harness.

  Stop.

Test Step 5. CHECK THE WIRING OF THE MACHINE HARNESS FOR A SHORT TO + BATTERY.

A. The wiring harness connector for the MSS ECM and the exciter coil remain disconnected.

B. The jumper wire remains installed.

C. Measure the resistance between pin 7 and pin 1 of the connector for the MSS ECM.

D. Measure the resistance between pin 53 and pin 1 of the connector for the MSS ECM.

Expected Result:

The resistance is greater than 5000 ohms.

Results:

- **YES -** The resistance is greater than 5000 ohms. The resistance is correct.

Repair: The ECM has failed. It is unlikely that the ECM has failed. Perform the previous Test Steps again. If the cause of the problem is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NO -** The resistance is less than 5 ohms. The wiring harness is shorted to the + battery circuit.

  Repair: Check the wiring harness for signs of damage. Repair the machine harness or replace the machine harness.

  Stop.

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Diagnostic Code List

SMCS - 7569

Module Identifier (MID)

The electronic control module that has detected a failure is identified by the Module Identifier (MID). Each electronic control module on the machine has a unique MID. The MID for the ECM of the Machine Security System is 124.

Component Identifier (CID)

The Component Identifier (CID) is a code that describes the component that is believed to have caused the failure.

Failure Mode Identifier (FMI)

The codes for the Failure Mode Identifier (FMI) are defined by the Society of Automotive Engineers (SAE). The list of codes in Table 1 is used on Caterpillar products.

Table 1

Descriptions of the Failure Mode Identifiers (FMI)	
FMI No.	**Description of Failure**
00	"Data is valid, but above normal operating range"
01	"Data valid, but below normal operating range"
02	"Data erratic, intermittent, or incorrect"
03	"Voltage above normal or shorted high"
04	"Voltage below normal or shorted low"
05	"Current below normal or open circuit"
06	"Current above normal or grounded circuit"

07	"Mechanical system not responding properly"
08	"Abnormal frequency, pulse width, or period"
09	"Abnormal update"
10	"Abnormal rate of change"
11	"Failure mode is not identifiable."
12	"Bad device or component"
13	"Out of calibration"

Detailed FMI Explanations

FMI 00 - "Data Valid But Above Normal Operating Range." Every electronic control system sets a high limit for the expected operating range of the signal. The limit includes signals that are above the expected range. A sensor that is still working but sending a signal above the expected limit will cause an FMI 00 to be stored.

Some possible causes of FMI 00 are listed here:

- Signal above normal (High pressure or high temperature)
- Calibration is needed. FMI 13 is the preferred code.

For example, a certain PWM sensor is expected to generate a valid signal over 80 percent duty cycle. If the sensor generates a signal of 81 percent duty cycle, the sensor is still working but the signal is above the expected signal limits.

FMI 01 - "Data Valid But Below Normal Operating Range." Every electronic control system sets a low limit for the expected operating range of the signal. The limit includes signals that are under the expected range. A low engine oil pressure signal from a working sensor could produce this FMI. A sensor that is still working but sending a signal below the expected limit will cause an FMI 01 to be stored.

Some possible causes of FMI 01 are listed here:

- The signal is below normal. (The voltage, pressure, or temperature is low.)
- Timing is retarded.

For example, a certain PWM sensor is not expected to generate a PWM signal below 5 percent duty cycle even with zero air pressure. If the sensor generates a signal of 4 percent duty cycle with the engine shutdown, the sensor is still working but the signal is below the expected signal limits.

FMI 02 - "Data Erratic, Intermittent Or Incorrect." Signal data that is received from a component is valid. The data that is received from the component has become intermittent or erratic. Data can be correct sometimes and the data may be incorrect at other times. The communication that occurs between electronic controls also relates to this condition.

Some possible causes of FMI 02 are listed here:

- Loose connections in switches, harness, etc.

- Intermittent/erratic signal
- Programmed data has changed.
- Noisy signal
- The signal is out of range. FMI 00 or FMI 01 is the preferred code.
- A failed power or ground connection to the ECM
- Failed ECM

FMI 03 - "Voltage Above Normal Or Shorted High." The voltage that is received from a component is higher than the expected value that is identified by the CID. FMI 03 most often relates to a signal circuit.

Some possible components that can cause an FMI 03 are listed here:

- The sensor (switch)
- The harness
- The related electronic control

Some possible causes of an FMI 03 are listed here:

- A sensor output that is not related to the duty cycle is stuck at the maximum output of the sensor.
- A harness that has the sensor signal wire shorted to any voltage that is greater than the voltage of the sensor power supply.
- A sensor signal wire is open in the machine harness between the sensor and the control. When a sensor has been disconnected from an electronic control, the input circuit voltage is normally pulled up to a positive level.
- A sensor signal contact of a failed control that is internally shorted to a positive voltage source
- A failed control believes that a failure exists in a circuit that is working correctly. This is unlikely.

FMI 04 - "Voltage Below Normal Or Shorted Low." The voltage that is received from a component is lower than the expected value that is identified by the CID. FMI 04 most often relates to a signal circuit. FMI 04 is very similar to FMI 06. FMI 04 is sometimes used in the place of FMI 06.

Some possible causes of FMI 04 are listed here:

- The sensor
- The harness
- The related electronic control

Some possible cause of FMI 04 are listed here:

- A sensor output that is not related to the duty cycle is stuck at the minimum output of the sensor.
- The signal wire is shorted to ground in the harness.
- Electronic control has an internal short to ground on the connector contact of the signal input.

FMI 05 - Current Below Normal Or Open Circuit. The current of the monitored circuit is below normal. This usually results from an open circuit. FMI 05 is generally related to an output of a driver circuit.

Some possible causes of FMI 05 are listed here:

- Open circuit or poor harness connection
- High resistance circuit in a component (relay coil)
- Component in the open position (switch)

FMI 06 - "Current Above Normal Or Grounded Circuit." The current of the monitored circuit is above normal. This code is most commonly caused by a circuit that is shorted to ground. This is very similar to an FMI 04. FMI 06 is sometimes used in the place of FMI 04. FMI 06 is generally related to an output of a driver circuit.

Some possible causes of FMI 06 are listed here:

- A short to ground in the harness
- Low resistance (failure) in component coil (relay)
- Electronic control has an internal short to ground on the connector contact of signal input.

FMI 07 - "Mechanical System Not Responding Properly." A mechanical system does not respond in the expected manner when electrical commands are received from the electronic control.

For example, a sluggish solenoid valve causes a slow shift.

Some possible causes of FMI 07 are listed here:

- Improper response of a component
- Stuck component
- Component failure
- The engine is shutdown.
- Improper machine operation

FMI 08 - "Abnormal Frequency, Pulse Width Or Period. "The frequency of the signal or the width of a given signal pulse is not in the expected range. This code can also relate to a failed output circuit of a sensor or an open output circuit of a sensor.

Note: The period is the time in seconds for one cycle at a given frequency.

Some possible causes of FMI 08 are listed here:

- Intermittent connection of a signal circuit
- Misfire.
- Noisy signals that are caused by a nearby radio or magnetic field

FMI 09 - "Abnormal Update." This code relates to the communication that occurs between electronic controls via a data link. This code occurs when given control is unable to receive required information from another control via the data link. This code indicates that the communication link to the ECM has been lost for more than 5 seconds. The ECM is not responding.

Some possible causes of FMI 09 are listed here:

- Loose connections in the harness or switches
- Failed power or ground connections to the ECM
- No communication is available on the data link.
- Abnormal update because of a mismatch of software between electronic controls
- Failure of the electronic control

FMI 10 - "Abnormal Rate Of Change." The code is related to a signal that changes at a rate that is different from the expected rate. The RATE OF CHANGE is outside of the expected limit. This value is not outside of the expected maximum or minimum value.

For example, The ground speed increases too fast for normal operation. The output of the transmission speed sensor is sending an unreasonable signal.

FMI 11 - "Failure Mode Not Identifiable." This code is used when an electronic control determines that multiple Failure Mode Identifiers are responsible for a single failure.

Some possible causes of FMI 11 are listed here:

- Mechanical failure
- Machine damage to multiple circuits

FMI 12 - "Bad Device Or Component." The code is used for the situations that are listed here: The code is used when an electronic control does not receive an expected response from another electronic control via the data link. The code is also used when an electronic control receives an expected response from another electronic control but the response is not valid. This condition is also used when an electronic control is expected to send data periodically and the control does not send the data.

Some possible causes of FMI 12 are listed here:

- Control failure.
- Failure of the data link

- One or more controls with the incorrect software

FMI 13 - "Out Of Calibration." This code is used when the electrical signal of a given mechanical condition is not within the expected limits of the electronic control. The sensor needs calibration, adjustment or replacement.

The possible causes of FMI 13 are listed here:

- Calibration is required.
- Data out of range

Troubleshooting Procedures

Go to the procedure that corresponds to the CID and FMI that has been indicated. These procedures are used only for maintenance events (CID and FMI) that originate from the MSS. These procedures are used for CID's that have an MID of 124.

If the MID is not for the MSS, see the Module Identifier chart on the Electrical System Schematic for the machine that is being serviced. Once you have determined the electronic control modules that detected the event, refer to the Service Manual for that control for troubleshooting information. The Service Manual modules for each control are part of the machine Service Manual.

Diagnostic Codes

Table 2

Component Identifier (CID) Machine Security System (MID 124)	
CID/FMI	**Description**
CID 0168 System Voltage	
FMI 00	Voltage above normal
FMI 01	Voltage below normal
CID 0248 Cat Data Link	
FMI 12	Cat Data Link
CID 0817 ECM Internal Backup Battery	
FMI 02	Real Time Clock not running or abnormal update (Battery OK)
FMI 04	Voltage below normal
CID 1391 MSS Output Driver No. 1	
FMI 03	Short to battery
FMI 04	Short to ground
CID 1392 MSS Output Driver No. 2	

FMI 03	Short to battery
FMI 04	Short to ground

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Troubleshooting
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

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Using Caterpillar Electronic Technician to Determine Diagnostic Codes

SMCS - 0785-UE; 7569



Illustration 1 g02615483

Connections for the Cat Electronic Technician (Cat ET) service tool

The components required to use Cat ET to determine diagnostic codes are listed here:

(1) A current version of Cat ET software

(2) 317-7484 Communication Adapter Group

(3) Service diagnostic cable

(4) Cable

Use Cat ET with the following materials:

- Special Publication, JERD2124, "ET Single Use Program License"
- Special Publication, JEHP1026, "Information and Requirements Sheet"
- **7X-1425** Data Link Cable and the Data Subscription
- Special Publication, JERD2142, "Data Subscription"

The following features make Cat ET a valuable tool for troubleshooting:

- Required to determine diagnostic codes
- Displays the history of a diagnostic code
- Displays the diagnostic code parameter status
- Required to clear diagnostic codes

Perform the following steps to determine diagnostic codes with Cat ET:

1. Connect the computer to the machine diagnostic connector.

   Note: For locations of the connectors, see Testing and Adjusting, "Electrical Components and Connector Locations" and the machine Electrical Schematic.

2. Turn the keyswitch to the RUN position.
3. Start Cat ET.

   Cat ET will initiate communications with the ECMs

4. Cat ET will list the available ECMs on the machine.
5. Follow the Cat ET instructions.

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MID 124 - CID 0168 - FMI 00

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is associated with a high system voltage. The diagnostic code is recorded when the system voltage is above 32.5 VDC. The diagnostic code should be ACTIVE only if the engine is running.

The possible causes of this diagnostic code are listed below:

- A charging system component has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE BATTERY VOLTAGE.

A. Start the engine and run the engine at high idle for several minutes. Make sure that no battery charger is connected to the engine.

B. Measure the battery voltage at the battery posts.

Expected Result:

The battery voltage should be less than 32.5 VDC for a 24 volt system, and less than 16 VDC for a 12 volt system.

Results:

- **OK -** The battery voltage is correct. Proceed to Test Step 2.
- **NOT OK -** The battery voltage is too high.

  Repair: The charging system is not correct. Check the charging system. See Special Instruction, REHS0354, "Charging System Troubleshooting".

  Stop.

Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Stop the engine. Make sure that no battery charger is connected to the engine.

B. Remove the connector from the ECM. Inspect the contacts and clean the contacts of the harness connectors.

C. Reconnect all harness connectors.

D. Turn the key start switch to the ON position.

E. Use the Caterpillar Electronic Technician and clear all inactive diagnostic codes.

F. Operate the machine.

G. Determine if CID 0168 FMI 00 is present.

Expected Result:

CID 0168 FMI 00 is present.

Results:

- **YES -** CID 0168 FMI 00 is present.

  Repair: The problem has not been corrected. It is unlikely that the ECM has failed. Perform the previous Test Steps again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** CID 0168 FMI 00 is not present.

  Repair: The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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MID 124 - CID 0168 - FMI 01

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is associated with a low system voltage. This diagnostic code is recorded when the system voltage is below 9 VDC. On a machine with a 24 volt system, this diagnostic may not be recorded, even if a low voltage condition is present.

The possible causes of this diagnostic code are listed below:

- A charging system component has failed.
- The wiring in the machine harness has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE BATTERY VOLTAGE.

A. Start the engine and run the engine at high idle for several minutes. Make sure that no battery charger is connected to the engine.

B. Measure the battery voltage at the battery posts.

Expected Result:

The battery voltage should be greater than 9 VDC for a 12 volt system, and the battery voltage should be greater than 21.3 VDC for a 24 volt system.

Results:

- **OK -** The battery voltage is good. Proceed to Test Step 2.
- **NOT OK -** The battery voltage is too low.

  Repair: The charging system is not correct. Check the charging system. See Special Instruction, REHS0354, "Charging System Troubleshooting".

  Stop.

Test Step 2. CHECK THE SYSTEM VOLTAGE AT THE ECM.

A. The engine must still be running at high idle.

B. DO NOT DISCONNECT the machine harness from the ECM. At the connector of the ECM, prepare to make a voltage measurement by using the **7X-1710** Multimeter Probe .

C. At the machine harness for the ECM, insert the probe into the back of connector. Measure the voltage (VDC) between pin 1 and pin 3.

Expected Result:

The battery voltage should be greater than 9 VDC for a 12 volt system, and the battery voltage should be greater than 21.3 VDC for a 24 volt system.

Results:

- **OK -** The battery voltage is correct. Proceed to Test Step 3.
- **NOT OK -** The battery voltage is too low.

  Repair: The machine harness is not correct. Repair the machine harness or replace the machine harness.

  Stop.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Remove the connector from the ECM. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Clear all inactive diagnostic codes.

E. Operate the machine.

F. Determine if CID 0168 FMI 01 is present.

Expected Result:

CID 0168 FMI 01 is present.

Results:

- **YES -** CID 0168 FMI 01 is present.

  Repair: The problem has not been corrected. It is unlikely that the ECM has failed. Perform the previous Test Steps again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** CID 0168 FMI 01 is not present.

Repair: The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

Stop.

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MID 124 - CID 0248 - FMI 12

SMCS - 7631-038

Conditions Which Generate This Code:

This code is associated with a communication problem on the Cat Data Link. This diagnostic code is recorded when the ECM cannot send information, or the ECM does not receive expected information from the data link (wire 892-BR and wire 893-GN or wire 944-OR and wire 945-BR).

Possible causes of this diagnostic code are listed:

- There is an open circuit or a short circuit on the data link.
- There is a failure of the hardware for data link.

System Response:

The machine response is listed:

- The service tool can not detect the ECM.
- Communication failures are indicated by another ECM.

Test Step 1. CLEAR THE DIAGNOSTIC CODES.

A. Use the ET to clear the logged diagnostic codes.

B. Use a valid electronic key to start the machine.

C. Determine if CID 0248 FMI 12 is present.

Expected Result:

CID 0248 FMI 12 is present.

Results:

- **YES -** CID 0248 FMI 12 is present. The problem was not caused by the use of an invalid electronic key. Proceed to Test Step 2.

- **NO -** CID 0248 FMI 12 is NOT present. The problem was caused by the use of an invalid key in the key start switch. **Stop.**

Test Step 2. INSPECT THE HARNESS CONNECTORS.

A. Inspect the connections for the machine harness that are related to the data link.

B. Make sure that connectors are clean and tight.

C. If necessary, repair the machine harness or replace the machine harness.

D. Use the ET to clear the diagnostic codes.

E. Use a valid electronic key to start the machine.

F. Determine if CID 0248 FMI 12 is present.

Expected Result:

CID 0248 FMI 12 is present.

Results:

- **YES -** The diagnostic code is present. Proceed to Test Step 3.
- **NO -** The diagnostic code no longer exists and a machine harness connector was faulty. The failure is not present now. An intermittent connection may exist in the data link circuits of the machine harness.

  Repair: Replace any connectors that do not have a tight fitting. Repair any wiring in the harness that appears to be damaged. Watch for a recurrence of this fault

  Stop.

Test Step 3. CHECK FOR A SHORTED HARNESS.

A. Turn the battery disconnect switch to the OFF position.

B. Disconnect the connector for the machine wiring harness from the MSS ECM. Disconnect the Cat Data Link from all other electronic control modules.

C. At the connector for the MSS ECM, measure the resistance between contact 42 (wire 892-BR or wire 944-OR) and contact45 (wire 893-GN or wire 945-BR).

Expected Result:

The resistance is greater than 5000 Ohms.

Results:

- **YES -** The resistance is greater than 5000 Ohms (no continuity). Harness circuit resistance is correct. Proceed to Test Step 4.
- **NO -** Resistance is less than 5000 Ohms (continuity). The machine harness has failed. There is a short in the machine harness.

Repair: Repair the machine harness or replace the machine harness.

Stop.

Test Step 4. CHECK FOR AN OPEN HARNESS.

A. The disconnect switch remains OFF.

B. The MSS ECM will remain disconnected from the machine harness.

C. Check the continuity of the data link circuit in the machine harness.

   a. Locate the connector for the machine harness at the MSS ECM. Place a jumper wire between contact 42 (wire 892-BR or wire 944-OR) and 45 (wire 893-GN or wire 945-BR).

   b. Locate the machine harness connector of another ECM. Check for continuity in the wiring for the Cat Data Link at the ECM. The pin numbers and the wires will vary between electronic control modules. Each ECM must be checked individually.

Expected Result:

There is continuity in the data link wiring.

Results:

- **YES -** There is continuity in the data link wiring. This circuit is not the cause of the fault. It is possible that the ECM is bad.

  Repair: If more than one ECM is reporting this fault code, it is unlikely that the ECM is bad. If only one ECM has this fault, replace that ECM.

  Stop.

- **NO -** There is NO continuity in the data link wiring. The machine harness is faulty. The data link circuit is open in the machine harness.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

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i01756905

MID 124 - CID 0817 - FMI 04

SMCS - 1401-038-UB

Conditions Which Generate This Code:

This diagnostic code is recorded when the voltage of the backup battery is between 1.5 DCV and 1.7 DCV. This diagnostic code may result in the following conditions:

- The loss of stored data
- The loss of the real time clock

Test Step 1. VERIFY THE DIAGNOSTIC CODE.

A. Turn the disconnect switch to the ON position.

B. Connect the ET to the ECM and clear the fault codes.

C. Determine if CID 0817 FMI 12 is present.

Expected Result:

CID 0817 FMI 12 is present.

Results:

- **YES -** The diagnostic code is present. The internal battery for the MSS ECM has a low voltage.

  Repair: The battery in the MSS ECM cannot be replaced. The entire ECM must be replaced. Refer to Testing and Adjusting Section, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The code is no longer present. The internal battery in the MSS ECM is no longer below voltage. **Stop.**

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Troubleshooting
Machine Security System
Media Number -RENR2462-17 **Publication Date -01/05/2013** **Date Updated -03/05/2013**

i01756912

MID 124 - CID 1391 - FMI 03

SMCS - 7631-038-OJ

Conditions Which Generate This Code:

This diagnostic code is associated with the output driver of the MSS ECM.. This code is recorded if voltage is present on the output driver circuit when the MSS is armed. **This circuit is not used on all machines. Check for the presence of wires at contact 11 and contact 58 before you perform the procedure.**

The possible causes of this diagnostic code are listed below:

- There is a problem with the software in the ECM.
- There is a short to the +battery circuit in the wiring harness.
- The ECM has failed. This is unlikely.

Test Step 1. FLASH THE ECM.

A. Load the latest software file for the MSS into the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program".

B. Clear the diagnostic code log.

C. Start the machine and operate the machine.

D. Determine if CID 1391 FMI 03 is present.

Expected Result:

CID 1391 FMI 03 is present.

Results:

- **YES -** CID 1391 FMI 03 is present. The software did not cause a problem. Go to Test Step 2.
- **NO -** The diagnostic code was caused by a problem in the software. **Stop.**

Test Step 2. TEST THE MACHINE HARNESS.

A. The key start switch must be in the OFF position.

B. Disconnect the machine harness from the MSS ECM.

C. Measure the voltage between pin 11 and pin 58 on the connector for the MSS ECM.

Expected Result:

Voltage is present.

Results:

- **YES -** Voltage is present between pin 11 and pin 58. The wiring harness is shorted.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

- **NO -** Voltage is not present between pin 11 and pin 58. Go to Test Step 3.

Test Step 3. CHECK THE ECM.

A. Remove pin 18 from the connector of the MSS ECM.

B. Reconnect the MSS ECM to the system.

C. Use the ET to check the diagnostic codes.

Expected Result:

CID 1391 FMI 03 is active.

Results:

- **YES -** CID 1391 FMI 03 is active.

  Repair: The MSS ECM has an internal failure. Replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace". Return the failed ECM to Caterpillar. Enclose a note with the following message: "The ECM has suffered an internal short to battery voltage."

  Stop.

- **NO -** CID 1391 FMI 03 is NOT active.

  Repair: The MSS ECM has an internal failure. Replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace". Return the failed ECM to Caterpillar. Enclose a note with the following message: "The ECM has suffered a short to battery voltage in the driver #1 circuit."

  Stop.

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i01756920

MID 124 - CID 1391 - FMI 04

SMCS - 7631-038-OJ

Conditions Which Generate This Code:

This diagnostic code is recorded when an output in the MSS ECM is shorted to ground. **This circuit is not used on all machines. Check for the presence of wires at contact 11 and contact 58 before you perform the procedure.**

The possible causes of this diagnostic code are listed below:

- The wiring in the machine harness has failed.
- The driven component in the circuit has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE WIRING HARNESS.

A. Disconnect the wiring harness connector from the MSS ECM.

B. Measure the resistance between pin 9 in the wiring harness and a ground on the machine.

Expected Result:

The resistance is greater than 5000 Ohms.

Results:

- **YES -** The resistance is greater than 5000 Ohms. Harness circuit resistance is correct. Proceed to Test Step 3.
- **NO -** Resistance is less than 5000 Ohms (continuity). The machine harness is faulty. There is a short between frame ground and the machine harness. The driven component in the circuit may also be bad. Proceed to Test Step 2.

Test Step 2. CHECK THE COMPONENT.

A. Trace the harness to the driven component in the circuit. The component will be a relay. The component may also be a solenoid.

B. Measure the resistance of the component. Measure the resistance from each terminal to the case of the component.

Expected Result:

The resistance is greater than 5000 Ohms.

Results:

- **YES -** The resistance of the driven component is greater than 5000 Ohms (no continuity). The component is good. The machine harness has failed. There is a short between frame ground and the machine harness.

  Repair: Check the harness for signs of damage. Repair the machine harness or replace the machine harness.

  Stop.

- **NO -** Resistance is less than 5000 Ohms (continuity). The driven component has failed.

  Repair: Replace the component that has failed.

  Stop.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Remove the connector from the ECM. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Clear all inactive diagnostic codes.

E. Operate the machine.

F. Determine if CID 1391 FMI 04 is present.

Expected Result:

CID 1391 FMI 04 is present.

Results:

- **YES -** CID 1391 FMI 04 is present.

  Repair: The problem has not been corrected. It is unlikely that the ECM has failed. Perform the previous Test Steps again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** CID 1391 FMI 04 is not present.

Repair: The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by an intermittent short in the wiring harness. Inspect the harness for any signs of damage. If the harness passes through a hole with a grommet, that area of the harness can become chafed. This may cause an intermittent short. The harness may also be damaged in locations that could pinch the harness. Repair any wiring that could have caused the problem. Resume normal machine operation.

Stop.

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i01756923

MID 124 - CID 1392 - FMI 03

SMCS - 7631-038-OJ

Conditions Which Generate This Code:

This diagnostic code is associated with the circuit of the second output driver of the MSS ECM. This diagnostic code is recorded when the MSS is "armed" and the ECM detects voltage on the circuit for the output driver. **This circuit is not used on all machines. Check for the presence of wires at contact 5 and contact 52 before you perform the procedure.**

The possible causes of this diagnostic code are listed below:

- There is a problem with the software in the ECM.
- There is a short to the +battery circuit in the wiring harness.
- The ECM has failed. This is unlikely.

Test Step 1. FLASH THE ECM.

A. Load the latest software file for the MSS into the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program".

B. Clear the diagnostic code log.

C. Start the machine and operate the machine.

D. Determine if CID 1392 FMI 03 is present.

Expected Result:

CID 1392 FMI 03 is present.

Results:

- **YES -** CID 1392 FMI 03 is present. The software did not cause a problem. Go to Test Step 2.
- **NO -** The diagnostic code was caused by a problem in the software. **Stop.**

Test Step 2. TEST THE MACHINE HARNESS.

A. The key start switch must be in the OFF position.

B. Disconnect the machine harness from the MSS ECM.

C. Measure the voltage between pin 5 and pin 52 on the connector for the MSS ECM.

Expected Result:

Voltage is present.

Results:

- **YES -** Voltage is present between pin 5 and pin 52. The wiring harness is shorted.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

- **NO -** Voltage is not present between pin 5 and pin 52. Go to Test Step 3.

Test Step 3. CHECK THE ECM.

A. Remove pin 18 from the 70-pin connector of the MSS ECM.

B. Reconnect the MSS ECM to the system.

C. Use the ET to check the fault codes.

Expected Result:

CID 1392 FMI 03 is active.

Results:

- **YES -** CID 1392 FMI 03 is active.

  Repair: The MSS ECM has an internal failure. Replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace". Return the failed ECM to Caterpillar. Enclose a note with the following message: "The ECM has suffered an internal short to battery voltage."

  Stop.

- **NO -** CID 1392 FMI 03 is NOT active.

  Repair: The MSS ECM has an internal failure. Replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace". Return the failed ECM to Caterpillar. Enclose a note with the following message: "The ECM has suffered a short to battery voltage in the driver #2 circuit."

  Stop.

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i01756926

MID 124 - CID 1392 - FMI 04

SMCS - 7631-038-OJ

Conditions Which Generate This Code:

This diagnostic code is recorded when the second output driver in the MSS ECM is shorted to ground. **This circuit is not used on all machines. Check for the presence of wires at contact 5 and contact 52 before you perform the procedure.**

The possible causes of this diagnostic code are listed below:

- The wiring in the machine harness has failed.
- The driven component in the circuit has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE WIRING HARNESS.

A. Disconnect the wiring harness connector from the MSS ECM.

B. Measure the resistance between pin 18 in the wiring harness and a ground on the machine.

Expected Result:

The resistance is greater than 5000 Ohms.

Results:

- **YES -** The resistance is greater than 5000 Ohms (no continuity). Harness circuit resistance is correct. Proceed to Test Step 3.
- **NO -** Resistance is less than 5000 Ohms (continuity). The machine harness is faulty. There is a short between frame ground and the machine harness. The driven component in the circuit may also be bad. Proceed to Test Step 2.

Test Step 2. CHECK THE COMPONENT.

A. Trace the harness to the driven component in the circuit. The component will be a relay. The component may also be a solenoid.

B. Measure the resistance of the component. Measure the resistance from each terminal to the case of the component.

Expected Result:

The resistance is greater than 5000 Ohms.

Results:

- **YES -** The resistance of the driven component is greater than 5000 Ohms (no continuity). The component is good. The machine harness has failed. There is a short between frame ground and the machine harness.

  Repair: Check the harness for signs of damage. Repair the machine harness or replace the machine harness.

  Stop.

- **NO -** Resistance is less than 5000 Ohms (continuity). The driven component has failed.

  Repair: Replace the component that has failed.

  Stop.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Remove the connector from the ECM. Inspect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Clear all inactive diagnostic codes.

E. Operate the machine.

F. Determine if CID 1392 FMI 04 is present.

Expected Result:

CID 1392 FMI 04 is present.

Results:

- **YES -** CID 1392 FMI 04 is present.

  Repair: The problem has not been corrected. It is unlikely that the ECM has failed. Perform the previous Steps again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** CID 1392 FMI 04 is not present.

Repair: The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by an intermittent short in the wiring harness. Inspect the harness for any signs of damage. If the harness passes through a hole with a grommet, that area of the harness can become chafed. This may cause an intermittent short. The harness may also be damaged in locations that could pinch the harness. Repair any wiring that could have caused the problem. Resume normal machine operation.

Stop.

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i03990058

General Information

SMCS - 7606

General Hazard Information

To prevent injury or death, all machines equipped with a Caterpillar PL522 or 523 system require a warning label that is clearly posted in the cab.

WARNING

This machine is equipped with a Caterpillar Product Link communication device. When electric detonators are used, this communication device should be deactivated within 12 m (40 ft) of a blast site, or within the distance mandated under applicable legal requirements. Failure to do so could cause interference with blasting operations and result in serious injury or death.

WARNING

To prevent possible personal injury during installation, removal, testing, and adjustment of the Product Link system, use an approved access system and appropriate fall protection to reach the intended location. Do not climb on the machine.

The blast site is defined as the area that handles explosive material during loading. This includes the perimeter that is formed by the loaded blast holes. If the machine is required to work within 12 m (40 ft) of a blast area, then the operator must take one of the following precautions:

- Disconnect the PL522 or 523 module from the power source by disconnecting the wiring harness at the PL522 or 523 module.
- Temporarily remove the PL522 or 523 module from the machine.
- Add an ON/OFF switch in order to allow the PL522 or 523 module to be turned off from the cab.

Consult your Caterpillar Dealer if there are any questions.

The following PL522 and 523 specifications are provided to aid in conducting hazard assessments and ensuring compliance with all local regulations.

Product Link Transmitter Power - 0.747 to 1.738 Watts (varies with frequency)

Transmit Frequency Range - 824 to 849 MHz, 880 to 915 MHz, 1710 to 1785 MHz, 1850 to 1910 MHz

General Troubleshooting Information

Many Caterpillar machines have a published Electrical System Schematic that reflects a Product Link installation. Refer to these schematics if a troubleshooting procedure instructs you to "Repair the harness". Perform continuity checks and resistance checks at the connectors in order to locate a failure in the harness. At a component connector, always check the ground circuit. Less than 5 ohms of resistance is required from the ground contacts to frame ground. A problem may be incorrectly diagnosed, if an excessive resistance that is greater than 5 ohms is present in the ground circuit. During a troubleshooting procedure, inspect all component and harness connections before a component is replaced. If these connections are not clean and tight, the connection may cause an electrical problem.

The problem can be permanent or the problem may be intermittent. Ensure that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are performed. A failure of an electrical component may cause a failure of another component or a failure may be caused by the failure of other components. Always attempt to find a failure. The following test procedures are written for a technician with a working knowledge of electricity and electronics. Correct the cause of a failure in the electrical system before you replace a component.

The test procedures that are found in Systems Operation, Troubleshooting, Testing and Adjusting Manual are written for a technician that has a working knowledge of electricity and electronics. Caterpillar recommends that the technician has a knowledge regarding the danger that is inherent in electrical troubleshooting. Caterpillar recommends that the technician can measure voltage and resistance with a multimeter. In some cases, a technician may perform checks of the electrical circuits.

Consider the following guidelines before performing electronic troubleshooting procedures:

- Remove power.
- Before you read the resistance or continuity, lock out the test circuit with a tag.
- Isolate circuit branches for resistance or continuity checks in order to prevent reading through components.

- When reading a wire end to end and within a connector, read the test input pin to all adjacent pins for shorts within the connector locking mechanism.
- Keep fingers and hands clear of test leads during all electrical checks in order to prevent false indications.

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i04456508

Service Tools

SMCS - 0785

The following service tools should be used to aid in troubleshooting the electrical system.

Table 1

Tools List
Description
Laptop computer with Caterpillar Electronic Technician software for the Product Link PL522/523 Systems
Digital Multimeter
Connector Repair Kit
Terminal Repair Kit
Crimp Tool
Standard Socket Wrench Set (1/2 Inch Drive)
Metric Socket Wrench Set (1/2 Inch Drive)
Hand Tool Group (Screwdrivers)
Torque Wrench (1/2 Inch Drive)

For instructions on servicing the Deutsch"DT"Type connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for making continuity checks or for measuring voltage.

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04489189

Electronic Service Tool Does Not Communicate with ECM

SMCS - 0785-038-UE

System Operation Description:

During the installation of a PL522 or 523 system, the wiring harness is connected to the existing Cat Data Link wiring on the machine. If the installation is not done properly, the continuity of the Cat Data Link wiring may be open intermittently. This condition may not be apparent immediately. Improper installation will cause a problem when you are trying to connect the Caterpillar Electronic Technician (Cat ET) service tool to the machine.

- Cat ET may report that no ECM has been found.
- Cat ET may not report every ECM that is on the machine.
- Cat ET may report an ECM but the ECM will not have any data.

If the Cat Data Link wires for the PL522 or 523 are reversed, the ECM will not appear after connecting Cat ET.

Test Step 1. VERIFY THAT THE CAT DATA LINK WIRES ARE NOT REVERSED.

A. Check that the positive CAT Data Link wire (893-GN) in the wiring harness for the Product Link is connected to the positive CAT Data Link wire (893-GN or 944-OR) of the wire harness for the machine.

B. Check that the negative CAT Data Link wire (892-BR) in the wiring harness for the Product Link is connected to the negative CAT Data Link wire (892-BR or 945-BR) of the wire harness for the machine.

Expected Result:

The CAT Data Link wires are properly connected.

Results:

- **OK -** The wires for the CAT Data Link are properly connected. Proceed to Test Step 2.
- **NOT OK -** The wires for the CAT Data Link are reversed.

Repair: Reinstall the CAT Data Link wires correctly and check the operation of the Product Link module by using Cat ET .

STOP

Test Step 2. CHECK THE WIRING WITH A MULTIMETER.

A. Turn off the machine and turn the disconnect switch to the OPEN position.

B. Measure the resistance of the negative CAT Data Link wire from the service connector (contact "E") to the location for the spliced CAT Data Link wire. Note the resistance.

C. Measure the resistance of the positive CAT Data Link wire from the service connector (contact "D") to the location for the spliced CAT Data Link wire. Note the resistance.

Expected Result:

The resistance in both wires is less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is greater than 5 ohms.

  Repair: Repair the wiring harness. After repairing, resume the Product Link installation setup procedures.

  STOP

Test Step 3. VERIFY THAT THE WIRING FOR THE CAT DATA LINK IS PROPERLY CONNECTED.

A. Check the spliced connections for the CAT Data Link that were made during the installation. Verify that all connections are clean and tight.

B. Reconnect the harness connectors that were disturbed during the installation. Ensure that all of the pins are correctly seated in the sockets.

C. Reconnect the cable from the service tool connector. Attempt to access the Cat Data Link by using Cat ET .

Expected Result:

Cat ET lists the ECM systems that are available on the machine. The ECM for the PL522 or 523 can be accessed.

Results:

- **OK -** Cat ET lists the electronic control modules that are available on the machine. The ECM for the PL522 or 523 can be accessed. Resume the setup procedures for the installation of the PL522 or 523.**STOP**
- **NOT OK -** The Cat ET does not list the electronic control modules that are installed on the machine. The Product Link ECM cannot be accessed. Proceed to Test Step 4.

Test Step 4. CHECK FOR A MONITORING SYSTEM.

Check if the machine is equipped with a monitoring system. Some common monitoring systems include the following systems: Electronic Monitoring System, Computerized Monitoring System, Caterpillar Monitoring System, VIDS and VIMS. Also, many machines have monitors that are specific to the type of machine such as excavators and cold planers.

Expected Result:

The machine is equipped with a monitor.

Results:

- **YES -** The machine is equipped with a monitoring system. Proceed to Test Step 5.
- **NO -** The machine is not equipped with a monitoring system. Proceed to Test Step 6.

Test Step 5. CHECK FOR A DIAGNOSTIC CODE FOR THE CAT DATA LINK.

Check the monitoring system for a diagnostic code for the Cat Data Link.

Expected Result:

There is a diagnostic code for the Cat Data Link.

Results:

- **YES -** There is a diagnostic code for the Cat Data Link .

  Repair: Perform the troubleshooting procedure for that diagnostic code that is found in the service manual for that ECM.

  STOP

- **NO -** There are no diagnostic codes for the Cat Data Link. Proceed to Test Step 6.

Test Step 6. RETURN THE WIRING TO THE ORIGINAL CONDITION.

A. Return the Cat Data Link wires to the original condition. Remove any splices that were made and reconnect the wiring harness.

B. Connect Cat ET to the service connector. Verify that all of the appropriate electronic control modules are present. The ECM for the PL522 or 523 will not be present.

Expected Result:

All of the appropriate electronic control modules are present.

Results:

- **YES -** All of the appropriate electronic control modules are present. The wiring is correct. Return to the installation procedure for the PL522 or 523 and reinstall the wiring for the Cat Data Link. Continue with the setup of the PL522 or 523.**STOP**
- **NO -** All of the appropriate electronic control modules are not present.

Repair: A problem still exists with the Cat Data Link wiring. This problem does not relate to the installation of the PL522 or 523. Troubleshoot the entire Cat Data Link circuit to all available electronic control modules. After the problem is found and corrected, return to the installation procedure for the PL522 or 523. Reinstall the wiring for the Cat Data Link. Continue with the setup of the PL522 or 523.

STOP

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04461322

Reports and Messages Not Available

SMCS - 7606-038-RPT

System Operation Description:

There are problems that could be reported with the PL522 or 523 system but the problems are not caused by the PL522 or 523 system. Check for active diagnostic codes for the PL522 or 523. Correct any diagnostic codes before proceeding. Visually inspect the following for damage: module, antenna and cables. Verify that there are no loose connections.

The PL522 or 523 system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The cellular network for communications is operational in the geographic area of concern. The network is operational when messages can travel to the cell tower and then to Caterpillar.
- The PL522 or 523 system is correctly configured to communicate on the network for cellular communications. Correct configuration was verified during manufacturing tests.
- The PL522 or 523 is configured properly and the software is functioning.

The PL522 or 523 module should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues. Subscriptions to the PL522 or 523 module must be up to the current date.

If reports and messages are not available, perform the following steps in order to determine the cause.

Test Step 1. ACCESS THE PL522 AND 523 THROUGH CATERPILLAR ELECTRONIC TECHNICIAN (CAT ET).

A. Connect Cat ET to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is available. Proceed to Test Step 4.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not present, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PL522 or 523 MODULE HAS NOT BEEN DISABLED.

A. Go to the "GSM (Cellular) Information" screen in Cat ET.

B. Verify that the "Cellular Network Coverage Status" is "In Coverage".

Expected Result:

The "Cellular Network Coverage Status" module is "In Coverage", PL522 or 523 is reporting.

Results:

- **OK -** The "Cellular Network Coverage Status" for PL522 or 523 is "In Coverage". Go to Test Step 4.
- **NOT OK -** The "Cellular Network Coverage Status" for PL522 or 523 is "Out of Coverage". Got to Test Step 4.
- **NOT OK -** The "Cellular Network Coverage Status" for PL522 or 523 is "Network Not Allowed". Proceed to Test Step 3

Test Step 3. VERIFY THAT THE PL522 or 523 MODULE IS RECEIVING CELLULAR SIGNALS.

A. Go to the "GSM (Cellular) Information" status screen inCat ET.

B. Verify that the "Cellular Signal Quality" is greater than 25 percent.

C. Verify that the antenna is correctly installed.

D. Verify that the unit is in cellular map coverage of the provider.

Expected Result:

The "Cellular Signal Quality" detected is greater than 25 percent.

Results:

- **OK -** There is cell coverage in the area and the antenna is correctly installed. Proceed to Test Step 5.

- **NOT OK -** Either the unit is out of cell coverage or antenna is installed incorrectly. Verify that the unit is in cellular map coverage of the provider. Proceed to Test Step 8 to check antenna installation.

Test Step 4. VERIFY THAT THE PL522 or 523 MODULE IS CONFIGURED PROPERLY.

A. Go to the "APN Configuration" screen.

B. Verify that the "APN Cellular Carrier" is configured to the correct cellular service provider.

C. Verify that the "APN Username" is configured to the correct cellular network. Refer to cellular provider for correct APN info.

D. Verify that the "APN Password" is configured with the correct password for cellular network. Refer to cellular provider for correct APN info.

E. Verify that the "APN SIM PIN" is configured with the correct SIM Card PIN. Refer to SIM Card Provider to determine and program SIM PIN.

F. Go to the "Configuration" screen.

G. Verify that the "Machine Serial Number" is configured with the correct machine serial number.

H. Verify that "Maintenance Mode" is configured as "OFF".

Expected Result:

All settings are correct.

Results:

- **OK -** The PL522 and 523 is configured correctly. Proceed to Test Step 5.
- **NOT OK -** The PL522 and 523 is not configured correctly.

  Repair: Correct the configuration of the PL522 and 523. The "APN Configuration" can be verified in the "Cellular Network Coverage Status" within "GSM Information" of Cat ET.

  STOP

Test Step 5. VERIFY WHICH POWER MODE THE PL522 AND 523 IS IN.

A. Go to "Status Parameters" of Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1" or "Power Mode 2". Verify that the "Key Switch Status" is "On".

Expected Result:

The Cat ET screen shows that the machine is in "Power Mode 1" or "Power Mode 2" and "Key Switch On".

Results:

- **OK -** The Cat ET screen is correct. The PL522 or 523 should send a Standard report and a position report daily. Proceed to Test Step 7.
- **NOT OK -** Cat ET shows an incorrect power mode. A report of the position is sent in the incorrect power mode. Proceed to Test Step 6.

Test Step 6. VERIFY THAT THE PL522 or 523 MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" of Cat ET.

B. Start the machine.

C. Verify that the "Power Mode Status" changes to "Power Mode 1".

D. Verify that the "Alternator Running Input" changes to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The Cat ET Status screen changes to "Power Mode 1" and "Engine Running". The "Key Switch Status" should be "On".

Results:

- **OK -** The Cat ETscreens are correct. The PL522 or 523 will send a standard report and a position report daily. The power mode can be viewed in VisionLink.**STOP**
- **NOT OK - ENGINE OFF -** The Cat ET screen shows "Engine Off".

  Repair: Verify that the Alternator R-Terminal wiring has not been damaged. Machine SMH and the SMH of PL522 or 523 no longer matching is likely. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Operating Hours Discrepancy".

  STOP
- **NOT OK - POWER MODE 2 -** Cat ET shows "Power Mode 2".

  Repair: Verify that the wiring for the switched power 308-YL has not been damaged. Repair the wiring.

  STOP

Test Step 7. CHECK FOR "ACTIVE" AND/OR "LOGGED" CODES FOR THE PL522 or 523 ECM.

A. Follow the steps in the Special Instruction, REHS2365 in order to connect a laptop computer to the PL522 or 523 system.

B. Go to the menu bar for Cat ET. Select the "Diagnostics" tab. From the drop-down menu, choose the type of code. Choose "Active Codes" or "Logged Codes".

Results:

- **OK -** There are no "active" or "logged" diagnostic codes. Proceed to Test Step 8.

- **Not OK -** An "active" or "logged" diagnostic code exists.

  Repair: Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "Diagnostic Code List" in order to correct possible problems.

  STOP

Test Step 8. CHECK THE INSTALLATION OF THE ANTENNA.

Observe installation of the antenna for the PL522 or 523. Verify that the antenna is installed with a clear view of the sky. The antenna must be in a location that is free from interference. Examples of interference include the following items:

- Devices on the roof of the machine that could potentially be sources of radio frequency interference
- Other antennas that are close to the antenna for the PL522 or 523
- The machine is inside a metal building or another similar structure
- The machine is under large signs that are lighted
- The machine is under power lines

Note: Refer to Special Instruction, REHS2365 for additional details on optimal installation of the antenna.

Expected Result:

The antenna is installed on the highest point on the machine. There is a clear view of the sky.

Results:

- **OK -** The antenna for the PL522 and 523 is installed properly. Verify that all of the connections for the antenna are tight. Proceed to Test Step 9.
- **NOT OK -** The installation of the antenna is not optimal.

  Repair: Accept the current performance of the communication or reinstall the antenna at a superior location.

  STOP

Test Step 9. CHECK THE VOLTAGE FOR THE PL522 or 523 AT THE CONNECTION FOR THE GPS ANTENNA.

With the disconnect closed, check the voltage for the PL522 or 523 at the connection for the GPS antenna on the ECM.

Expected Result:

With neg. lead on the shield and pos. lead on the center pin, the voltage is approximately 3.3 VDC.

Results:

- **OK -** The voltage is 3.3 VDC. Proceed to Test Step 10.
- **NOT OK -** The voltage is greater than 3.3 VDC or less than 3.3 VDC. The measurement is incorrect.

  Repair: Replace the module. Verify that the system is operating correctly.

  STOP

Test Step 10. CHECK THE COAXIAL CABLE FOR THE CELLULAR ANTENNA.

The cellular antenna can be checked in order to determine if the antenna cable has a broken center conductor. Use an ohmmeter to check resistance between the center conductor of the TNC connector for the cellular antenna to the threaded metal socket at the top of the hard mount antenna or magnetic mount antenna.

Refer to Table 1 for making resistance checks. First column is positive lead and first row is negative lead of the multimeter.

Table 1

Measurements for the PL522 and 523 Antenna (1)					
	Cellular Center Connector	**Cellular Outer Connector**	**GPS Center Connector**	**GPS Outer Connector**	**Metal Base of Antenna**
Cellular Center Connector	0 + 3 Ohm	9K +/- 5% Ohm	495K +/- 15K Ohm	9K +/- 5% Ohm	9K +/- 5% Ohm
Cellular Outer Connector	9K +/- 5% Ohm	0 + 3 Ohm	486K +/- 15K Ohm	0 + 3 Ohm	0 + 3 Ohm
GPS Center Connector	584K +/- 15K Ohm	575K +/- 15K Ohm	0 + 3 Ohm	574K +/- 15K Ohm	574K +/- 15K Ohm
GPS Outer Connector	9K +/- 5% Ohm	0 + 3 Ohm	486K +/- 15K Ohm	0 + 3 Ohm	0 + 3 Ohm

(1) Valid only for Fluke 87 Series Multimeters

Note: All measurements taken with a Fluke 87 V. Different multimeters might provide varying results.

Results:

Continue to the next test step.

Test Step 11. VERIFY THAT THE CENTER CONDUCTOR OF THE ANTENNA HAS NOT SHORTED TO THE SHIELD.

A. Disconnect the GPS and the cellular antenna cable from the radio.

B. Measure the resistance from the shield of the antenna cable (GPS) and the cellular antenna cable to the conductor at the center of each of the cable connectors. The shield is the threaded part of the connector.

Refer to Table 1 for a complete listing of resistance checks for the antenna and resistance values.

Expected Result:

The resistance for the GPS antenna meets the defined specifications in Table 1.

The resistance for the cellular antenna meets the defined specifications in Table 1.

Results:

- **OK -** The resistance for the GPS antenna meets the specifications that are defined in the tables that are listed above. The resistance for the cellular antenna meets the specifications that are defined in the tables that are listed above. The resistance is correct.**STOP**
- **NOT OK -** The resistance for the GPS antenna does not meet the specifications that are defined in the tables that are listed above. The resistance for the cellular antenna does not meet the specifications that are defined in the tables that are listed above. The resistance is incorrect.

  Repair: The antenna cable or the antenna has a short from the center conductor to the outer shield. Replace the antenna assembly. Verify that the radio is operating correctly.

  STOP

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i04461363

Position Reports Not Available

SMCS - 7606-038-RPT

System Operation Description:

This section contains steps that can be used to help determine the possible cause of erratic reports of interval. Check for active diagnostic codes for the PL522 or 523. Correct any diagnostic codes before proceeding. Visually inspect the following items for damage: PL522 or 523 module, antenna and cables. Verify that there are no loose connections.

The PL522 or 523 system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The network for cellular communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can be sent VisionLink.
- The PL522 or 523 system is correctly configured to communicate on the network for cellular communications. Correct configuration was verified during manufacturing tests.
- VisionLink is configured properly and the software is functioning.

The PL522 or 523 module should not be replaced without verifying that these issues have been investigated. Contact the Caterpillar Technical Communicator for aid in resolving these issues.

Refer to the PL522 or 523 device configuration and status information in Systems Operation, Troubleshooting, Testing and Adjusting, RENR8143, "Diagnostic Capabilities" in order to ensure that the lack of reporting is not due to the power mode. The unit is likely to have been configured correctly if the SMH report is received.

There is a probability that the system GPS has failed. Proceed with the following steps in order to determine the cause.

Test Step 1. ACCESS THE PL522 or 523 THROUGH CATERPILLAR ELECTRONIC TECHNICIAN (CAT ET).

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is present. Proceed to Test Step 3.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not present, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY IF THE MACHINE HAS MOVED

Verify if the machine has moved more than the configured minimum distance since the last known position report.

Expected Result:

The machine has not moved.

Results:

- **OK -** The machine has moved less than the configured minimum distance since the last known position report. Therefore, the machine has not sent any position reports.**STOP**
- **NOT OK -** The machine movement is unknown. Proceed to Test Step 3.

Test Step 3. VERIFY THAT THE PRODUCT LINK MODULE IS IN POWER MODE 1.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The screens for Cat ET display "Power Mode 1". Proceed to Test Step 4.
- **NOT OK -** Cat ET screens are not correct. Proceed to Test Step 4.

Test Step 4. VERIFY THAT THE GPS RECEIVER FUNCTIONS.

A. Select "GPS Information" for Cat ET.

B. Verify that the "GPS Position Status" is "Valid".

C. Verify that the GPS has calculated a location within the configured amount of time ("GPS Fix Validity Time Duration"). The "GPS Time Stamp" can be compared to the "PC Current Date/Time" in order to calculate the time since the last calculation of the position.

D. Select "Status Parameters". Verify "GPS Receiver" states "Functional".

Expected Result:

The "GPS Position Status" is "Valid". The last calculation (GPS) of the position was within the configured amount of time ("GPS Fix Validity Time Duration") in "Power Mode 1".

Results:

- **OK -** The indications on the Cat ET screen are correct. The GPS Receiver is functioning properly. Proceed to Test Step 6.
- **NOT OK -** The indications on the "GPS Information" are incorrect. Proceed to Test Step 5.
- **NOT OK -** The indications on the "GPS Receiver" are not "Functional". Proceed to Test Step 5.

Test Step 5. VERIFY THAT THE CENTER CONDUCTOR OF THE ANTENNA HAS NOT SHORTED TO THE SHIELD OR BECOME AN OPEN CIRCUIT.

A. Disconnect the connection of the GPS antenna at the module.

B. Measure the resistance from the shield of the antenna cable to the conductor at the center of the cable. The shield is the threaded part of the connector.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available" for the following information:

- Illustrations that show the resistance checks
- Listing of resistance checks for the antenna
- Listing of resistance values

Expected Result:

The resistance for the GPS antenna meets the specifications that are defined in Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available".

Results:

- **OK -** The resistance is correct. Proceed to Test Step 6.
- **NOT OK -** The resistance is incorrect.

  Repair: The antenna cable or the antenna has a short or open from the center conductor to the outer shield. Disconnect the cable from the antenna in order to isolate the problem. Replace the antenna assembly. Verify that the module is operating correctly.

  STOP

Test Step 6. VERIFY TRANSMISSION OF A MESSAGE.

A. Verify that the "Message Transmission Timestamp" is recent. If the time stamp indicates 1984, the module has never transmitted a message.

B. Verify the "Cellular Network Coverage Status" within "GSM Information" of Cat ET.

C. Go to the drop-down menu in the Cat ET and select "Service". Then select "PLM Commands" and "Fuel Report". Fuel report will provide a location update.

Results:

- **OK -** The PL522 or 523 appears to be operating properly. Verify that the message was successfully received at the office. Remember that the delay time is dependent on the configuration of the software at the office.**STOP**

- **NOT OK -** There is a problem with the antenna or with the module. Do not replace the module until the antenna and cable are verified.

  Repair: Refer to Troubleshooting, "Reports and Messages Not Available".

  STOP

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Troubleshooting
Product Link - PL522/523
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i04461422

Reporting Interval Erratic

SMCS - 7606-038-RPT

System Operation Description:

There are problems that could be reported with the PL522 or 523 system but the problems are not caused by the PL522 or 523 system. The problem can be described as the intervals between reports are erratic. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the PL522 or 523. Correct any diagnostic codes before proceeding. Visually inspect the following items for damage: PL522 or 523 module, antenna and cables. Verify that there are no loose connections.

The PL522 or 523 system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The network for cellular communications is operational in the geographic area of concern. The network is operational when messages can be sent to VisionLink.
- The PL522 or 523 system is correctly configured to communicate on the network for cellular communications.
- The Caterpillar Electronic Technician (Cat ET) is configured properly and the software is functioning.

The PL522 or 523 modules should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

Test Step 1. ACCESS THE PL522 or 523 THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is available. Proceed to Test Step 2.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the screen for the Cat ET service tool.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not present, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PL522 or 523 IS IN POWER MODE 1.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The screens for Cat ET are correct. Proceed to Test Step 3.
- **NOT OK -** The screens for Cat ET are not correct. A report of the position is sent in "Power Mode 2". Even if this problem explains the current reports that are arriving at the office, proceed to Step 3.

Test Step 3. VERIFY THAT THE PL522 or 523 MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" for Cat ET .

B. Start the machine.

C. Verify that the "Power Mode Status" changes to " Power Mode 1".

D. Verify the "Alternator Running Input" switches to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The status screen for Cat ET changes to "Power Mode 1" and "Engine Running". The "Key Switch Status" should be "On".

Results:

- **OK -** The screens for Cat ET are correct. The PL522 or 523 should send four position reports and one report daily until the power mode changes to "Power Mode 2". The power mode can be viewed in CPLS. Proceed to Test Step 4.
- **NOT OK -** The screen for Cat ET shows "Engine Off".

Repair: Verify that the Alternator R-Terminal wiring has not been damaged. Check to see that the machine SMU and the PL522 or 523 SMH no longer match. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Operating Hours Discrepancy".

STOP

- **NOT OK -** The screen Cat ET shows "Power Mode 2".

  Repair: Verify that the wiring for the switched power (308-YL) is correct. Repair the wiring.

  STOP

Test Step 4. CHECK THE INSTALLATION OF THE ANTENNA.

Observe installation of the antenna for the PL522 or 523. Verify that the antenna is installed with a clear view of the sky. The antenna must be in a location that is free from interference. Examples of interference include the following items: devices on the roof of the machine that emit power, other antennas that are close to the antenna for the PL522 or 523, indoor machine, machine under large signs that are lighted and machine under power lines.

Expected Result:

The antenna is installed on the highest point of the machine. There is a clear view of the sky.

Results:

- **OK -** The antenna for the PL522 or 523 is installed properly. Verify that all of the connections for the antenna are tight. A test message can be sent in order to verify communications. Monitor the performance of the communication in order to verify that reports are not erratic.**STOP**
- **NOT OK -** Installation of the antenna is not optimal. Accept the current performance of the communication or reinstall the antenna at a superior location.**STOP**

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Troubleshooting
Product Link - PL522/523
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i04461438

Diagnostics and Events Not Available

SMCS - 0785-038-UE; 7610-038

System Operation Description:

There are problems that could be reported with the PL522 or 523 system but the problems are not caused by the PL522 or 523 system. The problem is that the diagnostic information or events are not received at the office. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the PL522 or 523. Correct any diagnostic codes before proceeding. Visually inspect the following items for damage: PL522 or 523 module, antenna and cables. Verify that there are no loose connections.

The PL522 and 523 system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The network for cellular communications is operational in the geographic area of concern. The network is operational when messages can be sent to VisionLink.
- The PL522 or 523 system is correctly configured to communicate on the network for cellular communications.
- The worldwide network of Caterpillars computers is passing messages to software of the Caterpillar VisionLink.
- The Caterpillar Electronic Technician (Cat ET) is configured properly and the software is functioning.

The PL522 or 523 modules should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

The PL522 or 523 can be configured in order to transmit diagnostics and events to the office. These transmissions are highly dependent on the configuration of the PL522 or 523. The following troubleshooting steps assume that the position and the standard report are being received.

Test Step 1. ACCESS THE PL522 AND 523 THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is present. Proceed to Test Step 2.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not available, see Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. CHECK FOR LOGGED EVENTS OR DIAGNOSTICS THAT MAY HAVE OCCURRED.

Use the Cat ET service tool to verify the existence of logged events or diagnostics on other ECM systems. Note any events and diagnostics that are not reported.

Expected Result:

There are no logged events or diagnostics that should have been reported.

Results:

- **OK -** There are no logged events or diagnostics that should have been reported. The PL522 or 523 appears to be working correctly.**STOP**
- **NOT OK -** There are logged events or diagnostics that should have been reported. Monitor the operation of the PL522 or 523 for reporting of events and diagnostics. Problems in this area are not usually a problem with the device. The device should not be replaced.**STOP**

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04461523

Operating Hours Discrepancy

SMCS - 7606-038

System Operation Description:

There are problems that could be reported with the PL522 or 523 system but the problems are not caused by the PL522 or 523 system. The description of the problem is described as a discrepancy of the service meter units. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the PL522 or 523. Correct any diagnostic codes before proceeding. visually inspect the following items for damage: PL522 or 523 module, antenna and cables. Verify that there are no loose connections.

The PL522 or 523 system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The network for Cellular communications is operational in the geographic area of concern. The network is operational when messages can be sent to VisionLink.
- The PL522 or 523 system is correctly configured to communicate on the network for Cellular communications.
- The worldwide network of Caterpillars computers is passing messages to software for the Caterpillar VisionLink web application.
- The VisionLink web Application is configured properly and the software is functioning.

The PL522 or 523 modules should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

Note: The Service Meter Hours that are reported by the PL522 and 523 modules should approximately match the machine operating hours.

Test Step 1. ACCESS THE PL522 AND 523 THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is present. Proceed to Test Step 2.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the screen for Cat ET.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not available, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PL522 or 523 MODULE IS CONFIGURED PROPERLY.

A. Go to the "Information" pull-down menu.

B. Select "Synchronize Service Meter Hours".

C. If PL522 or 523 is not the master ECM, verify that the "VIMS Main Module SMH" matches the SMH of the master ECM. If PL522 or 523 is the master ECM, verify that the PL522 or 523 SMH matches the machine service meter units.

Expected Result:

The hours are within 1%.

Results:

- **OK -** The hours are within 1%. The hours are synchronized. The PL522 or 523 is operating correctly.**STOP**
- **NOT OK -** The hours are not within 1%. In a PL522 or 523 system using sync-clock where PL522 or 523 is not the master ECM, the PL522 or 523 module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is greater than 50 hours, a diagnostic will be generated in ET that indicates that a manual sync is required. In that instance, sync the hours (Service/Synchronize Service Meter Hours). Proceed to Test Step 3 unless the master ECM hours are incorrect. If PL522 or 523 is not the master ECM, and the hours for the master ECM are not correct, troubleshoot on machine side. Do not replace the PL522 or 523 module. STOP.

Test Step 3. VERIFY THAT THE PL522 or 523 MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" for Cat ET.

B. Verify that the "Alternator Running Input" displays "Engine Off".

C. Start the machine.

D. Verify that the "Alternator Running Input" changes to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The "Status" screen for Cat ET changes from "Engine Off" to "Engine Running" when the machine is started. The "Key Switch Status" should be "On".

Results:

- **OK -** The screens for Cat ET are correct. The PL522 or 523 is correctly reading the "machine run status". Correctly reading the "machine run status" allows the PL522 or 523 to monitor the machine operating hours correctly.

  Repair: Check the splices for the R-Terminal wire (403-GN) and power wire (308-YL) in order to ensure that there are no intermittent connections.

  STOP

- **NOT OK -** On the Cat ET screen, the status did not change from "Engine Off" to "Engine Running".

  Repair: Verify the Alternator R-Terminal wiring (403-GN). Verify the switched power wire (308-YL). If the problem is not corrected, replace the PL522 or 523 module.

  STOP

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Troubleshooting
Product Link - PL522/523
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Event Code List

SMCS - 7569

Event codes alert the operator or the technician that an abnormal operating condition exists in one of the machine systems.

When an Electronic Control Module (ECM) activates an event code, the operator or the technician will be alerted by the Messenger. Most active events will be logged by the ECM. Some events are active only. Active only events are not logged. The events that are active and the events that are logged can be viewed with the following equipment:

- Messenger
- Caterpillar Electronic Technician (Cat ET)

Warning Levels

The ECM will assign a warning level to an active event code. Event codes are one of three levels. The level represents the severity of the abnormal condition. Each warning level requires a specific response from the operator. The warning levels and the required operator response are listed below.

Warning Level 1

Warning level 1 alerts the operator that a machine system requires attention. The operator should check the system condition or perform maintenance on the involved system at the earliest possible time.

Warning Level 2

Warning level 2 requires changing the operation of the machine or performing a maintenance procedure. Failure to correct the problem that caused this warning may damage the components that are involved in the system.

Warning Level 3

Warning level 3 requires an immediate safe shutdown of the machine in order to avoid damage to the machine or injury to personnel. The problem that caused the event must be corrected before machine operation can resume.

Indications and System Response

Caterpillar Electronic Technician (Cat ET) Service Tool

When an abnormal operating condition occurs, the status screen on the Cat ET indicates that there is an active event.

Event codes are displayed on Cat ET in the following format:

EXXXX Description of the code

The "E" means that the code is an event code. The "XXXX" is a numeric identifier. The numeric identifier is followed by a description of the code.

Active event codes are listed in ascending numerical order. The code with the lowest number is listed first. The active event code is removed from the list when the condition is no longer present.

Logged Event Codes

Some event codes are logged in the ECM memory. Some event codes are active only. The logged event codes are listed in chronological order. The most recent code is listed first.

A logged code is cleared from memory when one of the following conditions occur:

- The service technician manually clears the code.
- The code does not reoccur after a number of hours determined by each ECM.
- A new code is logged and there are already ten logged codes in memory. In this case, the oldest logged code is cleared.

Note: Always clear logged event codes after investigating and correcting the problem which generated the code.

List of Event Codes

The following table lists event codes and the recommended responses. Use the Cat ET service tool in order to determine the event codes that are active or logged.

Table 1

List of Event Codes (EID)			
EID	**Level**	**Description**	**Possible Cause and Recommended Response**
861	1	Synchronized clock notification of manual synch required	In a PL522 or 523 system using sync-clock and Product Link that is not the master ECM, the Product Link module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is

			greater than 50 hours, a diagnostic will be generated in Cat ET that indicates that a manual sync is required. In that instance, sync the hours. In Cat ET, use "Service/Synchronize Service Meter Hours".
630	2	Switched Sensor #1 trip condition is activated	The PL522 or 523 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
631	2	Switched Sensor #2 trip condition is activated	The PL522 or 523 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
632	2	Switched Sensor #3 trip condition is activated	The PL522 or 523 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
633	2	Switched Sensor #4 trip condition is activated	The PL522 or 523 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.

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Diagnostic Code List

SMCS - 7569

Table 1

Module Identifier 161 Diagnostic Codes [1]	
CID 0168 Electrical System	
FMI 00	Voltage above normal
FMI 01	Voltage below normal
CID 0254 Electronic Control Module	
FMI 04	Voltage below normal
FMI 12	Failed Module
CID 1250 Remote Communication Module	
FMI 09	Unable to establish communication
CID 1251 Alternator R-Terminal	
FMI 03	Voltage above normal
CID 1888Local GPS Antenna [2]	
FMI 14	GPS Antenna not present
CID 3766 Subscriber Identity Module (SIM) Card	
FMI 14	SIM Card not detected

[1] For troubleshooting, see the procedure with the same CID FMI.

[2] For troubleshooting information refer to the, "Position Reports Not Available" section of this book

Note: A machine ECM will self-erase a diagnostic if the diagnostic does not reappear after 100 operating hours. The event history screen in the VisionLink application will show a code that

occurred 100 hours in the past. This event no longer shows up in Cat ET because the diagnostic has not reoccurred.

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490210

MID 161 - CID 0168 - FMI 00

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the diagnostic circuit in the PL522 and 523 identifies a system voltage that is above 32 VDC.

The possible causes of this fault are listed below:

- A charging system component is faulty.
- The harness wiring is faulty.
- The PL522 or 523 is faulty. Module failure is unlikely.

Note: Determine if a battery charger or a welder is being used on the machine. Disconnect the charger or the welder if one is used. Recheck for the diagnostic code.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE 70-PIN CONNECTOR OF THE PL522 or 523.

A. Start the engine and operate the engine at a high idle for 5 to10 minutes.

B. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 11 VDC to 32 VDC.

Results:

- **OK -** The voltage is 11 VDC to 32 VDC. The PL522 or 523 should not be logging this diagnostic code.

  Repair: Use the Caterpillar Electronic Technician (Cat ET) in order to clear the diagnostic code from the PL522 or 523. If the voltage is correct and the PL522 or 523 records the diagnostic code again, replace the PL522 or 523. Before replacing the PL522 or 523, contact your Caterpillar Technical Communicator.

STOP

- **NOT OK -** The voltage is not 11 VDC to 32 VDC. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

A. Run the engine at high idle for 5 to 10 minutes.

B. Measure the voltage output at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. The battery could be faulty. Proceed to Test Step 3.
- **NOT OK -** The voltage is above 32 VDC. Troubleshoot the alternator. The voltage regulator could be faulty. If conditions are not resolved, proceed to Test Step 3.

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the key start switch to the OFF position. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. Proceed to Test Step 4.
- **NOT OK -** The voltage is above 32 VDC.

  Repair: Refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

  If conditions are not resolved, proceed to Test Step 4.

Test Step 4. CHECK EVERY ECM ON THE MACHINE.

Check the logged diagnostics of any other ECM that is installed on the machine. Compare each ECM that has logged the "CID 168 FMI 00" code in the same time period. The Service Meter Hours (SMH) on the logs may be different. The difference between the current SMH and the logged SMH is important.

Expected Result:

Other "CID 168 FMI 00" diagnostic codes can be found on other Electronic Control Modules (ECM).

Results:

- **YES -** "CID 168 FMI 00" diagnostic codes are found on other Electronic Control Modules (ECM).

Repair: Clear the fault if all the following conditions occur:

- A problem is not found with the charging system.
- A problem is not found with the wiring.
- The fault has occurred a few times.

Monitor the module and the machine for further occurrences. If the fault occurs again, the PL522 or 523 module has not failed as other electronic control modules are displaying the same fault. Recheck the system voltage.

STOP

- **NO -** No other "CID 168 FMI 00" diagnostic codes can be found on other ECMs.

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.
  - The fault has occurred a few times.

  Monitor the module and the machine for further occurrences. If the fault occurs again, then the PL522 or 523 module is possibly faulty. The PL522 or 523 should be replaced. Refer to Systems operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the PL522 or 523 has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490231

MID 161 - CID 0168 - FMI 01

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the PL522 and 523 detects a battery voltage of less than 11 VDC.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE 70-PIN CONNECTOR OF THE PL522 AND 523 MODULE.

Start the engine and operate the engine at a high idle for 5 to 10 minutes. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 27 VDC to 29 VDC for a 24 VDC system. The voltage is 13 VDC to 15 VDC for a 12 VDC system.

Results:

- **OK -** The voltage is correct. Clear the diagnostic code and check for another occurrence of the diagnostic code.**STOP**
- **NOT OK -** The voltage is incorrect. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

Run the engine at a high idle for 5 to 10 minutes. Measure the voltage output at the battery posts.

Expected Result:

For a 24 VDC system, the voltage range should be 27 VDC to 29 VDC. The voltage range should be 13 VDC to 15 VDC for a 12 VDC system.

Results:

- **OK -** The voltage is correct. Proceed to Test Step 3.

- **NOT OK -** The voltage is incorrect.

  Repair: Repair the alternator or replace the alternator.

  STOP

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the keyswitch to the OFF position. Measure the battery voltage at the battery posts. Be sure to use proper Personal Protective Equipment.

Expected Result:

The voltage should be 12 VDC to 15 VDC for a 12 VDC system. The voltage should be 24 VDC to 27 VDC for a 24 VDC system.

Results:

- **OK -** The voltage is between 12 VDC and 15 VDC or the voltage is between 24 VDC and 27 VDC.

  Repair: The PL522 or 523 could be faulty. Recheck the system before replacing the PL522 or 523. The PL522 or 523 is seldom the cause of a diagnostic code. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the PL522 or 523 has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

- **NOT OK -** The voltage is not between 12 VDC and 15 VDC or the voltage is not between 24 VDC and 27 VDC.

  Repair: See Special Instruction, REHS0354, "Charging System Troubleshooting". If conditions are not resolved, the PL522 or 523 could be faulty. Recheck the system before replacing the PL522 or 523. The PL522 or 523 is seldom the cause of a diagnostic code. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the PL522 or 523 has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490236

MID 161 - CID 0254 - FMI 04

SMCS - 7610-038

Conditions Which Generate This Code:

Communication will not occur when power to the PL522 or 523 is below 10.5 VDC. The PL522 or 523 will still communicate with Caterpillar Electronic Technician (Cat ET) when power to the module is down to 9 VDC. A diagnostic code of "CID 168 FMI 01" will occur when the system voltage drops below 11 VDC. A diagnostic code of "CID 254 FMI 04" will occur when the system voltage drops below 9 VDC. This CID code is logged so that no messages will be communicated from the machine to the office.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE PL522 and 523.

A. Start the engine and operate the engine at a high idle for 5 to 10 minutes.

B. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 11 VDC to 32 VDC.

Results:

- **OK -** The voltage is 11 VDC to 32 VDC. The PL522 and 523 should not be logging this diagnostic code.

  Repair: Use Cat ET in order to clear the diagnostic code from the PL522 and 523. If the voltage is correct and the PL522 and 523 records the diagnostic code again, Replace the PL522 and 523. Before replacing the PL522 and 523, contact your Caterpillar Technical Communicator.

  STOP

- **NOT OK -** The voltage is not 11 VDC to 32 VDC. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

A. Run the engine at high idle for 5 to 10 minutes.

B. Measure the voltage output at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. The battery could be faulty. Proceed to Test Step 3.
- **NOT OK -** The voltage is above 32 VDC. Repair the alternator or replace the alternator. The voltage regulator could be faulty. If conditions are not resolved, proceed to Test Step 3.

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the keyswitch to the OFF position. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. Proceed to Test Step 4.
- **NOT OK -** The voltage is above 32 VDC.

  Repair: See Special Instruction, REHS0354, "Charging System Troubleshooting".

  If conditions are not resolved, proceed to Test Step 4.

Test Step 4. CHECK EVERY ECM ON THE MACHINE.

Check the logged diagnostics of any other ECM that is installed on the machine. Compare each ECM that has logged the"CID 168 FMI 00" code in the same time period. The Diagnostic Clock Hours (DCH) on the logs may be different. The difference between the current DCH and the logged DCH is important.

Expected Result:

Other "CID 168 FMI 00" diagnostic codes can be found on other Electronic Control Modules (ECM).

Results:

- **YES -** "CID 168 FMI 00" diagnostic codes are found on other Electronic Control Modules (ECM).

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.

- The fault has occurred a few times.

Monitor the module and the machine for further occurrences. If the fault occurs again, the PL522 or 523 module has not failed as other electronic control modules are displaying the same fault. Recheck the system voltage.

STOP

- **NO -** No other "CID 168 FMI 00" diagnostic codes can be found on other electronic control modules.

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.
  - The fault has occurred a few times.

  Monitor the module and the machine for further occurrences. If the fault occurs again, then the PL522 or 523 module is possibly faulty. The PL522 or 523 should be replaced. Refer to Systems operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the PL522 or 523 has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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i04490257

MID 161 - CID 0254 - FMI 12

SMCS - 7610-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the PL522 or 523 detects a problem that is internal to the control module. This diagnostic code can only be caused if the ECM for PL522 or 523 is faulty. There are no serviceable parts within the control module.

Test Step 1. CHECK THE HARNESS CONNECTIONS.

A. Disconnect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Determine if "CID 0254 FMI 12" diagnostic code is present by using Cat ET .

Expected Result:

The "CID 0254 FMI 12" diagnostic code is present.

Results:

- **OK -** The "CID 0254 FMI 12" diagnostic code is present.

  Repair: The problem has not been corrected. ECM failure is unlikely. Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the PL522 or 523 ECM. Before replacing the PL522 or 523, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The "CID 0254 FMI 12" diagnostic code is not present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or

a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04461930

MID 161 - CID 1250 - FMI 09

SMCS - 7606-038

Conditions Which Generate This Code:

This code signals a lack of communication between the Gateway and the telematic components within the PL522 or 523 enclosure. The lack of communication can be caused by the following actions:

- A failure of either the Gateway or Telematic firmware
- A failure in the connection of the Gateway and the Telematic components

Test Step 1. CHECK THE VERSION OF SOFTWARE FOR THE GATEWAY AND TELEMATIC COMPONENTS.

By using Caterpillar Electronic Technician (Cat ET), check the version of software on the Gateway and Telematic components. Click "ECM Summary" and check "Software Group" for Gateway info and "Telematic Device Software" for telematic info.

Expected Result:

The version of software should be latest provided by Caterpillar.

Results:

- **OK -** The version of software is latest version. Proceed to Test Step 2.
- **NOT OK -** The version of software is not the latest version.

  Repair: Update "VIMS Main Module" to the latest version of software. Clear the diagnostic code.

  STOP

Test Step 2. REPLACE THE PL522 OR 523.

Replace the PL522 or 523.

Expected Result:

The diagnostic code should be cleared.

Results:

- **OK -** The diagnostic code was cleared.

  Repair: Replace the PL522 or 523. Before replacing the PL522 or 523, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The diagnostic code was not cleared.

  Repair: Repeat the diagnostic procedure. If the diagnostic code still exists, contact your Caterpillar Technical Communicator for additional assistance.

  STOP

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490269

MID 161 - CID 1251 - FMI 03

SMCS - 1406-038

Conditions Which Generate This Code:

The PL522 or 523 modules track the machine operating hours for reporting to the office. The Alternator R-Terminal signal is used to detect when the machine is operating. If the input continually receives a voltage signal that is above normal, then machine operation cannot be detected. Also, the reported Service Meter Hours (SMU) would be inaccurate.

Test Step 1. CHECK THE R-TERMINAL CABLING FOR SHORT TO BATTERY.

A. Disconnect the PL522 or 523 cable (P1) from the PL522 or 523 module.

B. Measure the resistance from the Alternator R-terminal input J1-4 (403MC9-GN-18 to battery (J1-1).

Expected Result:

The resistance should be greater than 5000 ohms.

Results:

- **OK -** The PL522 or 523 harness is likely correct. Proceed to Test Step 2.
- **NOT OK -** The PL522 or 523 cable has a probable short to battery.

  Repair: Repair the cable and verify that the fault has been removed.

  STOP

Test Step 2. CHECK THE PL522 AND 523 HARNESS FOR A SHORT TO A VOLTAGE SOURCE.

A. Disconnect the PL522 or 523 cable (P1) from the PL522 or 523 module.

B. Start the engine.

C. Measure the Alternator R-Terminal input (J1-4) to verify that there is an 11 VDC to 32 VDC square-wave. The measurement should range from 5Hz to 2 kHz or a steady DC voltage equivalent to the battery present.

Expected Result:

The Alternator R-Terminal input does not measure at a steady DC voltage equivalent to the battery voltage.

Results:

- **OK -** The signal is an 11 VDC to 32 VDC square-wave. The measurement should range from 0kHz to 2 kHz or a steady DC voltage equivalent to the battery present. The PL522 or 523 harness is likely not faulty. Proceed to Test Step 3.
- **NOT OK -** The PL522 or 523 cable has a possible short to a DC voltage source other than battery voltage.

  Repair: Repair the cable and verify that the fault has been removed.

  STOP

Test Step 3. CHECK THE MACHINE ALTERNATOR.

A. Disconnect the PL522 or 523 machine cable from the alternator.

B. Start the engine.

C. Using a multimeter and scope, measure the Alternator R-Terminal to verify that there is 11 VDC to 32 VDC square-wave. The measurement should range from 0 kHz to 2 kHz.

Expected Result:

The alternator R-Terminal should be an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz.

Results:

- **OK -** The alternator R-Terminal is an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz. Proceed to Test Step 4.
- **NOT OK -** The alternator R-Terminal is not an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz.

  Repair: Repair the alternator or replace the alternator.

  STOP

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position and operate the machine.

D. Determine if "CID 1251 FMI 03" diagnostic code is present by using the Caterpillar Electronic Technician (Cat ET).

Expected Result:

A "CID 1251 FMI 03" diagnostic code is present.

Results:

- **YES -** The problem has not been corrected. ECM failure is unlikely.

  Repair: Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the Product Link ECM. Before replacing the PL522 or 523, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NO -** The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04466509

MID 161 - CID 1888 - FMI 14

SMCS - 733B-038; 7606-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the diagnostic circuit in the PL522 and 523 identifies a fault in the GPS antenna system.

Test Step 1. ACCESS THE PL522 or 523 THROUGH CATERPILLAR ELECTRONIC TECHNICIAN (CAT ET).

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (VIMS Main Module) is present.

Expected Result:

The ECM (VIMS Main Module) is present.

Results:

- **OK -** The ECM (VIMS Main Module) is present. Proceed to Test Step 3.
- **NOT OK -** The ECM (VIMS Main Module) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the PL522 or 523 has been installed correctly. Check the wiring with a multimeter. If the ECM (VIMS Main Module) is not present, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY IF THE MACHINE HAS MOVED

Verify if the machine has moved more than the configured minimum distance since the last known position report.

Expected Result:

The machine has not moved.

Results:

- **OK -** The machine has moved less than the configured minimum distance since the last known position report. Therefore, the machine has not sent any position reports.**STOP**
- **NOT OK -** The machine movement is unknown. Proceed to Test Step 3.

Test Step 3. VERIFY THAT THE PRODUCT LINK MODULE IS IN POWER MODE 1.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The screens for Cat ET display "Power Mode 1". Proceed to Test Step 4.
- **NOT OK -** Cat ET screens are not correct. Proceed to Test Step 4.

Test Step 4. VERIFY THAT THE GPS RECEIVER FUNCTIONS.

A. Select "GPS Information" for Cat ET.

B. Verify that the "GPS Position Status" is "Valid".

C. Verify that the GPS has calculated a location within the configured amount of time ("GPS Fix Validity Time Duration"). The "GPS Time Stamp" can be compared to the "PC Current Date/Time" in order to calculate the time since the last calculation of the position.

D. Select "Status Parameters". Verify "GPS Receiver" states "Functional".

Expected Result:

The "GPS Position Status" is "Valid". The last calculation (GPS) of the position was within the configured amount of time ("GPS Fix Validity Time Duration") in "Power Mode 1".

Results:

- **OK -** The indications on the Cat ET screen are correct. The GPS Receiver is functioning properly. Proceed to Test Step 6.
- **NOT OK -** The indications on the "GPS Information" are incorrect. Proceed to Test Step 5.
- **NOT OK -** The indications on the "GPS Receiver" are not "Functional". Proceed to Test Step 5.

Test Step 5. VERIFY THAT THE CENTER CONDUCTOR OF THE ANTENNA HAS NOT SHORTED TO THE SHIELD.

A. Disconnect the connection of the GPS antenna at the module.

B. Measure the resistance from the shield of the antenna cable to the conductor at the center of the cable. The shield is the threaded part of the connector.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available" for the following information:

- Illustrations that show the resistance checks
- Listing of resistance checks for the antenna
- Listing of resistance values

Expected Result:

The resistance for the GPS antenna meets the specifications that are defined in Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available".

Results:

- **OK -** The resistance is correct. Proceed to Test Step 6.
- **NOT OK -** The resistance is incorrect.

  Repair: The antenna cable or the antenna has a short from the center conductor to the outer shield. Disconnect the cable from the antenna in order to isolate the short. Replace the antenna assembly. Verify that the module is operating correctly.

  STOP

Test Step 6. VERIFY TRANSMISSION OF A MESSAGE.

A. Verify that the "Message Transmission Timestamp" is recent. If the time stamp indicates 1984, the module has never transmitted a message.

B. Verify the "Cellular Network Coverage Status" within "GSM Information" of Cat ET.

C. Go to the drop-down menu in the Cat ET and select "Service". Then select "PLM Commands" and "Fuel Report". Fuel report will provide a location update.

Results:

- **OK -** The PL522 or 523 appears to be operating properly. Verify that the message was successfully received at the office. Remember that the delay time is dependent on the configuration of the software at the office.**STOP**
- **NOT OK -** There is a problem with the antenna or with the module. Do not replace the module until the antenna and cable are verified.

  Repair: Refer to Troubleshooting, "Reports and Messages Not Available".

  STOP

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Troubleshooting
Product Link - PL522/523
Media Number -RENR8143-02 **Publication Date -01/07/2013** **Date Updated -23/07/2013**

i04490695

MID 161 - CID 3766- FMI 14

SMCS - 7606-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the VIMS Main Module has received three consecutive samples from the masterboard indicating that the SIM Card was not detected.

Test Step 1. CHECK SIM STATUS AFTER A POWER CYCLE.

A. Turn the key to OFF.

B. Close the disconnect.

C. Wait a few moments and reapply power.

D. Turn on the disconnect .

E. Turn the key to ON.

F. After 3 minutes, connect Cat ET and recheck the SIM status.

Expected Result:

The SIM card is detected by the masterboard.

Results:

- **OK -** Masterboard was in a low-power mode. Low power is an expected function. Proceed with operation.**STOP**
- **NOT OK -** SIM was not detected. Proceed to Test Step 2

Test Step 2. VERIFY THAT THE SIM CARD IS INSTALLED.

A. Remove power from the machine.

B. Remove SIM card cover.

C. Verify that the SIM card is firmly in the slot.

Expected Result:

The SIM card is present and firmly in the slot.

Results:

- **OK -** Proceed to Step 3
- **NOT OK -** If present, secure the SIM card in the slot. If not present, contact your Caterpillar Technical Communicator to report the issue and to order a new SIM card.**STOP**

Test Step 3. VERIFY THAT THE SIM CARD IS ACTIVATED.

A. . Contact your Product Link Administrator to verify that the device has subscriptions in Trimble Store.

B. Contact your Product Link Administrator to contact Trimble for verification that the SIM card is active, approved on the network, and roaming is enabled.

Expected Result:

The device has subscriptions in Trimble Store. Trimble confirms that the SIM card is active.

Results:

- **OK -** Proceed to Step 4
- **NOT OK -** Purchase subscriptions in Trimble Store. Once subscriptions are purchased, verify that the SIM status is correct in Cat ET. **STOP**

Test Step 4. VERIFY THAT THE SIM CARD IS ACTIVATED.

A. . Contact your Product Link Administrator to verify that the device has subscriptions in Trimble Store.

B. Contact your Product Link Administrator to contact Trimble for verification that the SIM card is active.

Expected Result:

The device has subscriptions in Trimble Store. Trimble confirms that the SIM card is active.

Results:

- **OK -** Verify that the machine is in a location to receive cellular communications. Verify that the antenna has not failed. If both criteria are met, replace the device.**STOP**
- **NOT OK -** Purchase subscriptions in Trimble Store. Once subscriptions are purchased, verify that the SIM status is correct in Cat ET.**STOP**

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906924

General Information

SMCS - 7606

General Hazard Information

In order to prevent injury or death, all machines that are equipped with a Caterpillar Product Link system are required to have a warning label that is clearly posted in the cab.

WARNING

This machine is equipped with a Caterpillar Product Link communication device. When electric detonators are used, this communication device should be deactivated within 12 m (40 ft) of a blast site for satellite-based systems and within 3 m (10 ft) of a blast site for cellular based systems, or within the distance mandated under applicable legal requirements. Failure to do so could cause interference with blasting operations and result in serious injury or death.

In cases where the type of Product Link module cannot be identified, Caterpillar recommends that the device be disabled no less than 12 m (40 ft) from the blast perimeter.

If the machine is required to work within 12 m (40 ft) of a blast area, then the operator must take one of the following precautions:

- Disconnect the Product Link module from the power source by disconnecting the wiring harness at the Product Link module.
- Temporarily remove the Product Link module from the machine.
- Add an ON/OFF switch in order to allow the Product Link module to be turned off from the cab.

Consult your Caterpillar Dealer if there are any questions.

This warning does not supersede the published requirements and regulations that are found in "Title 30 of the Code of Federal Regulations (CFR)". This warning does not allow a deviation from the published requirements and regulations that are found in "Title 30 of the Code of Federal Regulations (CFR)". Every mine operation should conduct hazard assessments. Also, every mine operation should meet all of the requirements of "Title 30 of the Code of Federal Regulations (CFR)" in order to ensure safe operation in the storage, transportation, loading, and blasting of explosives.

The following Product Link specifications are provided to aid in conducting hazard assessments and ensuring compliance with all local regulations.

Product Link Transmitter Power - 5 to 10 W

Transmit Frequency Range - 148 to 150 MHz

General Troubleshooting Information

Many Caterpillar machines have a published Electrical System Schematic that reflects a Product Link installation. Refer to these schematics if a troubleshooting procedure instructs you to "Repair the harness". Perform continuity checks and resistance checks at the connectors in order to locate a failure in the harness. At a component connector, always check the ground circuit. Less than 5 ohms of resistance is required from the ground contacts to frame ground. A problem may be incorrectly diagnosed, if an excessive resistance that is greater than 5 ohms is present in the ground circuit. During a troubleshooting procedure, the user should inspect all component and harness connections before a component is replaced. If these connections are not clean and tight, the connection may cause an electrical problem.

The problem can be permanent or the problem may be intermittent. Ensure that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are performed. A failure of an electrical component may cause a failure of another component or a failure may be caused by the failure of other components. Always attempt to find a failure. The following test procedures are written for a technician with a working knowledge of electricity and electronics. The user should correct the cause of a failure in the electrical system before you replace a component.

The test procedures that are found in Systems Operation, Troubleshooting, Testing and Adjusting Manual are written for a technician that has a working knowledge of electricity and electronics. Caterpillar recommends that the electrician has a knowledge regarding the danger that is inherent in electrical troubleshooting. Caterpillar recommends that the technician can measure voltage and resistance with a multimeter. In some cases, a technician may perform checks of the electrical circuits. Consider the following guidelines before performing electronic troubleshooting procedures:

- Remove power.
- Before you read the resistance or continuity, lock out the test circuit with a tag.
- Isolate circuit branches for resistance or continuity checks in order to prevent reading through components.
- When reading a wire end to end and within a connector, read the test input pin to all adjacent pins for shorts within the connector locking mechanism.

- Look for readings of high resistance during continuity checks. High resistance could indicate damage or corrosion in the circuit.
- Keep fingers and hands clear of test leads during all electrical checks in order to prevent false indications.

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Service Tools

SMCS - 0785

The following service tools should be used to aid in troubleshooting the electrical system.

Table 1

Tools List
Description
Laptop computer with Caterpillar Electronic Technician software for the Product Link PL121SR/PL300 Systems
Digital Multimeter
Connector Repair Kit
Terminal Repair Kit
Crimp Tool
Standard Socket Wrench Set (1/2 Inch Drive)
Metric Socket Wrench Set (1/2 Inch Drive)
Hand Tool Group (Screwdrivers)
Torque Wrench (1/2 Inch Drive)

For instructions on servicing the Deutsch"DT"Type connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for making continuity checks or for measuring voltage.

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905815

Electronic Service Tool Does Not Communicate with ECM

SMCS - 0785-038-UE

System Operation Description:

During the installation of a Product Link 321 system, the wiring harness is connected to the existing Cat Data Link wiring on the machine. If this is not done properly, the continuity of the Cat Data Link wiring may be open intermittently. This condition may not be apparent immediately. This will cause a problem when you are trying to connect the Caterpillar Electronic Technician (Cat ET service tool) to the machine.

- Cat ET may report that no ECM has been found.
- Cat ET may not report every ECM that is on the machine.
- Cat ET may report an ECM but the ECM will not have any data.

If the wires for the Cat Data Link are reversed during the installation, the Product Link ECM will not be shown after connecting Cat ET to the machine.

Test Step 1. VERIFY THAT THE CAT DATA LINK WIRES ARE NOT REVERSED.

A. Check that the positive Cat Data Link (CDL+) wire (893-GN) in the wiring harness for the Product Link is connected to the CDL+ wire (893-GN or 944-OR) of the wire harness for the machine.

B. Check that the negative Cat Data Link (CDL-) wire (892-BR) in the wiring harness for the Product Link is connected to the negative Cat Data Link (CDL-) wire (892-BR or 945-BR) of the wire harness for the machine.

Expected Result:

The Cat Data Link wires are properly connected.

Results:

- **OK -** The wires for the Cat Data Link are properly connected. Proceed to Test Step 2.
- **NOT OK -** The wires for the Cat Data Link are reversed.

Repair: Reinstall the Cat Data Link wires correctly and check the operation of the Product Link module by using Cat ET.

STOP

Test Step 2. CHECK THE WIRING WITH A MULTIMETER.

A. Turn off the machine and turn the disconnect switch to the OPEN position.

B. Measure the resistance of the negative Cat Data Link wire from the service connector (contact "E") to the location for the spliced Cat Data Link wire. Note the resistance.

C. Measure the resistance of the positive Cat Data Link wire from the service connector (contact "D") to the location for the spliced Cat Data Link wire. Note the resistance.

Expected Result:

The resistance in both wires is less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is greater than 5 ohms. Repair the wiring harness.

  Repair: After repairing, resume the setup procedures for the installation of the Product Link.

  STOP

Test Step 3. VERIFY THAT THE WIRING FOR THE CAT Data Link IS PROPERLY CONNECTED.

A. Check the spliced connections for the Cat Data Link that were made during the installation. Verify that all connections are clean and tight.

B. Reconnect the harness connectors that were disturbed during the installation. Ensure that all of the pins are correctly seated in the sockets.

C. Reconnect the cable from the service tool connector. Attempt to access the Cat Data Link by using Cat ET.

Expected Result:

Cat ET lists the ECM systems that are available on the machine. The ECM for the Product Link can be accessed.

Results:

- **OK -** Cat ET lists the electronic control modules that are available on the machine. The ECM for the Product Link can be accessed. Resume the setup procedures for the installation of the Product Link.**STOP**
- **NOT OK -** The Cat ET does not list the electronic control modules that are available on the machine. The ECM for the Product Link cannot be accessed. Proceed to Test Step 4.

Test Step 4. CHECK FOR A MONITORING SYSTEM.

Check if the machine is equipped with a monitoring system. Some common monitoring systems include the following systems: Electronic Monitoring System, Computerized Monitoring System, Caterpillar Monitoring System, VIDS and VIMS. Also, many machines have monitors that are specific to the type of machine such as excavators and cold planers.

Expected Result:

The machine is equipped with a monitor.

Results:

- **YES -** The machine is equipped with a monitoring system. Proceed to Test Step 5.
- **NO -** The machine is not equipped with a monitoring system. Proceed to Test Step 6.

Test Step 5. CHECK FOR A DIAGNOSTIC CODE FOR THE CAT Data Link.

Check the monitoring system for a diagnostic code for the Cat Data Link.

Expected Result:

There is a diagnostic code for the Cat Data Link.

Results:

- **YES -** There is a diagnostic code for the Cat Data Link .

  Repair: Perform the troubleshooting procedure for that diagnostic code that is found in the service manual for that ECM.

  STOP

- **NO -** There are no diagnostic codes for the Cat Data Link. Proceed to Test Step 6.

Test Step 6. RETURN THE WIRING TO THE ORIGINAL CONDITION.

A. Return the Cat Data Link wires to the original condition. Remove any splices that were made and reconnect the wiring harness.

B. Connect Cat ET to the service connector. Verify that all of the appropriate electronic control modules are present. The ECM for the Product Link will not be present.

Expected Result:

All of the appropriate electronic control modules are present.

Results:

- **YES -** All of the appropriate electronic control modules are present. The wiring is correct at this time. Return to the installation procedure for the Product Link and reinstall the wiring for the Cat Data Link. Continue with the setup of the Product Link.**STOP**
- **NO -** All of the appropriate electronic control modules are not present.

Repair: A problem still exists with the Cat Data Link wiring. This problem does not relate to the installation of the Product Link. Troubleshoot the entire Cat Data Link circuit to all available electronic control modules. After the problem is found and the problem is corrected, return to the installation procedure for the Product Link. Reinstall the wiring for the Cat Data Link. Continue with the setup of the Product Link.

STOP

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Troubleshooting
Product Link 121S/300
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i04906980

Reports and Messages Not Available

SMCS - 7606-038-RPT

System Operation Description:

There are problems that could be reported with the Product Link System but the problems are not caused by the Product Link System. Check for active diagnostic codes for the Product Link. Correct any diagnostic codes before proceeding. The following items should be visually inspected for damage: module, antenna, radio and cables. Verify that there are no loose connections.

The Product Link system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The satellite network for VHF communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can travel to the earth and Caterpillar.
- The Product Link system is correctly configured to communicate on the network for VHF communications. This was verified during manufacturing tests.
- The worldwide network of Caterpillar's computers is passing messages to the software for the Caterpillar Equipmentmanager (EM). The system must be registered properly.
- The EM is configured properly and the software is functioning.

The Product Link module or the radio should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues. Subscriptions to the Product Link module must be up to the current date.

If messages are not available, proceed with the following steps in order to determine the cause.

Test Step 1. ACCESS THE PRODUCT LINK THROUGH CATERPILLAR ELECTRONIC TECHNICIAN (CAT ET).

A. Connect Cat ET to the machine.

B. Verify that the ECM (Product Link) is available.

Expected Result:

The ECM (Product Link) is available.

Results:

- **OK -** The ECM (Product Link) is available. Proceed to Test Step 2.
- **NOT OK -** The ECM (Product Link) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the Product Link has been installed correctly. Check the wiring with a multimeter. If the ECM (Product Link) is not available, refer toSystems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PRODUCT LINK MODULEHAS NOT BEEN DISABLED.

A. Go to the "Satellite Information" screen of Cat ET.

B. Verify that the "Communication Modem Status" is "Enabled".

Expected Result:

The Product Link module is enabled.

Results:

- **OK -** The "Communications Modem Status" for Product Link is "Enabled". Go to Test Step 3.
- **NOT OK -** The "Communications Modem Status" for Product Link is "Disabled" or "Pending".

  Repair: Contact your Caterpillar Technical Communicator.

  STOP

Test Step 3. VERIFY THAT THE PRODUCT LINK MODULE IS CONFIGURED PROPERLY.

A. Go to the "Configuration" screen. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Installation Parameters Configure" for more information.

B. Verify that the "PLM Registration Status" is "Registered". Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Diagnostic Capabilities" for an explanation of the "PLM Registration Status".

C. Verify that the "Dealer Identification Code" is configured with the correct code for the Dealer.

D. Verify that the "DBS Machine Make Code" is configured correctly.

E. Verify that the "Machine Serial Number" is configured with the correct machine serial number.

F. Verify that "Maintenance Mode" is configured as "Off".

Expected Result:

All settings are correct.

Results:

- **OK -** The Product Link is configured correctly. Proceed to Test Step 4.
- **NOT OK -** The Product Link is not configured correctly.

  Repair: Correct the configuration of the Product Link. The "PLM Registration Status" can be verified in the "Status Parameters" of Cat ET .

STOP

Test Step 4. VERIFY THAT THE PRODUCT LINK MODULE HAS NOT BEEN TURNED OFF.

A. Go to "Status Parameters" of Cat ET.

B. Verify " the Possible Device Power Disconnection" is labeled as "No".

Expected Result:

"Possible Device Power Disconnection" is labeled as "No".

Results:

- **OK -** The "Possible Device Power Disconnection" is labeled as "No". The Product Link has operated since successfully transmitting the last report. Proceed to Test Step 5.
- **NOT OK -** The "Possible Device Power Disconnection" is labeled as "Yes". The Product Link has been disconnected from power and transmissions have been prevented. This could explain the failure to get any messages.

  Repair: Turn on the unit.

  STOP

Test Step 5. DETERMINE IF THE PRODUCT LINK SYSTEM HAS BEEN IN AN AREA OF BLOCKED COMMUNICATIONS.

A. Go to "Status Parameters" of Cat ET.

B. Verify that the "Possible Periods of Communications Blockage" is "No".

Expected Result:

Caterpillar Electronic Technician shows that the "Possible Periods of Communications Blockage" is "No".

Results:

- **OK -** The Product Link has seen satellites since the transmission of the last report. Verify that the machine has a clear view of the sky. Proceed to Test Step 6.
- **NOT OK -** The Product Link has experienced blocked communications. Transmissions have been prevented. This could explain the failure to get any messages. Verify that the machine has a clear view of the sky. Proceed to Test Step 6.

Test Step 6. VERIFY THAT THE PRODUCT LINK IS IN POWER MODE 1.

A. Go to "Status Parameters" of Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The Cat ET screen shows that the machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The Cat ET screen is correct. The Product Link should send a Standard report and a position reports daily. Proceed to Test Step 10.

- **NOT OK -** Cat ET shows "Power Mode 2" or "Power Mode 3". A report of the position is sent in "Power Mode 2" when the machine moves more than the "Position Report Minimum Location Change". Even if this explains the current reports that are arriving at the office, proceed to Test Step 7.

Test Step 7. VERIFY THAT THE PRODUCT LINK MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" of Cat ET.

B. Start the machine.

C. Verify that the "Power Mode Status" changes to "Power Mode 1".

D. Verify that the "Alternator Running Input" changes to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The Cat ET Status screen changes to "Power Mode 1" and "Engine Running". The "Key Switch Status" should be "On".

Results:

- **OK -** The Cat ET screens are correct. The Product Link should send a Standard report and a position reports daily. Reports are sent until the Power Mode changes to "mode 2". The power mode can be viewed in EM.**STOP**

- **NOT OK - ENGINE OFF -** The Cat ET screen shows "Engine Off".

  Repair: Verify that the Alternator R-Terminal wiring has not been damaged. It is likely that the machines SMH and the SMH of Product Link no longer match. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Operating Hours Discrepancy".

  STOP

- **NOT OK - POWER MODE 2 OR 3 -** Cat ET shows "Power Mode 2" or "Power Mode 3".

  Repair: Verify that the wiring for the switched power 308-YL has not been damaged. Repair the wiring.

  STOP

Test Step 8. CHECK FOR "ACTIVE" AND/OR "LOGGED" CODES FOR THE PL300 ECM.

A. Follow the steps in the Special Instruction, REHS2365 in order to connect a laptop computer to the Product Link system.

B. Go to the menu bar for Cat ET. Select the "Diagnostics" tab. From the drop-down menu, choose the type of code. Choose "Active Codes" or "Logged Codes".

Results:

- **OK -** There are no "active" or "logged" diagnostic codes. Proceed to Test Step 9.

- **Not OK -** An "active" or "logged" diagnostic code exists.

  Repair: Refer to the Systems Operation, Troubleshooting, Testing and Adjusting, "Diagnostic Code List" in order to correct possible problems.

STOP

Test Step 9. CHECK THE INSTALLATION OF THE ANTENNA.

Observe installation of the antenna for the Product Link. Verify that the antenna is installed with a clear view of the sky. The antenna must be in a location that is free from interference. Examples of interference include the following items:

- Devices on the roof of the machine that emit power
- Other antennas that are close to the antenna for the Product Link
- The machine is inside a metal building or another similar structure.
- The machine is under large signs that are lighted.
- The machine is under power lines.

Note: Refer to Special Instruction, REHS2365 for additional details on optimal installation of the antenna.

Expected Result:

The antenna is installed on the highest point on the machine. There is a clear view of the sky.

Results:

- **OK -** The antenna for the Product Link is installed properly. Verify that all of the connections for the antenna are tight. Proceed to Test Step 10.
- **NOT OK -** The installation of the antenna is not optimal.

  Repair: Accept the current performance of the communication or reinstall the antenna at a superior location.

  STOP

Test Step 10. VERIFY TRANSMISSION OF A MESSAGE.

A. Monitor the parameters on the "Satellite Information" status screen. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Diagnostic Capabilities" for an explanation of the Product Link parameters.

B. Verify that the "Message Transmission Timestamp" is recent. If the time stamp indicates 1984, the module has never transmitted a message.

C. Go to the drop-down menu in the Cat ET and select "Service". Then select "PLM Commands" and "Position Report". If a message is in the queue, proceed to "Step F".

D. Go to "Message Queue" of Cat ET.

E. Verify that the "Queued Position Report" equals 1.

F. Go to "Message Queue" of Cat ET.

G. Verify that the "Queued Position Report" changes to 0 typically within 15 minutes. This signifies that the message has been successfully transmitted.

H. Go to "Status Parameters" of Cat ET.

I. Verify the "Primary Communication Link" switches to "On-Line" typically within 15 minutes.

Expected Result:

The "Primary Communication Link" switches to "On-Line" and the "Queued Position Report" is transmitted typically within 30 minutes. If the "Communications Modem Signal-to-Noise Ratio" is never above 10 during the 30 minute period, refer to the Special Instruction, REHS2365, "An Installation Guide for the Product Link PL121SR and for the PL300" in order to verify correct placement of the antenna.

Results:

- **OK -** The Product Link appears to be operating properly. Verify that the message was successfully received at the office. Remember that the delay time is dependent on the configuration of the software at the office.**STOP**
- **NOT OK -** There is a problem with the antenna or with the module. Do not replace the module until the antenna and cable are verified. Proceed to Test Step 12.

Test Step 11. CHECK THE VOLTAGE FOR THE PL121 AT THE CONNECTION FOR THE GPS ANTENNA.



Illustration 1 g01457897

View of checking the voltage

The voltage of the PL121 is detected at the connection for the GPS antenna.

Expected Result:

The voltage is approximately 3.3 VDC.

Results:

- **OK -** The voltage is 3.3 VDC. Proceed to Test Step 12.
- **NOT OK -** The voltage is greater than 3.3 VDC or less than 3.3 VDC. The measurement is incorrect.

  Repair: Replace the module. Verify that the system is operating correctly.

  STOP

Test Step 12. CHECK FOR A BROKEN "OPEN" COAXIAL CABLE FOR THE VHF ANTENNA.

The VHF antenna can be checked in order to determine if the antenna cable has a broken center conductor. Use an ohmmeter to check between the center conductor of the TNC connector for the VHF antenna to the threaded metal socket at the top of the hard mount antenna or magnetic mount antenna.

Note: This measurement cannot be made on the GPS antenna.

Refer to Table 1, Table 2, Illustration 2, and Illustration 3 for making resistance checks.

Table 1

Measurements for the PL121SR Antenna 263-8948, 263-7802, or 266-2861						
	Connector Center Pin for VHF Communication	**Connector Outer Shield for VHF Communication**	**GPS Connector Center Pin**	**GPS Connector Outer Shield**	**Threaded Socket for Whip Antenna**	**Metal Base Antenna**
Connector Center Pin for VHF Communication	N/A	open	N/A	N/A	less than 3 Ω	open
Connector Outer Shield for VHF Communication	open	N/A	N/A	less than 1 Ω	N/A	less than 1 Ω
GPS Connector Center Pin	N/A	60 to 70 Ω	N/A	60 to 70 Ω	N/A	60 to 70 Ω
GPS Connector Outer Shield	N/A	N/A	60 to 70 Ω	N/A	N/A	less than 1 Ω

Table 2

Measurements for the PL121SR Antenna 284-8533, 310-2393, 284-8532, 310-2391, 284-8531, or 310-2392						
	Connector Center Pin for VHF Communication	**Connector Outer Shield for VHF Communication**	**GPS Connector Center Pin**	**GPS Connector Outer Shield**	**Threaded Socket for Whip Antenna**	**Metal Base Antenna**
Connector Center Pin for VHF Communication	0 Ω	open	open	open	0 Ω	open
Connector Outer Shield for VHF Communication	open	0 Ω	open	open	open	0 Ω

GPS Connector Center Pin	open	open	0 Ω	6 to 10 M Ω	open	open
GPS Connector Outer Shield	open	open	6 to 10 M Ω	0 Ω	open	open

Note: The antenna is shipped from the supplier with a "removable strength" thread lock. The thread lock is located between the antenna whip and the base adapter. If the antenna whip is removed, Caterpillar recommends clearing any debris from the base by cleaning the threads. Use a "removable strength" thread lock when you attach the antenna whip again. Caterpillar recommends using **185-3996** Thread Lock Compound.

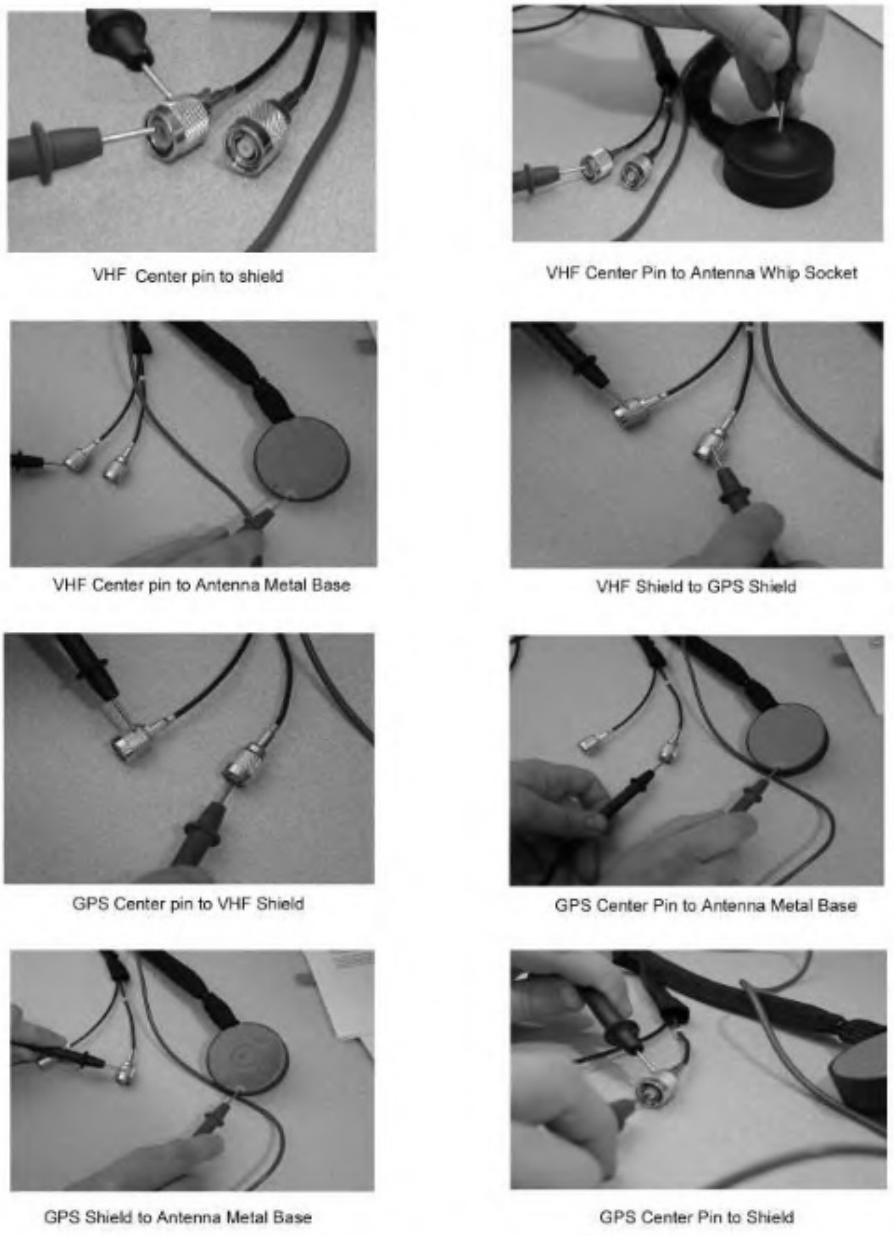


Illustration 2 g01452981



Illustration 3 g01136183

Resistance Checks for the VHF Antenna and GPS Antenna

(1) Locknut for the Antenna (Hard Mount), Lockwasher, and Threaded Metal Base

Expected Result:

The resistance should measure less than 3 ohms.

Results:

- **OK -** The resistance checks less than 3 ohms. Proceed to Test Step 13.
- **NOT OK -**

  Repair: Replace antenna assembly.

  STOP

Test Step 13. VERIFY THAT THE CENTER CONDUCTOR OF THE ANTENNA HAS NOT SHORTED TO THE SHIELD.

A. Disconnect the GPS and the VHF antenna cable from the radio.

B. Measure the resistance from the shield of the antenna cable (GPS) and the VHF antenna cable to the conductor at the center of each of the cable connectors. The shield is the threaded part of the connector.

Refer to Table 1 and Table 2 for a complete listing of resistance checks for the antenna and resistance values.

Expected Result:

The resistance for the GPS antenna meets the defined specifications in Table 1 and Table 2.

The resistance for the VHF antenna meets the defined specifications in Table 1 and Table 2.

Results:

- **OK -** The resistance for the GPS antenna meets the specifications that are defined in the tables that are listed above. The resistance for the VHF antenna meets the specifications that are defined in the tables that are listed above. The resistance is correct.**STOP**
- **NOT OK -** The resistance for the GPS antenna does not meet the specifications that are defined in the tables that are listed above. The resistance for the VHF antenna does not meet the specifications that are defined in the tables that are listed above. The resistance is incorrect.

  Repair: The antenna cable or the antenna has a short from the center conductor to the outer shield. Replace the antenna assembly. Verify that the radio is operating correctly.

  STOP

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Troubleshooting
Product Link 121S/300
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i04906981

Position Reports Not Available

SMCS - 7606-038-RPT

System Operation Description:

This section contains steps that can be used to help determine the possible cause of erratic reports of interval. Check for active diagnostic codes for the Product Link. Correct any diagnostic codes before proceeding. The following items should be visually inspected for damage: PL121SR radio, PL300 module, antenna and cables. Verify that there are no loose connections.

The Product Link system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The satellite network for VHF communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can travel to the earth and Caterpillar.
- The Product Link system is correctly configured to communicate on the network for VHF communications. This was verified during manufacturing tests.
- The worldwide network of Caterpillar's computers is passing messages to the software for the Caterpillar Equipmentmanager (EM).
- EM is configured properly and the software is functioning.

The Product Link module nor the radio should not be replaced without verifying that these issues have been investigated. Contact the Caterpillar Technical Communicator for aid in resolving these issues.

Refer to the Product Link device configuration and status information in Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Diagnostic Capabilities" in order to ensure that the lack of reporting is not due to the power mode. The unit is likely to have been configured correctly if the following statements exist:

- There is no position report after moving the machine ("Position Report Minimum Location Change").
- The SMH report is received.

There is likely to be a problem with the systems GPS. Proceed with the following steps in order to determine the cause:

Test Step 1. ACCESS THE PRODUCT LINK THROUGH CATERPILLAR ELECTRONIC TECHNICIAN (CAT ET).

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (Product Link) is available.

Expected Result:

The ECM (Product Link) is available.

Results:

- **OK -** The ECM (Product Link) is available. Proceed to Test Step 3.
- **NOT OK -** The ECM (Product Link) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the Product Link has been installed correctly. Check the wiring with a multimeter. If the ECM (Product Link) is not available, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY IF THE MACHINE HAS MOVED

Verify if the machine has moved more than the configured minimum distance ("Position Report Minimum Location Change") since the last known Position Report.

Expected Result:

The machine has not moved.

Results:

- **OK -** The machine has moved less than the configured minimum distance ("Position Report Minimum Location Change") since the last known position report. Therefore, the machine has not sent any position reports.**STOP**
- **NOT OK -** The machine has moved more than the "Position Report Minimum Location Change" or machine movement is unknown. Proceed to Test Step 3.

Test Step 3. VERIFY THAT THE PRODUCT LINK MODULE IS IN POWER MODE 1.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The screens for Cat ET display "Power Mode 1". Proceed to Test Step 4.
- **NOT OK -** Cat ET screens are not correct. Proceed to Test Step 4.

Test Step 4. VERIFY THAT THE GPS RECEIVER FUNCTIONS.

A. Select "GPS Information" for Cat ET.

B. Verify that the "GPS Position Status" is "Valid".

C. Verify that the GPS has calculated a location within the configured amount of time ("GPS Fix Validity Time Duration"). The "GPS Time Stamp" can be compared to the "PC Current Date/Time" in order to calculate the time since the last calculation of the position.

Expected Result:

The "GPS Position Status" is "Valid". The last calculation (GPS) of the position was within the configured amount of time ("GPS Fix Validity Time Duration") in "Power Mode 1".

Results:

- **OK -** The indications on the Cat ET screen are correct. The GPS Receiver is functioning properly. Proceed to Test Step 6.
- **NOT OK -** The indications on the Cat ET are incorrect. Proceed to Test Step 5.

Test Step 5. VERIFY THAT THE CENTER CONDUCTOR OF THE ANTENNA HAS NOT SHORTED TO THE SHIELD.

A. Disconnect the connection of the GPS antenna at the module.

B. Measure the resistance from the shield of the antenna cable to the conductor at the center of the cable. The shield is the threaded part of the connector.

Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available" for the following information:

- Illustrations that show the resistance checks
- Listing of resistance checks for the antenna
- Listing of resistance values

Expected Result:

The resistance for the GPS antenna meets the specifications that are defined in Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available".

Results:

- **OK -** The resistance is correct. Proceed to Test Step 6.
- **NOT OK -** The resistance is incorrect.

Repair: The antenna cable or the antenna has a short from the center conductor to the outer shield. Disconnect the cable from the antenna in order to isolate the short. Replace the antenna assembly. Verify that the module is operating correctly.

STOP

Test Step 6. VERIFY TRANSMISSION OF A MESSAGE.

A. Monitor the parameters on the "Satellite Information" status screen. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, RENR7911, "Diagnostic Capabilities" for an explanation of the Product Link parameters.

B. Verify that the "Message Transmission Timestamp" is recent. If the time stamp indicates 1984, the module has never transmitted a message.

C. Go to the drop-down menu in the Cat ET and select "Service". Then select "PLM Commands" and "Position Report". If a message is in the queue, proceed to "Step F".

D. Go to "Message Queue" of Cat ET.

E. Verify that the "Queued Position Report" equals 1.

F. Go to "Message Queue" of Cat ET.

G. Verify that the "Queued Position Report" changes to 0 typically within 15 minutes. This signifies that the message has been successfully transmitted.

H. Go to "Status Parameters" of Cat ET.

I. Verify the "Primary Communication Link" switches to "On-Line" typically within 15 minutes.

Expected Result:

The "Primary Communication Link" switches to "On-Line" and the "Queued Position Report" is transmitted typically within 30 minutes.

Results:

- **OK -** The Product Link appears to be operating properly. Verify that the message was successfully received at the office. Remember that the delay time is dependent on the configuration of the software at the office.**STOP**
- **NOT OK -** There is a problem with the antenna or with the module. Do not replace the module until the antenna and cable are verified.

  Repair: Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Reports and Messages Not Available".

  STOP

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i04906983

Reporting Interval Erratic

SMCS - 7606-038-RPT

System Operation Description:

There are problems that could be reported with the Product Link system but the problems are not caused by the Product Link system. The problem can be described as the intervals between reports are erratic. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the Product Link. Correct any diagnostic codes before proceeding. The following items should be visually inspected for damage: PL121SR radio, module, antenna and cables. Verify that there are no loose connections.

The Product Link system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The satellite network for VHF communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can travel to the earth and Caterpillar.
- The Product Link system is correctly configured to communicate on the network for VHF communications.
- The worldwide network of Caterpillar's computers is passing messages to software for the Caterpillar Equipmentmanager (EM).
- The Caterpillar Electronic Technician (Cat ET) is configured properly and the software is functioning.

The PL300 module or the PL121SR radio should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

Test Step 1. ACCESS THE PRODUCT LINK THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (Product Link) is available.

Expected Result:

The ECM (Product Link) is available.

Results:

- **OK -** The ECM (Product Link) is available. Proceed to Test Step 2.
- **NOT OK -** The ECM (Product Link) is not present in the screen for the Cat ET service tool.

  Repair: Verify that the wiring for the Product Link has been installed correctly. Check the wiring with a multimeter. If the ECM (Product Link) is not available, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PRODUCT LINK HAS NOT BEEN TURNED OFF.

A. Select "Status Parameters" for Cat ET.

B. Verify that the " Possible Device Power Disconnection" is labeled as "No".

Expected Result:

"Possible Device Power Disconnection" is labeled as "No".

Results:

- **OK -** The "Possible Device Power Disconnection" is labeled as "No". The Product Link has operated since successfully transmitting the last report. Proceed to Test Step 3.
- **NOT OK -** "Possible Device Power Disconnection" is labeled as "Yes". The Product Link has been disconnected from power and transmissions have been prevented. This could explain the failure to get any messages. Proceed to Test Step 3 in order to verify proper operation.

Test Step 3. DETERMINE IF THE PRODUCT LINK SYSTEM HAS BEEN IN AN AREA OF BLOCKED COMMUNICATIONS.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Possible Periods of Communications Blockage" is "No".

Expected Result:

"Possible Periods of Communications Blockage" is "No".

Results:

- **OK -** The Product Link has seen satellites since the transmission of the last report. Verify that the machine has a clear view of the sky. Proceed to Test Step 5.
- **NOT OK -** Product Link has experienced blocked communications. Transmissions have been prevented. This could explain the failure to get any messages. Verify that the machine has a clear view of the sky. Proceed to Test Step 4.

Test Step 4. VERIFY THAT THE PRODUCT LINK IS IN POWER MODE 1.

A. Select "Status Parameters" for Cat ET.

B. Verify that the "Power Mode Status" is "Power Mode 1". Verify that the "Key Switch Status" is "On".

Expected Result:

The machine is in "Power Mode 1" and "Key Switch On".

Results:

- **OK -** The screens for Cat ET are correct. Proceed to Test Step 5.
- **NOT OK -** The screens for Cat ET are not correct. A report of the position is sent in "Power Mode 2" and in "Power Mode 3" when the machine moves more than the "Position Report Minimum Location Change". Even if this explains the current reports that are arriving at the office, proceed to 5.

Test Step 5. VERIFY THAT THE PRODUCT LINK MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" for Cat ET.

B. Start the machine.

C. Verify that the "Power Mode Status" changes to " Power Mode 1".

D. Verify the "Alternator Running Input" switches to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The status screen for Cat ET changes to "Power Mode 1" and "Engine Running". The "Key Switch Status" should be "On".

Results:

- **OK -** The screens for Cat ET are correct. The Product Link should send four position reports and one Standard Report daily until the Power Mode changes to "Power Mode 2". The power mode can be viewed in CPLS. Proceed to Test Step 6.
- **NOT OK -** The screen for Cat ET shows "Engine Off".

  Repair: Verify that the Alternator R-Terminal wiring has not been damaged. It is likely that the machine SMU and Product Link SMH no longer match. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Operating Hours Discrepancy".

  STOP

- **NOT OK -** The screen Cat ET shows "Power Mode 2" or "Power Mode 3".

  Repair: Verify that the wiring for the switched power (308-YL) is correct. Repair the wiring.

STOP

Test Step 6. CHECK THE INSTALLATION OF THE ANTENNA.

Observe installation of the antenna for the Product Link. Verify that the antenna is installed with a clear view of the sky. The antenna must be in a location that is free from interference. Examples of interference include the following items: devices on the roof of the machine that emit power, other antennas that are close to the antenna for the Product Link, indoor machine, machine under large signs that are lighted and machine under power lines.

Expected Result:

The antenna is installed on the highest point on the machine. There is a clear view of the sky.

Results:

- **OK -** The antenna for the Product Link is installed properly. Verify that all of the connections for the antenna are tight. A test message can be sent in order to verify communications. Monitor the performance of the communication in order to verify that reports are not erratic.**STOP**
- **NOT OK -** Installation of the antenna is not optimal. Accept the current performance of the communication or reinstall the antenna at a superior location.**STOP**

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906995

Diagnostics and Events Not Available

SMCS - 0785-038-UE; 7610-038

System Operation Description:

There are problems that could be reported with the Product Link system but the problems are not caused by the Product Link system. The problem can be described as the diagnostic information or events are not received at the office. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the Product Link. Correct any diagnostic codes before proceeding. The following items should be visually inspected for damage: PL121SR radio, PL300 module, antenna and cables. Verify that there are no loose connections.

The Product Link system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The satellite network for VHF communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can travel to the earth and Caterpillar.
- The Product Link system is correctly configured to communicate on the network for VHF communications.
- The worldwide network of Caterpillar's computers is passing messages to software of the Caterpillar Equipmentmanager (EM).
- The Caterpillar Electronic Technician (Cat ET) is configured properly and the software is functioning.

The PL121SR radio or the PL300 module should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

The Product Link can be configured in order to transmit diagnostics and events to the office. These transmissions are highly dependent on the configuration of the Product Link. The following troubleshooting steps assume that the position and the Standard Report are being received.

Test Step 1. ACCESS THE PRODUCT LINK THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (Product Link) is available.

Expected Result:

The ECM (Product Link) is available.

Results:

- **OK -** The ECM (Product Link) is available. Proceed to Test Step 2.
- **NOT OK -** The ECM (Product Link) is not present in the Cat ET screen.

  Repair: Verify that the wiring for the Product Link has been installed correctly. Check the wiring with a multimeter. If the ECM (Product Link) is not available, see Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PRODUCT LINK MODULE IS CONFIGURED PROPERLY.

A. Go to the "Configuration" screen. See Systems Operation, Troubleshooting, Testing and Adjusting, "Installation Parameters Configure" for more information.

B. Verify that the "Warning Level 3 Report Configuration" is set to either "Immediate" or "Next Scheduled".

C. Verify that the "Warning Level 2 Report Configuration" is set to either "Immediate" or "Next Scheduled".

D. Verify that the "Warning Level 1 Report Configuration" is set to either "Immediate" or "Next Scheduled".

E. Verify that the "Diagnostic Report Configuration" is set to either "Immediate" or "Next Scheduled".

Expected Result:

All settings are correct.

Results:

- **OK -** The Product Link is configured correctly. Proceed to Test Step 3.
- **NOT OK -** The Product Link is not configured correctly.

  Repair: Configure the Product Link again. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Installation Parameters Configure".

  STOP

Test Step 3. CHECK FOR LOGGED EVENTS OR DIAGNOSTICS THAT MAY HAVE OCCURRED.

Use the Cat ET service tool in order to verify the existence of logged events or diagnostics on other ECM systems to report to the office. Note any events and diagnostics that are not reported.

Expected Result:

There are no logged events or diagnostics that should have been reported.

Results:

- **OK -** There are no logged events or diagnostics that should have been reported. The Product Link appears to be working correctly.**STOP**
- **NOT OK -** There are logged events or diagnostics that should have been reported. Monitor the operation of the Product Link for reporting of events and diagnostics. Problems in this area are not usually a problem with the module. Ensure that the "Event/Diagnostic Report Interval (SMU)" and the "Event/Diagnostic Message Interval (RT)" are configured properly. Ensure that the module is reporting as expected based on those settings. The module should not be replaced.**STOP**

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i04906996

Operating Hours Discrepancy

SMCS - 7606-038

System Operation Description:

There are problems that could be reported with the Product Link system but the problems are not caused by the Product Link system. The description of the problem is described as a discrepancy of the service meter units. This section contains steps that are used to determine the possible cause. Check for active diagnostic codes for the Product Link. Correct any diagnostic codes before proceeding. The following items should be visually inspected for damage: PL121SR radio, PL300 module, antenna and cables. Verify that there are no loose connections.

The Product Link system depends on several communication links in order to transfer data from the machine to the office. The following procedures assume that these communication links are operating properly. The proper communication links are listed below:

- The satellite network for VHF communications is operational in the geographic area of concern. The network is operational when messages can travel to the satellite and the messages can travel to the earth and Caterpillar.
- The Product Link system is correctly configured to communicate on the network for VHF communications.
- The worldwide network of Caterpillar's computers is passing messages to software for the Caterpillar Equipmentmanager (EM).
- The EM is configured properly and the software is functioning.

The PL300 module or the PL121SR radio should not be replaced without verifying that these issues have been investigated. Contact your Caterpillar Technical Communicator for aid in resolving these issues.

Note: The Service Meter Hours that are reported by the Product Link module should approximately match the machine operating hours.

Test Step 1. ACCESS THE PRODUCT LINK THROUGH THE CAT ET SERVICE TOOL.

A. Connect the Cat ET service tool to the machine.

B. Verify that the ECM (Product Link) is available.

Expected Result:

The ECM (Product Link) is available.

Results:

- **OK -** The ECM (Product Link) is available. Proceed to Test Step 2.
- **NOT OK -** The ECM (Product Link) is not present in the screen for Cat ET.

  Repair: Verify that the wiring for the Product Link has been installed correctly. Check the wiring with a multimeter. If the ECM (Product Link) is not available, refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Service Tool Does Not Communicate with ECM".

  STOP

Test Step 2. VERIFY THAT THE PRODUCT LINK MODULE IS CONFIGURED PROPERLY.

For PL121 only, perform the following steps:

A. Go to the "Information" pull-down menu.

B. Select "Current Totals".

C. Verify that the "Product Link Machine Operating Hours" match the machine service meter units.

For PL321 only, perform the following steps:

a. Go to the "Service" pull-down menu.

b. Select "Synchronize Service Meter Hours".

c. If Product Link is not the master ECM, verify that the "Product Link SMH" matches the SMH of the master ECM. If Product Link is the master ECM, verify that the Product Link SMH matches the machine service meter units.

Expected Result:

The hours are within 1 percent.

Results:

- **OK -** The hours are within 1 percent. The hours are synchronized. The Product Link is operating correctly.**STOP**
- **NOT OK -** (PL121) The hours are not within 1 percent. Proceed to Test Step 3.
- **NOT OK -** (PL321) The hours are not within 1 percent. In a PL321 system using sync-clock where Product Link is not the master ECM, the Product Link module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is greater than 50 hours, a diagnostic will be generated in ET that indicates

that a manual sync is required. In that instance, sync the hours (Service/Synchronize Service Meter Hours). Proceed to Test Step 3 unless the master ECM hours are incorrect. If Product Link is not the master ECM, and the hours for the master ECM are not correct, troubleshoot on machine side. Do not replace the Product Link module. STOP.

Test Step 3. VERIFY THAT THE PRODUCT LINK MODULE MONITORS THE "MACHINE RUN STATUS" PROPERLY.

A. Go to "Status Parameters" for Cat ET.

B. Verify that the "Alternator Running Input" displays "Engine Off".

C. Start the machine.

D. Verify that the "Alternator Running Input" changes to "Engine Running".

E. Verify that the "Key Switch Status" is "On".

Expected Result:

The "Status" screen for Cat ET changes from "Engine Off" to "Engine Running" when the machine is started. The "Key Switch Status" should be "On".

Results:

- **OK -** The screens for Cat ET are correct. The Product Link is correctly reading the "machine run status". This allows the Product Link to monitor the machine operating hours correctly.

  Repair: Check the splices for the R-Terminal wire (403-GN) and power wire (308-YL) in order to ensure that there are no intermittent connections.

  STOP

- **NOT OK -** On the Cat ET screen, the status did not change from "Engine Off" to "Engine Running".

  Repair: Verify the Alternator R-Terminal wiring (403-GN). Verify the switched power wire (308-YL). If the problem is not corrected, replace the Product Link module.In a PL321 system where Product Link is not the master ECM, Product Link receives the r-term input from the master ECM. In this instance, do not replace the Product Link module. Instead, troubleshoot the master ECM and the inputs from the master ECM.

  STOP

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Troubleshooting
Product Link 121S/300
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i04907026

Event Code List

SMCS - 7569

Event codes alert the operator or the technician that an abnormal operating condition exists in one of the machine systems.

When an Electronic Control Module (ECM) activates an event code, the operator or the technician will be alerted by the Messenger. Most active events will be logged by the ECM. Some events are active only. Active only events are not logged. The events that are active and the events that are logged can be viewed with the following equipment:

- Messenger
- Caterpillar Electronic Technician (Cat ET)

Warning Levels

The ECM will assign a warning level to an active event code. Event codes are one of three levels. The level is according to the severity of the abnormal condition. Each warning level requires a specific response from the operator. The warning levels and the required operator response are listed below.

Warning Level 1

Warning level 1 alerts the operator that a machine system requires attention. The operator should check that the involved system condition or the operator should perform maintenance on the involved system at the earliest possible time.

Warning Level 2

Warning level 2 requires changing the operation of the machine or performing a maintenance procedure. Failure to correct a problem that caused this warning may result in damage to the components involved in the system.

Warning Level 2S

Warning level 2S requires an immediate change in machine operation in order to avoid possible damage to the system.

Warning Level 3

Warning level 3 requires an immediate safe shutdown of the machine in order to avoid damage to the machine or injury to personnel around the machine. The problem that caused the event must be corrected before machine operation can resume.

Indications and System Response

Caterpillar Electronic Technician (Cat ET) Service Tool

When an abnormal operating condition occurs, the status screen on the Cat ET indicates that there is an active event.

Event codes are displayed on Cat ET in the following format:

EXXXX Description of the code

The "E" means that the code is an event code. The "XXXX" is a numeric identifier. The numeric identifier is followed by a description of the code.

Active event codes are listed in ascending numerical order. The code with the lowest number is listed first. The active event code is removed from the list when the condition is no longer present.

Logged Event Codes

Some event codes are logged in the ECM memory. Some event codes are active only. The logged event codes are listed in chronological order. The most recent code is listed first.

A logged code is cleared from memory when one of the following conditions occur:

- The service technician manually clears the code.
- The code does not reoccur for 1000 hours.
- A new code is logged and there are already ten logged codes in memory. In this case, the oldest logged code is cleared.

Note: Always clear logged event codes after investigating and correcting the problem which generated the code.

List of Event Codes

The following table lists event codes and the recommended responses. Use the Cat ET service tool in order to determine the event codes that are active or logged.

Table 1

List of Event Codes (EID)			
		Description	**Possible Cause and Recommended Response**

EID	Level		
861	1	Synchronized clock notification of manual synch required	In a PL321 system using sync-clock and Product Link is not the master ECM, the Product Link module will automatically sync to the master ECM hours if the difference is not greater than 50 hours. If the difference is greater than 50 hours, a diagnostic will be generated in Cat ET that indicates that a manual sync is required. In that instance, sync the hours. In Cat ET, use "Service/Synchronize Service Meter Hours".
2131	2	Inclusion Geo-Fencing boundary violated	Inclusive Geo-Fence sets up a "virtual fence" around a work site. Once Inclusive Geo-Fence is activated, a report is generated if the machine leaves the work site area. No repair or service is required.
2132	2	Exclusion Geo-Fencing boundary violated	Exclusive Geo-Fence sets up a "virtual fence" around areas that the machine is not allowed to enter. A report is generated if a machine enters a restricted area. No repair or service is required.
2133	2	Time-Fencing boundary violated	Time Based Fence allows the owner of a machine to choose the time that a machine can be operated. A report is generated if the machine is operated outside of the time that is set for machine operation. No repair or service is required.
630	2	Switched Sensor #1 trip condition is activated	The Product Link PL300 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
631	2	Switched Sensor #2 trip condition is activated	The Product Link PL300 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
632	2	Switched Sensor #3 trip condition is activated	The Product Link PL300 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.
633	2	Switched Sensor #4 trip condition is activated	The Product Link PL300 has four additional inputs that can be configured in order to monitor switches on the machine. These inputs can be configured by using Caterpillar Electronic Technician (Cat ET service tool). Troubleshoot input as setup by the dealer.

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i04907013

Diagnostic Code List

SMCS - 7569

Table 1

Module Identifier 122 Diagnostic Codes [1]	
CID 0168 Electrical System	
FMI 03 for PLVIMS and PL GSM	Voltage above normal
FMI 04 for PLVIMS and PL GSM	Voltage below normal
CID 0254 Electronic Control Module	
FMI 04	Voltage below normal
FMI 12	Failed Module
CID 0269 Sensor Power Supply	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 1250 Remote Communication Module	
FMI 09	Unable to establish communication
CID 1251 Alternator R-Terminal	
FMI 03	Voltage above normal

[1] For troubleshooting, see the procedure with the same CID FMI.

Note: A machine ECM will self-erase a diagnostic if the diagnostic does not reappear after 100 operating hours. When this event happens, the event history screen in the EquipmentManager application will show a code that occurred 100 hours in the past that no longer shows up in Cat ET because the diagnostic has not reoccurred.

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Troubleshooting
Product Link 121S/300
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i04906997

MID 122 - CID 0168 - FMI 00

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the diagnostic circuit in the Product Link identifies a system voltage that is above 32 VDC.

The possible causes of this fault are listed below:

- A charging system component is faulty.
- The harness wiring is faulty.
- The Product Link is faulty, however a faulty Product Link is unlikely.

Note: Determine if a battery charger or a welder is being used on the machine. Disconnect the charger or the welder if one is used. Recheck for the diagnostic code.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE PRODUCT LINK.

A. Start the engine and operate the engine at a high idle for 5 to 10 minutes.

B. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 11 VDC to 32 VDC.

Results:

- **OK -** The voltage is 11 VDC to 32 VDC. The Product Link should not be logging this diagnostic code.

  Repair: Use the Caterpillar Electronic Technician (Cat ET) in order to clear the diagnostic code from the Product Link. If the voltage is correct and the Product Link records the diagnostic code again, the Product Link may need to be replaced. Before replacing the Product Link, contact your Caterpillar Technical Communicator.

STOP

- **NOT OK -** The voltage is not 11 VDC to 32 VDC. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

A. Run the engine at high idle for 5 to 10 minutes.

B. Measure the voltage output at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. The battery could be faulty. Proceed to Test Step 3.
- **NOT OK -** The voltage is above 32 VDC. Troubleshoot the alternator. The voltage regulator could be faulty. If conditions are not resolved, proceed to Test Step 3.

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the key start switch to the OFF position. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 DCV. Proceed to Test Step 4.
- **NOT OK -** The voltage is above 32 VDC.

  Repair: Refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

  If conditions are not resolved, proceed to Test Step 4.

Test Step 4. CHECK EVERY ECM ON THE MACHINE.

Check the logged diagnostics of any other ECM that is installed on the machine. Compare each ECM that has logged the "CID 168 FMI 00" code in the same time period.

Note: The Service Meter Hours (SMH) on the logs may be different. The difference between the current SMH and the logged SMH is important.

Expected Result:

Other "CID 168 FMI 00" diagnostic codes can be found on other Electronic Control Modules (ECM).

Results:

- **YES -** "CID 168 FMI 00" diagnostic codes are found on other Electronic Control Modules (ECM).

Repair: Clear the fault if all the following conditions occur:

- A problem is not found with the charging system.
- A problem is not found with the wiring.
- The fault has occurred a few times.

Monitor the module and the machine for further occurrences. If the fault occurs again, the Product Link module has not failed as other electronic control modules are displaying the same fault. Recheck the system voltage.

STOP

- **NO -** No other "CID 168 FMI 00" diagnostic codes can be found on other electronic control modules.

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.
  - The fault has occurred a few times.

  Monitor the module and the machine for further occurrences. If the fault occurs again, then the Product Link module is possibly faulty. The Product Link should be replaced. Refer to Systems operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the Product Link has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04907019

MID 122 - CID 0168 - FMI 01

SMCS - 1406-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the Product Link detects a battery voltage of less than 11 VDC.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE PRODUCT LINK MODULE.

Start the engine and operate the engine at a high idle for 5 to 10 minutes. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 27 VDC to 29 VDC for a 24 VDC system. The voltage is 13 VDC to 15 VDC for a 12 VDC system.

Results:

- **OK -** The voltage is correct. Clear the diagnostic code and check for another occurrence of the diagnostic code.**STOP**
- **NOT OK -** The voltage is incorrect. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

Run the engine at a high idle for 5 to 10 minutes. Measure the voltage output at the battery posts.

Expected Result:

For a 24 VDC system, the voltage range should be 27 VDC to 29 VDC. The voltage range should be 13 VDC to 15 VDC for a 12 VDC system.

Results:

- **OK -** The voltage is correct. Proceed to Test Step 3.
- **NOT OK -** The voltage is incorrect.

Repair: Repair the alternator or replace the alternator.

STOP

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the key start switch to the OFF position. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be 12 VDC to 15 VDC for a 12 VDC system. The voltage should be 24 VDC to 27 VDC for a 24 VDC system.

Results:

- **OK -** The voltage is between 12 VDC and 15 VDC or the voltage is between 24 VDC and 27 VDC.

  Repair: The Product Link could be faulty. Recheck the system before replacing the Product Link. The Product Link is seldom the cause of a diagnostic code. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the Product Link has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

- **NOT OK -** The voltage is not between 12 VDC and 15 VDC or the voltage is not between 24 VDC and 27 VDC.

  Repair: See Special Instruction, REHS0354, "Charging System Troubleshooting". If conditions are not resolved, the Product Link could be faulty. Recheck the system before replacing the Product Link. The Product Link is seldom the cause of a diagnostic code. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the Product Link has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905835

MID 122 - CID 0254 - FMI 04

SMCS - 7610-038

Conditions Which Generate This Code:

Communication with the satellite will not occur when power to the Product Link is below 10.5 VDC. The Product Link will still communicate with Caterpillar Electronic Technician (Cat ET) when power to the module is down to 9 VDC. A diagnostic code of "CID 168 FMI 01" will occur when the system voltage drops below 11 VDC. A diagnostic code of "CID 254 FMI 04" will occur when the system voltage drops below 9 VDC. This CID code is logged so that no messages will be communicated from the machine to the office.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE PRODUCT LINK.

A. Start the engine and operate the engine at a high idle for 5 to 10 minutes.

B. Measure the system voltage between the "Unswitched Power" and the "Ground" contacts. Pin 52 is the terminal for "Unswitched Power" and pin 65 is the terminal for "Ground".

Expected Result:

The voltage is 11 VDC to 32 VDC.

Results:

- **OK -** The voltage is 11 VDC to 32 VDC. The Product Link should not be logging this diagnostic code.

  Repair: Use Cat ET in order to clear the diagnostic code from the Product Link. If the voltage is correct and the Product Link records the diagnostic code again, the Product Link may need replaced. Before replacing the Product Link, contact your Caterpillar Technical Communicator.

  STOP

- **NOT OK -** The voltage is not 11 VDC to 32 VDC. Proceed to Test Step 2.

Test Step 2. CHECK THE ALTERNATOR.

A. Run the engine at high idle for 5 to 10 minutes.

B. Measure the voltage output at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. The battery could be faulty. Proceed to Test Step 3.
- **NOT OK -** The voltage is above 32 VDC. Repair the alternator or replace the alternator. The voltage regulator could be faulty. If conditions are not resolved, proceed to Test Step 3.

Test Step 3. CHECK THE BATTERY VOLTAGE.

Turn the key start switch to the OFF position. Measure the battery voltage at the battery posts.

Expected Result:

The voltage should be below 32 VDC.

Results:

- **OK -** The voltage is below 32 VDC. Proceed to Test Step 4.
- **NOT OK -** The voltage is above 32 VDC.

  Repair: See Special Instruction, REHS0354, "Charging System Troubleshooting".

  If conditions are not resolved, proceed to Test Step 4.

Test Step 4. CHECK EVERY ECM ON THE MACHINE.

Check the logged diagnostics of any other ECM that is installed on the machine. Compare each ECM that has logged the"CID 168 FMI 00" code in the same time period.

Note: The Diagnostic Clock Hours (DCH) on the logs may be different. The difference between the current DCH and the logged DCH is important.

Expected Result:

Other "CID 168 FMI 00" diagnostic codes can be found on other Electronic Control Modules (ECM).

Results:

- **YES -** "CID 168 FMI 00" diagnostic codes are found on other Electronic Control Modules (ECM).

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.

- The fault has occurred a few times.

Monitor the module and the machine for further occurrences. If the fault occurs again, the Product Link module has not failed as other electronic control modules are displaying the same fault. Recheck the system voltage.

STOP

- **NO -** No other "CID 168 FMI 00" diagnostic codes can be found on other electronic control modules.

  Repair: Clear the fault if all the following conditions occur:

  - A problem is not found with the charging system.
  - A problem is not found with the wiring.
  - The fault has occurred a few times.

  Monitor the module and the machine for further occurrences. If the fault occurs again, then the Product Link module is possibly faulty. The Product Link should be replaced. Refer to Systems operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace". If the Product Link has been replaced, recheck the system and check the status of the diagnostic code.

  STOP

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04905845

MID 122 - CID 0254 - FMI 12

SMCS - 7610-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the Product Link detects a problem that is internal to the control module. This diagnostic code can only be caused if the ECM for Product Link is faulty. There are no serviceable parts within the control module.

Test Step 1. CHECK THE HARNESS CONNECTIONS.

A. Disconnect the contacts and clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Determine if "CID 0254 FMI 12" diagnostic code is present by using Cat ET.

Expected Result:

The "CID 0254 FMI 12" diagnostic code is present.

Results:

- **OK -** The "CID 0254 FMI 12" diagnostic code is present.

  Repair: The problem has not been corrected. It is unlikely that the ECM is faulty. Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the ECM for Product Link. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The "CID 0254 FMI 12" diagnostic code is not present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or

a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906861

MID 122 - CID 0269 - FMI 03

SMCS - 1408-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the voltage of the sensor supply circuit (T930-WH-18) is above the normal range (nominal 8.3 VDC). Any sensor that is connected to this supply may not operate properly or the sensor may be damaged. If there is not a sensor connected, then this fault can be considered a nuisance fault. The possible causes of this diagnostic code are listed below:

- The circuit for +V (T930-WH-18) to the sensor is shorted to the battery.
- The sensor is faulty.
- The ECM is faulty, however ECM failure is unlikely.

Test Step 1. CHECK THE SUPPLY OUTPUT FOR THE SENSOR.

A. Disconnect the Product Link Input or Output cable (J2) from the sensor cable for the machine.

B. Turn the key start switch to the ON position.

C. Measure the sensor supply output (J2-1) to verify that it is less than 9 VDC when on and less than 4 VDC when off.

Expected Result:

The sensor supply output measures above less than 4 VDC in the off state and less than 9 VDC in the on state.

Results:

- **OK -** The voltage is in the required voltage range. The Product Link Sensor Supply and Product Link harness are likely not faulty. The machine harness or the external sensor may be faulty. Proceed to Test Step 3.
- **NOT OK -** The voltage is not in the required voltage range. The Product Link cable has a possible short to the battery. Proceed to Test Step 2.

Test Step 2. CHECK THE PRODUCT LINK HARNESS FOR A SHORT TO BATTERY.

A. Turn the key start switch to the OFF position.

B. Keep the Product Link Input or Output cable disconnected from the cable for the sensor for the machine.

C. At the Product Link harness, measure the resistance from sensor supply contact J2-1 (+V) to the Product Link cable J1-1.

Expected Result:

The resistance should be greater than 5000 ohms.

Results:

- **OK -** The Product Link harness is correct. Proceed to Test Step 3.
- **NOT OK -** There is a short in the Product Link harness J2-1 (T930-WH-18) and a battery source (J1-1).

  Repair: Repair the Product Link harness or replace the Product Link harness.

  STOP

Test Step 3. CHECK THE CABLE FOR THE SENSOR FOR A SHORT TO BATTERY.

A. Keep the Product Link harness Input or Output cable that is disconnected from the sensor cable for the machine.

B. At the sensor machine harness, measure the resistance from sensor supply contact J2-1 (+V) to battery power.

Expected Result:

The resistance should be greater than 5000 ohms.

Results:

- **OK -** The sensor or the sensor harness are not shorted to the battery. Proceed to Test Step 4.
- **NOT OK -** There is a short between the sensor harness "J2-1" (T930-WH-18) and the source for the battery, or the sensor has failed resulting in a short to the battery.

  Repair: Replace the wiring harness or repair the wiring harness.

  STOP

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 0269 FMI 03 diagnostic code is present by using Cat ET.

Expected Result:

The "CID 0269 FMI 03" diagnostic code is present.

Results:

- **OK -** The problem has not been corrected. However, ECM failure is unlikely.

  Repair: Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the Product Link ECM. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The diagnostic code is not present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04906882

MID 122 - CID 0269 - FMI 04

SMCS - 1408-038

Conditions Which Generate This Code:

This diagnostic code is recorded when the voltage of the sensor supply circuit (T930-WH-18) is below the normal range (nominal 8.3 VDC). Any sensor that is connected to this supply will not operate. If there is not a sensor connected, then this fault can be considered a nuisance fault. The possible causes of this diagnostic code are listed below:

- The sensor supply circuit (T930-WH-18) is shorted to ground.
- The sensor is faulty.
- The ECM is faulty, however ECM failure is unlikely.

Test Step 1. CHECK THE SENSOR SUPPLY OUTPUT.

A. Disconnect the Product Link Input or Output cable (J2) from the sensor cable for the machine.

B. Turn the key start switch to the ON position.

C. Measure the sensor supply output (J2-1) to verify that it is above 7.5 VDC.

Expected Result:

The sensor supply output measures above 7.5 VDC.

Results:

- **OK -** The voltage is above 7.5 VDC when on. The Product Link Sensor Supply and Product Link harness are likely not faulty. The machine harness or the external sensor may be faulty. Proceed to Test Step 3.
- **NOT OK -** The Product Link cable has a possible short to ground. Proceed to Test Step 2.

Test Step 2. CHECK THE PRODUCT LINK HARNESS FOR A SHORT TO GROUND.

A. Turn the key start switch to the OFF position.

B. Keep the Product Link Input or Output cable disconnected from the sensor cable for the machine.

C. At the Product Link harness, measure the resistance from sensor supply contact J2-1 (+V) to frame ground and the Product Link cable J1-2.

Expected Result:

Each resistance should be greater than 5000 ohms.

Results:

- **OK -** The Product Link harness is correct. Proceed to Test Step 3.
- **NOT OK -** There is a short in the Product Link harness J2-1 (T930-WH-18) and a ground source. The possible ground sources are J1-2 (202-BK), and frame ground.

  Repair: Repair the Product Link harness or replace the Product Link harness.

  STOP

Test Step 3. CHECK THE SENSOR CABLE FOR A SHORT TO GROUND.

A. Keep the Product Link Input or Output cable disconnected from the sensor cable for the machine.

B. At the sensor machine harness, measure the resistance from sensor supply contact J2-1 (+V) to frame ground and the Product Link cable J1-2.

Expected Result:

Each resistance should be greater than 5000 ohms.

Results:

- **OK -** The sensor and the sensor harness are correct. The sensor and the sensor harness are not shorted to ground. Proceed to Test Step 4.
- **NOT OK -** There is a short in the sensor harness J2-1 (T930-WH-18) and a ground source or the sensor has failed resulting in a short to ground. The possible ground sources are J1-2 (202-BK), and frame ground.

  Repair: Replace the sensor or correct the short to ground. If necessary, replace the sensor harness.

  STOP

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position.

D. Operate the machine.

E. Determine if "CID 0269 FMI 04" diagnostic code is present utilizing Caterpillar Electronic Technician (Cat ET).

Expected Result:

A "CID 0269 FMI 04" diagnostic code is present.

Results:

- **YES -** The problem has not been corrected. However, ECM failure is unlikely.

  Repair: Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the Product Link ECM. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NO -** The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04907021

MID 122 - CID 1250 - FMI 09

SMCS - 7606-038

Conditions Which Generate This Code:

This code signals a lack of communication between the PL300 and the PL121. The lack of communication can be caused by the following actions:

- "Sub-Module Flashing" of the PL121 with old software (prior to v3.0) on the PL300
- A failure in the harness between the PL300 and the PL121
- A failure of the hardware of the PL121 and the PL300

Note: In versions of software prior tov3.1, if the code clears following a power cycle, verify that the GPS Receiver is shown as "Functional". If the status for the GPS Receiver is shown as "Not Present", the lack of communication still exists.

Test Step 1. CHECK THE VERSION OF SOFTWARE ON THE PL300.

By using Caterpillar Electronic Technician (Cat ET), check the version of software on the PL300. Click "Service" and then click "Submodule Programming".

Expected Result:

The version of software should be version 3.0 or a later version.

Results:

- **OK -** The version of software is version 3.0 or a later version. Proceed to Test Step 2.
- **NOT OK -** The version of software is not version 3.0 or a later version.

  Repair: Flash the PL300 with the latest version of software. The version of software should be version 3.0 or a later version. Clear the diagnostic code.

  STOP

Test Step 2. VERIFY POWER FROM THE PL300 TO THE PL121.

A. Use a multimeter in order to verify power from the PL300 to the PL121.

B. Disconnect the 12-pin connector from the PL121.

C. Check the voltage on pin 1 and pin 2.

Expected Result:

The voltage should be between 11 VDC and 32 VDC.

Results:

- **OK -** The voltage is 11 VDC to 32 VDC. Proceed to Test Step 3.
- **NOT OK -** The voltage is not 11 VDC to 32 VDC.

  Repair: Check the harness for damage. Repair the harness or replace the harness. Clear the diagnostic code.

  STOP

Test Step 3. EXCHANGE THE PL121 WITH A "KNOWN GOOD UNIT".

Replace the PL121 with a second PL121. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Expected Result:

The diagnostic code should be cleared.

Results:

- **OK -** The diagnostic code was cleared.

  Repair: The Product Link should be replaced. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The diagnostic code was not cleared. Proceed to Test Step 4.

Test Step 4. REPLACE THE PL300.

Replace the PL300.

Expected Result:

The diagnostic code should be cleared.

Results:

- **OK -** The diagnostic code was cleared.

Repair: Replace the PL300. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP

- **NOT OK -** The diagnostic code was not cleared.

  Repair: Repeat the diagnostic procedure. If the diagnostic code still exists, contact your Caterpillar Technical Communicator for additional assistance.

  STOP

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Troubleshooting
Product Link 121S/300
Media Number -RENR7911-10 **Publication Date -01/06/2013** **Date Updated -27/06/2013**

i04907016

MID 122 - CID 1251 - FMI 03

SMCS - 1406-038

Conditions Which Generate This Code:

The Product Link module tracks the machine operating hours for reporting to the office. The Alternator R-Terminal signal is used to detect when the machine is operating. If the input continually receives a voltage signal that is above normal, then machine operation cannot be detected. If the input continually receives a voltage signal that is above normal, the reported Service Meter Hours (SMU) would be inaccurate.

Test Step 1. CHECK THE R-TERMINAL CABLING FOR SHORT TO BATTERY.

A. Disconnect the Product Link cable (P1) from the Product Link module.

B. Measure the resistance from the Alternator R-terminal input J1-4 (403MC9-GN-18 to battery (J1-1).

Expected Result:

The resistance should be greater than 5000 ohms.

Results:

- **OK -** The Product Link harness is likely correct. Proceed to Test Step 2.
- **NOT OK -** The Product Link cable has a probable short to battery.

  Repair: Repair the cable and verify that the fault has been removed.

  STOP

Test Step 2. CHECK THE PRODUCT LINK HARNESS FOR A SHORT TO A VOLTAGE SOURCE.

A. Disconnect the Product Link cable (P1) from the Product Link module.

B. Start the engine.

C. Measure the Alternator R-Terminal input (J1-4) to verify that there is an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz. Also, a steady DC voltage equivalent to the battery should be present.

Expected Result:

The Alternator R-Terminal input does not measure at a steady DC voltage equivalent to the battery voltage.

Results:

- **OK -** The signal is an 11 VDC to 32 VDC square-wave from 0kHz to 2 kHz or a steady DC voltage equivalent to the battery present. The Product Link harness is likely not faulty. Proceed to Test Step 3.
- **NOT OK -** The Product Link cable has a possible short to a DC voltage source other than battery voltage.

  Repair: Repair the cable and verify that the fault has been removed.

  STOP

Test Step 3. CHECK THE MACHINE ALTERNATOR.

A. Disconnect the Product Link machine cable from the alternator.

B. Start the engine.

C. Measure the Alternator R-Terminal to verify that there is 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz. There should not be a steady DC voltage equivalent to the battery present.

Expected Result:

The alternator R-Terminal should be an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz.

Results:

- **OK -** The alternator R-Terminal is an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz. Proceed to Test Step 4.
- **NOT OK -** The alternator R-Terminal is not an 11 VDC to 32 VDC square-wave from 0 kHz to 2 kHz.

  Repair: Repair the alternator or replace the alternator.

  STOP

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Clean the contacts of the harness connectors.

B. Reconnect all harness connectors.

C. Turn the key start switch to the ON position and operate the machine.

D. Determine if "CID 1251 FMI 03" diagnostic code is present by using the Caterpillar Electronic Technician (Cat ET).

Expected Result:

A "CID 1251 FMI 03" diagnostic code is present.

Results:

- **YES -** The problem has not been corrected. It is unlikely that the ECM is faulty.

  Repair: Perform this diagnostic test procedure again. If the cause of the diagnostic code is not found, replace the Product Link ECM. Before replacing the Product Link, contact your Caterpillar Technical Communicator. Refer to Systems Operation, Troubleshooting, Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NO -** The diagnostic code is NOT present. The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.**STOP**

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02536615

Alternator and Regulator

SMCS - 1405; 1410

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Note: Load the battery with a carbon pile **4C-4911** Battery Load Tester in order to get the maximum alternator output.

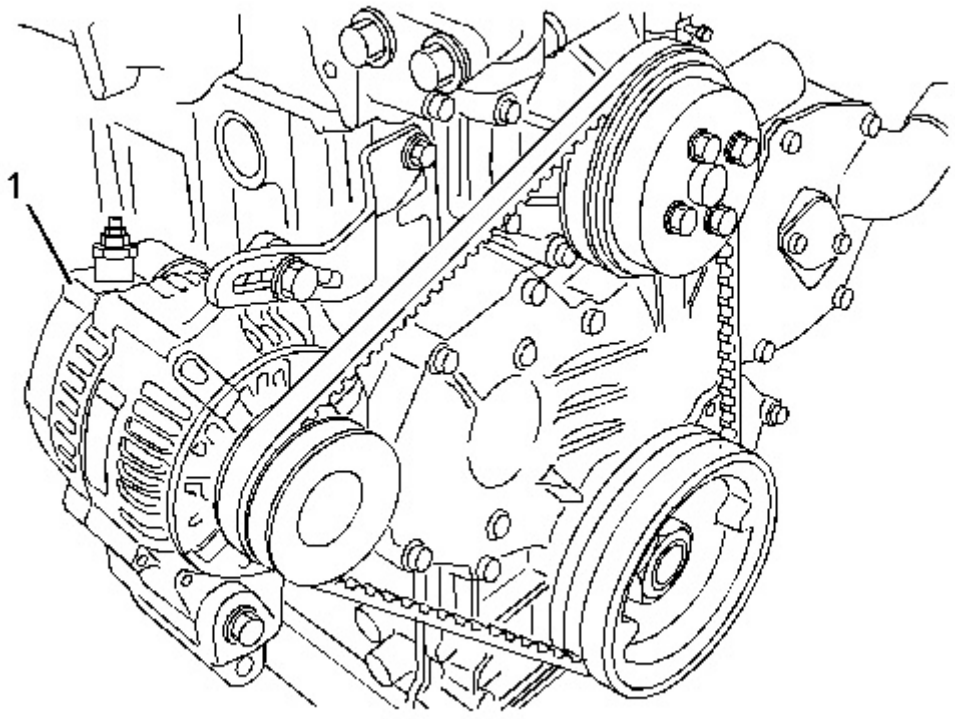


Illustration 1 g01269389

(1) Alternator and regulator

Voltage ... 13.5 V

Output current at 1500 rpm ... 20 amp or higher

Output current at 3000 rpm ... 50 amp or higher

Output current at 5000 rpm ... 60 amp or higher

Adjusting voltage of the regulator at 5000 rpm with a load of 5 amp or lower ... 14.2 V to 14.8 V

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02536615

Alternator and Regulator

SMCS - 1405; 1410

S/N - -

Note: Load the battery with a carbon pile **4C-4911** Battery Load Tester in order to get the maximum alternator output.

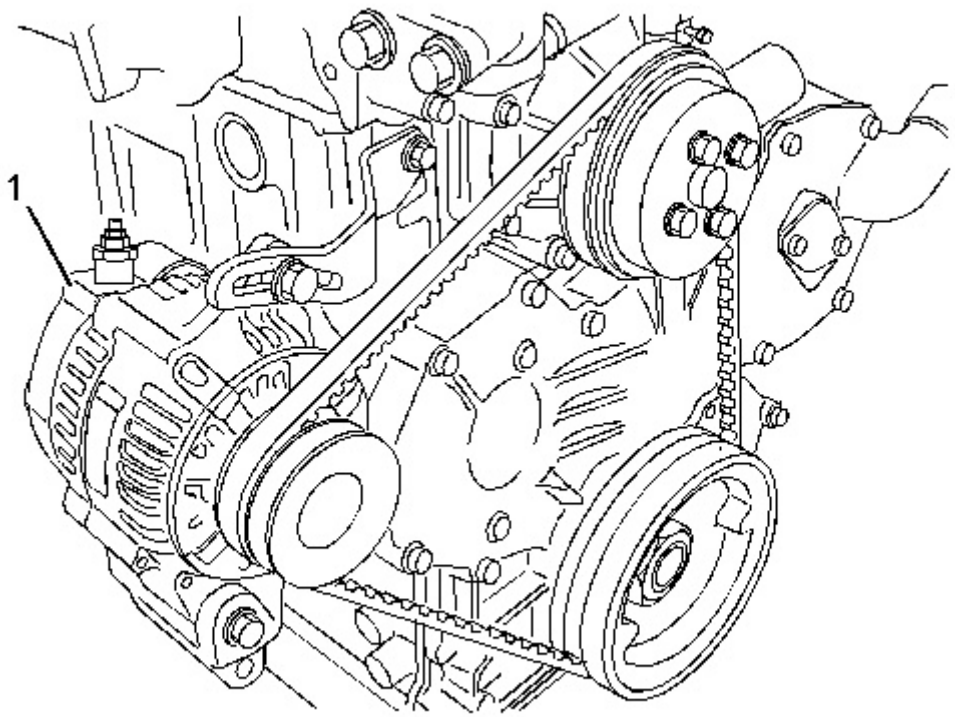


Illustration 1 g01269389

(1) Alternator and regulator

Voltage ... 13.5 V

Output current at 1500 rpm ... 20 amp or higher

Output current at 3000 rpm ... 50 amp or higher

Output current at 5000 rpm ... 60 amp or higher

Adjusting voltage of the regulator at 5000 rpm with a load of 5 amp or lower ... 14.2 V to 14.8 V

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i03037625

Alternator - Remove and Install

SMCS - 1405-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Start By:

A. Disconnect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

Note: The muffler has been removed for clarity.

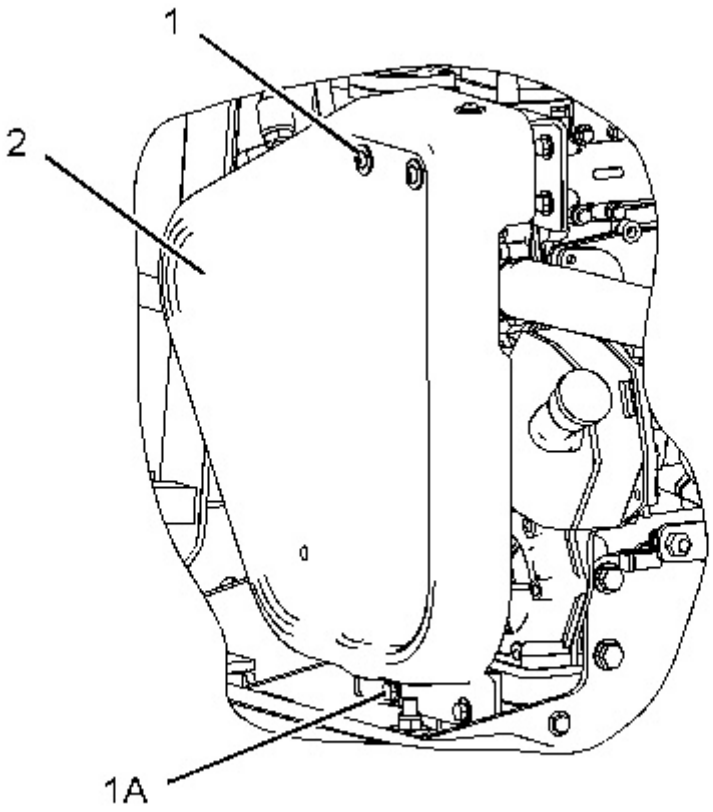


Illustration 1 g01541413

1. Remove bolts (1A) and screws (1) . Remove cover (2) .

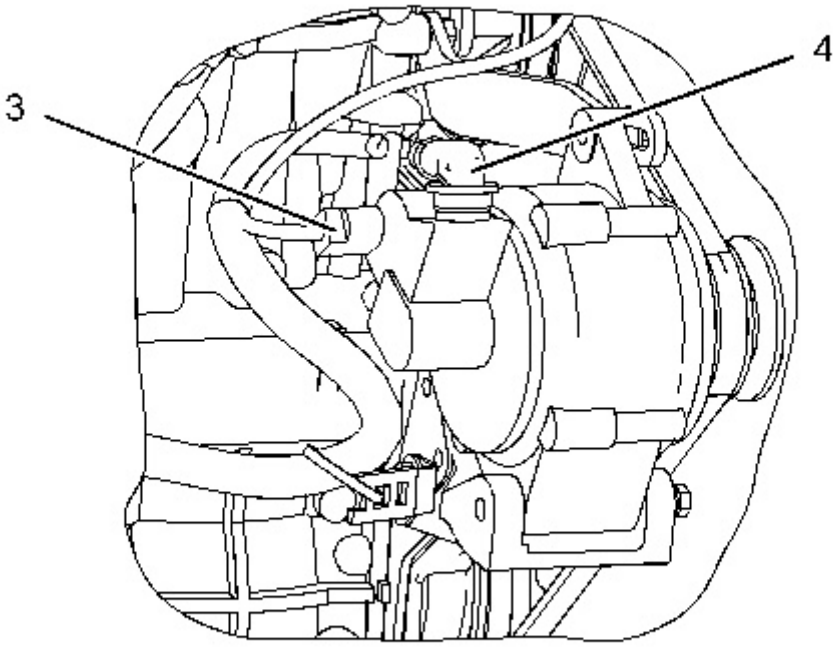


Illustration 2 g01038433

2. Disconnect harness assembly (3) . Raise the boot and disconnect harness assembly (4) .

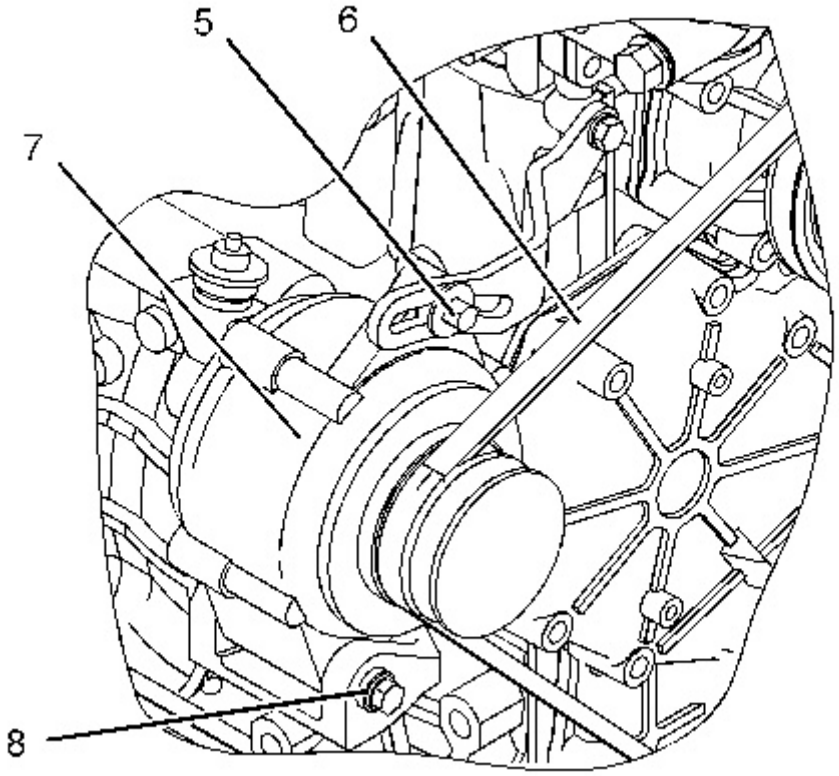


Illustration 3 g01038438

3. Loosen bolts (5) and (8) . Remove belt (6) and remove alternator (7) .

Installation Procedure

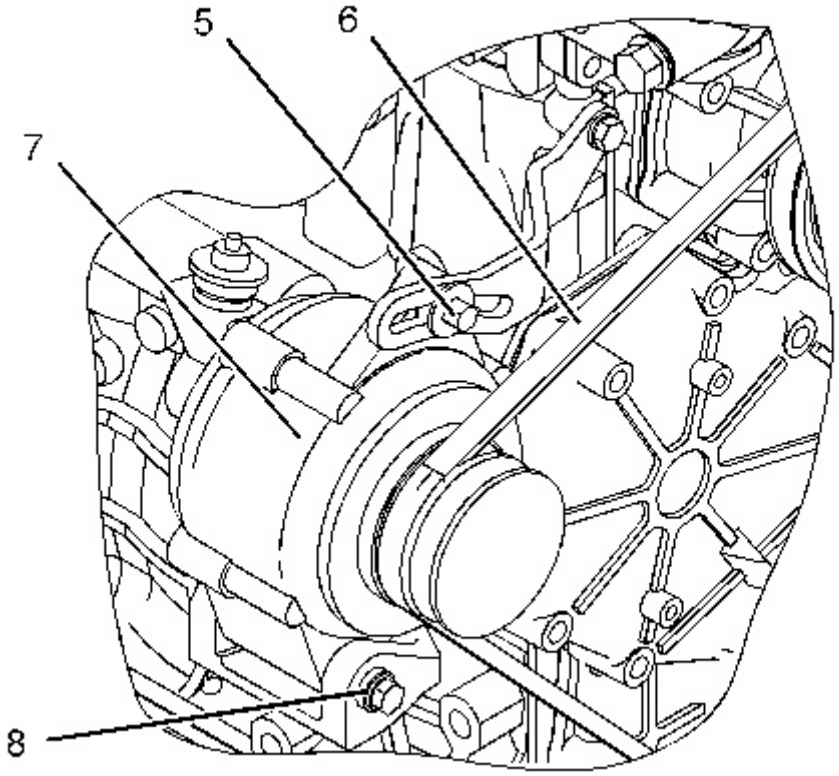


Illustration 4 g01038438

1. Install alternator (7) . Install belt (6) . Refer to Operation and Maintenance Manual, "Belt - Inspect/Adjust/Replace" for more information. Tighten bolts (5) and (8) .

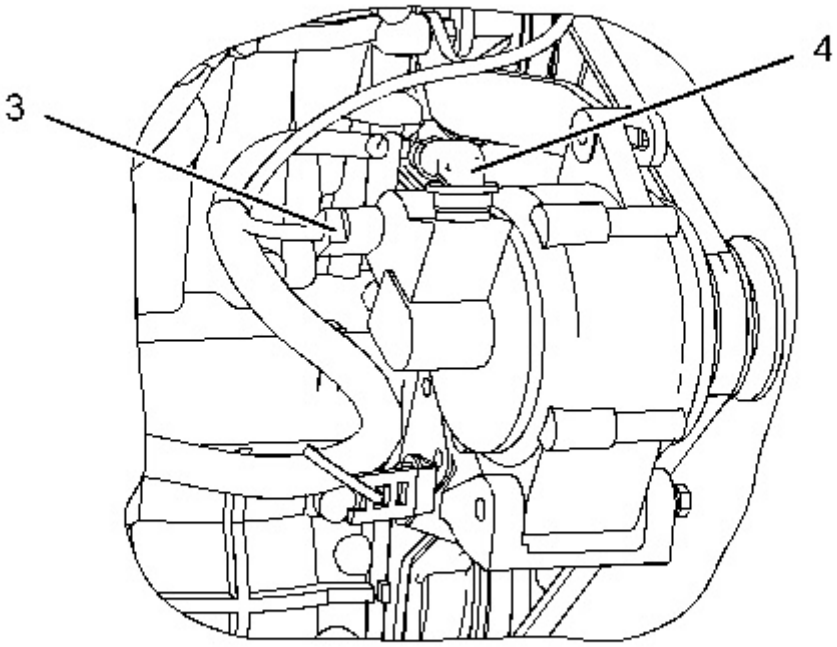


Illustration 5 g01038433

2. Connect harness assembly (3) . Raise the boot and connect harness assembly (4) .

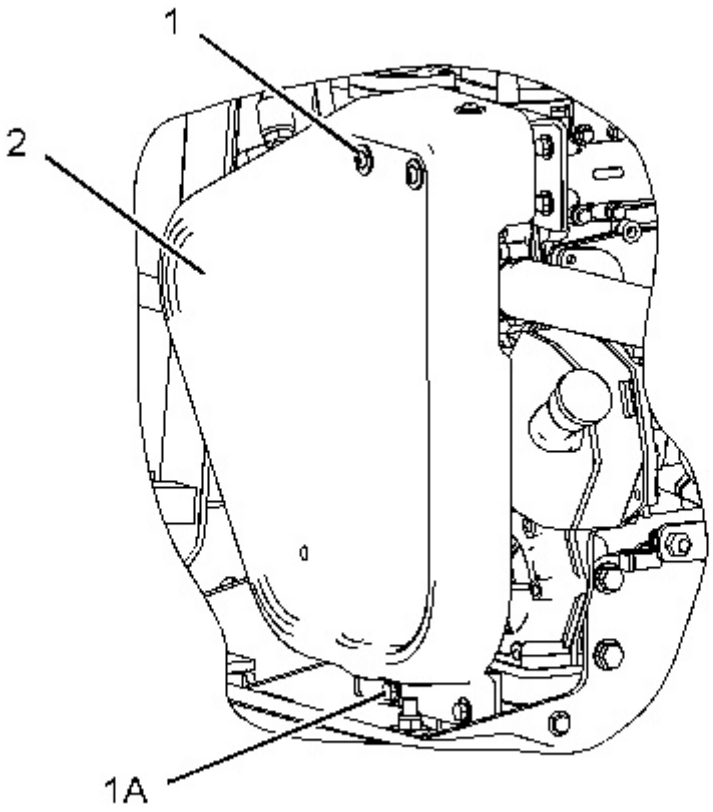


Illustration 6 g01541413

3. Install cover (2) and install screws (1) . Tighten screws (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).
4. Install bolts (1A) . Tighten bolts (1A) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

End By: Connect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i03037625

Alternator - Remove and Install

SMCS - 1405-010

Removal Procedure

Start By:

A. Disconnect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

Note: The muffler has been removed for clarity.

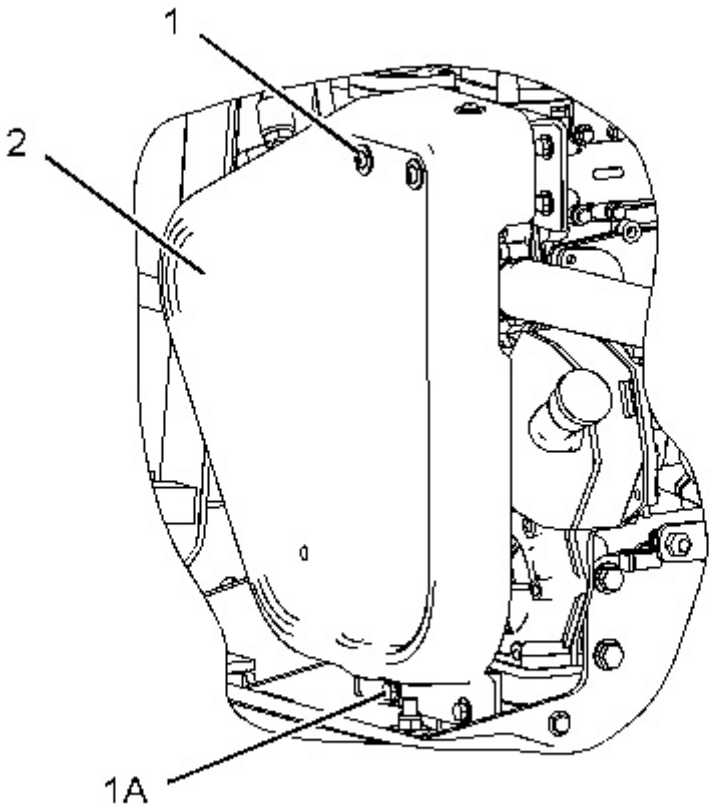


Illustration 1 g01541413

1. Remove bolts (1A) and screws (1) . Remove cover (2) .

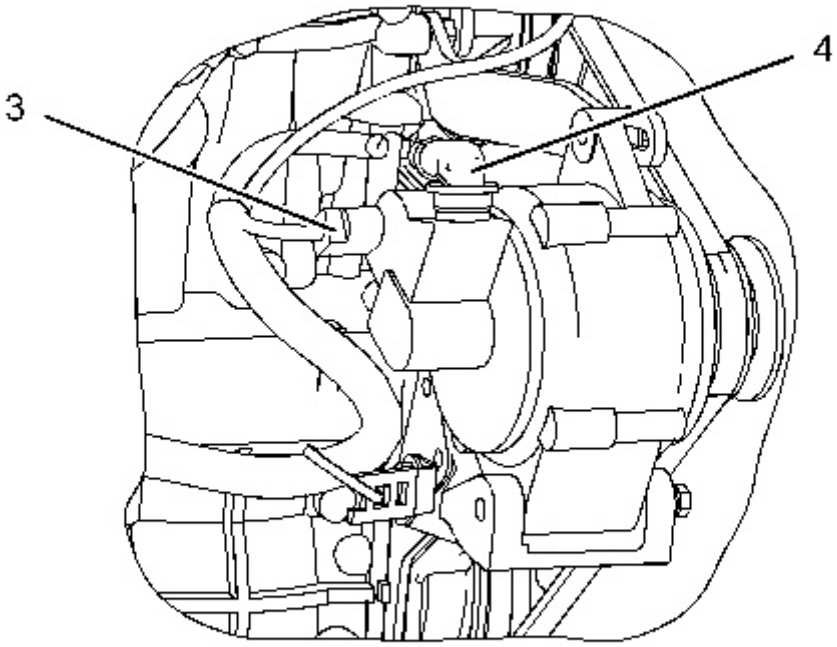


Illustration 2 g01038433

2. Disconnect harness assembly (3) . Raise the boot and disconnect harness assembly (4) .

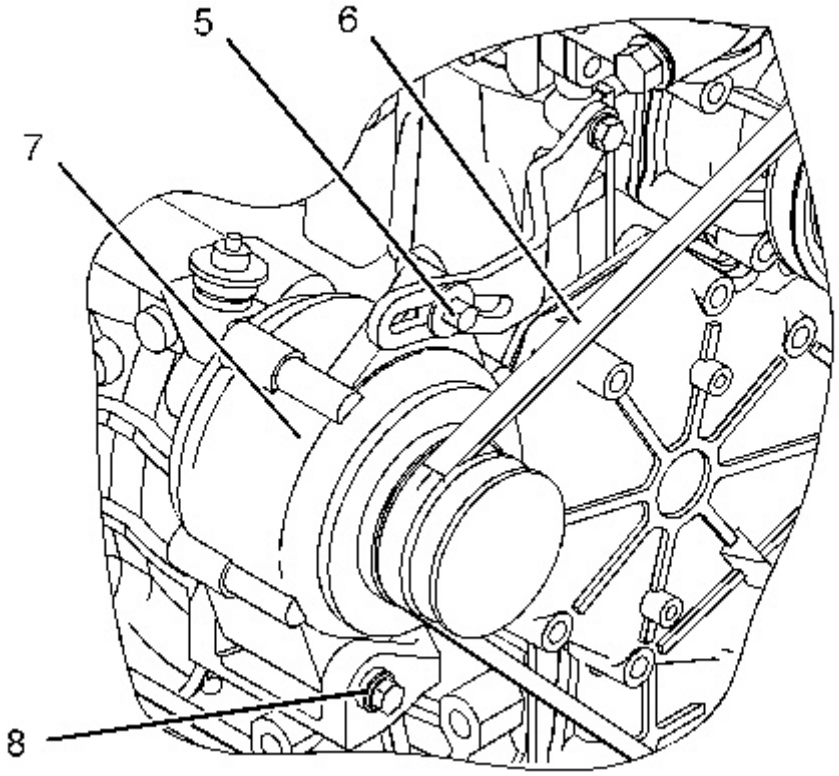


Illustration 3 g01038438

3. Loosen bolts (5) and (8) . Remove belt (6) and remove alternator (7) .

Installation Procedure

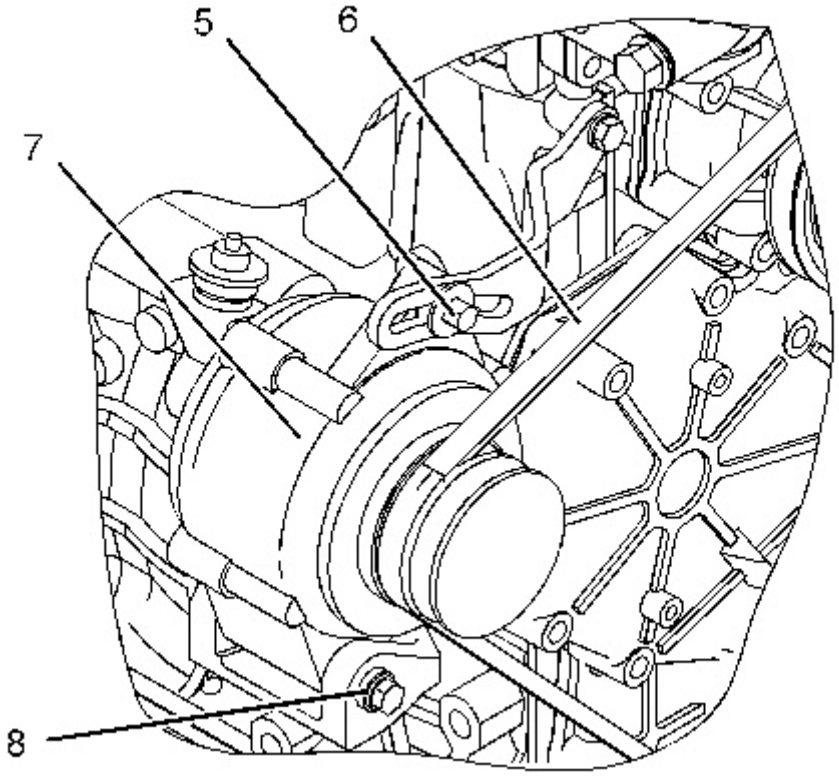


Illustration 4 g01038438

1. Install alternator (7) . Install belt (6) . Refer to Operation and Maintenance Manual, "Belt - Inspect/Adjust/Replace" for more information. Tighten bolts (5) and (8) .

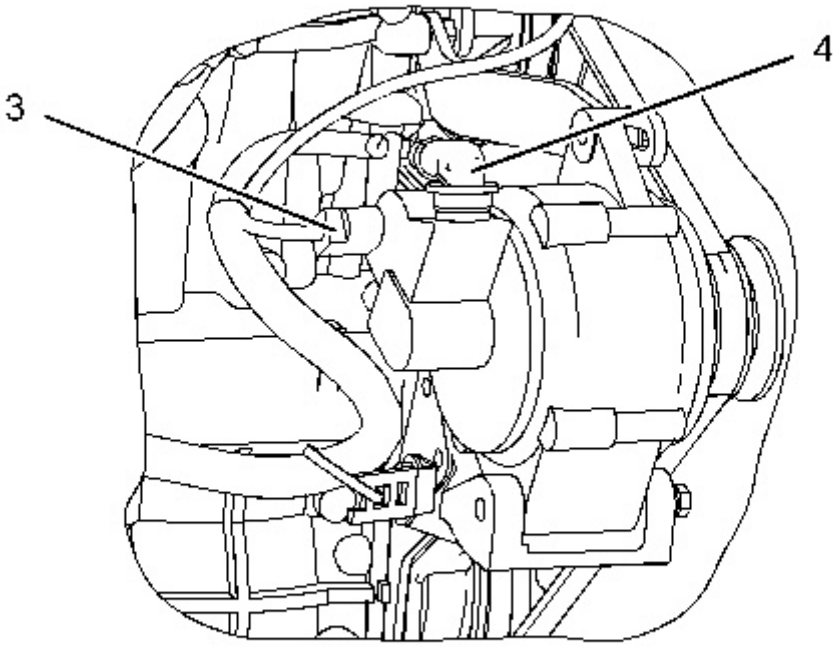


Illustration 5 g01038433

2. Connect harness assembly (3) . Raise the boot and connect harness assembly (4) .

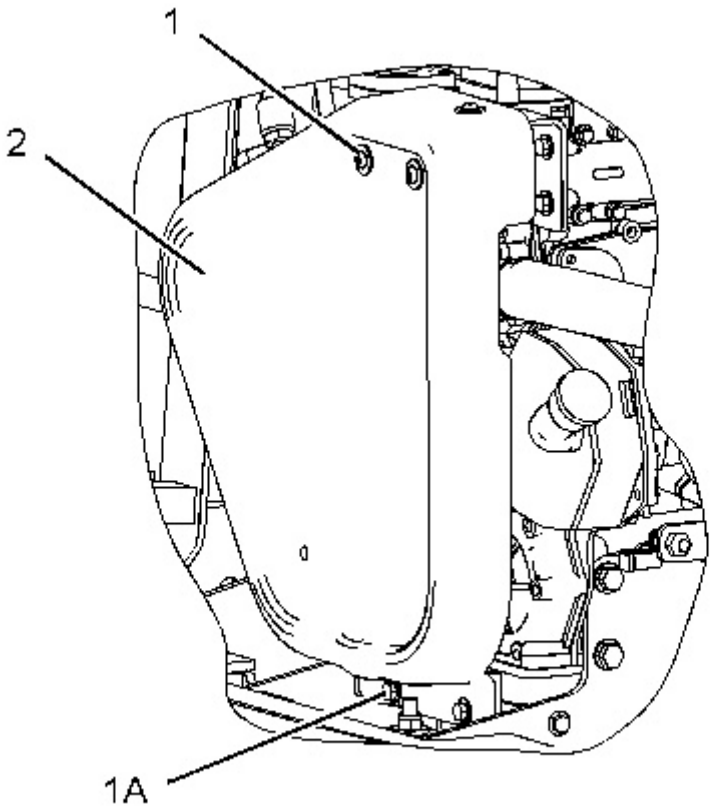


Illustration 6 g01541413

3. Install cover (2) and install screws (1) . Tighten screws (1) to a torque of 6 ± 1 N·m (53 ± 9 lb in).
4. Install bolts (1A) . Tighten bolts (1A) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

End By: Connect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639317

Alternator - Remove and Install

SMCS - 1405-010

Removal Procedure

Start By:

A. Remove the V-Belt. Refer to Disassembly and Assembly, "V-Belts - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Turn the battery disconnect switch to the OFF position.
2. Make temporary identification marks on the connections of the harness assembly.

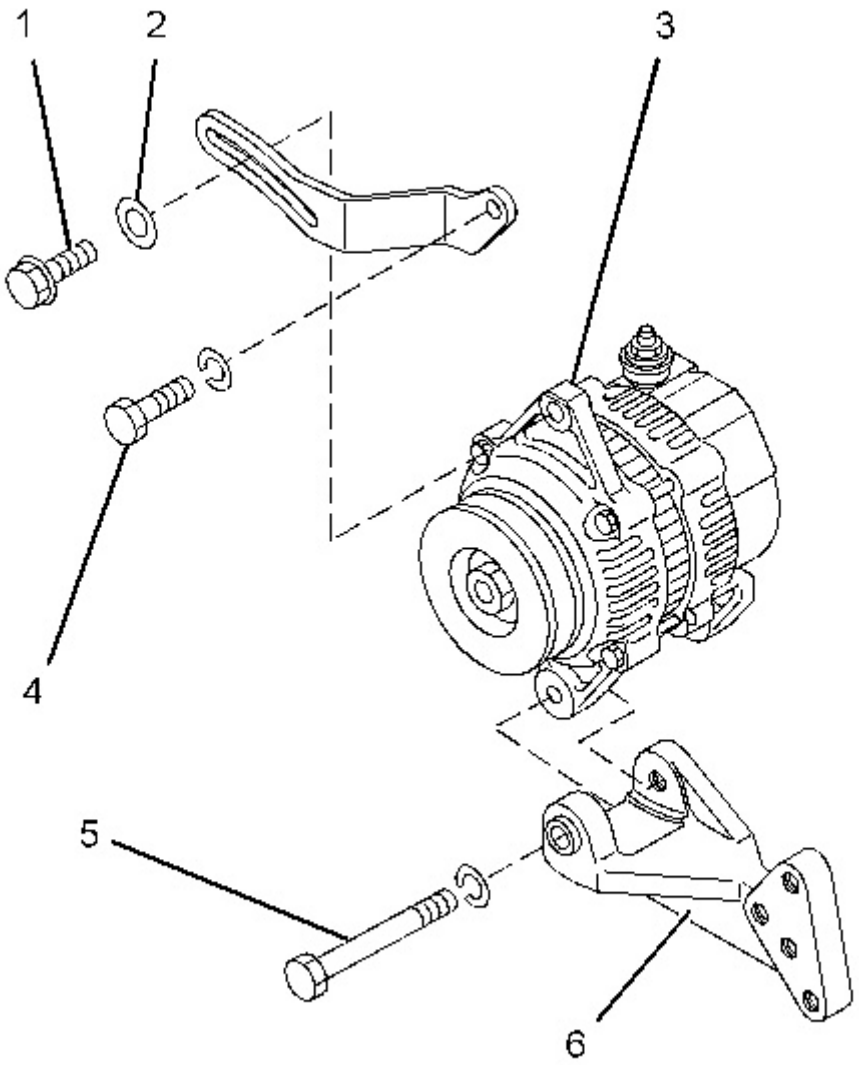


Illustration 1 g01343570

Typical Example

3. Disconnect the harness assembly from alternator (3) .
4. Loosen bolt (4). Remove bolt (1) and washer (2) from alternator (3) .
5. Remove bolt (5) from alternator (3). Remove the alternator from alternator bracket (6) .

Installation Procedure

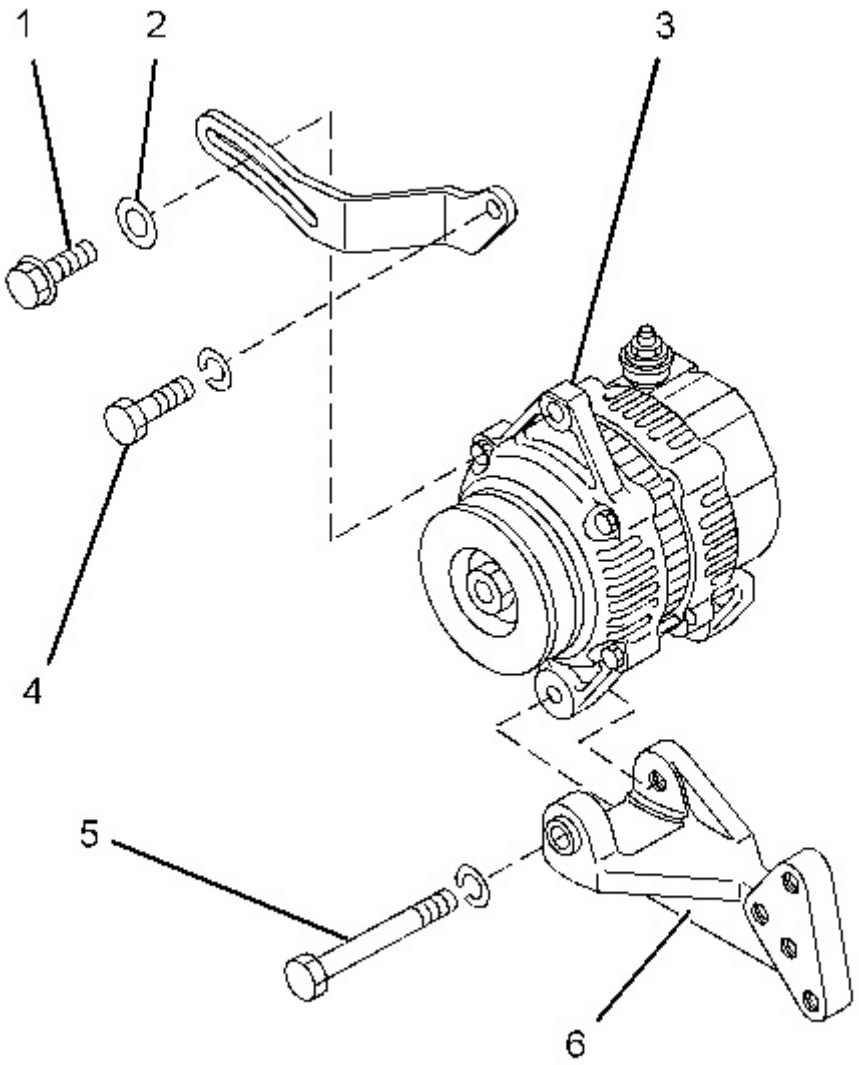


Illustration 2 g01343570

Typical example

1. Position alternator (3) on bracket (6) and install bolt (5) finger tight.
2. Install bolt (1) and washer (2) finger tight.
3. Install the V-belt. Refer to Disassembly and assembly, "V-belts - Remove and Install" for the correct procedure.
4. Tighten bolts (1) and (4) to a torque of 11 N·m (97 lb in). Tighten bolt (5) to a torque of 35 N·m (26 lb ft).
5. Connect the harness assembly to alternator (3) .
6. Turn the battery disconnect switch to the ON position.

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02156742

Battery and Battery Cable - Separate and Connect

SMCS - 1401-029-KA

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

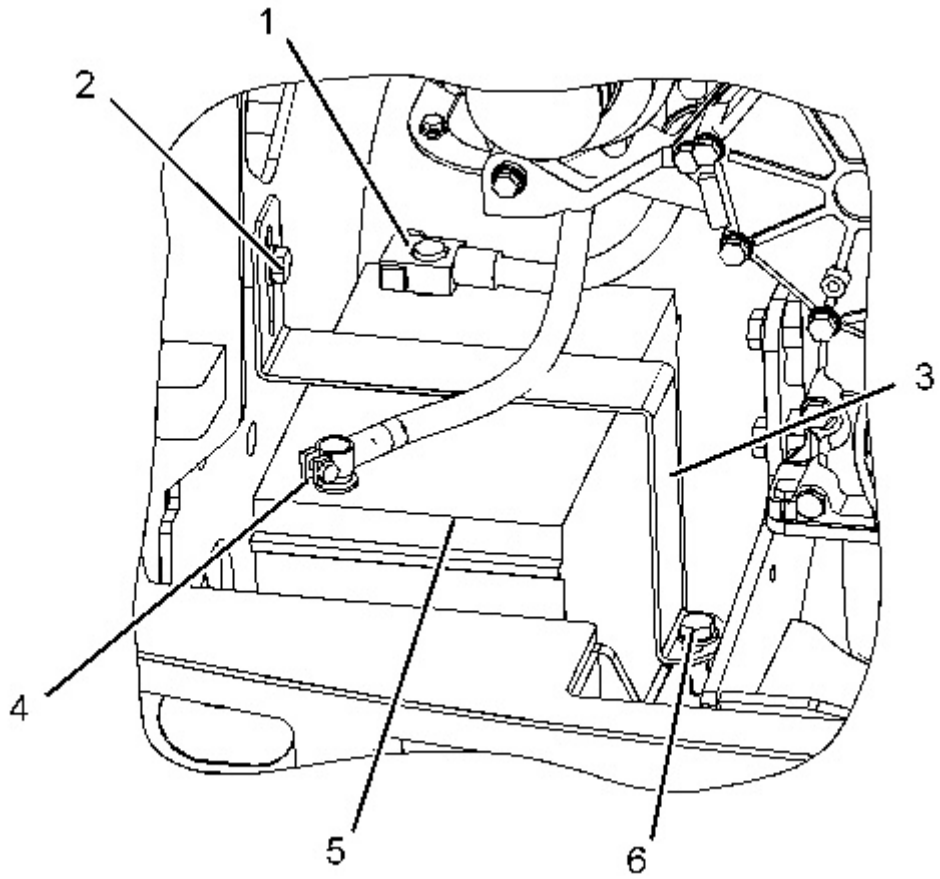


Illustration 1 g01041274

1. Disconnect negative battery cable (4) .
2. Disconnect positive battery cable (1) .
3. Remove bolts (2) and (6). Remove clamp (3) and remove battery (5). The weight of the battery is approximately 18 kg (40 lb).

Installation Procedure

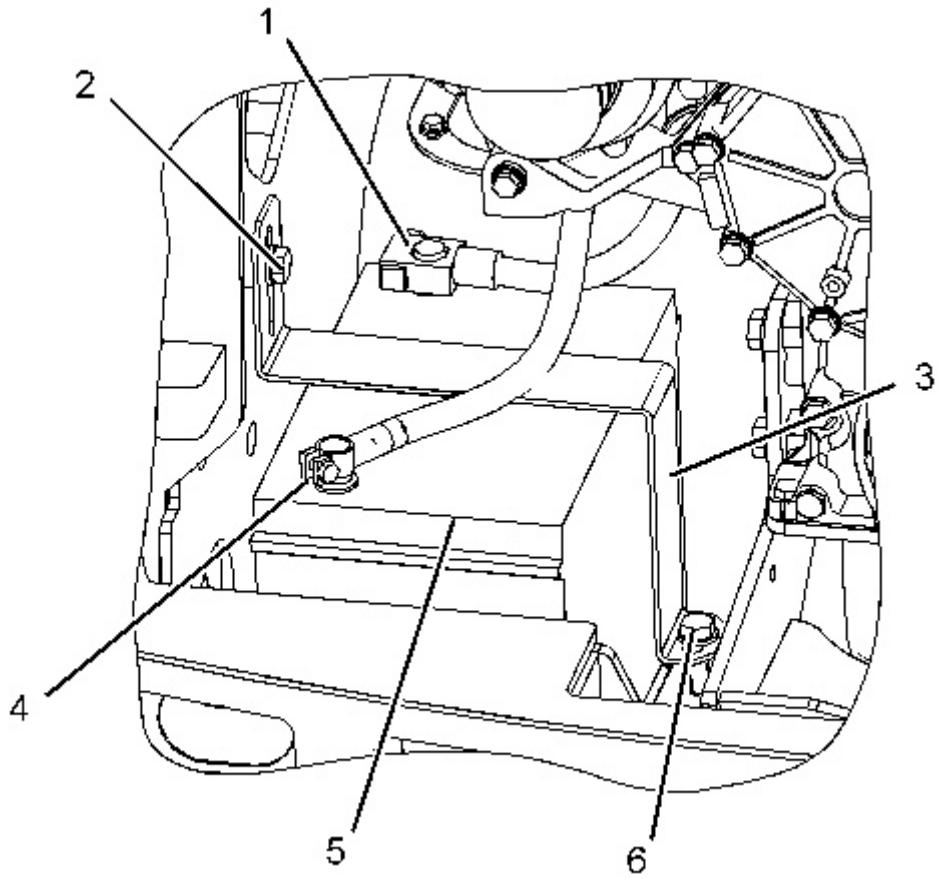


Illustration 2 g01041274

1. Install battery (5). The weight of the battery is approximately 18 kg (40 lb). Install clamp (3). Install bolts (2) and (6) .
2. Connect positive battery cable (1) .
3. Connect negative battery cable (4) .

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02156742

Battery and Battery Cable - Separate and Connect

SMCS - 1401-029-KA

Removal Procedure

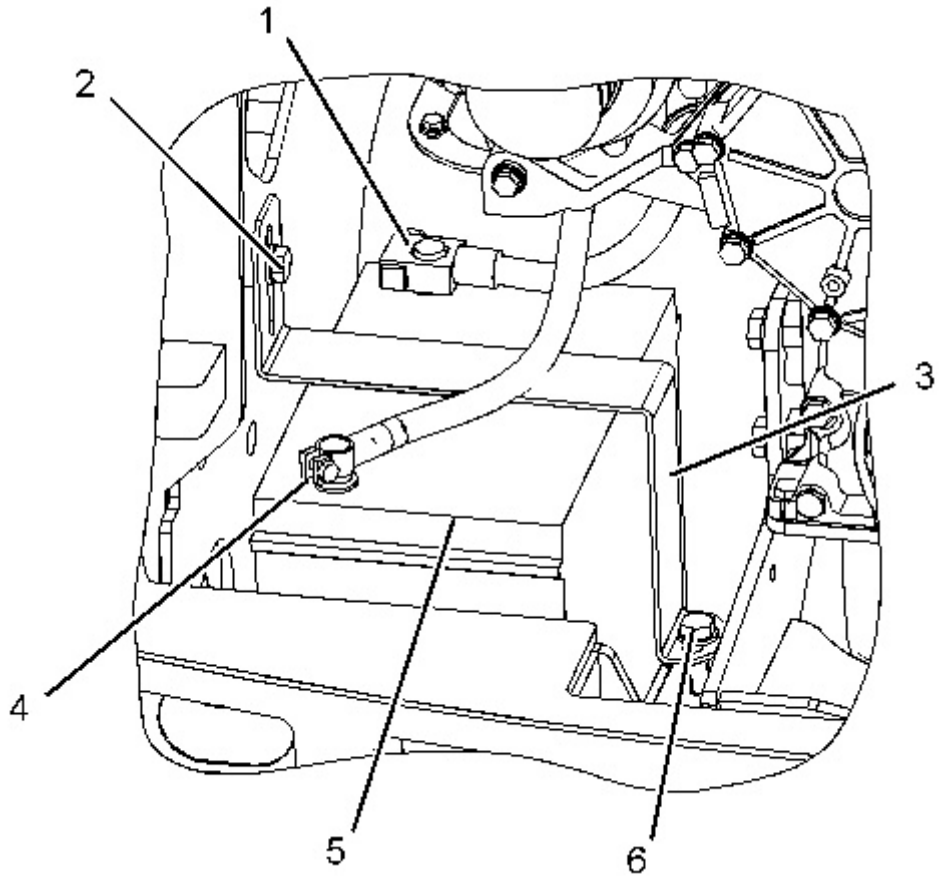


Illustration 1 g01041274

1. Disconnect negative battery cable (4) .
2. Disconnect positive battery cable (1) .
3. Remove bolts (2) and (6). Remove clamp (3) and remove battery (5). The weight of the battery is approximately 18 kg (40 lb).

Installation Procedure

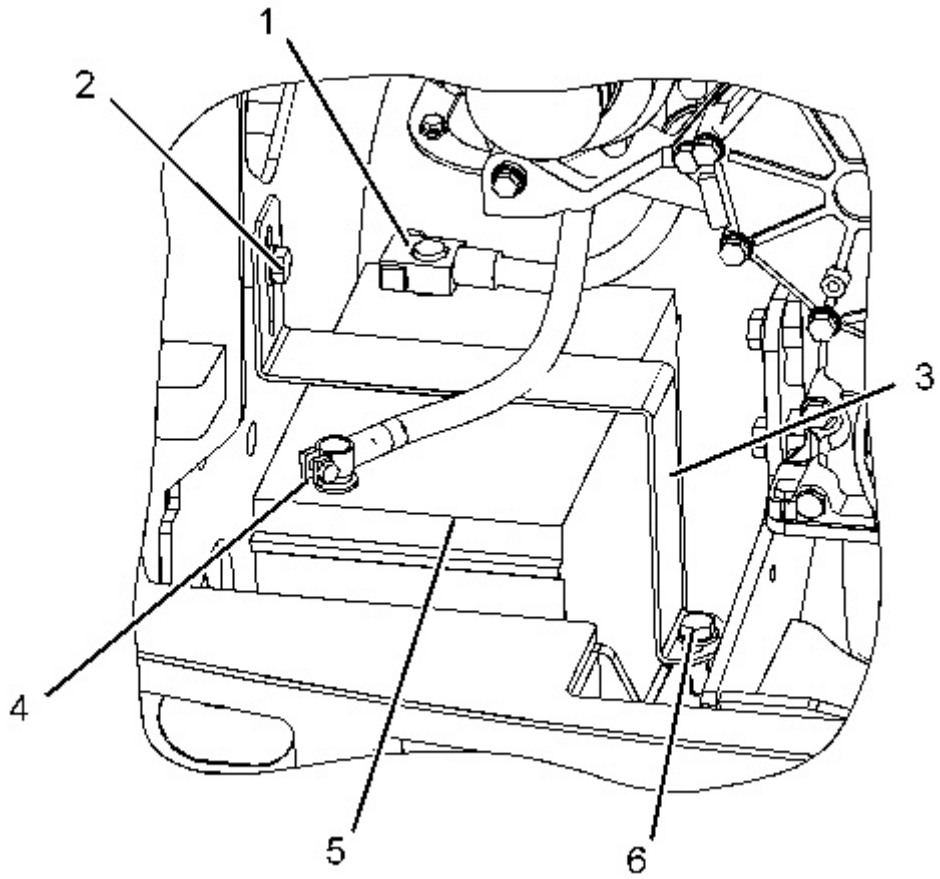


Illustration 2 g01041274

1. Install battery (5). The weight of the battery is approximately 18 kg (40 lb). Install clamp (3). Install bolts (2) and (6) .
2. Connect positive battery cable (1) .
3. Connect negative battery cable (4) .

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02699074

Glow Plugs

SMCS - 1412

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Naturally Aspirated Engines

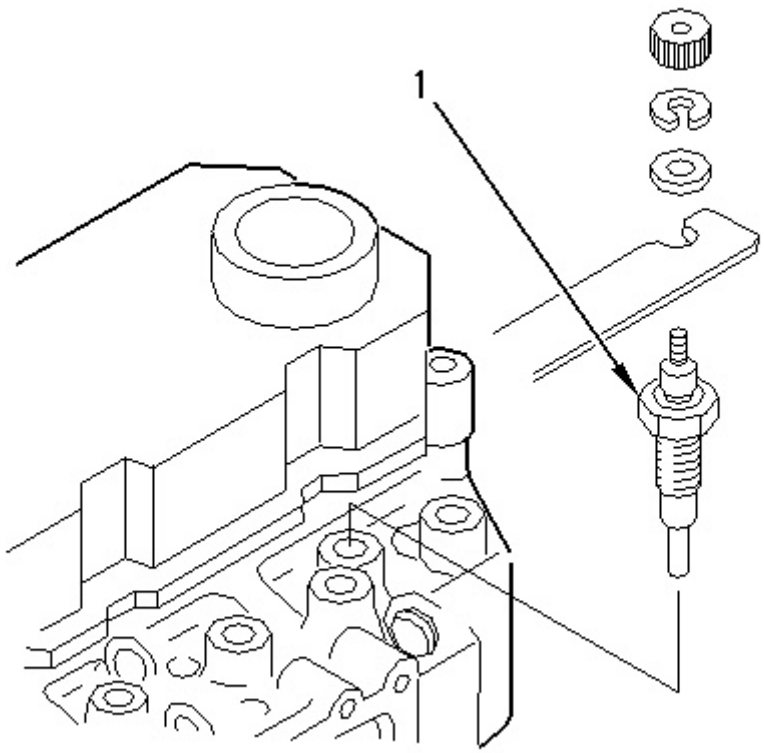


Illustration 1 g00988137

(1) Tighten the glow plugs in the cylinder head to the following torque. ... 15 to 20 N·m (11 to 15 lb ft)

Type ... 12 Volt

Current (30 second rating) ... 9.7 amperes

Turbocharged Engines

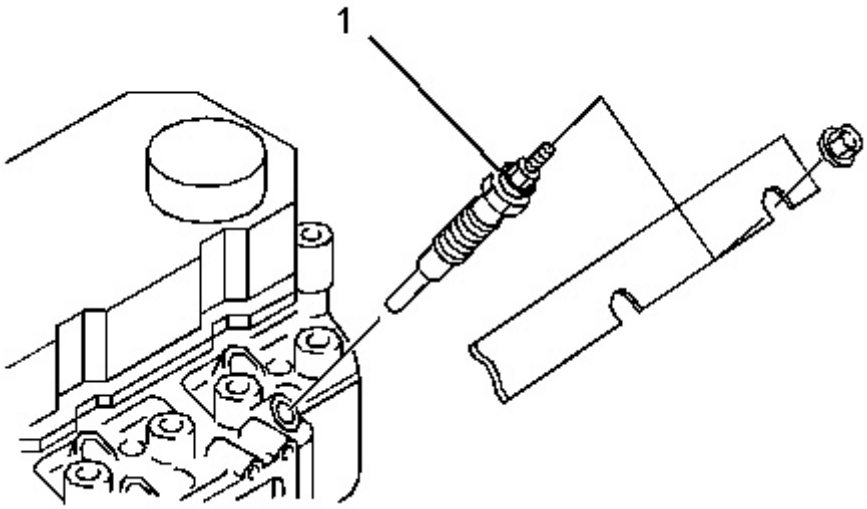


Illustration 2 g01353859

(1) Tighten the glow plugs in the cylinder head to the following torque. ... 20 to 30 N·m (15 to 22 lb ft)

Type ... 12 Volt

Current (30 second rating) ... 5.5 amperes

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02699074

Glow Plugs

SMCS - 1412

S/N - -

Naturally Aspirated Engines

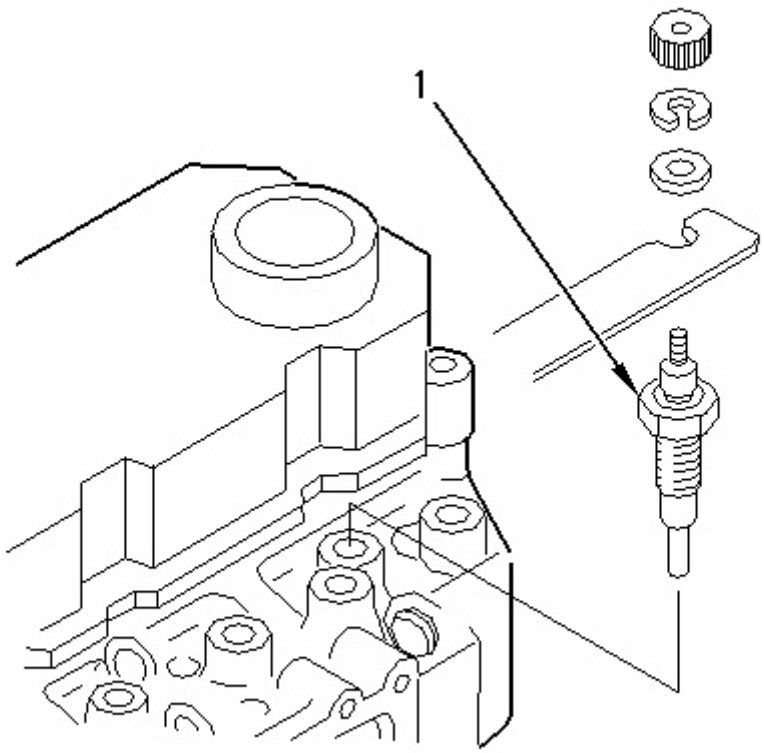


Illustration 1 g00988137

(1) Tighten the glow plugs in the cylinder head to the following torque. ... 15 to 20 N·m (11 to 15 lb ft)

Type ... 12 Volt

Current (30 second rating) ... 9.7 amperes

Turbocharged Engines

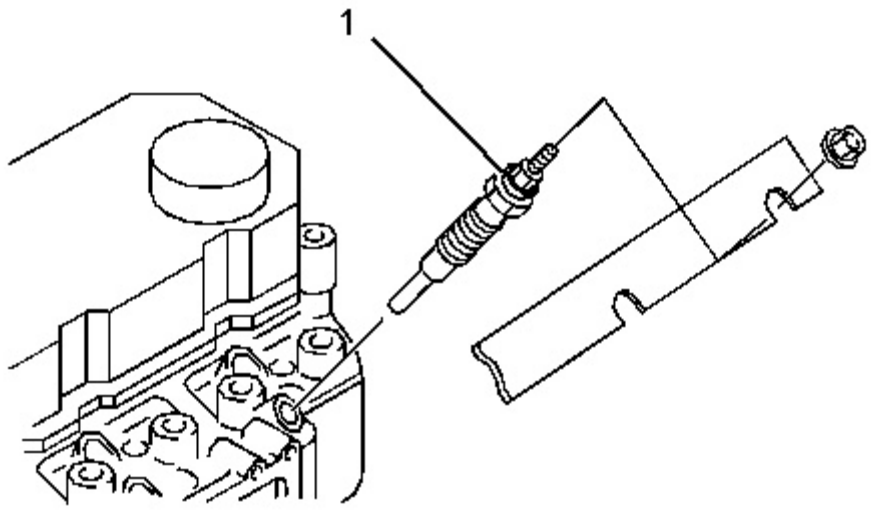


Illustration 2 g01353859

(1) Tighten the glow plugs in the cylinder head to the following torque. ... 20 to 30 N·m (15 to 22 lb ft)

Type ... 12 Volt

Current (30 second rating) ... 5.5 amperes

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i02001581

Glow Plugs - Remove and Install - Turbocharged Engines

SMCS - 1412-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

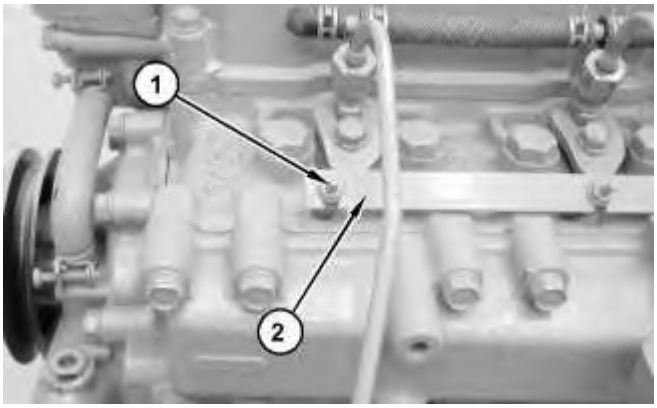


Illustration 1 g01035821

1. Remove nuts (1) and bus bar (2) .

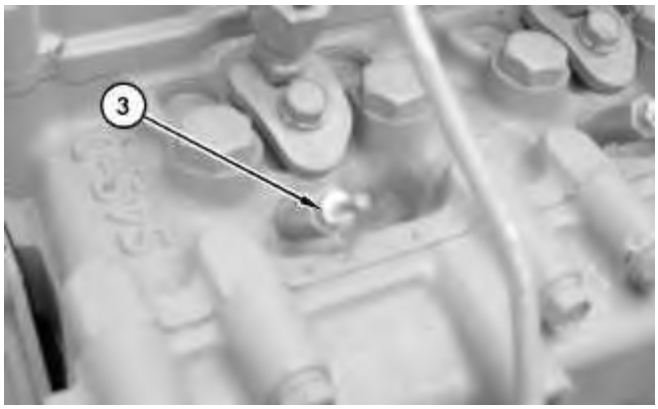


Illustration 2 g01035824

2. Remove glow plugs (3) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

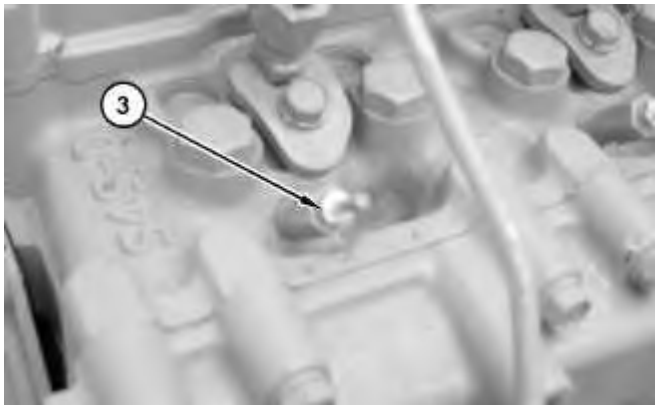


Illustration 3 g01035824

1. Install glow plugs (3). Tighten glow plugs (3) to a torque of 20 to 30 N·m (15 to 22 lb ft).

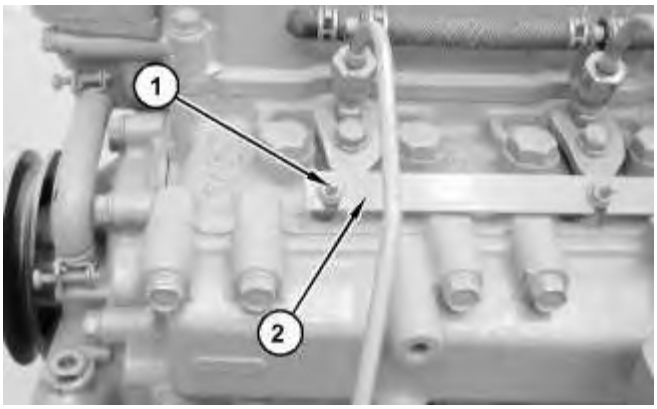


Illustration 4 g01035821

2. Position bus bar (2) and install nuts (1) .

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i02001581

Glow Plugs - Remove and Install - Turbocharged Engines

SMCS - 1412-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

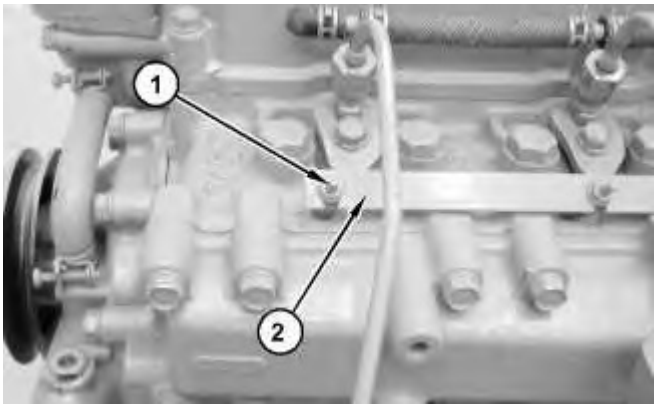


Illustration 1 g01035821

1. Remove nuts (1) and bus bar (2) .

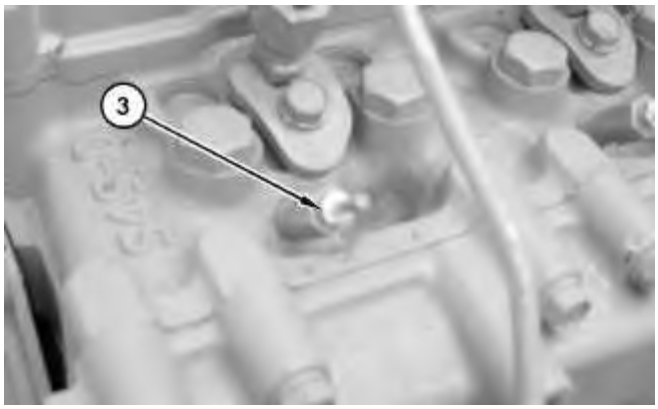


Illustration 2 g01035824

2. Remove glow plugs (3) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

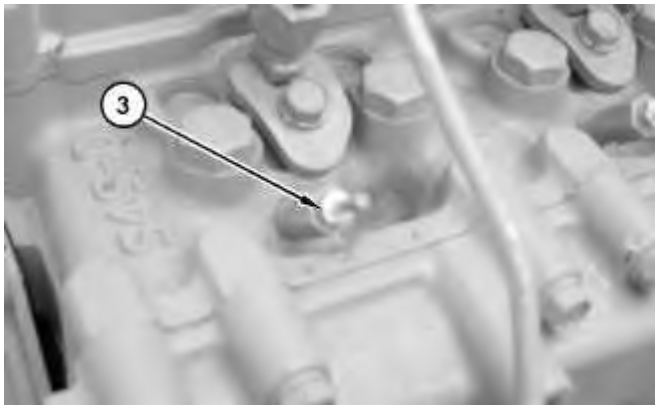


Illustration 3 g01035824

1. Install glow plugs (3). Tighten glow plugs (3) to a torque of 20 to 30 N·m (15 to 22 lb ft).

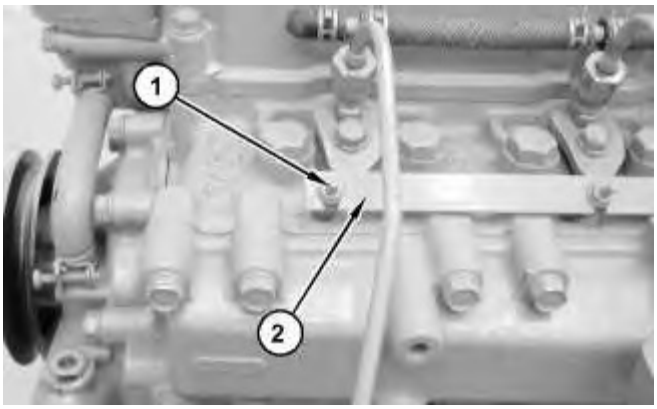


Illustration 4 g01035821

2. Position bus bar (2) and install nuts (1) .

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i02639313

Glow Plugs - Remove and Install

SMCS - 1412-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Turn the battery disconnect switch to the OFF position.

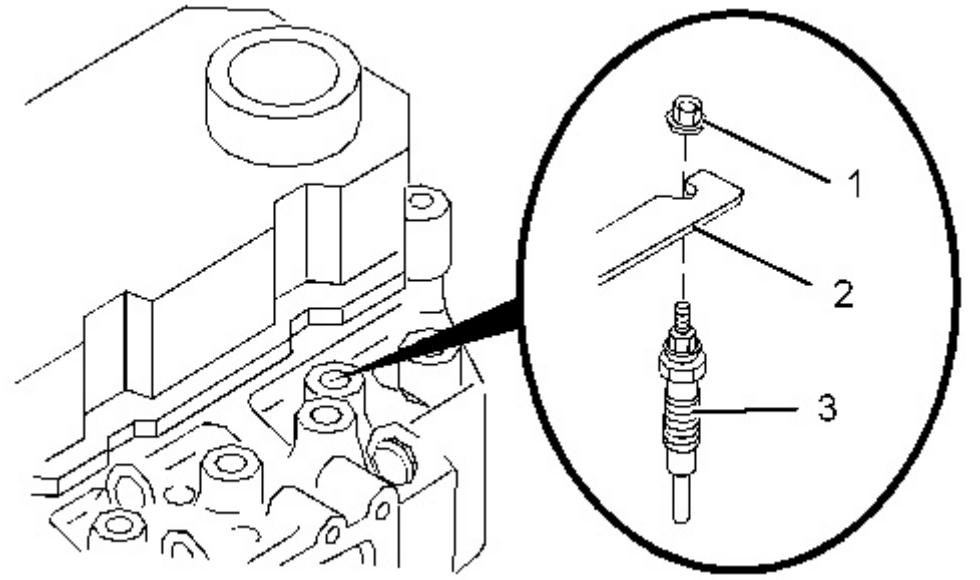


Illustration 1 g01343974

Naturally aspirated engine

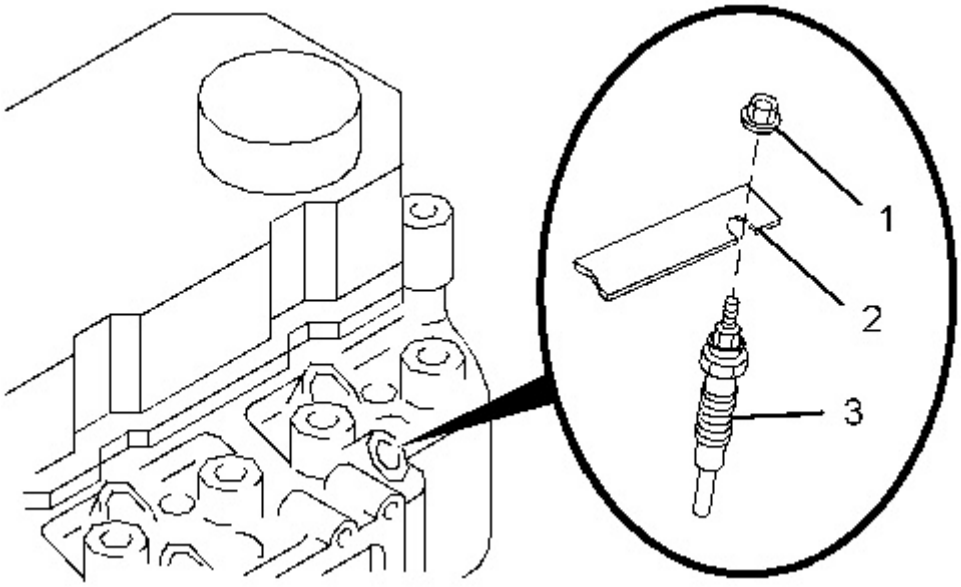


Illustration 2 g01343965

Turbocharged engine

2. Remove nuts (1) and bus bar (2) .
3. Use a deep socket in order to remove glow plugs (3) from the cylinder head.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	247-5377	Torque Wrench	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the threads of the glow plugs are clean and free from damage. Replace any damaged glow plugs.

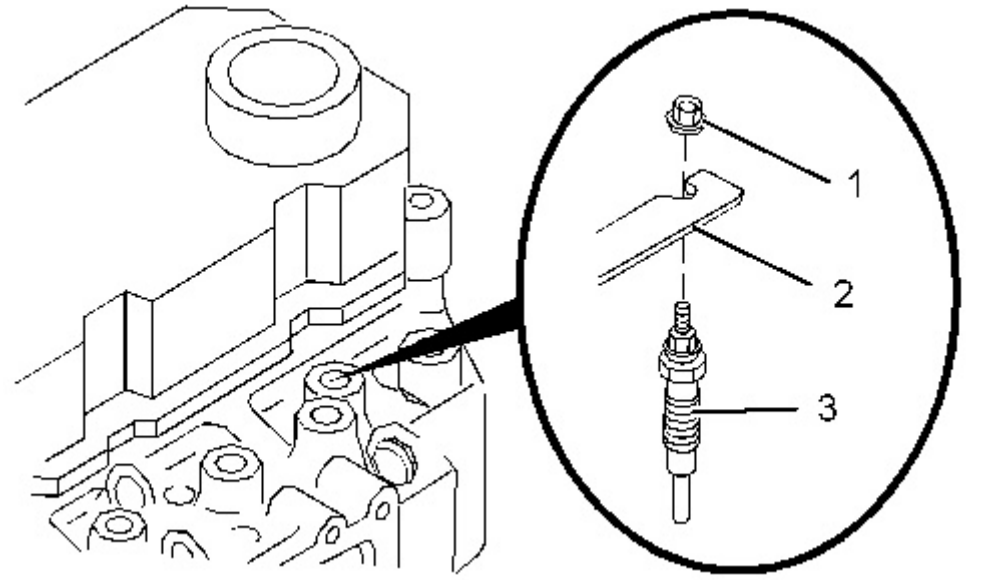


Illustration 3 g01343974

Naturally aspirated engine

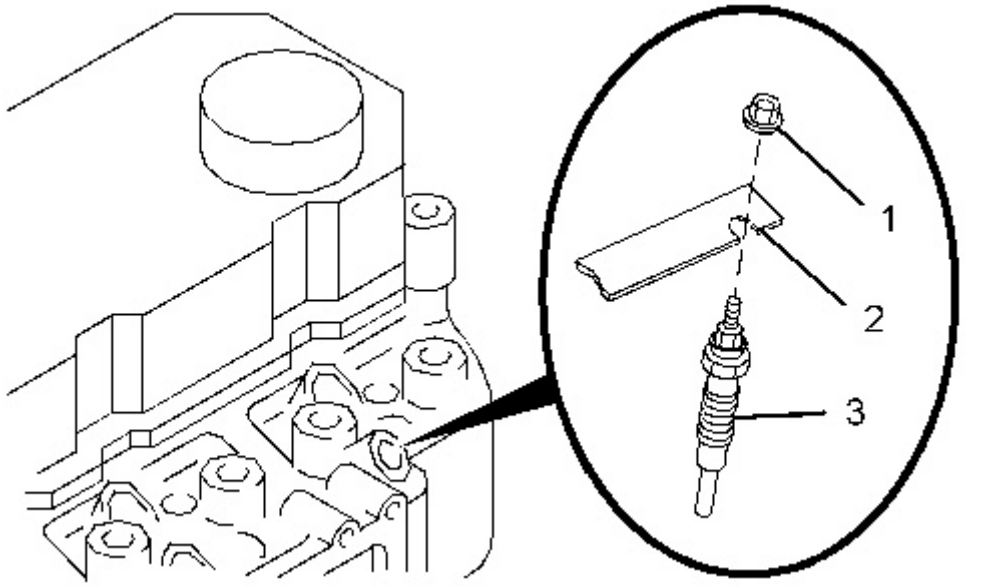


Illustration 4 g01343965

Turbocharged engine

2. Install glow plugs (3) to the cylinder head.

3. For naturally aspirated engines, use a deep socket in order to tighten the glow plugs to a torque of 18 N·m (13 lb ft).

   For turbocharged engines, use a deep socket in order to tighten the glow plugs to a torque of 25 N·m (18 lb ft).

4. Position bus bar (2) onto glow plugs (3) and install nuts (1). Use Tooling (A) to tighten the nuts to a torque of 1.2 N·m (11 lb in).

5. Turn the battery disconnect switch to the ON position.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7050; 7481-UN

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

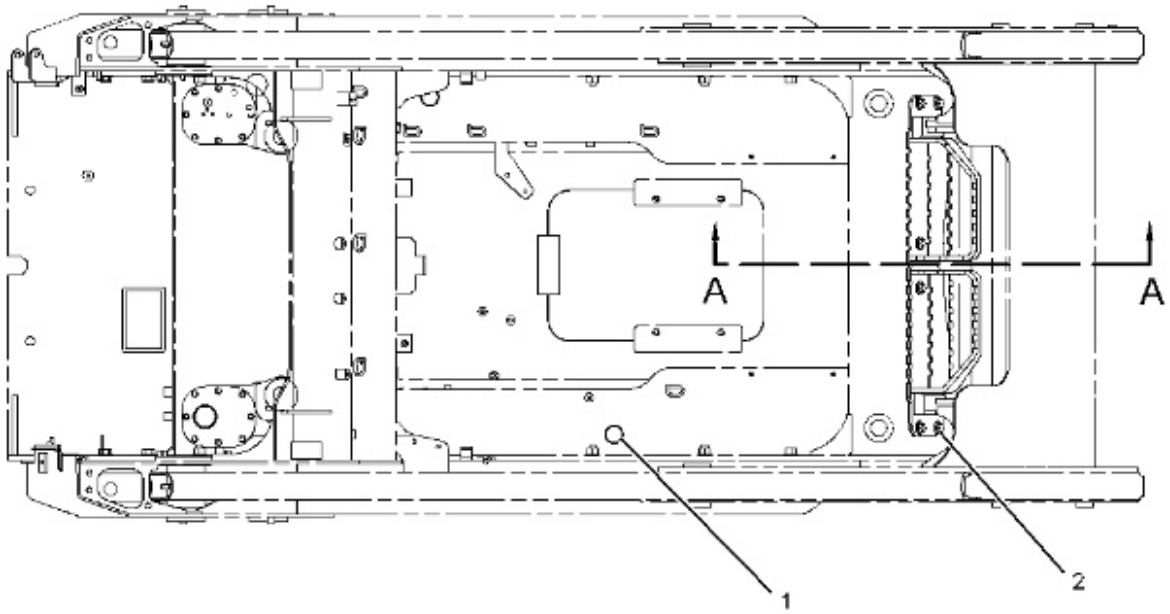


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

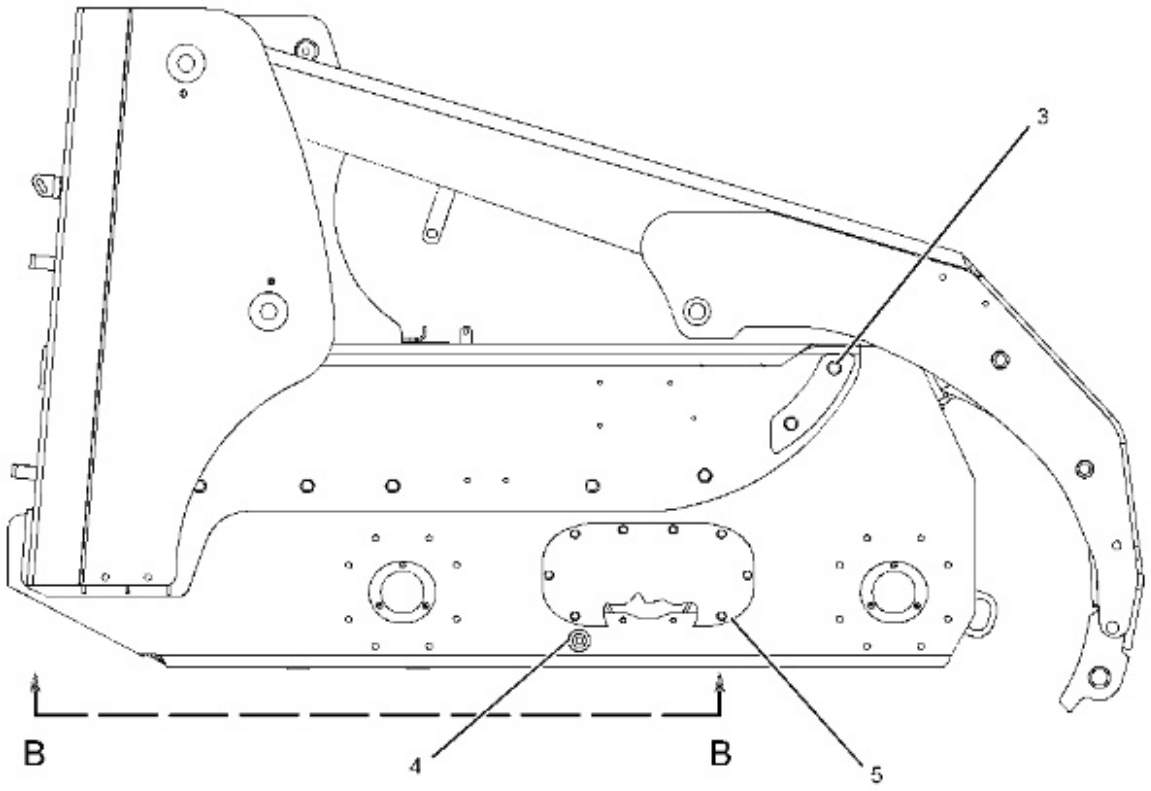


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

(5) Seal the two covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant. Orient the notch of the cover to the top.

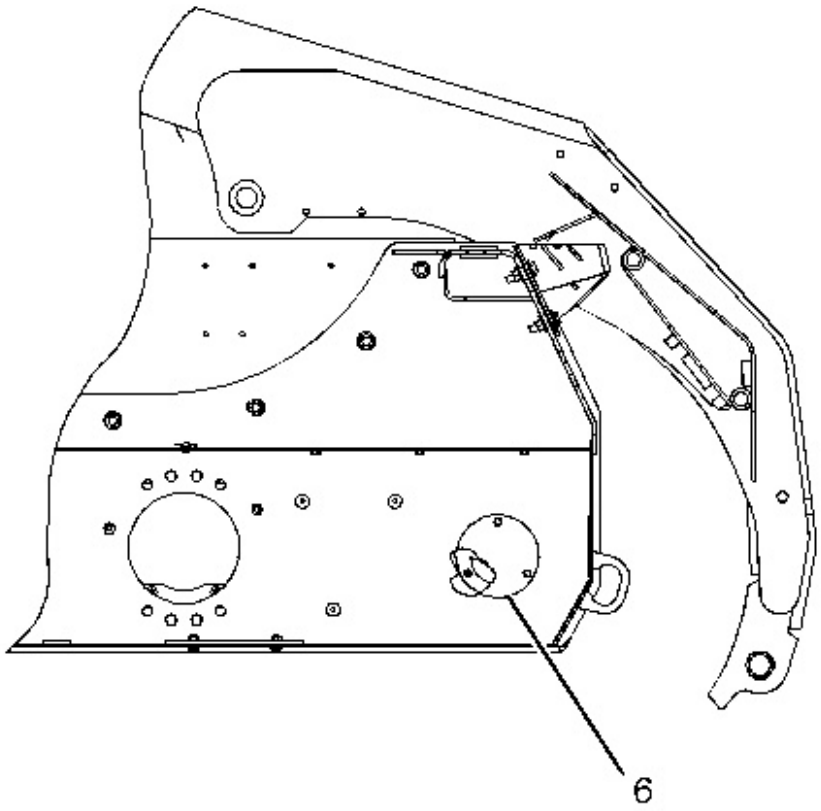


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

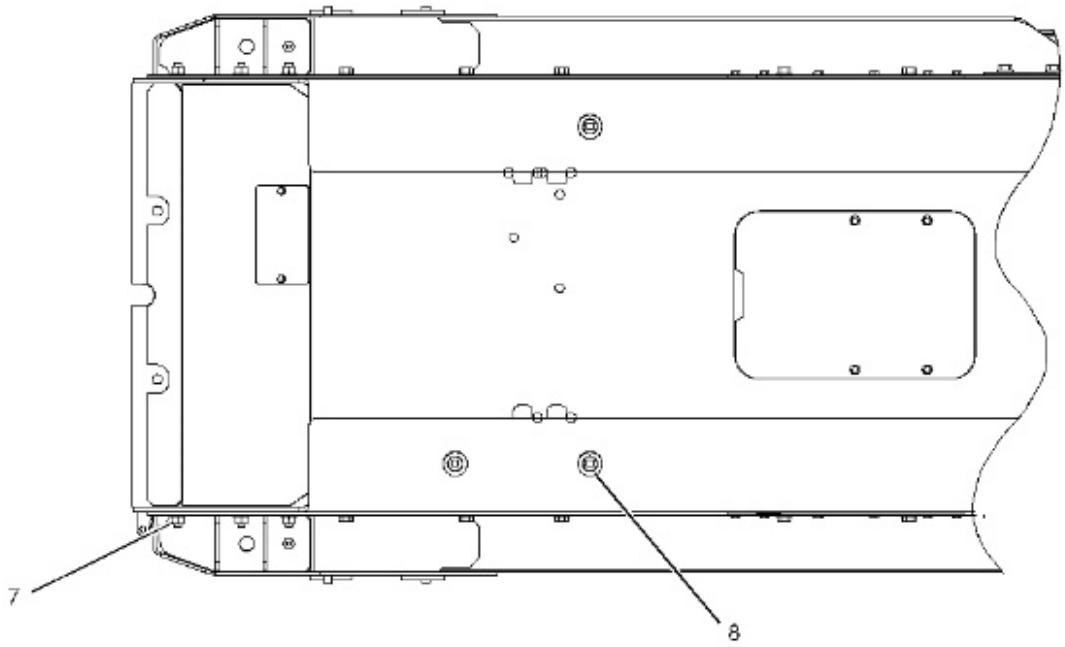


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7050; 7481-UN

S/N - HEN6750-UP

S/N - SCP4600-UP

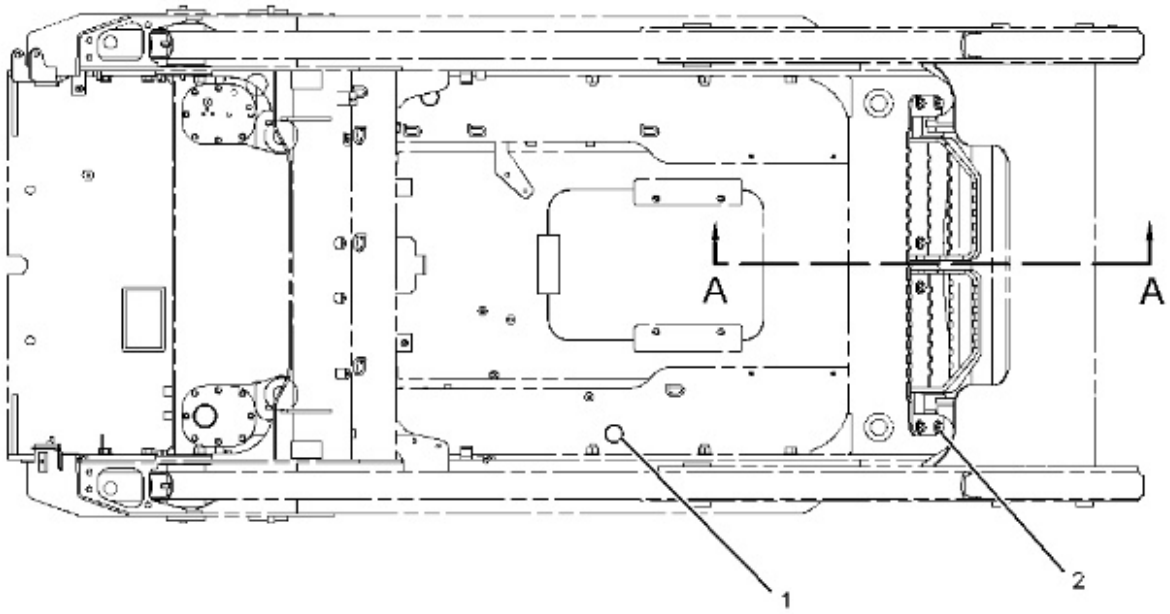


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

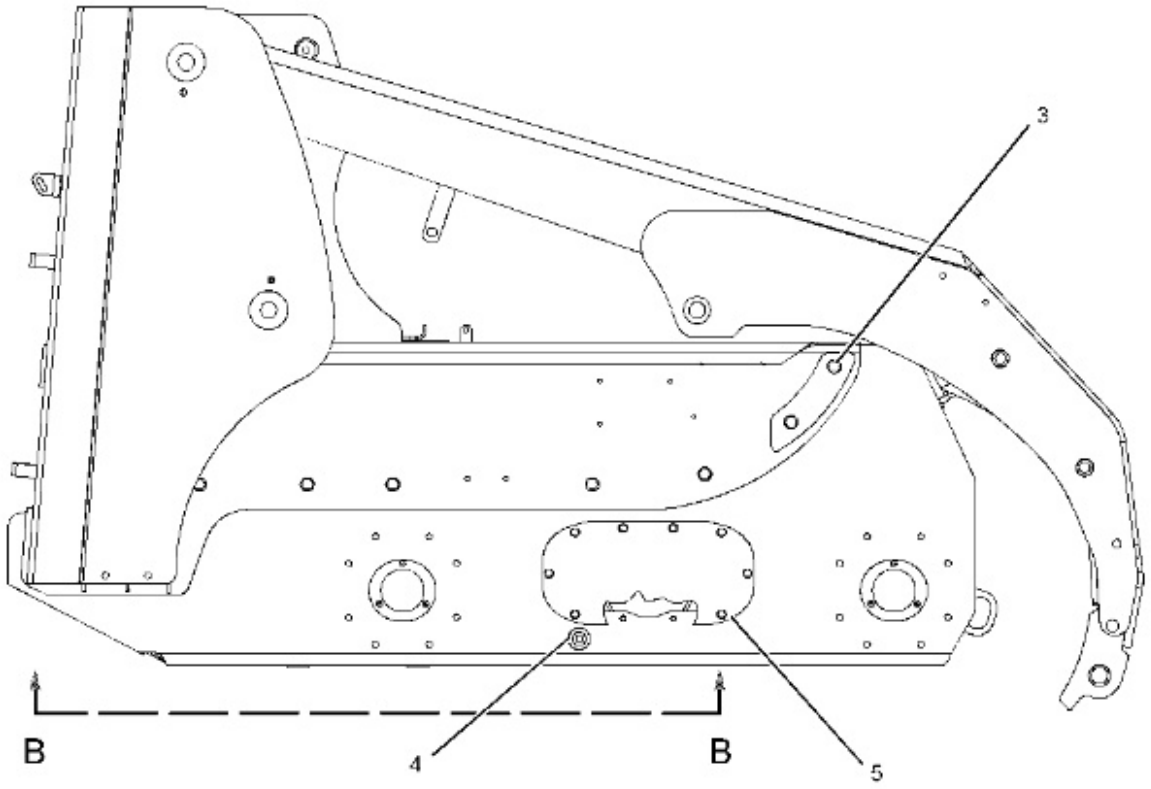


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

(5) Seal the two covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant. Orient the notch of the cover to the top.

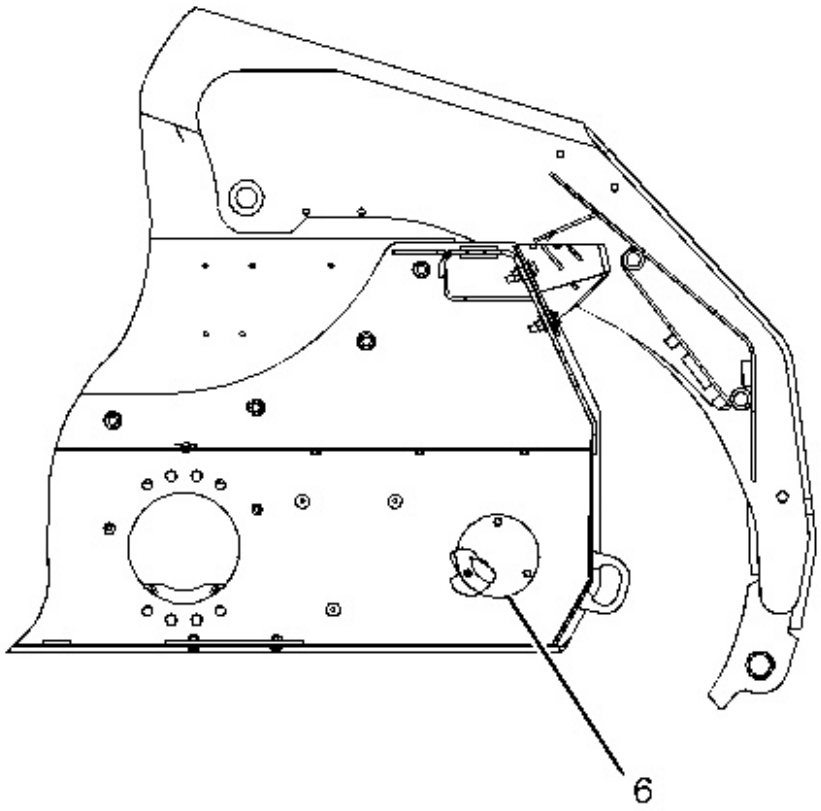


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

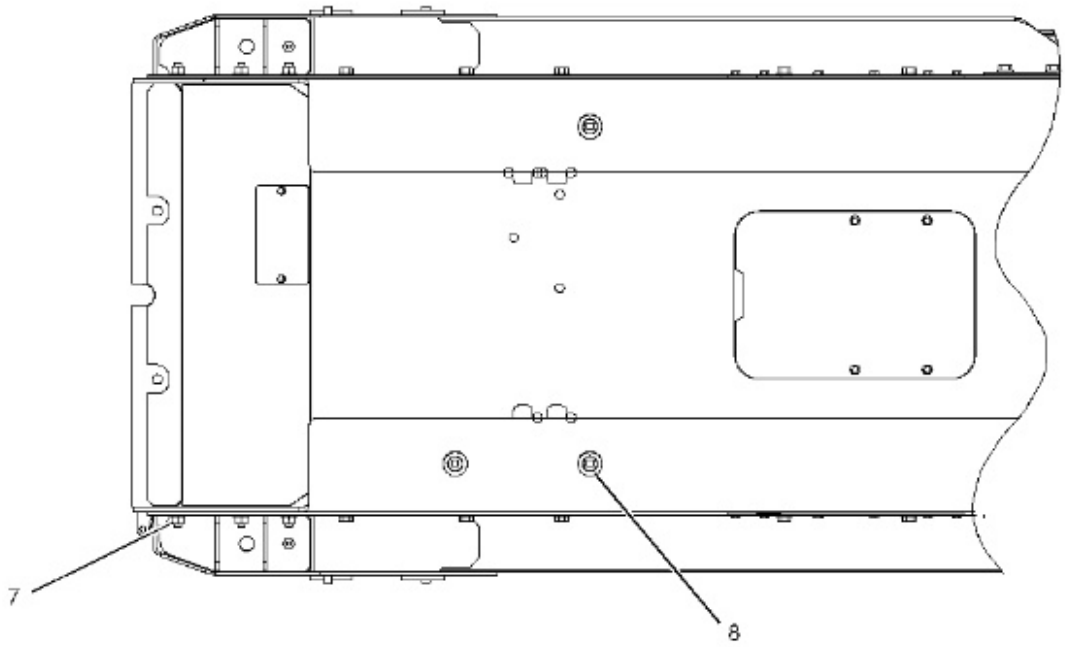


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i03864812

Engine Oil Pressure

SMCS - 1924

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Oil Pressure (1)	
Oil Pressure at 1500 rpm	300 to 500 kPa (44 to 73 psi)
Oil pressure at idle	100 kPa (15 psi)

(1) The oil temperature must be 70 ° to 90 °C (158 ° to 194 °F).

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i03864812

Engine Oil Pressure

SMCS - 1924

S/N - -

Table 1

Oil Pressure [1]	
Oil Pressure at 1500 rpm	300 to 500 kPa (44 to 73 psi)
Oil pressure at idle	100 kPa (15 psi)

(1) The oil temperature must be 70 ° to 90 °C (158 ° to 194 °F).

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i02639311

Coolant Temperature Sensor - Remove and Install

SMCS - 1906-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

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1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

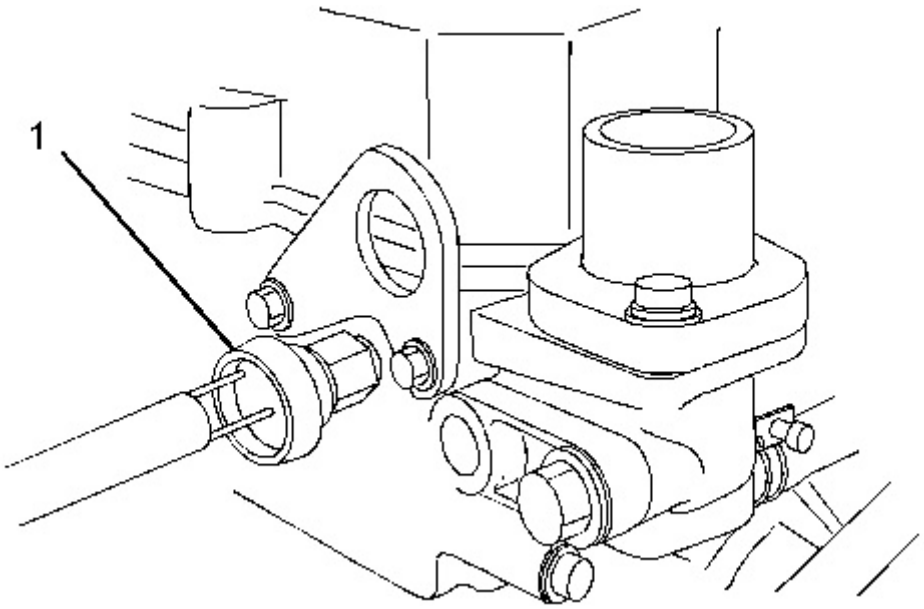


Illustration 1 g01343990

Typical example

2. Disconnect the harness assembly (not shown) from coolant temperature sensor (1) .
3. Remove coolant temperature sensor (1) from the cylinder head.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3413	Pipe Sealant	1

1. Ensure that the coolant temperature sensor is clean and free from damage.

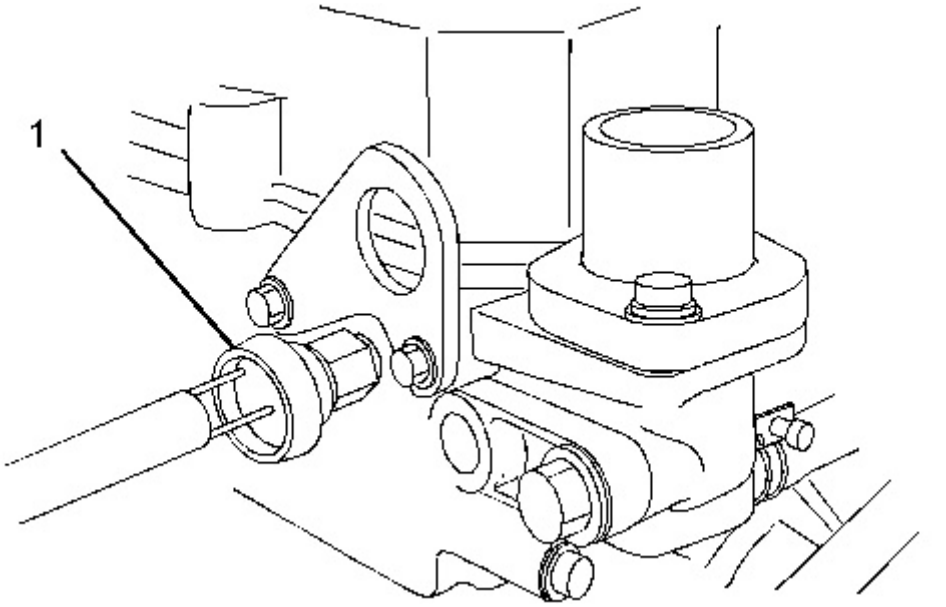


Illustration 2 g01343990

Typical example

2. Apply a thin layer of Tooling (A) to the threads of coolant temperature sensor (1) .
3. Install coolant temperature sensor (1) into the cylinder head. Tighten the coolant temperature sensor to a torque of 11 N·m (97 lb in).
4. Connect the harness assembly (not shown) to coolant temperature sensor (1) .
5. Fill the cooling system to the correct level. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change".

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639312

Engine Oil Pressure Sensor - Remove and Install

SMCS - 1924-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

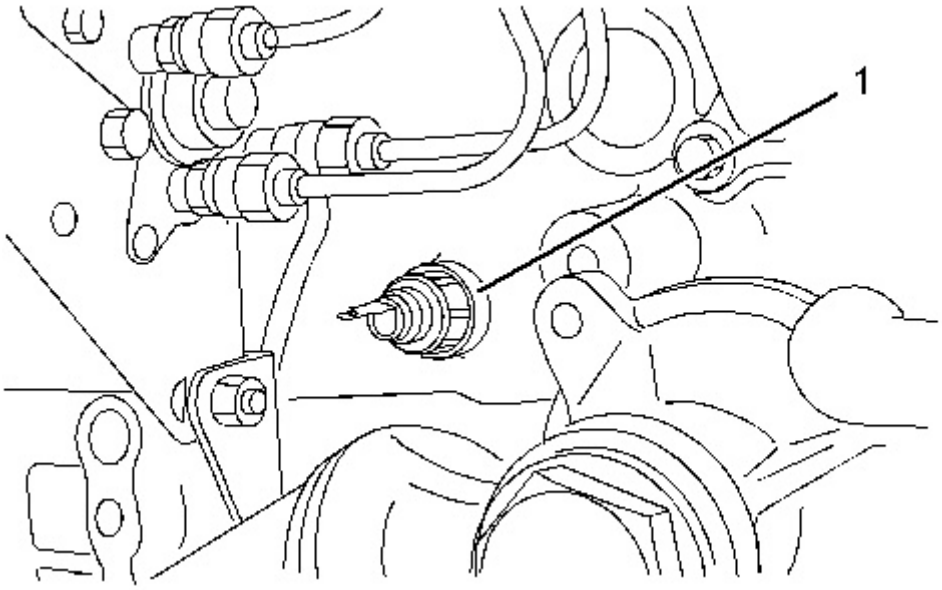


Illustration 1 g01343988

Typical example

1. Remove the harness assembly (not shown) from engine oil pressure sensor (1) .
2. Use a deep socket in order to remove engine oil pressure sensor (1) from the cylinder block.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	5P-3413	Pipe Sealant	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the engine oil pressure sensor is clean and free from damage.

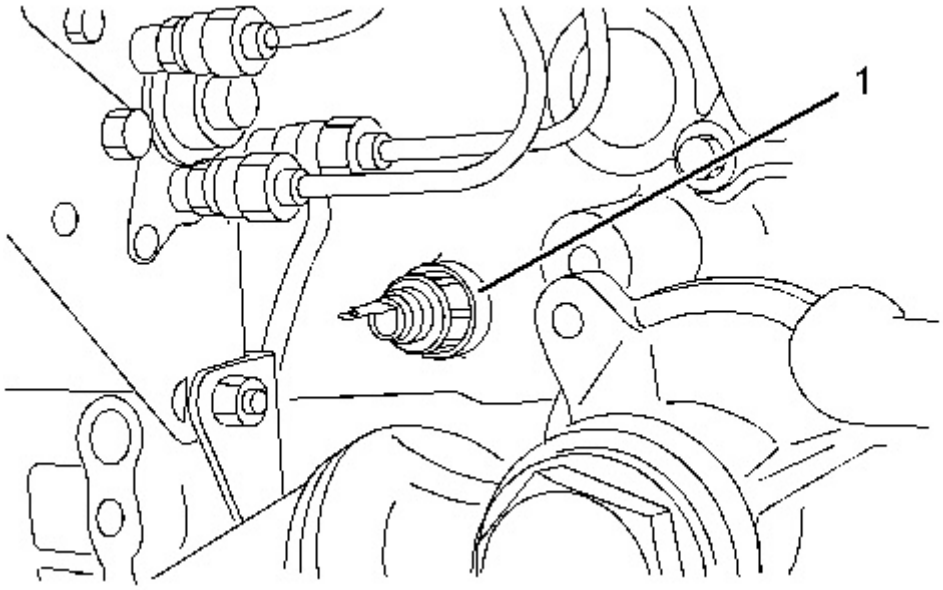


Illustration 2 g01343988

Typical example

2. Apply a thin layer of Tooling (A) to the threads of engine oil pressure sensor (1) .
3. Install engine oil pressure sensor (1) to the cylinder block. Use a deep socket in order to tighten the engine oil pressure sensor to a torque of 11 N·m (97 lb in).
4. Connect the harness assembly (not shown) to engine oil pressure sensor (1) .

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02506531

Electric Starting Motor

SMCS - 1453

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

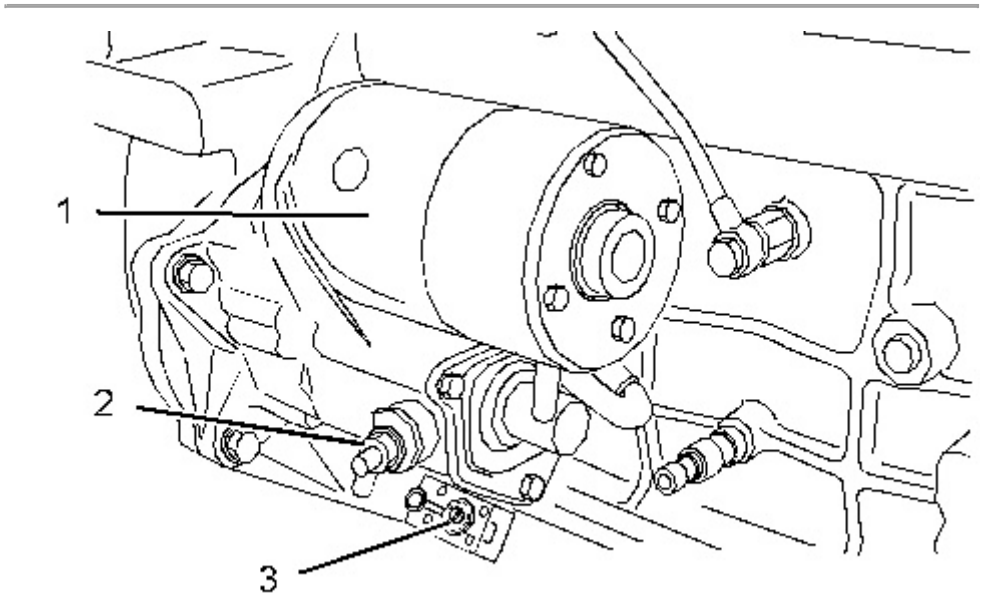


Illustration 1 g01024163

The starting motor

(1) Electric starting motor

(2) Tighten the nut on the starting motor terminal to the following torque. ... 18 to 25 N·m (13.3 to 18.4 lb ft)

(3) Tighten the starting motor terminal to the following torque. ... 2.6 to 4.6 N·m (23.0119 to 40.7134 lb in)

No load conditions at 25 °C (77 °F)

Speed ... 3000 rpm minimum
Current draw ... 200 amp maximum
Voltage ... 11 V

When the electric starting motor is viewed from the drive end, the motor rotates in the following direction. ... Clockwise

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02506531

Electric Starting Motor

SMCS - 1453

S/N - -

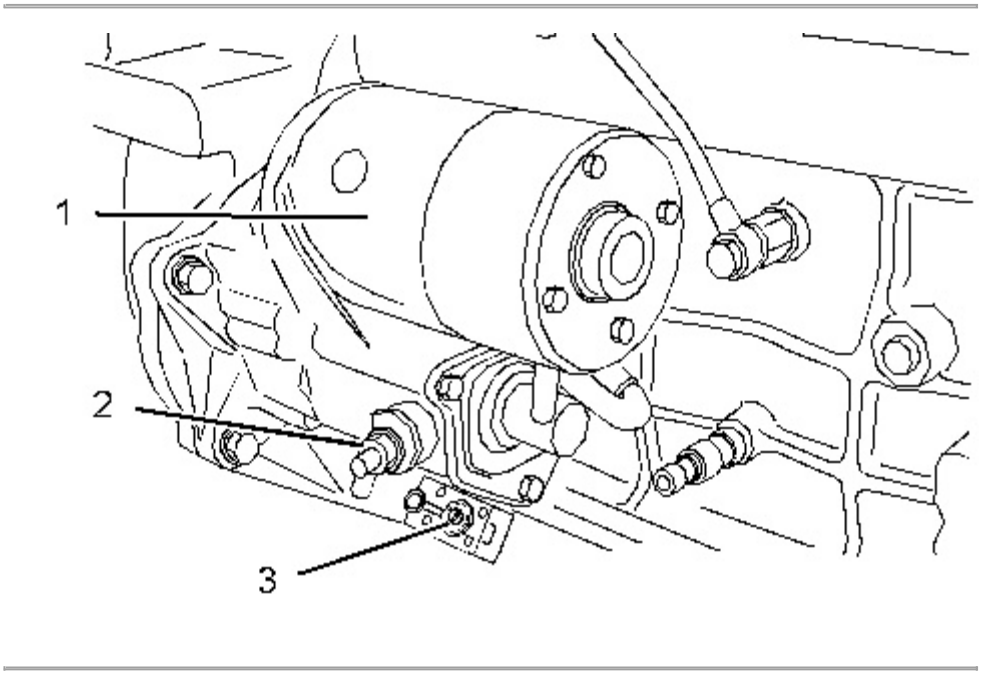


Illustration 1 g01024163

The starting motor

(1) Electric starting motor

(2) Tighten the nut on the starting motor terminal to the following torque. ... 18 to 25 N·m (13.3 to 18.4 lb ft)

(3) Tighten the starting motor terminal to the following torque. ... 2.6 to 4.6 N·m (23.0119 to 40.7134 lb in)

No load conditions at 25 °C (77 °F)

Speed ... 3000 rpm minimum
Current draw ... 200 amp maximum
Voltage ... 11 V

When the electric starting motor is viewed from the drive end, the motor rotates in the following direction. ... Clockwise

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02014524

Electric Starting Motor - Remove and Install

SMCS - 1453-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Start By:

A. Disconnect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

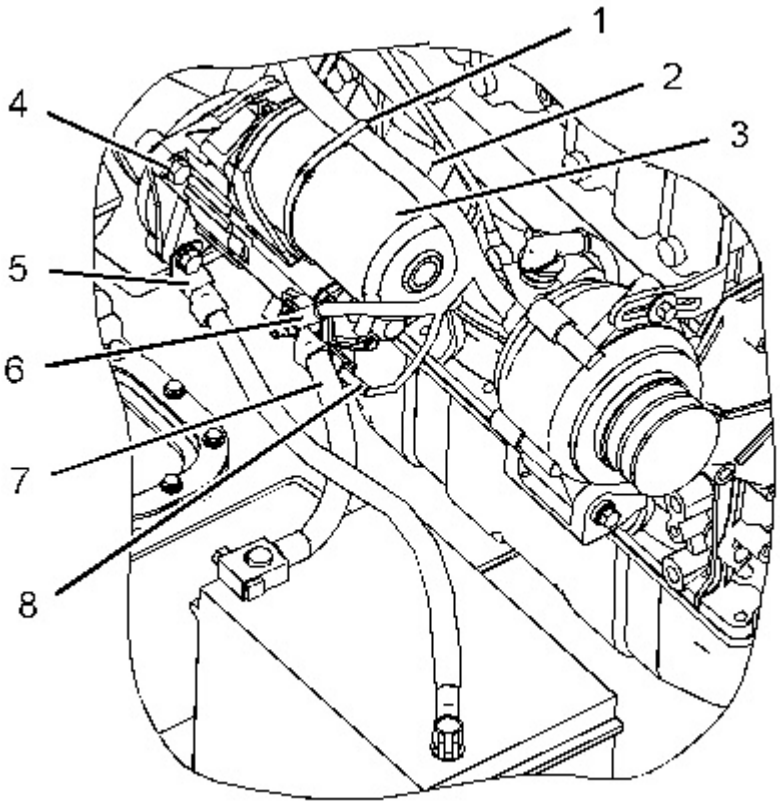


Illustration 1 g01041496

1. Disconnect cable assemblies (5), (6) and (7) .
2. Disconnect harness assembly (8) and cut cable strap (1) .
3. Remove bolts (4) and remove electric starting motor (3) and heat shield (2) .

Installation Procedure

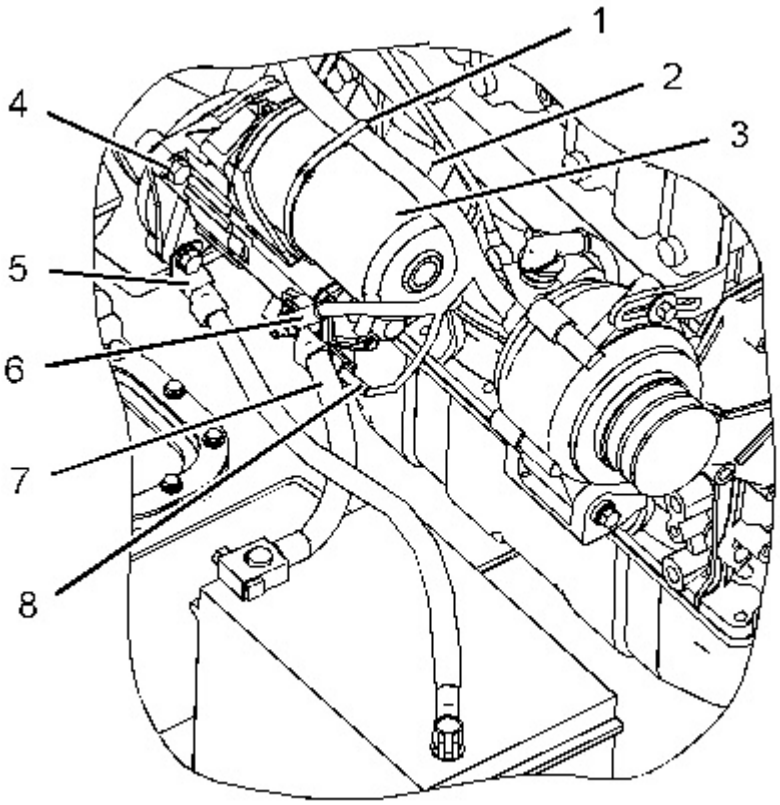


Illustration 2 g01041496

1. Install electric starting motor (3) and heat shield (2). Install bolts (4).
2. Connect harness assembly (8) and install cable strap (1) .
3. Connect cable assemblies (5), (6) and (7) .

End By: Connect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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i02014524

Electric Starting Motor - Remove and Install

SMCS - 1453-010

Removal Procedure

Start By:

A. Disconnect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

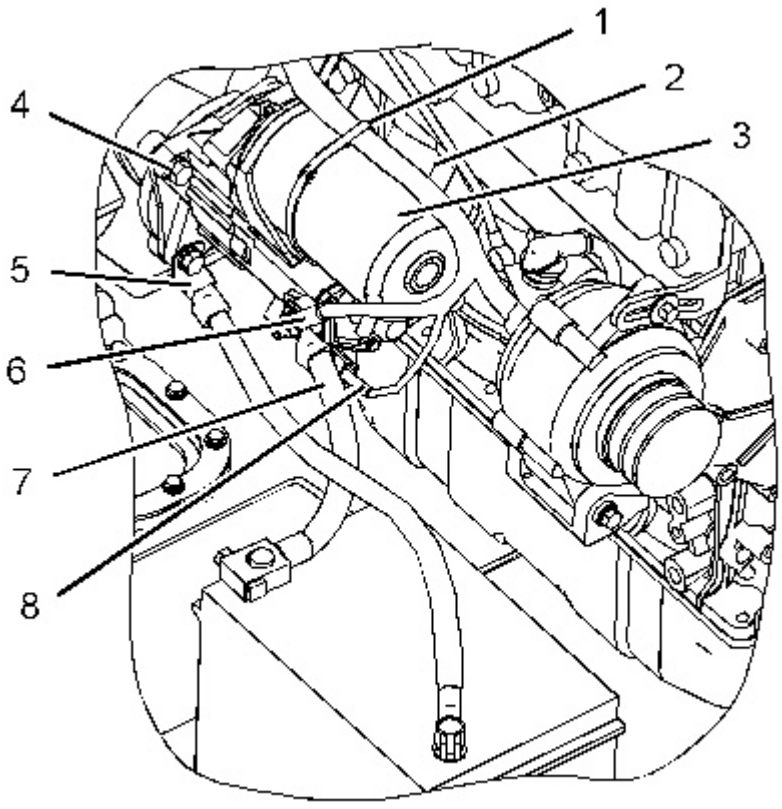


Illustration 1 g01041496

1. Disconnect cable assemblies (5), (6) and (7) .
2. Disconnect harness assembly (8) and cut cable strap (1) .
3. Remove bolts (4) and remove electric starting motor (3) and heat shield (2) .

Installation Procedure

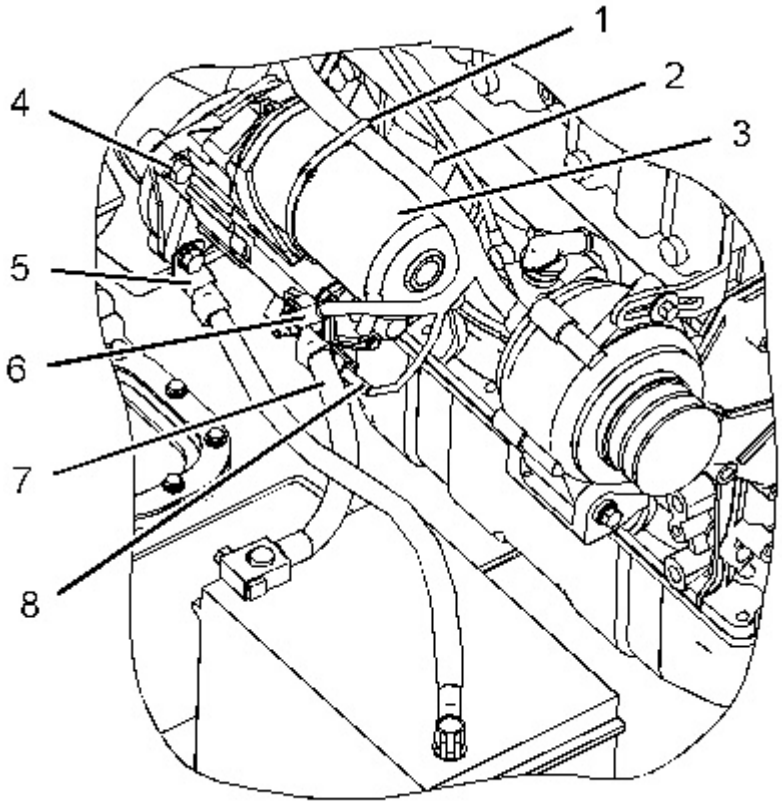


Illustration 2 g01041496

1. Install electric starting motor (3) and heat shield (2). Install bolts (4).
2. Connect harness assembly (8) and install cable strap (1) .
3. Connect cable assemblies (5), (6) and (7) .

End By: Connect the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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i02639319

Electric Starting Motor - Remove and Install

SMCS - 1453-010

Removal Procedure

WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

1. Disconnect the battery.
2. Make temporary identification marks on the harness assemblies that are connected to the electric starting motor. Disconnect the harness assemblies from the electric starting motor.

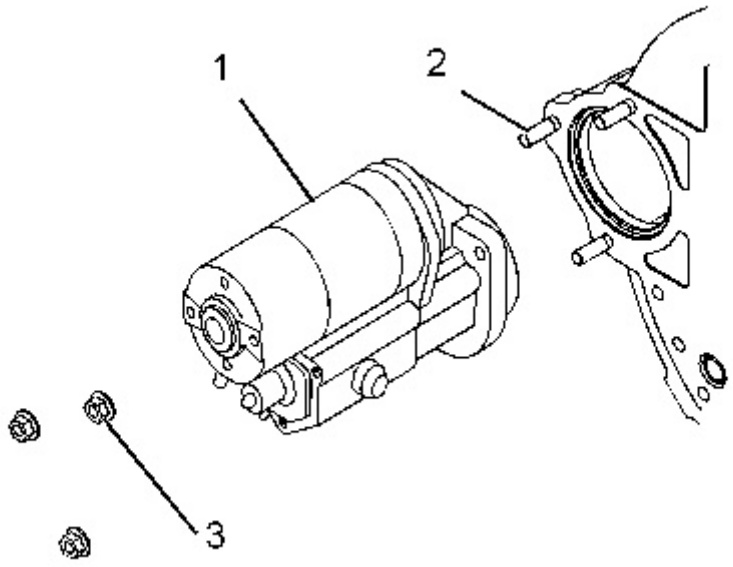


Illustration 1 g01343546

Typical example

3. Remove nuts (3) from electric starting motor (1) .

   Note: Support the weight of the electric starting motor as the nuts are removed.

4. Remove electric starting motor (1) .
5. If necessary, remove studs (2) .

Installation Procedure

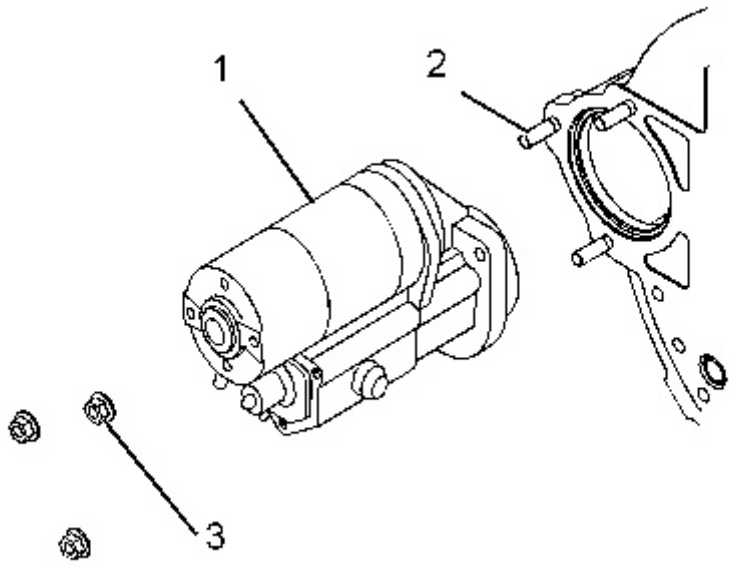


Illustration 2 g01343546

Typical example

1. If necessary, install studs (2) .
2. Align electric starting motor (1) to studs (2). Install the electric starting motor.
3. Install nuts (3). Tighten the nuts to a torque of 35 N·m (26 lb ft).
4. Connect the harness assemblies to the electric starting motor. Refer to Specifications, "Electric Starting Motor" for the tightening torques of the terminal nuts.
5. Connect the battery.

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i01996306

Engine Oil Pressure Switch - Remove and Install

SMCS - 1924

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

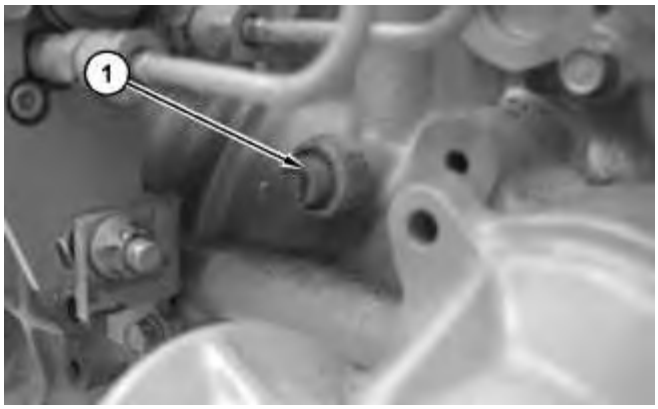


Illustration 1 g01033281

1. Remove the harness assembly from engine oil pressure switch (1) .
2. Remove engine oil pressure switch (1) from the cylinder block. Plug the opening immediately.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

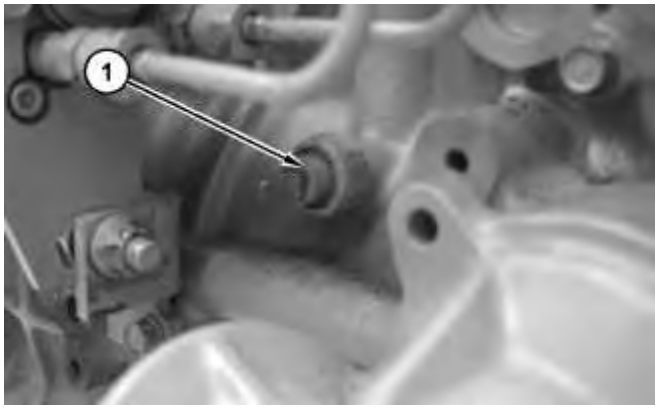


Illustration 2 g01033281

1. Install engine oil pressure switch (1) into the cylinder block and tighten evenly.
2. Connect the harness assembly to engine oil pressure switch (1) .

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02558315

General Information

SMCS - 1000

Note: When you are ordering new parts, refer to the engine identification number in order to receive the correct parts. Refer to the Operation and Maintenance Manual, "Product Identification Information" for the correct numbers for your engine.

The 3044C engine is an in-line four cylinder engine. The engines are controlled by a mechanically governed fuel injection pump.

The engines have been designed for many different applications. These engines are available in two different types of aspiration:

- Naturally aspirated
- Turbocharged

Lifting the Engine

NOTICE

Failure to follow recommended procedures for handling or transporting engines can lead to engine damage.

To avoid possible engine damage, use the following procedure.

When you are lifting or moving the engine, use the following procedures in order to prevent engine damage.

1. Do not tilt the engine to an extreme angle unless the lubricating oil is first drained from the oil pan.
2. Do not turn the engine onto a side or an end surface unless the lubricating oil is first drained from the oil pan.

3. If the oil is not drained prior to tilting the engine or turning the engine onto a side or an end surface, the lubricating oil from the oil pan can flow into the intake manifold and the cylinder bores. This situation could cause a hydraulic lock in the engine. Hydraulic lock can severely damage the engine.

4. The engine oil should be refilled to the correct level before the engine is started.

Naturally Aspirated Engine Views

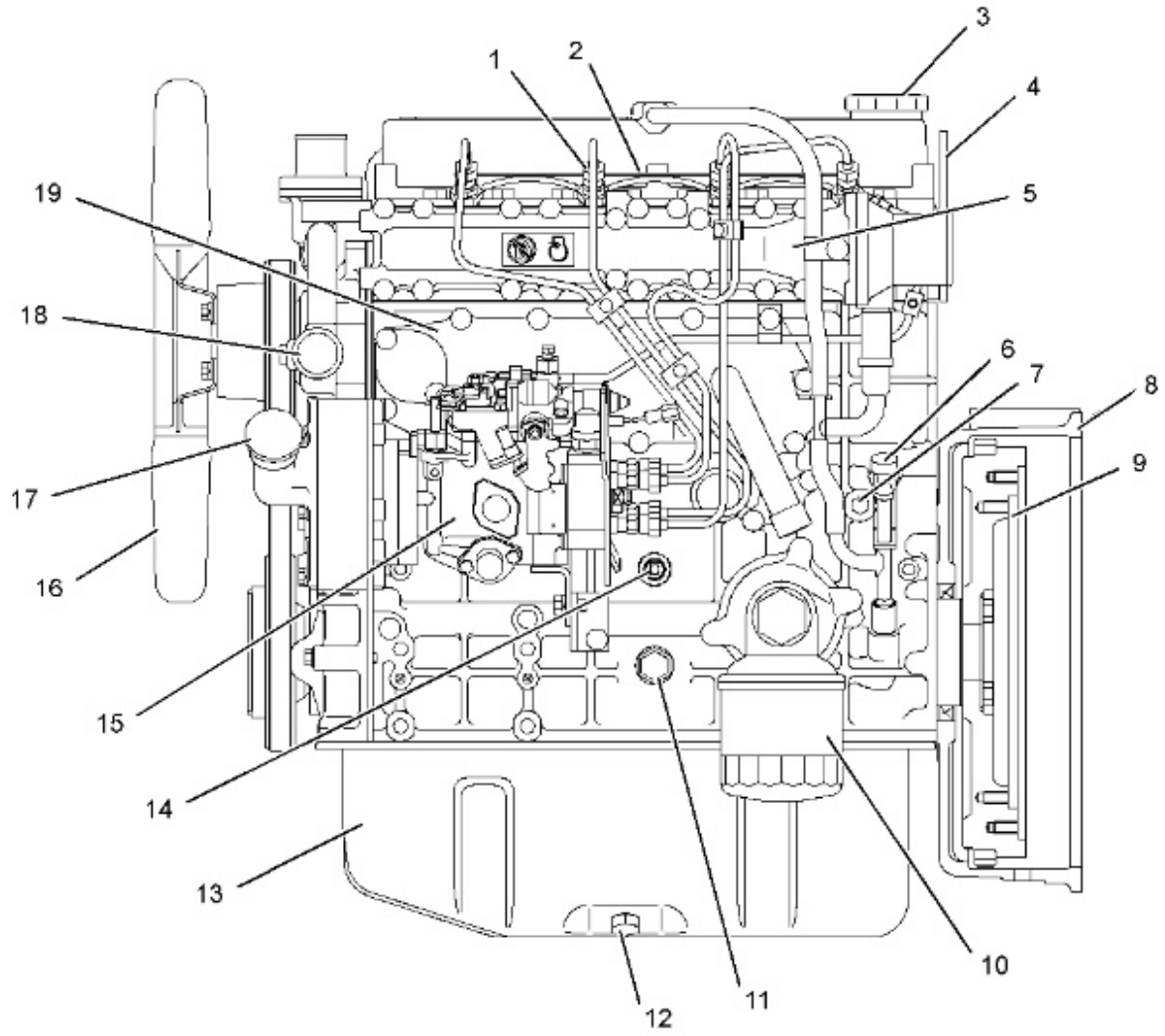


Illustration 1 g01280574

Left side view of the naturally aspirated engine

(1) Fuel injection nozzle

(2) Bus bar with glow plugs

(3) Oil fill cap (top)

(4) Engine lifting bracket

(5) Inlet manifold

(6) Engine oil level gauge

(7) Coolant drain plug

(8) Flywheel housing

(9) Flywheel

(10) Engine oil filter

(11) Engine oil relief valve

(12) Oil drain plug

(13) Engine oil pan

(14) Engine oil pressure switch

(15) Fuel injection pump

(16) Fan

(17) Oil fill cap (front)

(18) Water pump

(19) Engine oil cooler

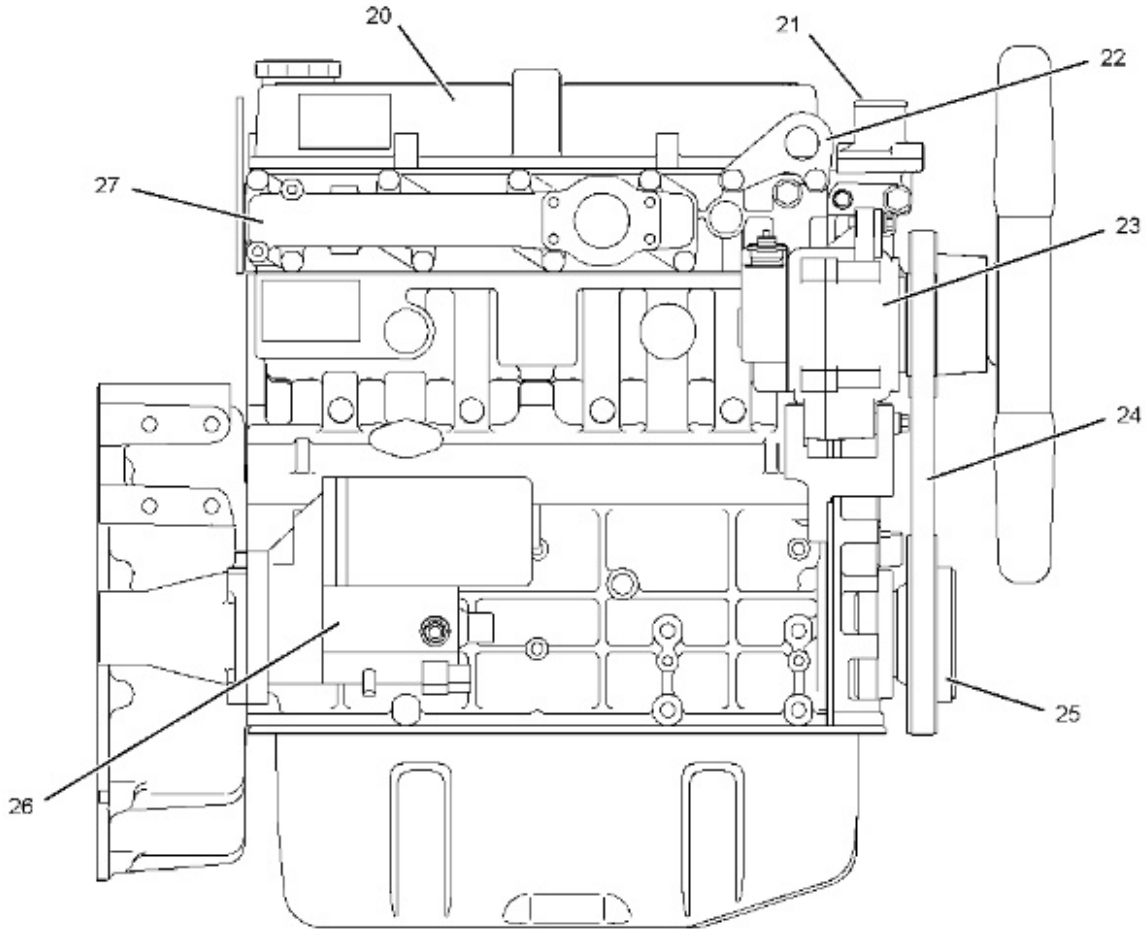


Illustration 2 g01280599

Right side view of the naturally aspirated engine

(20) Valve mechanism cover

(21) Water temperature regulator housing

(22) Engine lifting bracket

(23) Alternator

(24) V-Belt

(25) Crankshaft pulley

(26) Electric starting motor

(27) Exhaust manifold

Turbocharged Engine Views

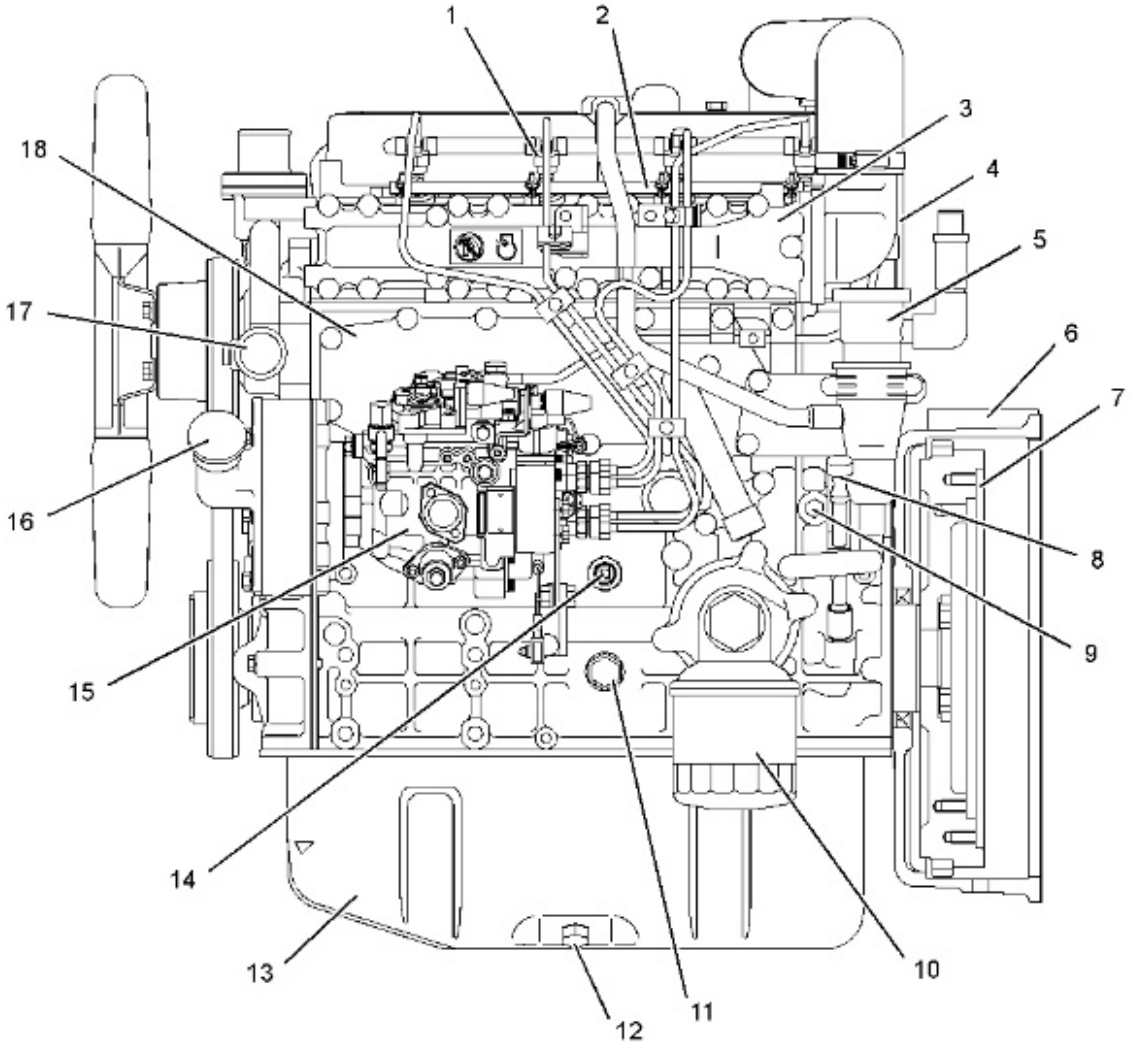


Illustration 3 g01280630

Left side view of the turbocharged engine

(1) Fuel injection nozzle

(2) Bus bar with glow plugs

(3) Inlet manifold

(4) Engine lifting bracket

(5) Closed crankcase breather

(6) Flywheel housing

(7) Flywheel

(8) Engine oil level gauge

(9) Coolant drain

(10) Engine oil filter

(11) Engine oil relief valve

(12) Oil drain plug

(13) Engine oil pan

(14) Engine oil pressure switch

(15) Fuel injection pump

(16) Oil fill cap (front)

(17) Water pump

(18) Engine oil cooler

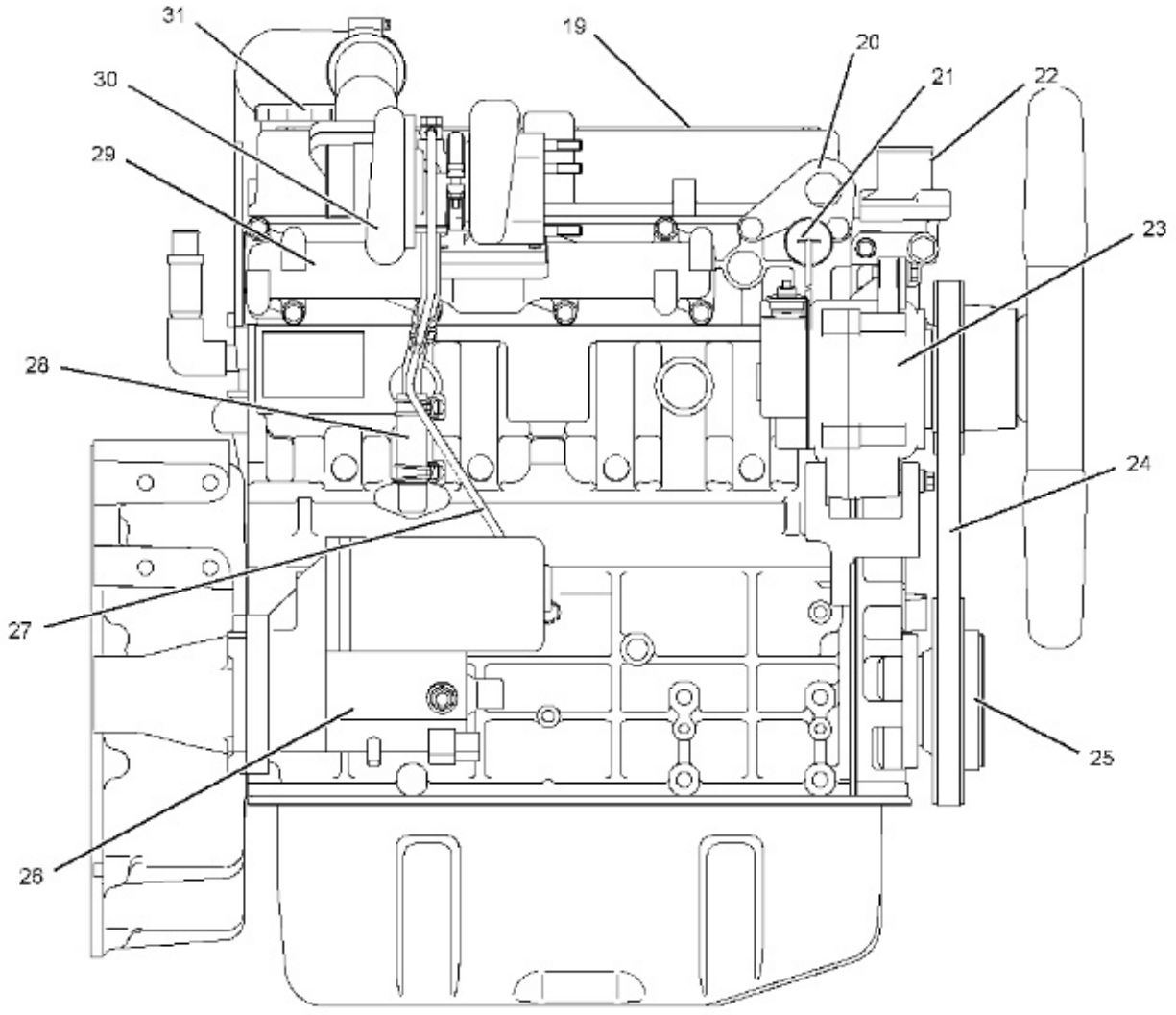


Illustration 4 g01280831

Right side view of the turbocharged engine

(19) Valve mechanism cover

(20) Engine lifting bracket

(21) Coolant temperature switch

(22) Water temperature regulator housing

(23) Alternator

(24) V-Belt

(25) Crankshaft pulley

(26) Electric starting motor

(27) Oil supply line for turbocharger

(28) Oil drain line for turbocharger

(29) Exhaust manifold

(30) Turbocharger

(31) Oil fill cap (top)

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Systems Operation
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02727199

General Information

SMCS - 1000

Note: When you are ordering new parts, refer to the engine identification number in order to receive the correct parts. Refer to the Operation and Maintenance Manual, "Product Identification Information" for the correct numbers for your engine.

The C3.4 engine is an in-line four cylinder engine. The engines are controlled by a mechanically governed fuel injection pump.

The engines have been designed for many different applications. These engines are available in two different types of aspiration:

- Naturally aspirated
- Turbocharged

Lifting the Engine

NOTICE

Failure to follow recommended procedures for handling or transporting engines can lead to engine damage.

To avoid possible engine damage, use the following procedure.

When you are lifting or moving the engine, use the following procedures in order to prevent engine damage.

1. Do not tilt the engine to an extreme angle unless the lubricating oil is first drained from the oil pan.
2. Do not turn the engine onto a side or an end surface unless the lubricating oil is first drained from the oil pan.

3. If the oil is not drained prior to tilting the engine or turning the engine onto a side or an end surface, the lubricating oil from the oil pan can flow into the intake manifold and the cylinder bores. This situation could cause a hydraulic lock in the engine. Hydraulic lock can severely damage the engine.

4. The engine oil should be refilled to the correct level before the engine is started.

Naturally Aspirated Engine Views

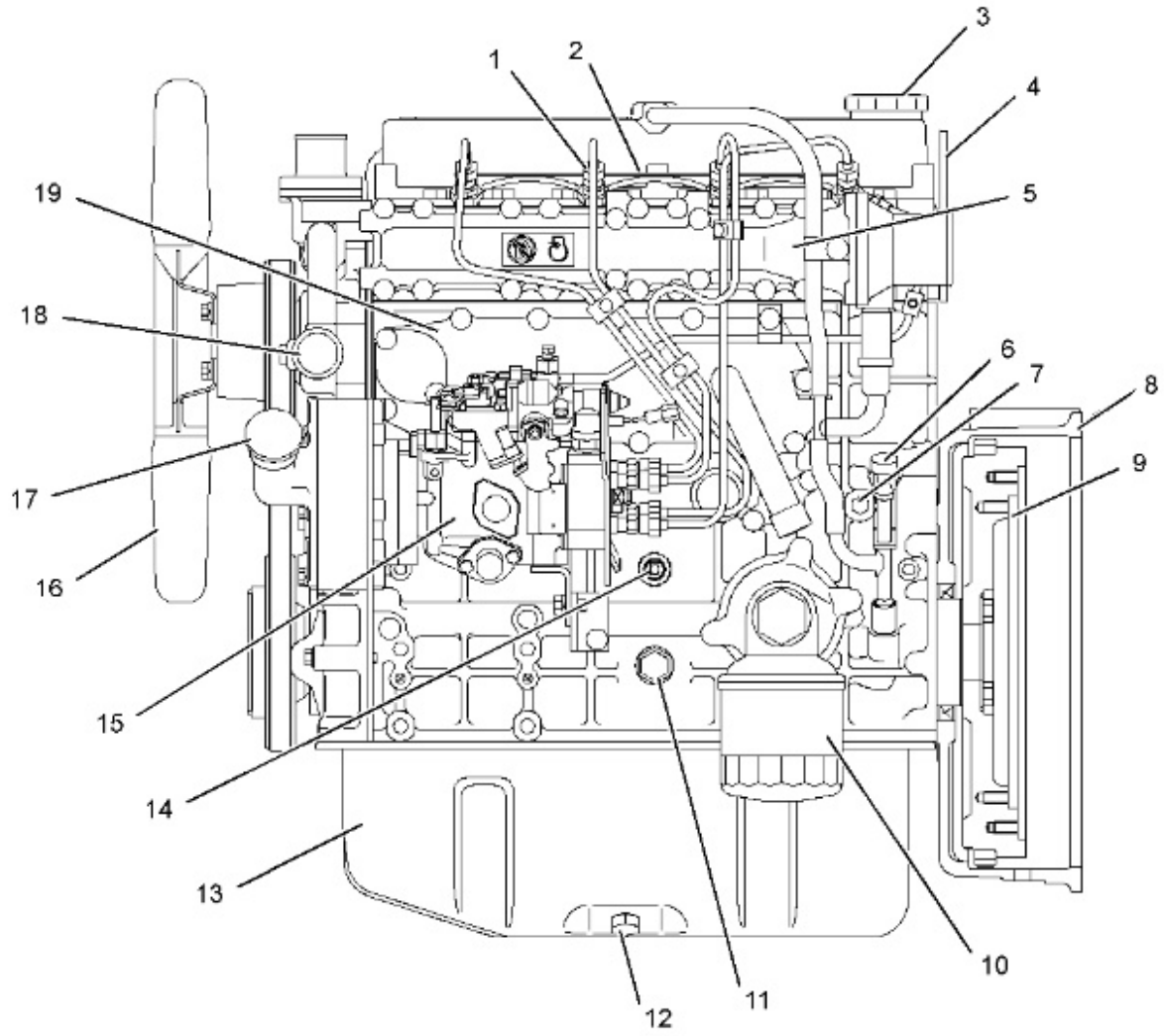


Illustration 1 g01280574

Left side view of the naturally aspirated engine

(1) Fuel injection nozzle

(2) Bus bar with glow plugs

(3) Oil fill cap (top)

(4) Engine lifting bracket

(5) Inlet manifold

(6) Engine oil level gauge

(7) Coolant drain plug

(8) Flywheel housing

(9) Flywheel

(10) Engine oil filter

(11) Engine oil relief valve

(12) Oil drain plug

(13) Engine oil pan

(14) Engine oil pressure switch

(15) Fuel injection pump

(16) Fan

(17) Oil fill cap (front)

(18) Water pump

(19) Engine oil cooler

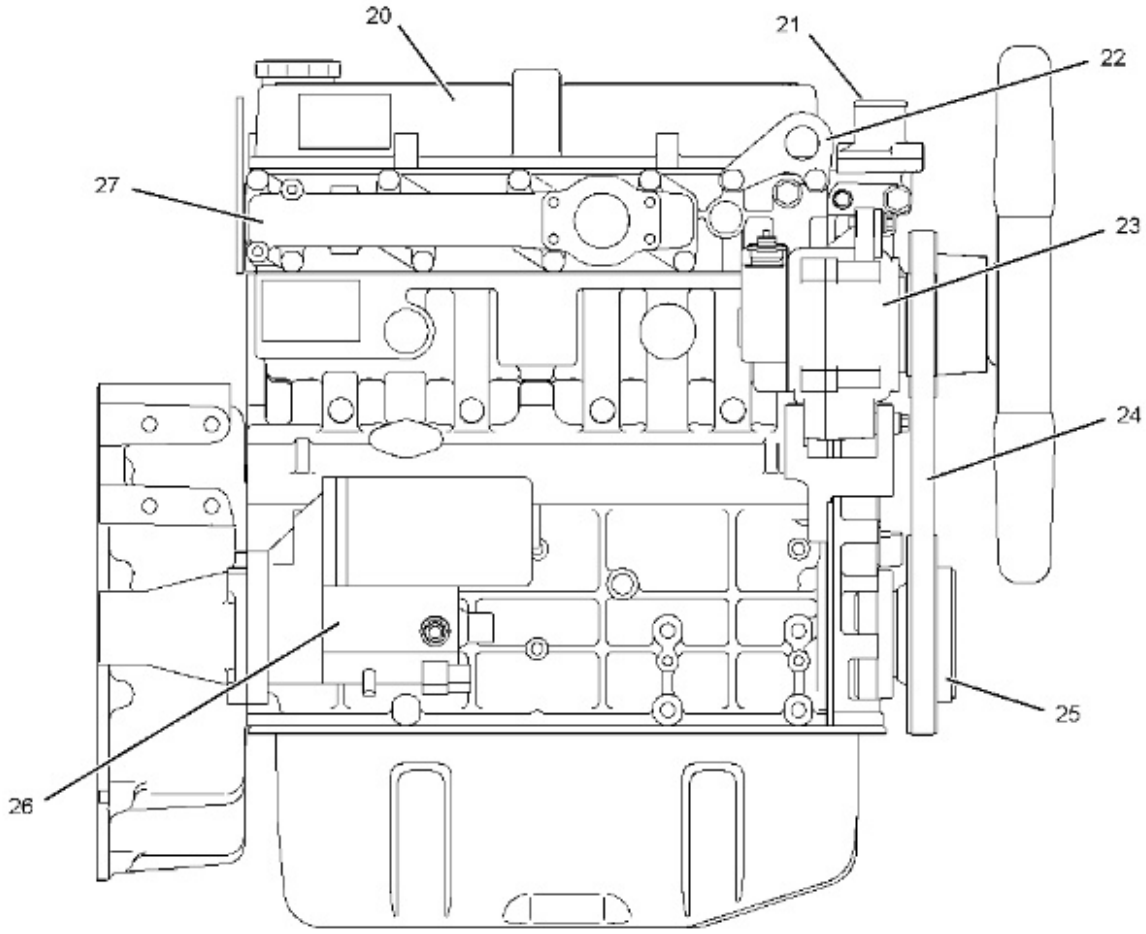


Illustration 2 g01280599

Right side view of the naturally aspirated engine

(20) Valve mechanism cover

(21) Water temperature regulator housing

(22) Engine lifting bracket

(23) Alternator

(24) V-Belt

(25) Crankshaft pulley

(26) Electric starting motor

(27) Exhaust manifold

Turbocharged Engine Views

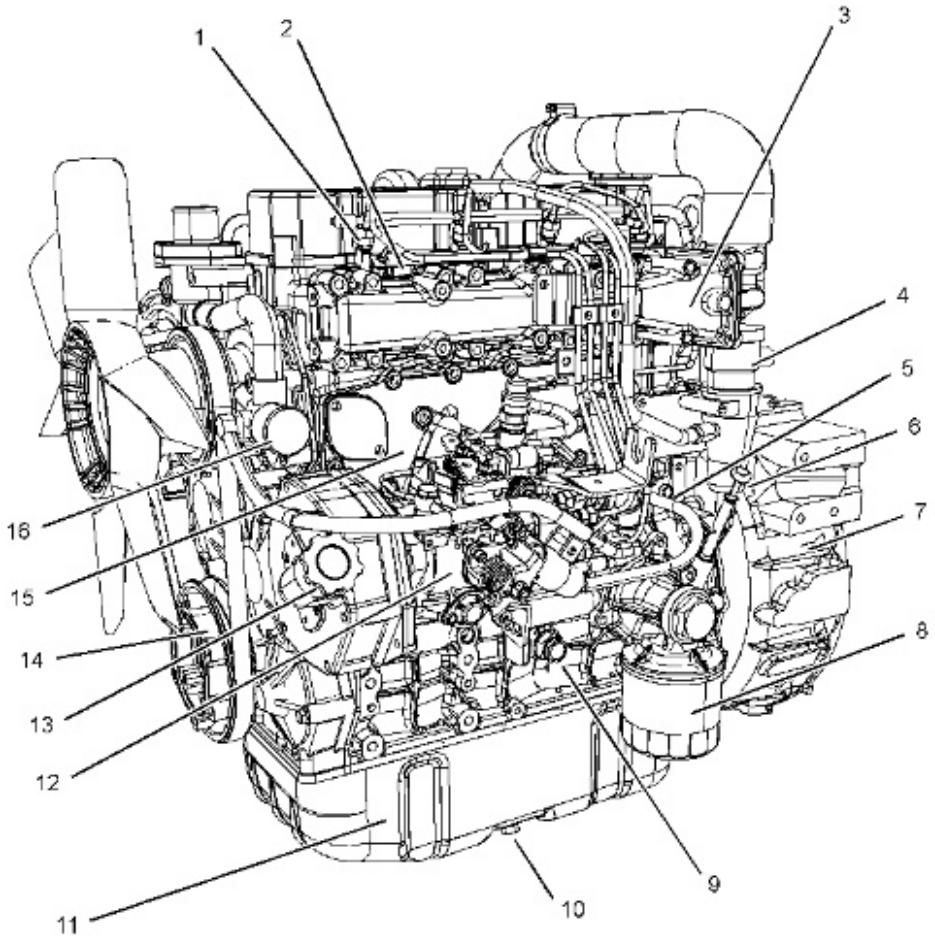


Illustration 3 g01367941

Left side view of the turbocharged engine

(1) Fuel injection nozzle

(2) Bus bar with glow plugs

(3) Inlet manifold

(4) Closed crankcase breather

(5) Coolant drain

(6) Engine oil level gauge

(7) Flywheel housing

(8) Engine oil filter

(9) Engine oil relief valve

(10) Oil drain plug

(11) Engine oil pan

(12) Fuel injection pump

(13) Oil fill cap (front)

(14) Crankshaft pulley

(15) Engine oil cooler

(16) Water pump

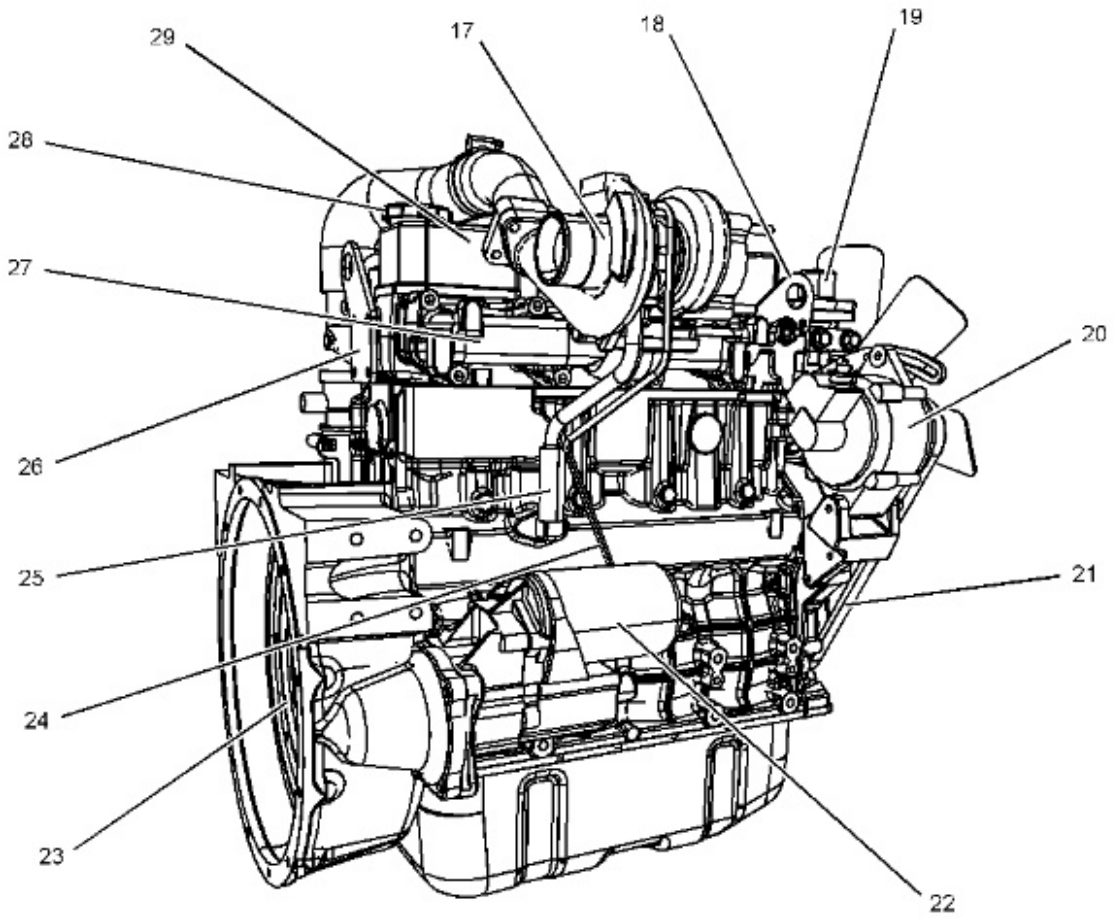


Illustration 4 g01367942

Right side view of the turbocharged engine

(17) Turbocharger

(18) Engine lifting bracket

(19) Water temperature regulator housing

(20) Alternator

(21) V-Belt

(22) Electric starting motor

(23) Flywheel

(24) Oil supply line for turbocharger

(25) Oil drain line for turbocharger

(26) Engine lifting bracket

(27) Exhaust manifold

(28) Oil fill cap (top)

(29) Valve mechanism cover

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i01936299

Troubleshooting

SMCS - 1000

Introduction

Troubleshooting can be difficult. To make a repair to a problem, refer to the possible cause and the corrective action. The most common problems are identified in this troubleshooting manual. The symptoms, causes, and guidance for solving the problems are given.

The list of problems, causes and corrections will only give an indication of the location of a possible problem. There is also a list that shows some of the repairs that are required.

Sometimes additional repair work is required beyond the repair which is recommended. Frequently, a problem does not exist in isolation. The problem can be a result of wear or of damage to several parts which operate together as part of a system.

Service personnel may remember similar complaints which were corrected by a previous method of troubleshooting. A similar complaint can have a different cause.

Get a good description of the problem from the operator and/or the person that owns the vehicle. Knowing the details of the problem can save time. This will make the repair job faster and easier.

All possible problems and the probable causes cannot be listed. The technician must follow a logical process of eliminating possible causes and of identifying the specific causes of the problems.

Troubleshooting The Fuel Injection Nozzles On The Engine

Note: Be careful when you are handling the fuel injection nozzles in order to prevent damage to the orifices, the threads, and other surfaces. When a fuel injection nozzle is installed, make sure that all surfaces and threads are clean.

Only personnel that have the proper training should disassemble the fuel injection nozzles. Only personnel that have the proper training should perform repairs to the fuel injection nozzle.

Replace the fuel injection nozzle if the fuel injection nozzle cannot be adjusted in order to operate correctly.

Refer to Specifications, "Fuel Injection Nozzles" for additional information.

The engine is difficult to start or the engine runs rough.

Probable Cause

1. The fuel injection nozzle does not seal correctly in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. There is debris on the mating surface of the cylinder head with the gaskets or the insert. Make sure that extra gaskets were removed from the threaded recess in the cylinder head for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles are the correct replacement parts for the engine. Refer to the Parts Manual for the correct replacement part.

The engine exhaust has too much black smoke.

Probable Cause

1. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the mating surface of the cylinder head with the gaskets or the insert.

   Remove any extra gaskets or debris.

2. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

3. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles are the correct replacement parts for the engine. Refer to the Parts Manual for the correct replacement part.

The engine has lost power and the engine uses too much fuel.

Probable Cause

1. The fuel injection nozzle does not seal in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the sealing surface for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

   Test the fuel injection nozzle on a nozzle tester.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles have the correct code for the engine.

6. A connection of the fuel return line leaks.

   Inspect all connections of the low pressure fuel line for tightening to the correct torque.

The engine is misfiring, running rough, or running poorly.

Probable Cause

1. The fuel injection nozzle does not seal in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the sealing surface for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

Test the fuel injection nozzle on a nozzle tester.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles have the correct code for the engine.

6. A restriction exists in the high pressure fuel line.

   Inspect all high pressure fuel lines for damage.

7. A seat washer that is not the correct thickness is installed.

   Install the correct thickness of the seat washer.

Troubleshooting Fuel Injection Nozzles on a Nozzle Tester

Note: Be careful when you are handling the fuel injection nozzles in order to prevent damage to the orifices, the threads, and other surfaces. When a fuel injection nozzle is installed, make sure that all surfaces and threads are clean.

Only personnel that have the proper training should disassemble the fuel injection nozzles. Only personnel that have the proper training should perform repairs to the fuel injection nozzles.

Replace the fuel injection nozzle if the fuel injection nozzle cannot be adjusted in order to operate correctly.

Refer to Specifications, "Fuel Injection Nozzles" for additional information.

Back leakage

1. Fuel leaks through the threaded connection of the body and the nozzle nut.

   Make sure that the threads are clean. Tighten the body to the correct torque.

2. Debris or damage exists on the orifices.

   Visually inspect the components of the valve for carbon pitting, for scoring, or for other damage. Clean the surface of the orifices with solvent. Replace the fuel injection nozzles if corrosion exists.

The fuel injection nozzle does not inject fuel in the correct quantity or in the correct pattern.

Probable Cause

1. The setting of the opening pressure is incorrect.

   Test the setting of the opening pressure. Adjust the setting to the correct pressure.

2. The fuel injection nozzle is stuck.

   Debris or damage exists on the fuel injection nozzle.

3. The orifices are blocked.

   Inspect the orifices for carbon buildup. The fuel injection nozzle must be cleaned or replaced.

4. The passage for the fuel return is obstructed.

   Clean the passage in order to remove any carbon buildup or other debris.

Troubleshooting the Turbocharger

The engine lacks power.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. A restriction exists in the tube between the air filter and the turbocharger.

   Find the restriction and repair or replace the component.

3. An air leak or a restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

4. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

5. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

6. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

7. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

8. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

9. The bearings of the turbocharger are worn.

   Replace the turbocharger.

10. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

11. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

12. The fuel injection pump is not operating correctly.

    The fuel injection pump must be repaired or replaced.

13. The fuel injection nozzles are worn or damaged.

    The fuel injection nozzles must be repaired or replaced.

14. The inlet valves and the exhaust valves are burned.

    Replace the inlet valves and the exhaust valves. Determine the cause of the damage to the valves.

15. The piston rings are worn.

    Replace the piston rings.

The engine exhaust has excessive black smoke.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

5. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

6. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

7. The bearings of the turbocharger are worn.

Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

The engine exhaust has excessive blue smoke.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

4. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

5. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

6. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

7. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

8. The bearings of the turbocharger are worn.

   Replace the turbocharger.

9. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

10. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

11. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

    Clean the turbocharger in order to remove the anti-corrosion fluid.

12. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

13. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

The engine uses an excessive amount of engine oil.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The incorrect type of engine oil is being used.

   Drain the engine oil. Install the correct quantity and type of engine oil.

5. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

6. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

7. The bearings of the turbocharger are worn.

   Replace the turbocharger.

8. The piston rings are worn.

   Replace the piston rings.

9. Lubricating oil is leaking from the supply line.

   The supply line must be repaired or replaced.

10. The high idle operates for an excessive period of time.

The fuel injection pump must be repaired or replaced.

11. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Excessive engine oil exists at the end of the turbine.

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The drain tube for the lubricating oil is restricted.

   The drain tube must be cleaned or replaced.

5. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

6. The bearings of the turbocharger are worn.

   Replace the turbocharger.

7. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

8. The piston rings are worn.

   Replace the piston rings.

9. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

   Clean the turbocharger in order to remove the anti-corrosion fluid.

10. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

11. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Excessive engine oil exists at the compressor end of the turbocharger.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be cleaned and replaced.

4. A air leak or restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

5. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

6. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

7. The bearings of the turbocharger are worn.

   Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. The piston rings are worn.

   Replace the piston rings.

10. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

    Clean the turbocharger in order to remove the anti-corrosion fluid.

11. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

12. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Engine oil exists in the exhaust manifold.

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

4. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

5. The bearings of the turbocharger are worn.

   Replace the turbocharger.

6. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

7. The piston rings are worn.

   Replace the piston rings.

8. The high idle operates for an excessive period of time.

   The fuel injection pump must be repaired or replaced.

9. A restriction exists in the bearing housing of the turbocharger.

   The bearing housing must be repaired or the turbocharger must be replaced.

Lack of lubrication to the turbocharger

Probable Cause

1. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

2. The flow of engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve

- Engine oil filter
- Viscosity of the engine oil
- Restrictions in oil lines

3. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

4. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

5. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

6. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

7. The high idle operates an insufficient period of time.

   Check the fuel injection pump for correct operation and settings.

8. Engine oil is leaking from the oil supply line.

   The oil supply line must be repaired or replaced.

9. A restriction exists in the bearing housing of the turbocharger.

   The bearing housing must be repaired or the turbocharger must be replaced.

10. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

11. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Cooling system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The inside of the inlet manifold is wet.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the air filter element and the air supply line to the turbocharger for correct installation.

4. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

5. An air leak or restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

6. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

7. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

8. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

9. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

10. The turbine housing is damaged or restricted.

    The turbine housing must be repaired or the turbocharger must be replaced.

11. Air or combustion gas is leaking through the seals of the turbocharger.

    Replace the turbocharger.

12. The bearings of the turbocharger are worn.

    Replace the turbocharger.

13. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

14. The piston rings are worn.

    Replace the piston rings.

15. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

16. The backplate of the compressor is cracked.

    The backplate of the compressor must be repaired or the turbocharger must be replaced.

Damaged compressor impeller of the turbocharger

Probable Cause

1. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the air filter element and the air supply line to the turbocharger for correct installation.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in the oil lines

5. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

6. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

7. The bearings of the turbocharger are worn.

Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

10. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

11. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

12. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

13. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

14. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Cooling system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Damage to the turbine

Probable Cause

1. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

2. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

3. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient engine oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

4. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

5. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

6. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

7. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

8. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

9. The bearings of the turbocharger are worn.

   Replace the turbocharger.

10. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

11. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

12. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

13. The fuel injection pump is not operating correctly.

    The fuel injection pump must be repaired or replaced.

14. The inlet valves and the exhaust valves are burned.

Replace the inlet valves and the exhaust valves. Determine the cause of the damage to the valves.

15. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

16. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

17. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

18. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The rotating assembly of the turbocharger does not rotate freely.

Probable Cause

1. The element of the air filter is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the element of the air filter and the air supply line to the turbocharger for correct installation.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

4. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

5. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient engine oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

6. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

7. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

8. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

9. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

10. The bearings of the turbocharger are worn.

    Replace the turbocharger.

11. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

12. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

13. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

14. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

15. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

16. A restriction exists in the bearing housing of the turbocharger.

The bearing housing must be repaired or the turbocharger must be replaced.

17. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

18. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Worn bearings, bearing bores, and journals

Probable Cause

1. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

5. The engine oil is dirty.

Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

6. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

7. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

8. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

9. The period of time at high idle is insufficient.

   Check the fuel injection pump for correct operation and settings.

10. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

11. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

12. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The turbocharger makes excessive noise.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

Inspect the air filter element and the air supply line to the turbocharger for correct installation.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

4. A air leak or restriction exists in the line between the turbocharger and the intake manifold.

   The component must be repaired or replaced.

5. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

6. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

7. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

8. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

9. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

10. The engine oil is dirty.

    Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

11. The incorrect type of engine oil is installed.

    Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

12. The oil supply line from the engine block is restricted.

    The oil supply line must be repaired or replaced.

13. The turbine housing is damaged or restricted.

The turbine housing must be repaired or the turbocharger must be replaced.

14. The bearings of the turbocharger are worn.

    Replace the turbocharger.

15. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

16. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

17. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

18. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

19. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

20. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

21. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

22. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Sludge or carbon deposits in the bearing housing

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

3. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

4. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

5. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

6. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

7. The period of time at high idle is insufficient.

   Check the fuel injection pump for correct operation and settings.

8. Engine oil is leaking from the oil supply line.

   The oil supply line must be repaired or replaced.

9. A restriction exists in the engine oil filter.

   Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

10. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system

- Fuel injection pump
- Air/fuel ratio control
- Valve lash
- Fuel injection nozzles

Troubleshooting the Engine

When you are troubleshooting the engine, refer to Specifications and Systems Operation, Testing and Adjusting for additional information.

The engine will not start.

Probable Cause

1. The engine starting procedure was incorrectly followed.

   Ensure that the engine starting procedure is correctly followed.

2. The manual valve in the fuel line is closed.

   Open the valve.

3. The fuel level is low in the fuel tank. Air is in the fuel system.

   Fill the fuel tank with fuel. Remove the air from the fuel system.

4. The fuel is contaminated.

   The fuel contains water, dirt, ice, or wax. Replace the fuel filters. Replace the fuel in the fuel tank with clean fuel.

5. Engine cranking speed is too slow.

   The engine oil is too thick. The connections of the battery cables to the starting motor are loose.

6. The glow plugs do not operate correctly.

   Inspect the cable connections and the electrical connections of the glow plugs and the electrical components of the starting aid circuit. Test the glow plugs for correct operation.

7. The fuel shutoff solenoid is not operating correctly.

   Ensure that the fuel shutoff solenoid operates correctly. Replace a fuel shutoff solenoid that is suspect.

8. The fuel filter or the fuel lines are restricted. Excess water has built up in the fuel filter.

   Check fuel lines and the fuel filter. Drain any water from the fuel filter.

9. The operation of the fuel injection pump is not correct.

Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. Check the timing of the drive gear for the fuel injection pump with the idler gear. The fuel injection pump must be repaired or replaced.

Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

10. A fuel injection nozzle is not operating correctly.

    Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

    Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles. Refer to Specifications, "Fuel Injection Nozzles" for additional information.

    Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

11. The cylinders have low compression.

    Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

    - Cylinder walls are worn or damaged.
    - Piston rings are worn or broken.
    - The piston height is incorrect.
    - The piston is damaged.
    - The fuel injection nozzles are not seated correctly.
    - The valve lash requires adjustment.
    - The fuel injection pump timing is incorrect.
    - The engine timing is incorrect.
    - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

12. The glow plugs do not operate correctly. The engine floods in cold weather.

Ensure that the glow plugs become very hot when the ignition switch is in the START position.

The engine starts and the engine runs for a brief period of time and the engine stops.

Probable Cause

1. The fuel filter or the fuel lines are restricted. Excess water has built up in the fuel filter.

   Check the fuel lines and the fuel filter. Replace the fuel filter. Drain any water from the fuel filter.

2. The operation of the fuel transfer pump is not correct.

   Check the fuel pressure when the engine is cranking. Remove the fuel transfer pump if the fuel pressure is too low. The fuel transfer pump must be repaired or replaced.

3. The air inlet or the exhaust system is restricted.

   Inspect the air inlet and the exhaust systems. Remove any restrictions.

4. Air is in the fuel system.

   Find the air leak in the fuel system. Repair the fuel system.

The engine misfires or the engine runs rough.

Probable Cause

1. The fuel pressure is low.

   Ensure that the fuel tank has enough fuel. Look for leaks or suspect bends in all of the fuel supply lines. Test the outlet pressure of the fuel transfer pump.

2. Air is in the fuel system.

   Find the air leak in the fuel system. Repair the air leak.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

5. A fuel injection nozzle does not operate correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

6. The engine mounts are not correctly tightened or the engine mounts are not mounted correctly. This condition also causes vibration.

   Check the engine mounts for correct positioning. Check the bolts of the engine mounts for correct tightening.

7. The fuel is contaminated with water, dirt, ice, or wax.

   Drain any water from the fuel tank and from the fuel filter. If the fuel is contaminated by dirt, ice, or wax, replace the fuel.

8. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

The engine runs evenly, but the engine loses power.

Probable Cause

1. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

2. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The air cleaner is restricted.

   The air cleaner must be repaired or the air cleaner must be replaced.

5. Air is in the fuel system.

   Remove the air from the fuel system. Make sure that the fittings of the fuel lines are aligned. Make sure that the fittings of the fuel lines are tightened correctly.

6. The fuel transfer pump is not operating correctly.

   Check the fuel pressure when the engine is cranking. Remove the fuel transfer pump if the fuel pressure is too low. The fuel transfer pump must be repaired or replaced.

The engine lacks power.

Probable Cause

1. Fuel of low quality is in the fuel system.

   Remove the fuel from the fuel tank. Install a new fuel filter. Put a good grade of clean fuel in the fuel tank.

2. The fuel pressure is low.

   Make sure that sufficient fuel is in the fuel tank. Look for leaks or suspect bends in the fuel line between the fuel tank and the fuel transfer pump. Remove any air in the fuel system. Check the outlet pressure of the fuel transfer pump.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

5. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

The engine has excessive vibration.

Probable Cause

1. The nut for the crankshaft pulley is loose. Refer to Specifications, "Crankshaft Pulley" for additional information.

Tighten the nut.

2. A pulley is suspect.

   Inspect the pulleys for wear or for damage. If the pulley is worn or damaged, use new parts for replacement.

3. The engine mounts are loose, worn, or suspect.

   Tighten all mounting bolts. Inspect the engine mounts for wear or for damage. Use new parts for replacement.

The engine has excessive combustion noise.

Probable Cause

1. Fuel of low quality is in the fuel system.

   Remove the fuel from the fuel tank. Install a new fuel filter. Put a good grade of clean fuel in the fuel tank.

2. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

3. The piston height is incorrect.

   Measure the piston height. To obtain the correct piston height, the piston, the piston pin, the bearings, or the connecting rod should be replaced.

The engine has excessive valve compartment noise.

Probable Cause

1. Valve springs or valve keepers are broken.

   Install new parts. Broken valve keepers can cause the valve to slide into the cylinder. Major damage to the engine can occur.

2. The bolts which hold the rocker arm assembly are loose.

   Tighten the bolts. Refer to Specifications, "Rocker Shaft" for additional information.

3. The valve lash exceeds the specification.

   Adjust the valve lash.

Engine oil is in the cooling system.

Probable Cause

1. The cylinder head gasket is suspect.

   Install a new cylinder head gasket.

Engine knock occurs.

Probable Cause

1. A main bearing is damaged.

   Inspect the main bearings and the bearing surfaces of the crankshaft. Replace damaged parts.

2. The crankshaft is damaged.

   Replace the crankshaft. Clean the engine thoroughly.

3. The piston height is incorrect.

   Check the piston height. Inspect the piston, the connecting rod, and the crankshaft for wear. Check for correct installation.

4. The projection of the fuel injection nozzle in the precombustion chamber is incorrect.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection line nuts are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

The rocker arm has insufficient movement and the valve lash exceeds the specification.

Probable Cause

1. Lubrication of internal engine components is inadequate.

   Check lubrication of the valves. There must be a strong flow of oil at high rpm. There must be a small flow of oil at low rpm. Oil passages in the engine must be clean.

2. Rocker arm parts are worn.

   If there is too much wear, install new parts or rocker arms. Adjust the valve lash.

3. The end of the valve stem is worn.

   Install new valves. Adjust the valve lash.

4. The valve lash exceeds the specification.

   Measure the valve lash. Adjust the valve lash.

5. The pushrods are worn.

   If there is too much wear, install new pushrods. Adjust the valve lash.

6. The valve lifters are worn.

   If there is too much wear, install new valve lifters. Adjust the valve lash.

7. The lobes of the camshaft are worn.

   Measure the valve lash. Check for free movement of the valves. Check for bent valve stems. Check for wear on the valve lifters. Replace suspect parts. Adjust the valve lash.

8. The bolts that hold the rocker arm assembly are loose.

   Tighten the bolts.

A cylinder head valve is loose.

Probable Cause

1. The valve keeper for the valve is broken.

   Replace the valve keepers. Broken valve keepers can cause the valve to slide into the cylinder. Major engine damage can result.

2. The valve springs are broken or damaged.

   Install new valve springs.

Oil condenses at the exhaust.

Probable Cause

1. The valve compartment contains too much oil.

   Look at both ends of the rocker arm shaft. Be sure that a plug is installed in each end.

2. The valve guides are worn.

   Install new valve guides. Recondition the cylinder head.

3. The piston rings are worn.

   Replace the piston rings.

The valve lash is less than the required specification.

Probable Cause

1. The valve seat or the face of the valve is worn.

   Adjust the valve lash.

Engine components have early wear.

Probable Cause

1. Dirt is in the engine oil.

   Remove the dirty engine oil. Install a new oil filter. Put clean oil in the engine.

2. Leaks exist in the air inlet system.

   Inspect all gaskets and connections. The components must be repaired or replaced.

3. Fuel leaks into the engine oil. Fuel leaks will cause high fuel consumption and low engine oil pressure.

   - Fuel leaks past the valve in a fuel injection nozzle.
   - The pressure setting of the fuel injection nozzles is too high.
   - The drive is broken on the fuel injection pump.

   Adjust the component. Replace a damaged component.

Coolant is in the engine oil.

Probable Cause

1. The cylinder head gasket is damaged.

   Install a new cylinder head gasket.

2. The cylinder head is cracked or damaged.

   Install a new cylinder head.

3. The cylinder block is cracked or damaged.

   Install a new cylinder block.

The engine exhaust has too much black smoke or too much gray smoke.

Probable Cause

1. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

2. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the linkage of the fuel rack operates correctly.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

3. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not

affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

4. The inlet air is restricted.

   Check the air cleaner for restrictions. The air cleaner must be cleaned or replaced.

The engine exhaust has too much white smoke or too much blue smoke.

Probable Cause

1. The engine contains too much engine oil.

   Drain the excess oil from the engine oil pan.

2. The fuel injection timing is not correct.

   Adjust the timing of the fuel injection pump.

3. The valve guides are worn.

   Replace the valve guides. Check the flatness of the cylinder head. Recondition the cylinder head if the flatness is out of tolerance.

4. The piston rings are worn. Refer to Specifications, "Pistons and Rings" for additional information.

   Replace the piston rings.

5. The engine consistently runs below the normal operating temperature. The water temperature regulator is suspect.

   Replace the water temperature regulator.

6. The breather hose or the vent hole in the breather assembly is obstructed.

   Clean the vent hole, the breather assembly, and the breather hose.

The engine has low oil pressure.

Probable Cause

1. The engine oil level is low.

Add engine oil to the correct level.

2. The engine oil filter is restricted.

   Install a new engine oil filter. Replace the oil in the engine with clean engine oil. Check the operation of the engine oil bypass valve.

3. Fuel leaks into the lubrication oil. Fuel leaks will cause high fuel consumption and low engine oil pressure.

   - Fuel leaks past the valve in a fuel injection nozzle.
   - The pressure setting of the fuel injection nozzles is too high.
   - The drive is broken on the fuel injection pump.

   Adjust the component. Replace a damaged component.

4. Too much clearance exists between the bore of the rocker arm and the rocker shaft.

   Check for adequate lubrication of the rocker arm assembly. Replace parts which are worn. Refer to Specifications, "Rocker Shaft" for additional information.

5. The suction pipe for the engine oil pump is suspect.

   Replace the suction pipe.

6. The engine oil bypass valve does not operate correctly.

   Clean the bypass valve. Replace the bypass valve if the spring is broken or the plunger is damaged.

7. The engine oil pump does not operate correctly.

   Check the distance of the face of the cover of the oil pump above the face of the idler gear. Check the wear of the lobe on the oil pump. The components of the idler gear and the oil pump must be repaired or replaced.

8. Too much clearance exists between the crankshaft and the crankshaft bearings.

   Replace the crankshaft or the crankshaft bearings.

9. Too much clearance exists between the camshaft and the camshaft bearings.

   Replace the camshaft or the camshaft bearings.

The engine oil pressure is too high.

Probable Cause

1. The engine oil bypass valve does not open.

   The bypass valve must be cleaned or replaced.

The engine uses too much engine oil.

Probable Cause

1. The engine contains too much engine oil.

   Drain the excess engine oil from the engine oil pan.

2. Oil lines have leaks.

   Find the source of the oil leaks. Repair the line or fitting.

3. The valve guides are worn.

   Replace the valve guides.

4. The piston rings are worn. Refer to Specifications, "Pistons and Rings" for additional information.

   Replace worn parts.

The engine overheats.

Probable Cause

1. The air flow through the radiator is restricted.

   Clean the exterior of the radiator in order to remove all restrictions.

2. The coolant level in the engine is low.

   Add coolant into the radiator to the correct level.

3. The pressure cap is suspect.

   Test the operation of the pressure cap. Replace a faulty pressure cap.

4. Gases from combustion are in the coolant.

   Find the source of the entry of the gases from combustion into the coolant system. Repair the source of the problem.

5. The water temperature regulator is suspect.

   Test the water temperature regulator for correct operation. Refer to Systems Operation, Testing and Adjusting or Specifications for additional information. Replace a faulty water temperature regulator.

6. The water pump is suspect.

   The water pump must be repaired or replaced.

7. The engine is operating with too much load.

   Reduce the load.

8. The timing of fuel injection pump is incorrect.

Adjust the timing.

The exhaust temperature is too high.

Probable Cause

1. A restriction exists in the air inlet or in the exhaust system.

   Remove the restriction.

2. The timing of the fuel injection pump is incorrect.

   Adjust the timing of the fuel injection pump.

The starting motor does not turn or the starting motor turns too slowly.

Probable Cause

1. The battery is discharged.

   Charge the battery. Replace a damaged battery. Clean all cable terminals and battery posts. Apply **1U-8267** Battery Saver and Cleaner on the cable clamps and the battery posts. Tighten the cable clamps on the battery posts.

2. The terminals or the brushes of the starting motor have a short circuit to ground.

   Find the short circuit. Repair the short circuit.

3. The ignition switch, the starting motor solenoid, or the start relay is damaged.

   Replace the ignition switch, the starting motor solenoid, or the start relay.

4. An excessive voltage drop exists in the cables or across the terminals in the circuits for the starting motor. The battery cables are loose at the terminals, corroded, or cracked. The battery terminals are corroded or broken.

   Inspect the battery cables and the battery terminals for loose connections, corrosion or other damage.

The starting motor turns, but the pinion gear does not engage the flywheel ring gear.

Probable Cause

1. The pinion drive or the overrunning clutch is suspect.

   Replace the pinion drive or the overrunning clutch.

2. The ring gear of the flywheel is damaged.

   Replace the flywheel.

3. The shift lever or the linkage is damaged.

Replace the shift lever or the linkage.

4. The starting motor solenoid is damaged.

   Replace the starting motor solenoid.

5. The armature or idler gear of the starting motor is damaged.

   Replace the starting motor.

The engine does not crank or the engine rotates slowly when the keyswitch is in the start position.

Probable Cause

1. The battery has a low charge.

   Charge the battery. Replace a faulty battery. Clean all cable terminals and battery posts. Apply the **1U-8267** Battery Saver and Cleaner on the cable clamps and to battery posts. Tighten the cable clamps on the battery posts.

2. The start relay is suspect.

   Replace the start relay.

3. An excessive voltage drop exists in the cables or across the terminals in the circuits for the starting motor. The battery cables are loose at the battery terminals, corroded, or cracked. The battery terminals are corroded or broken.

   Inspect the battery cables and battery terminals for loose connections, corrosion or other damage. Replace damaged parts.

   Refer to "The Starting Motor does not turn or the Starting motor turns too slowly.".

4. The overrunning clutch for the pinion drive slips.

   Replace the electric starting motor.

The starting motor continues to run after the ignition switch is released.

Probable Cause

1. The ignition switch, the start relay, or the starting motor solenoid is suspect.

   Replace the ignition switch, the start relay, or the starting motor solenoid.

The pinion gear does not disengage after the engine starts to run.

Probable Cause

1. The return spring of the pinion solenoid is damaged.

   Replace the return spring of the pinion solenoid.

2. The shift lever or the linkage is damaged.

   Replace the shift lever or the linkage.

3. The ignition switch or the start relay is suspect.

   Replace the ignition switch or the start relay.

The alternator does not charge the battery or the alternator charge rate is slow or irregular.

Probable Cause

1. The drive belt for the alternator is loose.

   Inspect the drive belt for wear and for damage. The drive belt must be adjusted or replaced.

2. The drive pulley for the alternator is loose or worn.

   Inspect the pulley for wear or for damage. Tighten the nuts of the pulley to the correct torque. Replace a damaged pulley.

3. The electrical cables and connections in the charging and starting circuits are loose or damaged.

4. Inspect all cables and connections. All connections must be clean and tight. Apply the **1U-8267** Battery Saver and Cleaner on the cable terminals and the connections. Replace suspect parts.

5. The regulator or the field winding of the rotor in the alternator are suspect.

   The alternator must be repaired or replaced.

6. The brushes of the alternator are worn or dirty.

   The brushes must be cleaned or replaced.

7. The rectifier in the alternator is suspect.

   Replace the rectifier or the alternator.

The alternator charges the battery to a voltage that is too high.

Probable Cause

1. The regulator is suspect.

   Replace the alternator.

The alternator is noisy.

Probable Cause

1. The drive belt for the alternator is worn or damaged.

   Replace the drive belt for the alternator.

2. The drive pulley for the alternator is loose or worn.

   Inspect the pulley for wear and for damage. Tighten the nuts of the pulley to the correct torque. Replace a damaged pulley.

3. The drive belt and the drive pulley are not in alignment.

   Adjust the alignment.

4. The bearings of the alternator are worn or damaged.

   Replace the alternator.

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Troubleshooting

SMCS - 1000

Introduction

Troubleshooting can be difficult. To make a repair to a problem, refer to the possible cause and the corrective action. The most common problems are identified in this troubleshooting manual. The symptoms, causes, and guidance for solving the problems are given.

The list of problems, causes and corrections will only give an indication of the location of a possible problem. There is also a list that shows some of the repairs that are required.

Sometimes additional repair work is required beyond the repair which is recommended. Frequently, a problem does not exist in isolation. The problem can be a result of wear or of damage to several parts which operate together as part of a system.

Service personnel may remember similar complaints which were corrected by a previous method of troubleshooting. A similar complaint can have a different cause.

Get a good description of the problem from the operator and/or the person that owns the vehicle. Knowing the details of the problem can save time. This will make the repair job faster and easier.

All possible problems and the probable causes cannot be listed. The technician must follow a logical process of eliminating possible causes and of identifying the specific causes of the problems.

Troubleshooting The Fuel Injection Nozzles On The Engine

Note: Be careful when you are handling the fuel injection nozzles in order to prevent damage to the orifices, the threads, and other surfaces. When a fuel injection nozzle is installed, make sure that all surfaces and threads are clean.

Only personnel that have the proper training should disassemble the fuel injection nozzles. Only personnel that have the proper training should perform repairs to the fuel injection nozzle.

Replace the fuel injection nozzle if the fuel injection nozzle cannot be adjusted in order to operate correctly.

Refer to Specifications, "Fuel Injection Nozzles" for additional information.

The engine is difficult to start or the engine runs rough.

Probable Cause

1. The fuel injection nozzle does not seal correctly in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. There is debris on the mating surface of the cylinder head with the gaskets or the insert. Make sure that extra gaskets were removed from the threaded recess in the cylinder head for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles are the correct replacement parts for the engine. Refer to the Parts Manual for the correct replacement part.

The engine exhaust has too much black smoke.

Probable Cause

1. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the mating surface of the cylinder head with the gaskets or the insert.

   Remove any extra gaskets or debris.

2. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

3. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles are the correct replacement parts for the engine. Refer to the Parts Manual for the correct replacement part.

The engine has lost power and the engine uses too much fuel.

Probable Cause

1. The fuel injection nozzle does not seal in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the sealing surface for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

   Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

   Test the fuel injection nozzle on a nozzle tester.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles have the correct code for the engine.

6. A connection of the fuel return line leaks.

   Inspect all connections of the low pressure fuel line for tightening to the correct torque.

The engine is misfiring, running rough, or running poorly.

Probable Cause

1. The fuel injection nozzle does not seal in the cylinder head.

   Make sure that the gaskets, the insert and the mating surface of the cylinder head are clean. Make sure that the fuel injection nozzle is tightened to the correct torque.

2. Extra gaskets were not removed from the threaded recess in the cylinder head for the fuel injection nozzle. There is debris on the sealing surface for the fuel injection nozzle.

   Remove any extra gaskets or debris.

3. The connections of the high pressure fuel line leak.

   Tighten the fittings of the high pressure fuel line.

4. The fuel injection nozzle does not operate correctly.

Make sure that the components of the fuel injection nozzle are tightened to the correct torques. Make sure that the gaskets and the insert are positioned correctly. Test the fuel injection nozzle on a nozzle tester in order to measure the pressure setting.

Test the fuel injection nozzle on a nozzle tester.

5. The incorrect fuel injection nozzle is installed.

   Make sure that all fuel injection nozzles have the correct code for the engine.

6. A restriction exists in the high pressure fuel line.

   Inspect all high pressure fuel lines for damage.

7. A seat washer that is not the correct thickness is installed.

   Install the correct thickness of the seat washer.

Troubleshooting Fuel Injection Nozzles on a Nozzle Tester

Note: Be careful when you are handling the fuel injection nozzles in order to prevent damage to the orifices, the threads, and other surfaces. When a fuel injection nozzle is installed, make sure that all surfaces and threads are clean.

Only personnel that have the proper training should disassemble the fuel injection nozzles. Only personnel that have the proper training should perform repairs to the fuel injection nozzles.

Replace the fuel injection nozzle if the fuel injection nozzle cannot be adjusted in order to operate correctly.

Refer to Specifications, "Fuel Injection Nozzles" for additional information.

Back leakage

1. Fuel leaks through the threaded connection of the body and the nozzle nut.

   Make sure that the threads are clean. Tighten the body to the correct torque.

2. Debris or damage exists on the orifices.

   Visually inspect the components of the valve for carbon pitting, for scoring, or for other damage. Clean the surface of the orifices with solvent. Replace the fuel injection nozzles if corrosion exists.

The fuel injection nozzle does not inject fuel in the correct quantity or in the correct pattern.

Probable Cause

1. The setting of the opening pressure is incorrect.

   Test the setting of the opening pressure. Adjust the setting to the correct pressure.

2. The fuel injection nozzle is stuck.

   Debris or damage exists on the fuel injection nozzle.

3. The orifices are blocked.

   Inspect the orifices for carbon buildup. The fuel injection nozzle must be cleaned or replaced.

4. The passage for the fuel return is obstructed.

   Clean the passage in order to remove any carbon buildup or other debris.

Troubleshooting the Turbocharger

The engine lacks power.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. A restriction exists in the tube between the air filter and the turbocharger.

   Find the restriction and repair or replace the component.

3. An air leak or a restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

4. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

5. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

6. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

7. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

8. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

9. The bearings of the turbocharger are worn.

   Replace the turbocharger.

10. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

11. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

12. The fuel injection pump is not operating correctly.

    The fuel injection pump must be repaired or replaced.

13. The fuel injection nozzles are worn or damaged.

    The fuel injection nozzles must be repaired or replaced.

14. The inlet valves and the exhaust valves are burned.

    Replace the inlet valves and the exhaust valves. Determine the cause of the damage to the valves.

15. The piston rings are worn.

    Replace the piston rings.

The engine exhaust has excessive black smoke.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

5. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

6. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

7. The bearings of the turbocharger are worn.

Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

The engine exhaust has excessive blue smoke.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

4. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

5. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

6. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

7. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

8. The bearings of the turbocharger are worn.

   Replace the turbocharger.

9. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

10. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

11. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

    Clean the turbocharger in order to remove the anti-corrosion fluid.

12. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

13. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

The engine uses an excessive amount of engine oil.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The incorrect type of engine oil is being used.

   Drain the engine oil. Install the correct quantity and type of engine oil.

5. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

6. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

7. The bearings of the turbocharger are worn.

   Replace the turbocharger.

8. The piston rings are worn.

   Replace the piston rings.

9. Lubricating oil is leaking from the supply line.

   The supply line must be repaired or replaced.

10. The high idle operates for an excessive period of time.

The fuel injection pump must be repaired or replaced.

11. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Excessive engine oil exists at the end of the turbine.

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The drain tube for the lubricating oil is restricted.

   The drain tube must be cleaned or replaced.

5. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

6. The bearings of the turbocharger are worn.

   Replace the turbocharger.

7. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

8. The piston rings are worn.

   Replace the piston rings.

9. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

   Clean the turbocharger in order to remove the anti-corrosion fluid.

10. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

11. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Excessive engine oil exists at the compressor end of the turbocharger.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be cleaned and replaced.

4. A air leak or restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

5. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

6. Air or combustion gas is leaking through the seals of the turbocharger.

   Replace the turbocharger.

7. The bearings of the turbocharger are worn.

   Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. The piston rings are worn.

   Replace the piston rings.

10. Excessive anti-corrosion fluid exists in the turbocharger. This condition only exists on a new engine which has not been operated.

    Clean the turbocharger in order to remove the anti-corrosion fluid.

11. The high idle operates for an excessive period of time.

    The fuel injection pump must be repaired or replaced.

12. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

Engine oil exists in the exhaust manifold.

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

4. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

5. The bearings of the turbocharger are worn.

   Replace the turbocharger.

6. Carbon has collected behind the rotor of the turbine.

   Remove the carbon.

7. The piston rings are worn.

   Replace the piston rings.

8. The high idle operates for an excessive period of time.

   The fuel injection pump must be repaired or replaced.

9. A restriction exists in the bearing housing of the turbocharger.

   The bearing housing must be repaired or the turbocharger must be replaced.

Lack of lubrication to the turbocharger

Probable Cause

1. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

2. The flow of engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve

- Engine oil filter
- Viscosity of the engine oil
- Restrictions in oil lines

3. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

4. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

5. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

6. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

7. The high idle operates an insufficient period of time.

   Check the fuel injection pump for correct operation and settings.

8. Engine oil is leaking from the oil supply line.

   The oil supply line must be repaired or replaced.

9. A restriction exists in the bearing housing of the turbocharger.

   The bearing housing must be repaired or the turbocharger must be replaced.

10. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

11. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Cooling system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The inside of the inlet manifold is wet.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

3. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the air filter element and the air supply line to the turbocharger for correct installation.

4. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

5. An air leak or restriction exists in the line between the turbocharger and the inlet manifold.

   The component must be repaired or replaced.

6. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

7. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

8. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

9. The drain tube for the lubricating oil is restricted.

   The drain tube must be repaired or replaced.

10. The turbine housing is damaged or restricted.

    The turbine housing must be repaired or the turbocharger must be replaced.

11. Air or combustion gas is leaking through the seals of the turbocharger.

    Replace the turbocharger.

12. The bearings of the turbocharger are worn.

    Replace the turbocharger.

13. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

14. The piston rings are worn.

    Replace the piston rings.

15. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

16. The backplate of the compressor is cracked.

    The backplate of the compressor must be repaired or the turbocharger must be replaced.

Damaged compressor impeller of the turbocharger

Probable Cause

1. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the air filter element and the air supply line to the turbocharger for correct installation.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in the oil lines

5. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

6. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

7. The bearings of the turbocharger are worn.

Replace the turbocharger.

8. Excessive dirt exists in the compressor housing.

   Clean the compressor housing.

9. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

10. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

11. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

12. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

13. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

14. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Cooling system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Damage to the turbine

Probable Cause

1. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

2. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

3. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient engine oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

4. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

5. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

6. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

7. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

8. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

9. The bearings of the turbocharger are worn.

   Replace the turbocharger.

10. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

11. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

12. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

13. The fuel injection pump is not operating correctly.

    The fuel injection pump must be repaired or replaced.

14. The inlet valves and the exhaust valves are burned.

Replace the inlet valves and the exhaust valves. Determine the cause of the damage to the valves.

15. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

16. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

17. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

18. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The rotating assembly of the turbocharger does not rotate freely.

Probable Cause

1. The element of the air filter is not sealed correctly. A connection between the air filter and the turbocharger is loose.

   Inspect the element of the air filter and the air supply line to the turbocharger for correct installation.

2. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

3. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

4. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

5. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient engine oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

6. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

7. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

8. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

9. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

10. The bearings of the turbocharger are worn.

    Replace the turbocharger.

11. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

12. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

13. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

14. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

15. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

16. A restriction exists in the bearing housing of the turbocharger.

The bearing housing must be repaired or the turbocharger must be replaced.

17. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

18. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Worn bearings, bearing bores, and journals

Probable Cause

1. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

2. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

3. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

4. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

5. The engine oil is dirty.

Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

6. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

7. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

8. The engine rpm increases too rapidly when the engine is started.

   Check the fuel injection pump for correct operation and settings.

9. The period of time at high idle is insufficient.

   Check the fuel injection pump for correct operation and settings.

10. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

11. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

12. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

The turbocharger makes excessive noise.

Probable Cause

1. The air filter element is dirty.

   The air filter element must be cleaned or replaced.

2. The air filter element is not sealed correctly. A connection between the air filter and the turbocharger is loose.

Inspect the air filter element and the air supply line to the turbocharger for correct installation.

3. A restriction exists in the tube between the air filter and the turbocharger.

   The component must be repaired or replaced.

4. A air leak or restriction exists in the line between the turbocharger and the intake manifold.

   The component must be repaired or replaced.

5. A restriction exists in the exhaust system.

   The component must be repaired or replaced.

6. The turbocharger is loose or the clamps and bolts on the turbocharger are loose.

   Correctly position the turbocharger and tighten the clamps and bolts.

7. The inlet manifold is cracked, loose or the flange is distorted.

   The inlet manifold must be repaired or replaced.

8. The exhaust manifold is cracked, loose, or the flange is distorted.

   The exhaust manifold must be repaired or replaced.

9. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

10. The engine oil is dirty.

    Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

11. The incorrect type of engine oil is installed.

    Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

12. The oil supply line from the engine block is restricted.

    The oil supply line must be repaired or replaced.

13. The turbine housing is damaged or restricted.

The turbine housing must be repaired or the turbocharger must be replaced.

14. The bearings of the turbocharger are worn.

    Replace the turbocharger.

15. Excessive dirt exists in the compressor housing.

    Clean the compressor housing.

16. Carbon has collected behind the rotor of the turbine.

    Remove the carbon.

17. The engine rpm increases too rapidly when the engine is started.

    Check the fuel injection pump for correct operation and settings.

18. The period of time at high idle is insufficient.

    Check the fuel injection pump for correct operation and settings.

19. Engine oil is leaking from the oil supply line.

    The oil supply line must be repaired or replaced.

20. A restriction exists in the bearing housing of the turbocharger.

    The bearing housing must be repaired or the turbocharger must be replaced.

21. A restriction exists in the engine oil filter.

    Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

22. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system
    - Fuel injection pump
    - Air/fuel ratio control
    - Valve lash
    - Fuel injection nozzles

Sludge or carbon deposits in the bearing housing

Probable Cause

1. The crankcase breather is restricted.

   The crankcase breather or the tubing must be cleaned or replaced.

2. The flow of the engine oil is delayed to the turbocharger when the engine is started. Insufficient oil flows to the turbocharger when the engine is running.

   Check the following components for correct operation:

   - Engine oil pump
   - Engine oil bypass valve
   - Engine oil filter
   - Viscosity of the engine oil
   - Restrictions in oil lines

3. The engine oil is dirty.

   Drain the engine oil. Install the correct type of engine oil. Replace the engine oil filter.

4. The incorrect type of engine oil is installed.

   Drain the engine oil. Replace the engine oil filter. Install the correct type of engine oil.

5. The oil supply line from the engine block is restricted.

   The oil supply line must be repaired or replaced.

6. The turbine housing is damaged or restricted.

   The turbine housing must be repaired or the turbocharger must be replaced.

7. The period of time at high idle is insufficient.

   Check the fuel injection pump for correct operation and settings.

8. Engine oil is leaking from the oil supply line.

   The oil supply line must be repaired or replaced.

9. A restriction exists in the engine oil filter.

   Clean the engine oil filter base and the housing for the engine oil filter. Check the operation of the engine oil bypass valve. Replace the engine oil filter.

10. The engine stopped too soon from a high load condition.

    Check the following components for correct operation or damage:

    - Compressor impeller of the turbocharger
    - Coolant system

- Fuel injection pump
- Air/fuel ratio control
- Valve lash
- Fuel injection nozzles

Troubleshooting the Engine

When you are troubleshooting the engine, refer to Specifications and Systems Operation, Testing and Adjusting for additional information.

The engine will not start.

Probable Cause

1. The engine starting procedure was incorrectly followed.

   Ensure that the engine starting procedure is correctly followed.

2. The manual valve in the fuel line is closed.

   Open the valve.

3. The fuel level is low in the fuel tank. Air is in the fuel system.

   Fill the fuel tank with fuel. Remove the air from the fuel system.

4. The fuel is contaminated.

   The fuel contains water, dirt, ice, or wax. Replace the fuel filters. Replace the fuel in the fuel tank with clean fuel.

5. Engine cranking speed is too slow.

   The engine oil is too thick. The connections of the battery cables to the starting motor are loose.

6. The glow plugs do not operate correctly.

   Inspect the cable connections and the electrical connections of the glow plugs and the electrical components of the starting aid circuit. Test the glow plugs for correct operation.

7. The fuel shutoff solenoid is not operating correctly.

   Ensure that the fuel shutoff solenoid operates correctly. Replace a fuel shutoff solenoid that is suspect.

8. The fuel filter or the fuel lines are restricted. Excess water has built up in the fuel filter.

   Check fuel lines and the fuel filter. Drain any water from the fuel filter.

9. The operation of the fuel injection pump is not correct.

Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. Check the timing of the drive gear for the fuel injection pump with the idler gear. The fuel injection pump must be repaired or replaced.

Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

10. A fuel injection nozzle is not operating correctly.

    Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

    Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles. Refer to Specifications, "Fuel Injection Nozzles" for additional information.

    Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

11. The cylinders have low compression.

    Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

    - Cylinder walls are worn or damaged.
    - Piston rings are worn or broken.
    - The piston height is incorrect.
    - The piston is damaged.
    - The fuel injection nozzles are not seated correctly.
    - The valve lash requires adjustment.
    - The fuel injection pump timing is incorrect.
    - The engine timing is incorrect.
    - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

12. The glow plugs do not operate correctly. The engine floods in cold weather.

Ensure that the glow plugs become very hot when the ignition switch is in the START position.

The engine starts and the engine runs for a brief period of time and the engine stops.

Probable Cause

1. The fuel filter or the fuel lines are restricted. Excess water has built up in the fuel filter.

   Check the fuel lines and the fuel filter. Replace the fuel filter. Drain any water from the fuel filter.

2. The operation of the fuel transfer pump is not correct.

   Check the fuel pressure when the engine is cranking. Remove the fuel transfer pump if the fuel pressure is too low. The fuel transfer pump must be repaired or replaced.

3. The air inlet or the exhaust system is restricted.

   Inspect the air inlet and the exhaust systems. Remove any restrictions.

4. Air is in the fuel system.

   Find the air leak in the fuel system. Repair the fuel system.

The engine misfires or the engine runs rough.

Probable Cause

1. The fuel pressure is low.

   Ensure that the fuel tank has enough fuel. Look for leaks or suspect bends in all of the fuel supply lines. Test the outlet pressure of the fuel transfer pump.

2. Air is in the fuel system.

   Find the air leak in the fuel system. Repair the air leak.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

5. A fuel injection nozzle does not operate correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

6. The engine mounts are not correctly tightened or the engine mounts are not mounted correctly. This condition also causes vibration.

   Check the engine mounts for correct positioning. Check the bolts of the engine mounts for correct tightening.

7. The fuel is contaminated with water, dirt, ice, or wax.

   Drain any water from the fuel tank and from the fuel filter. If the fuel is contaminated by dirt, ice, or wax, replace the fuel.

8. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

The engine runs evenly, but the engine loses power.

Probable Cause

1. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

2. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The air cleaner is restricted.

   The air cleaner must be repaired or the air cleaner must be replaced.

5. Air is in the fuel system.

   Remove the air from the fuel system. Make sure that the fittings of the fuel lines are aligned. Make sure that the fittings of the fuel lines are tightened correctly.

6. The fuel transfer pump is not operating correctly.

   Check the fuel pressure when the engine is cranking. Remove the fuel transfer pump if the fuel pressure is too low. The fuel transfer pump must be repaired or replaced.

The engine lacks power.

Probable Cause

1. Fuel of low quality is in the fuel system.

   Remove the fuel from the fuel tank. Install a new fuel filter. Put a good grade of clean fuel in the fuel tank.

2. The fuel pressure is low.

   Make sure that sufficient fuel is in the fuel tank. Look for leaks or suspect bends in the fuel line between the fuel tank and the fuel transfer pump. Remove any air in the fuel system. Check the outlet pressure of the fuel transfer pump.

3. The valve lash is not correct.

   Adjust the valve lash.

4. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

5. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

The engine has excessive vibration.

Probable Cause

1. The nut for the crankshaft pulley is loose. Refer to Specifications, "Crankshaft Pulley" for additional information.

Tighten the nut.

2. A pulley is suspect.

   Inspect the pulleys for wear or for damage. If the pulley is worn or damaged, use new parts for replacement.

3. The engine mounts are loose, worn, or suspect.

   Tighten all mounting bolts. Inspect the engine mounts for wear or for damage. Use new parts for replacement.

The engine has excessive combustion noise.

Probable Cause

1. Fuel of low quality is in the fuel system.

   Remove the fuel from the fuel tank. Install a new fuel filter. Put a good grade of clean fuel in the fuel tank.

2. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

3. The piston height is incorrect.

   Measure the piston height. To obtain the correct piston height, the piston, the piston pin, the bearings, or the connecting rod should be replaced.

The engine has excessive valve compartment noise.

Probable Cause

1. Valve springs or valve keepers are broken.

   Install new parts. Broken valve keepers can cause the valve to slide into the cylinder. Major damage to the engine can occur.

2. The bolts which hold the rocker arm assembly are loose.

   Tighten the bolts. Refer to Specifications, "Rocker Shaft" for additional information.

3. The valve lash exceeds the specification.

   Adjust the valve lash.

Engine oil is in the cooling system.

Probable Cause

1. The cylinder head gasket is suspect.

   Install a new cylinder head gasket.

Engine knock occurs.

Probable Cause

1. A main bearing is damaged.

   Inspect the main bearings and the bearing surfaces of the crankshaft. Replace damaged parts.

2. The crankshaft is damaged.

   Replace the crankshaft. Clean the engine thoroughly.

3. The piston height is incorrect.

   Check the piston height. Inspect the piston, the connecting rod, and the crankshaft for wear. Check for correct installation.

4. The projection of the fuel injection nozzle in the precombustion chamber is incorrect.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not affect the operation of the engine, the fuel injection nozzle is suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

   Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

   Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection line nuts are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

The rocker arm has insufficient movement and the valve lash exceeds the specification.

Probable Cause

1. Lubrication of internal engine components is inadequate.

   Check lubrication of the valves. There must be a strong flow of oil at high rpm. There must be a small flow of oil at low rpm. Oil passages in the engine must be clean.

2. Rocker arm parts are worn.

   If there is too much wear, install new parts or rocker arms. Adjust the valve lash.

3. The end of the valve stem is worn.

   Install new valves. Adjust the valve lash.

4. The valve lash exceeds the specification.

   Measure the valve lash. Adjust the valve lash.

5. The pushrods are worn.

   If there is too much wear, install new pushrods. Adjust the valve lash.

6. The valve lifters are worn.

   If there is too much wear, install new valve lifters. Adjust the valve lash.

7. The lobes of the camshaft are worn.

   Measure the valve lash. Check for free movement of the valves. Check for bent valve stems. Check for wear on the valve lifters. Replace suspect parts. Adjust the valve lash.

8. The bolts that hold the rocker arm assembly are loose.

   Tighten the bolts.

A cylinder head valve is loose.

Probable Cause

1. The valve keeper for the valve is broken.

   Replace the valve keepers. Broken valve keepers can cause the valve to slide into the cylinder. Major engine damage can result.

2. The valve springs are broken or damaged.

   Install new valve springs.

Oil condenses at the exhaust.

Probable Cause

1. The valve compartment contains too much oil.

   Look at both ends of the rocker arm shaft. Be sure that a plug is installed in each end.

2. The valve guides are worn.

   Install new valve guides. Recondition the cylinder head.

3. The piston rings are worn.

   Replace the piston rings.

The valve lash is less than the required specification.

Probable Cause

1. The valve seat or the face of the valve is worn.

   Adjust the valve lash.

Engine components have early wear.

Probable Cause

1. Dirt is in the engine oil.

   Remove the dirty engine oil. Install a new oil filter. Put clean oil in the engine.

2. Leaks exist in the air inlet system.

   Inspect all gaskets and connections. The components must be repaired or replaced.

3. Fuel leaks into the engine oil. Fuel leaks will cause high fuel consumption and low engine oil pressure.

   - Fuel leaks past the valve in a fuel injection nozzle.
   - The pressure setting of the fuel injection nozzles is too high.
   - The drive is broken on the fuel injection pump.

   Adjust the component. Replace a damaged component.

Coolant is in the engine oil.

Probable Cause

1. The cylinder head gasket is damaged.

   Install a new cylinder head gasket.

2. The cylinder head is cracked or damaged.

   Install a new cylinder head.

3. The cylinder block is cracked or damaged.

   Install a new cylinder block.

The engine exhaust has too much black smoke or too much gray smoke.

Probable Cause

1. The cylinders have low compression.

   Starting the engine may be difficult in warm weather. The engine may not start in cold weather. Low compression is most frequently caused by the following conditions:

   - Cylinder walls are worn or damaged.
   - Piston rings are worn or broken.
   - The piston height is incorrect.
   - The piston is damaged.
   - The fuel injection nozzles are not seated correctly.
   - The valve lash requires adjustment.
   - The fuel injection pump timing is incorrect.
   - The engine timing is incorrect.
   - When an inlet valve or an exhaust valve is fully seated, gases leak past the valve head.

2. The operation of the fuel injection pump is not correct.

   Check the timing of the fuel injection pump. Adjust the timing or replace the fuel injection pump. The fuel injection pump must be repaired or replaced.

   Make sure that the linkage of the fuel rack operates correctly.

   Make sure that the high pressure fuel lines are connected to the fuel injection nozzles in the correct order.

   Make sure that the mounting bolts of the fuel injection pump are tightened to the correct torque. Inspect the fuel lines for leaks or for restrictions. The damaged fuel lines or fittings must be repaired or replaced.

3. A fuel injection nozzle is not operating correctly.

   Run the engine at the rpm that gives maximum misfiring or rough running. Then, loosen a fuel line nut on the injection line for each cylinder. Loosen one nut at a time. Then, tighten that nut before the next fuel line nut is loosened. If loosening the fuel line nut does not

affect the operation of the engine, the fuel injection nozzle is probably suspect. Test the fuel injection nozzle for that cylinder. Replace the suspect fuel injection nozzle.

Make sure that all of the fuel injection nozzles are the correct type for the engine. Test the pressure setting of the fuel injection nozzles.

Make sure that the fuel injection nozzles are properly sealed in the threaded ports. Make sure that the fuel injection nozzles are correctly aligned in the threaded ports. Make sure that the fuel injection nozzles are tightened to the correct torque. Ensure that the gaskets and the seat washers are installed on the fuel injection nozzles correctly. Make sure that the bottom of the threaded ports are clean and free of debris. Make sure that the bottom of the threaded ports do not contain extra gaskets.

4. The inlet air is restricted.

   Check the air cleaner for restrictions. The air cleaner must be cleaned or replaced.

The engine exhaust has too much white smoke or too much blue smoke.

Probable Cause

1. The engine contains too much engine oil.

   Drain the excess oil from the engine oil pan.

2. The fuel injection timing is not correct.

   Adjust the timing of the fuel injection pump.

3. The valve guides are worn.

   Replace the valve guides. Check the flatness of the cylinder head. Recondition the cylinder head if the flatness is out of tolerance.

4. The piston rings are worn. Refer to Specifications, "Pistons and Rings" for additional information.

   Replace the piston rings.

5. The engine consistently runs below the normal operating temperature. The water temperature regulator is suspect.

   Replace the water temperature regulator.

6. The breather hose or the vent hole in the breather assembly is obstructed.

   Clean the vent hole, the breather assembly, and the breather hose.

The engine has low oil pressure.

Probable Cause

1. The engine oil level is low.

Add engine oil to the correct level.

2. The engine oil filter is restricted.

   Install a new engine oil filter. Replace the oil in the engine with clean engine oil. Check the operation of the engine oil bypass valve.

3. Fuel leaks into the lubrication oil. Fuel leaks will cause high fuel consumption and low engine oil pressure.

   - Fuel leaks past the valve in a fuel injection nozzle.
   - The pressure setting of the fuel injection nozzles is too high.
   - The drive is broken on the fuel injection pump.

   Adjust the component. Replace a damaged component.

4. Too much clearance exists between the bore of the rocker arm and the rocker shaft.

   Check for adequate lubrication of the rocker arm assembly. Replace parts which are worn. Refer to Specifications, "Rocker Shaft" for additional information.

5. The suction pipe for the engine oil pump is suspect.

   Replace the suction pipe.

6. The engine oil bypass valve does not operate correctly.

   Clean the bypass valve. Replace the bypass valve if the spring is broken or the plunger is damaged.

7. The engine oil pump does not operate correctly.

   Check the distance of the face of the cover of the oil pump above the face of the idler gear. Check the wear of the lobe on the oil pump. The components of the idler gear and the oil pump must be repaired or replaced.

8. Too much clearance exists between the crankshaft and the crankshaft bearings.

   Replace the crankshaft or the crankshaft bearings.

9. Too much clearance exists between the camshaft and the camshaft bearings.

   Replace the camshaft or the camshaft bearings.

The engine oil pressure is too high.

Probable Cause

1. The engine oil bypass valve does not open.

   The bypass valve must be cleaned or replaced.

The engine uses too much engine oil.

Probable Cause

1. The engine contains too much engine oil.

   Drain the excess engine oil from the engine oil pan.

2. Oil lines have leaks.

   Find the source of the oil leaks. Repair the line or fitting.

3. The valve guides are worn.

   Replace the valve guides.

4. The piston rings are worn. Refer to Specifications, "Pistons and Rings" for additional information.

   Replace worn parts.

The engine overheats.

Probable Cause

1. The air flow through the radiator is restricted.

   Clean the exterior of the radiator in order to remove all restrictions.

2. The coolant level in the engine is low.

   Add coolant into the radiator to the correct level.

3. The pressure cap is suspect.

   Test the operation of the pressure cap. Replace a faulty pressure cap.

4. Gases from combustion are in the coolant.

   Find the source of the entry of the gases from combustion into the coolant system. Repair the source of the problem.

5. The water temperature regulator is suspect.

   Test the water temperature regulator for correct operation. Refer to Systems Operation, Testing and Adjusting or Specifications for additional information. Replace a faulty water temperature regulator.

6. The water pump is suspect.

   The water pump must be repaired or replaced.

7. The engine is operating with too much load.

   Reduce the load.

8. The timing of fuel injection pump is incorrect.

Adjust the timing.

The exhaust temperature is too high.

Probable Cause

1. A restriction exists in the air inlet or in the exhaust system.

   Remove the restriction.

2. The timing of the fuel injection pump is incorrect.

   Adjust the timing of the fuel injection pump.

The starting motor does not turn or the starting motor turns too slowly.

Probable Cause

1. The battery is discharged.

   Charge the battery. Replace a damaged battery. Clean all cable terminals and battery posts. Apply **1U-8267** Battery Saver and Cleaner on the cable clamps and the battery posts. Tighten the cable clamps on the battery posts.

2. The terminals or the brushes of the starting motor have a short circuit to ground.

   Find the short circuit. Repair the short circuit.

3. The ignition switch, the starting motor solenoid, or the start relay is damaged.

   Replace the ignition switch, the starting motor solenoid, or the start relay.

4. An excessive voltage drop exists in the cables or across the terminals in the circuits for the starting motor. The battery cables are loose at the terminals, corroded, or cracked. The battery terminals are corroded or broken.

   Inspect the battery cables and the battery terminals for loose connections, corrosion or other damage.

The starting motor turns, but the pinion gear does not engage the flywheel ring gear.

Probable Cause

1. The pinion drive or the overrunning clutch is suspect.

   Replace the pinion drive or the overrunning clutch.

2. The ring gear of the flywheel is damaged.

   Replace the flywheel.

3. The shift lever or the linkage is damaged.

Replace the shift lever or the linkage.

4. The starting motor solenoid is damaged.

   Replace the starting motor solenoid.

5. The armature or idler gear of the starting motor is damaged.

   Replace the starting motor.

The engine does not crank or the engine rotates slowly when the keyswitch is in the start position.

Probable Cause

1. The battery has a low charge.

   Charge the battery. Replace a faulty battery. Clean all cable terminals and battery posts. Apply the **1U-8267** Battery Saver and Cleaner on the cable clamps and to battery posts. Tighten the cable clamps on the battery posts.

2. The start relay is suspect.

   Replace the start relay.

3. An excessive voltage drop exists in the cables or across the terminals in the circuits for the starting motor. The battery cables are loose at the battery terminals, corroded, or cracked. The battery terminals are corroded or broken.

   Inspect the battery cables and battery terminals for loose connections, corrosion or other damage. Replace damaged parts.

   Refer to "The Starting Motor does not turn or the Starting motor turns too slowly.".

4. The overrunning clutch for the pinion drive slips.

   Replace the electric starting motor.

The starting motor continues to run after the ignition switch is released.

Probable Cause

1. The ignition switch, the start relay, or the starting motor solenoid is suspect.

   Replace the ignition switch, the start relay, or the starting motor solenoid.

The pinion gear does not disengage after the engine starts to run.

Probable Cause

1. The return spring of the pinion solenoid is damaged.

   Replace the return spring of the pinion solenoid.

2. The shift lever or the linkage is damaged.

   Replace the shift lever or the linkage.

3. The ignition switch or the start relay is suspect.

   Replace the ignition switch or the start relay.

The alternator does not charge the battery or the alternator charge rate is slow or irregular.

Probable Cause

1. The drive belt for the alternator is loose.

   Inspect the drive belt for wear and for damage. The drive belt must be adjusted or replaced.

2. The drive pulley for the alternator is loose or worn.

   Inspect the pulley for wear or for damage. Tighten the nuts of the pulley to the correct torque. Replace a damaged pulley.

3. The electrical cables and connections in the charging and starting circuits are loose or damaged.

4. Inspect all cables and connections. All connections must be clean and tight. Apply the **1U-8267** Battery Saver and Cleaner on the cable terminals and the connections. Replace suspect parts.

5. The regulator or the field winding of the rotor in the alternator are suspect.

   The alternator must be repaired or replaced.

6. The brushes of the alternator are worn or dirty.

   The brushes must be cleaned or replaced.

7. The rectifier in the alternator is suspect.

   Replace the rectifier or the alternator.

The alternator charges the battery to a voltage that is too high.

Probable Cause

1. The regulator is suspect.

   Replace the alternator.

The alternator is noisy.

Probable Cause

1. The drive belt for the alternator is worn or damaged.

   Replace the drive belt for the alternator.

2. The drive pulley for the alternator is loose or worn.

   Inspect the pulley for wear and for damage. Tighten the nuts of the pulley to the correct torque. Replace a damaged pulley.

3. The drive belt and the drive pulley are not in alignment.

   Adjust the alignment.

4. The bearings of the alternator are worn or damaged.

   Replace the alternator.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02706797

Engine Design

SMCS - 1201

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

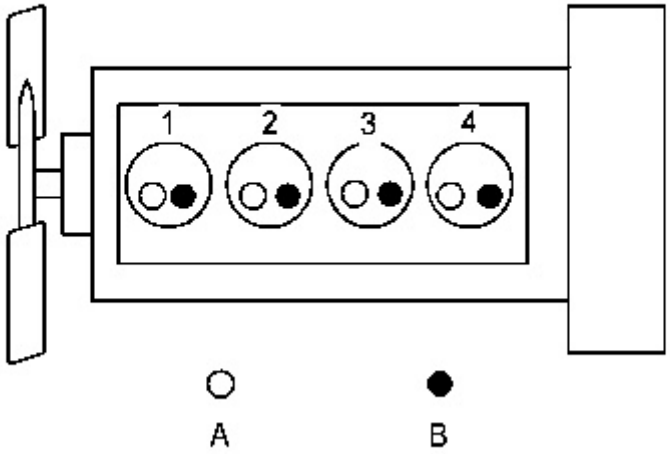


Illustration 1 g01357763

Cylinder and valve location

(A) Inlet valve

(B) Exhaust valve

Bore ... 94 mm (3.70 inch)

Stroke ... 120 mm (4.72 inch)

Displacement ... 3.3 L (203 in^3)

Cylinder arrangement ... In-line

Type of combustion

Naturally aspirated engines ... Indirect injection
Turbocharged engines ... Direct injection

Compression ratio

Naturally aspirated engines ... 22:1
Turbocharged engines ... 19:1

Number of cylinders ... 4

Valves per cylinder ... 2

Valve lash

Inlet valve ... 0.25 mm (0.0098 inch)
Exhaust valve ... 0.25 mm (0.0098 inch)

Firing order ... 1, 3, 4, 2

Fuel injection timing ... 5° BTC

When the crankshaft is viewed from the flywheel end of the engine, the crankshaft rotates in the following direction: ... Counterclockwise

When the camshaft is viewed from the flywheel end of the engine, the camshaft rotates in the following direction: ... Counterclockwise

Note: The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697312

Engine Design

SMCS - 1201

S/N - -

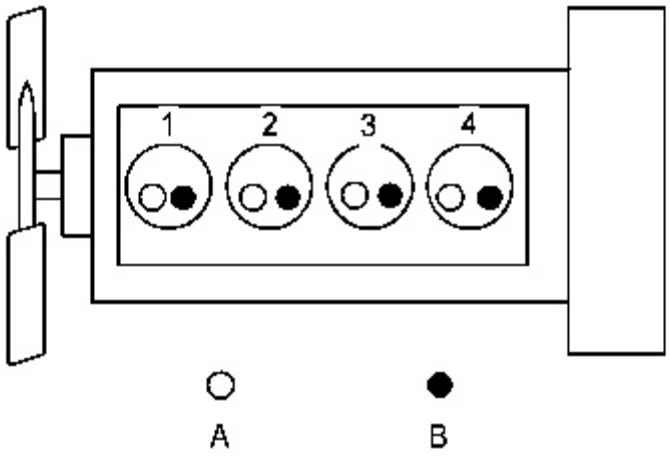


Illustration 1 g01353215

Cylinder and valve location

(A) Inlet valve

(B) Exhaust valve

Bore ... 94 mm (3.70 inch)

Stroke ... 120 mm (4.72 inch)

Displacement ... 3.3 L (203 in^3)

Cylinder arrangement ... In-line

Type of combustion

Naturally aspirated engines ... Indirect injection
Turbocharged engines ... Direct injection

Compression ratio

Naturally aspirated engines ... 22:1
Turbocharged engines (55 kW) ... 20.5:1
Turbocharged engines (62 kW) ... 19.5:1
Turbocharged engines (69 kW) ... 19:1

Number of cylinders ... 4

Valves per cylinder ... 2

Valve lash

Inlet valve ... 0.25 mm (0.0098 inch)
Exhaust valve ... 0.25 mm (0.0098 inch)

Firing order ... 1, 3, 4, 2

Fuel injection timing (55 kW) ... 3° BTDC

Fuel injection timing (62 kW) ... 6° BTDC

Fuel injection timing (69 kW) ... 5° BTDC

When the crankshaft is viewed from the flywheel end of the engine, the crankshaft rotates in the following direction: ... Counterclockwise

When the camshaft is viewed from the flywheel end of the engine, the camshaft rotates in the following direction: ... Counterclockwise

Note: The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i04351953

Engine - Remove

SMCS - 1000-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-4184	Bolt	2
	8T-4225	Washer	2
	8T-4244	Nut	4
	138-7575	Link Bracket	2
B	1U-9200	Lever Puller Hoist	1
C	368-0005	C-Frame Assembly	1
D	138-7575	Link Bracket	4
E	138-7573	Link Bracket	1

Start By:

A. Remove the muffler. Refer to Disassembly and Assembly, "Muffler - Remove and Install".

B. Remove the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".
C. Remove the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

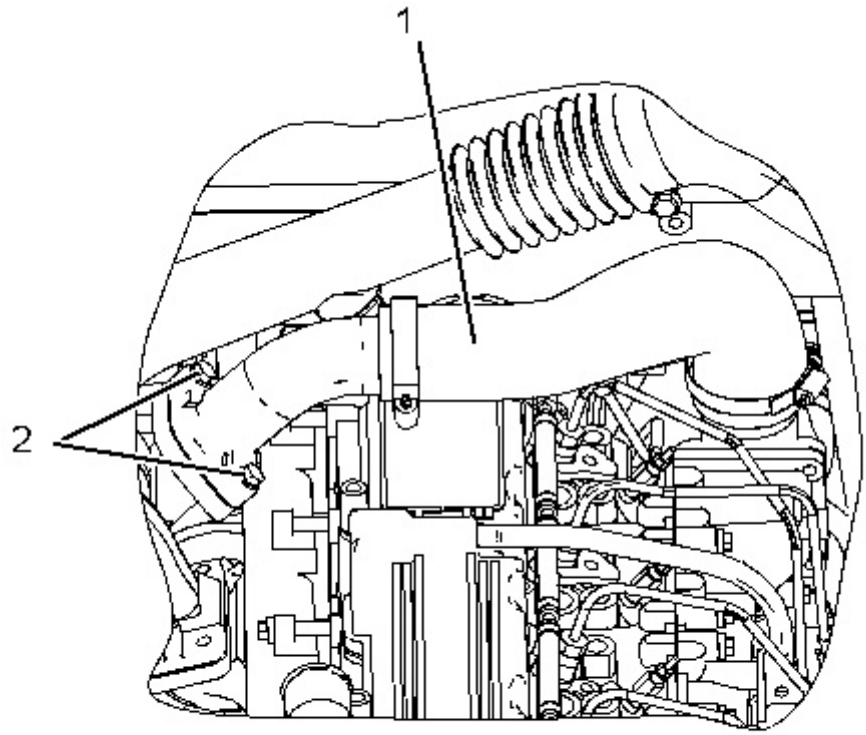


Illustration 1 g01040420

1. Remove bolts (2) . Remove the tube and hose (1) .

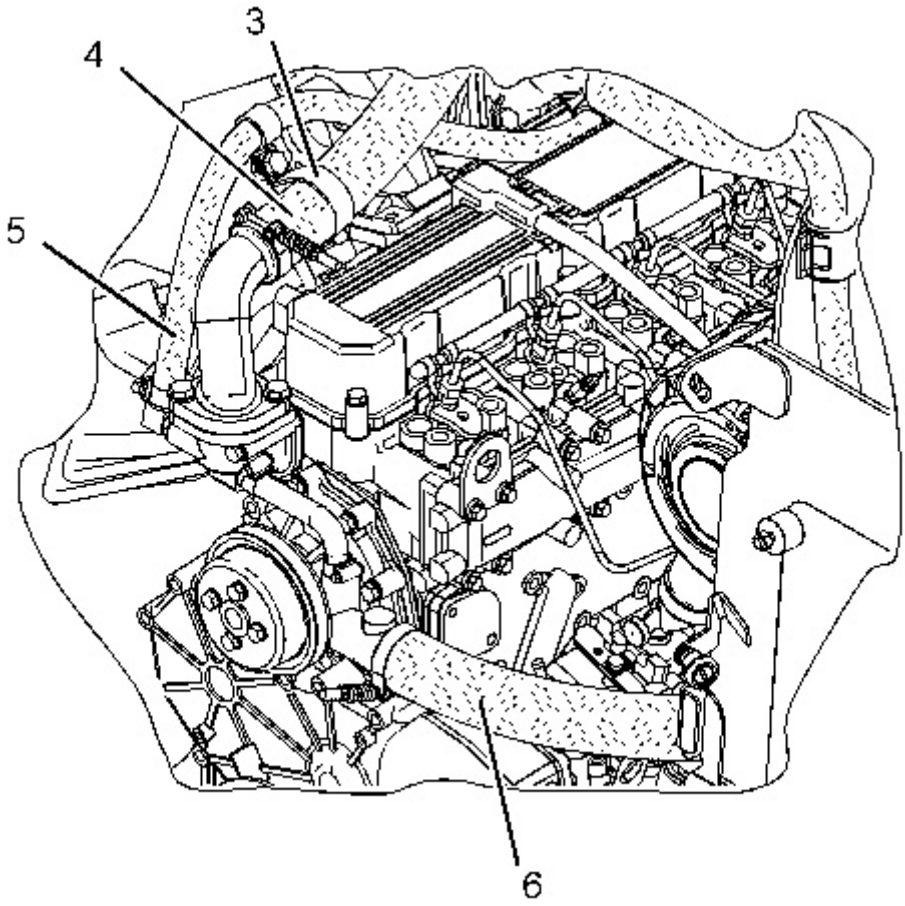


Illustration 2 g01040425

2. Remove clamp (3) . Disconnect hoses (4) , (5) , and (6) from the engine. Position hoses (4) , (5) , and (6) out of the way.

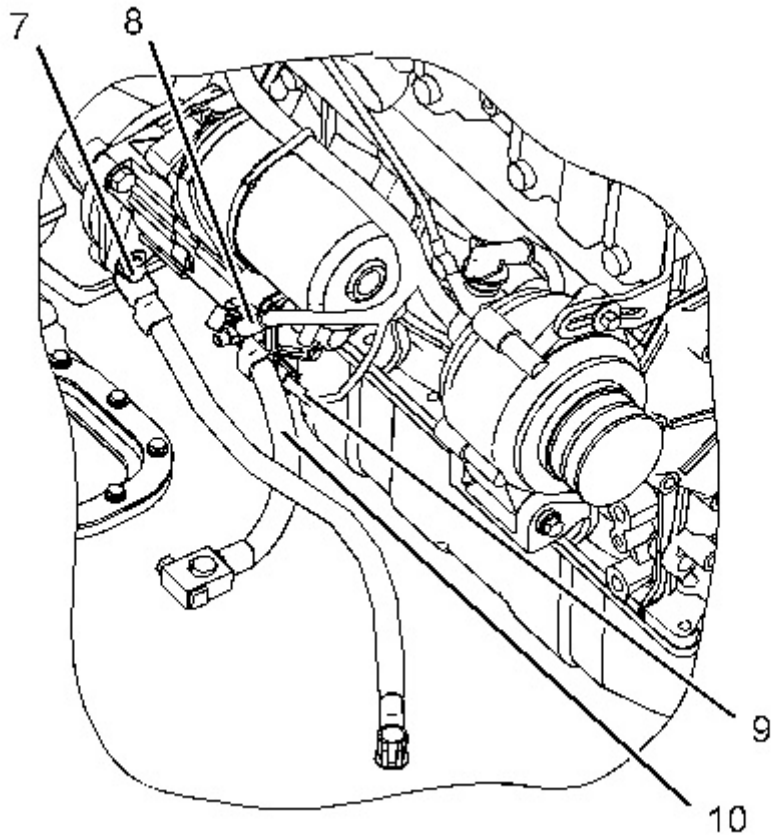


Illustration 3 g01040501

3. Disconnect cable assemblies (7) and (8) . Disconnect harness assembly (9) and cable assembly (10) .

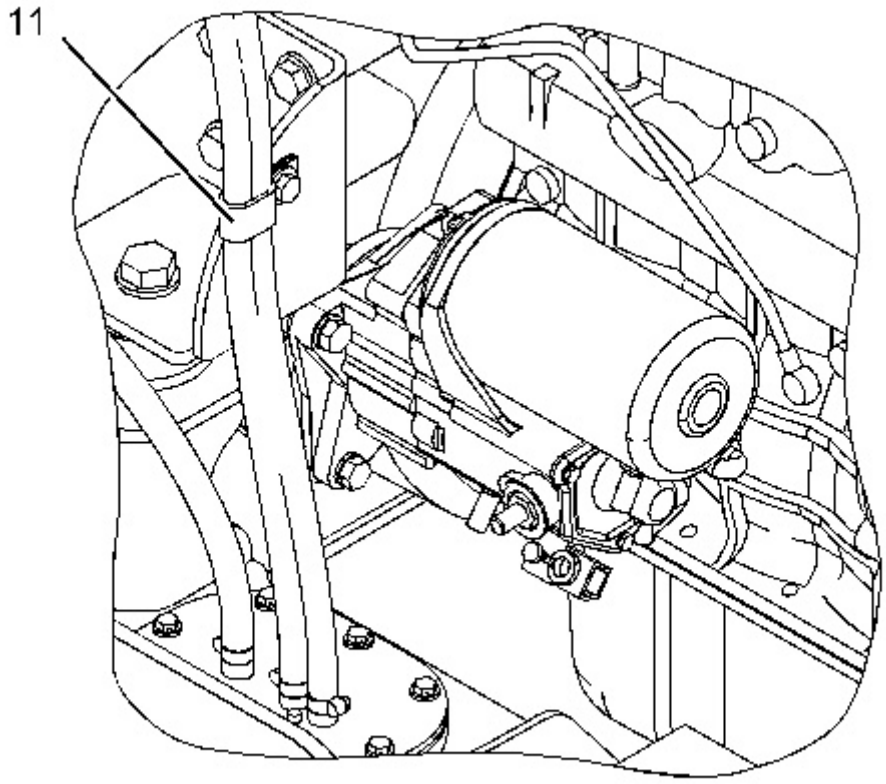


Illustration 4 g01040508

4. Remove clip (11) .

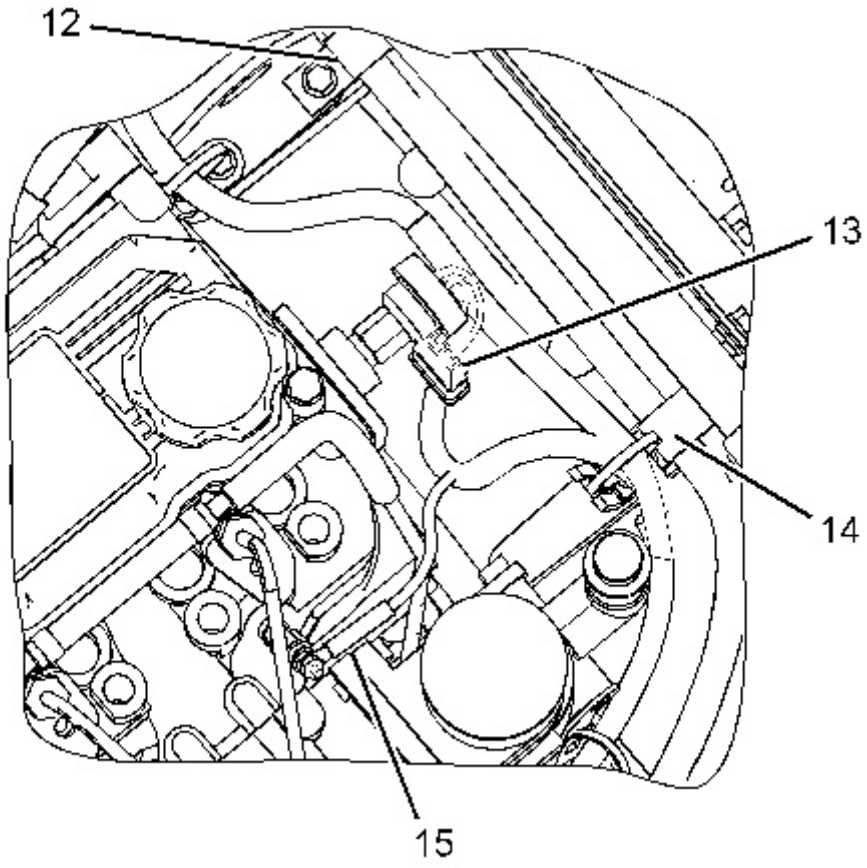


Illustration 5 g01040517

5. Disconnect harness assembly (13) . Remove clamps (12) and (14) . Disconnect cable assembly (15) .

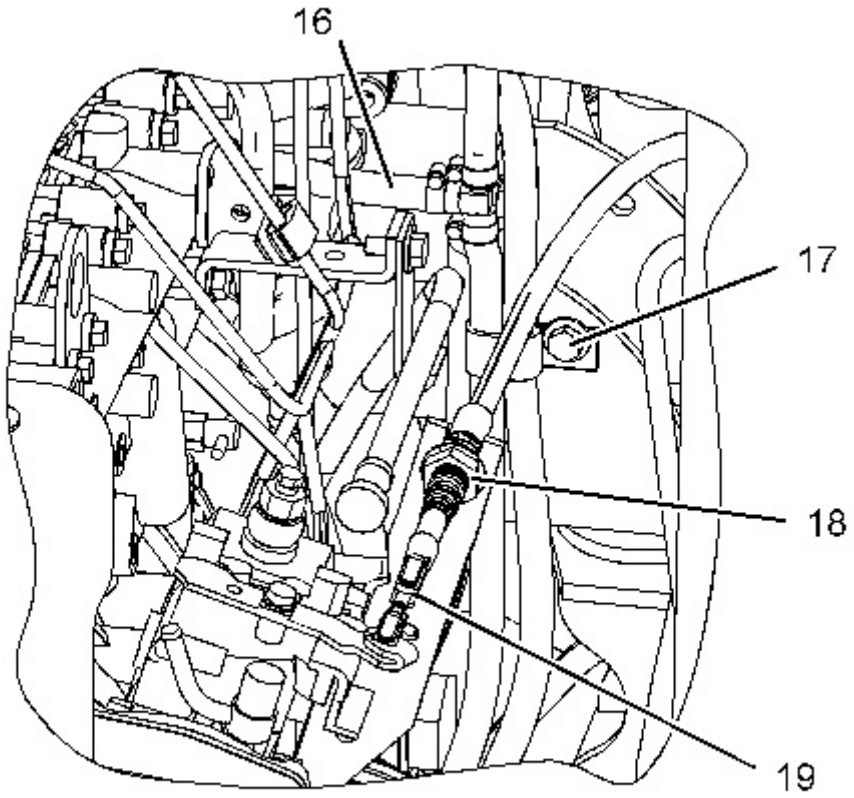


Illustration 6 g01040524

6. Disconnect hose (16) . Remove clip (17) . Loosen nut (18) and disconnect cable assembly (19) .

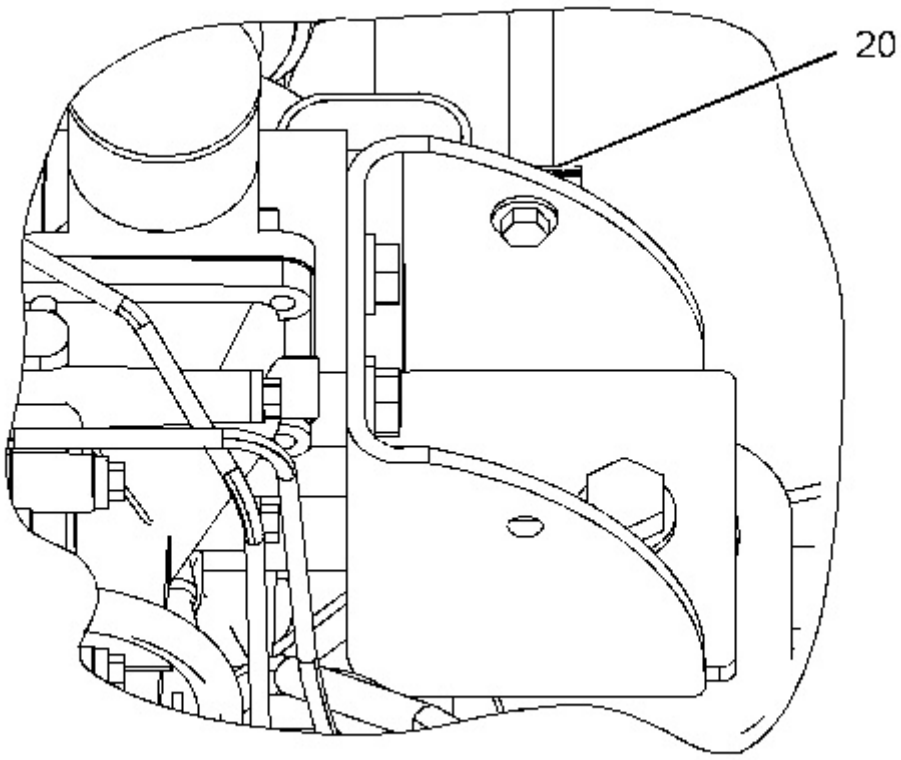


Illustration 7 g01040526

7. Remove clip (20) .

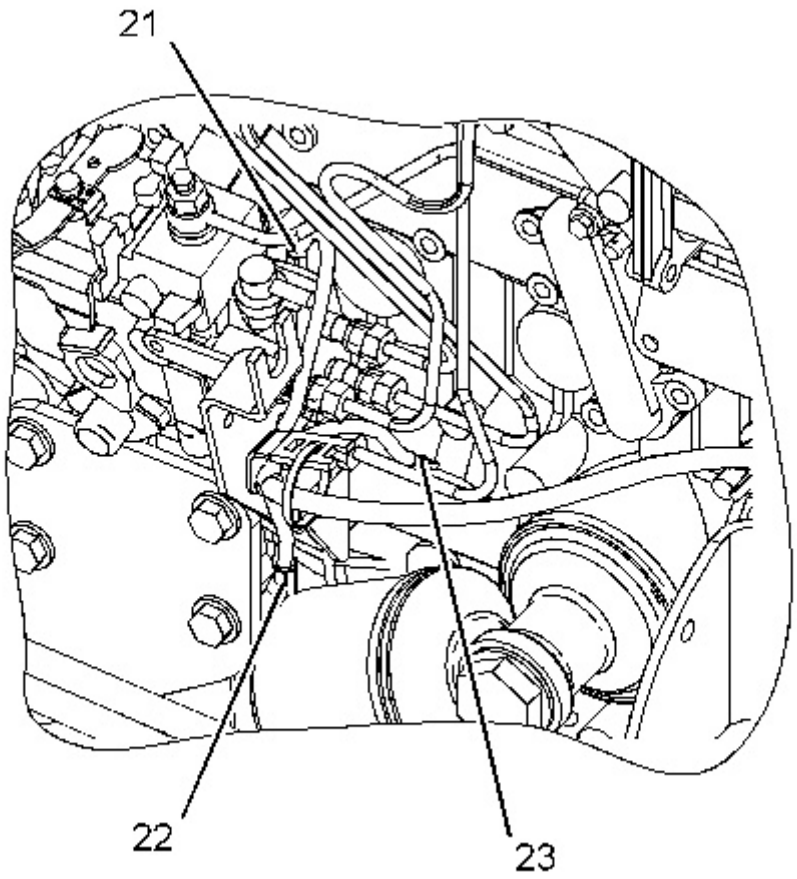


Illustration 8 g01040536

8. Disconnect harness assemblies (21) , (22) , and (23) .

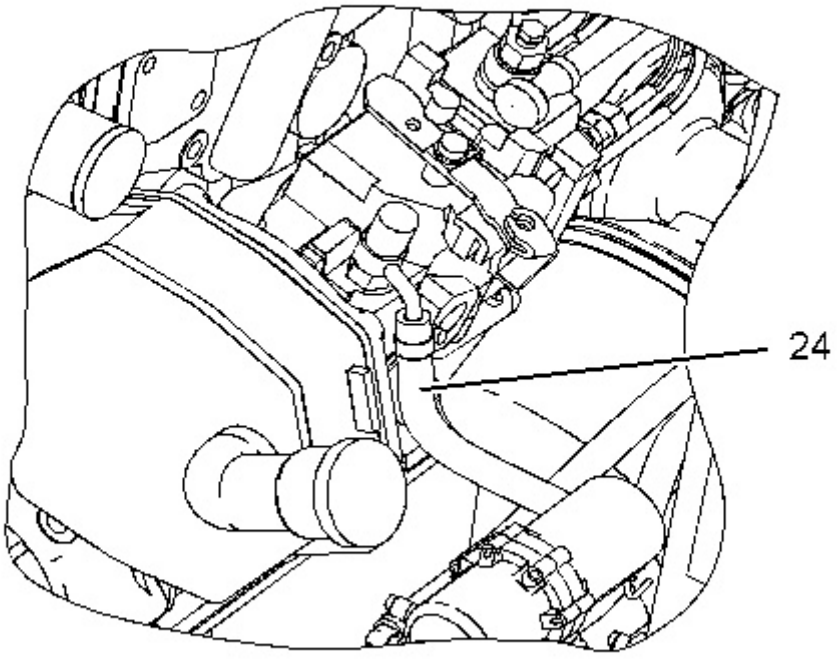


Illustration 9 g01040545

9. Disconnect hose assembly (24) .

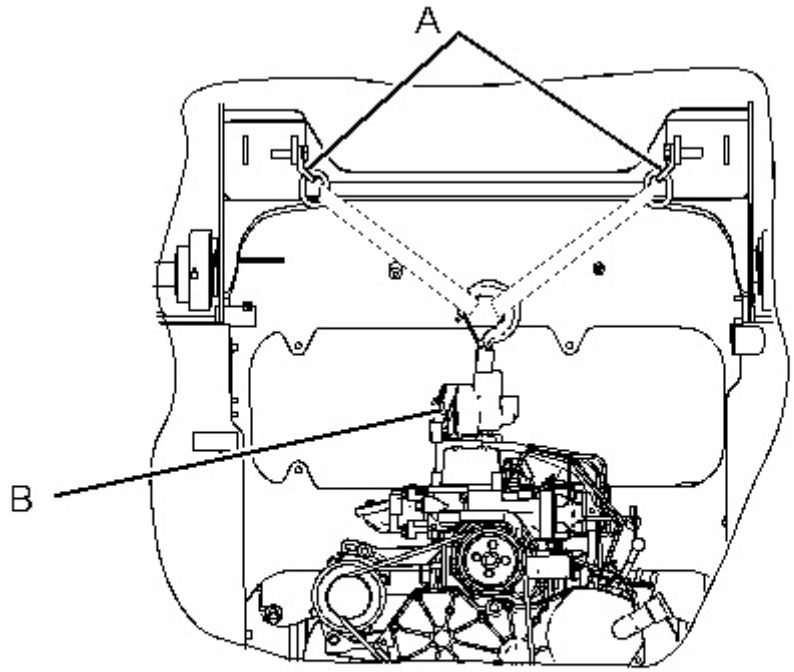


Illustration 10 g01040547

10. Attach Tooling (A) to the frame, as shown. Attach a suitable lifting device to Tooling (A) and Tooling (B) , as shown.

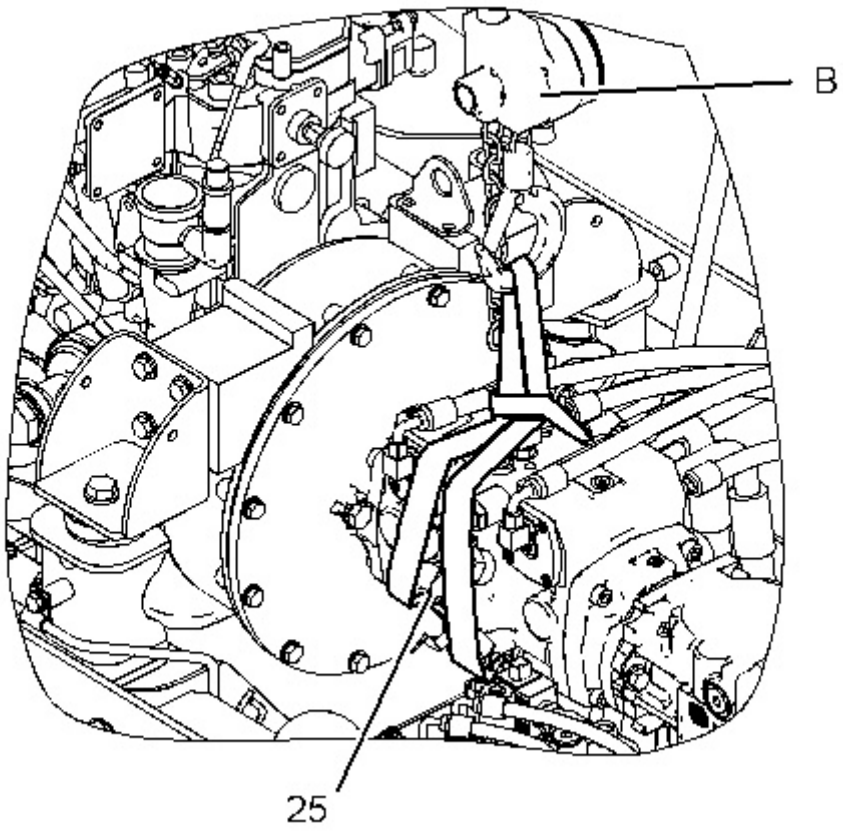


Illustration 11 g01040555

11. Attach a suitable lifting device to pump (25) and Tooling (B) to support the pump when the engine is removed.

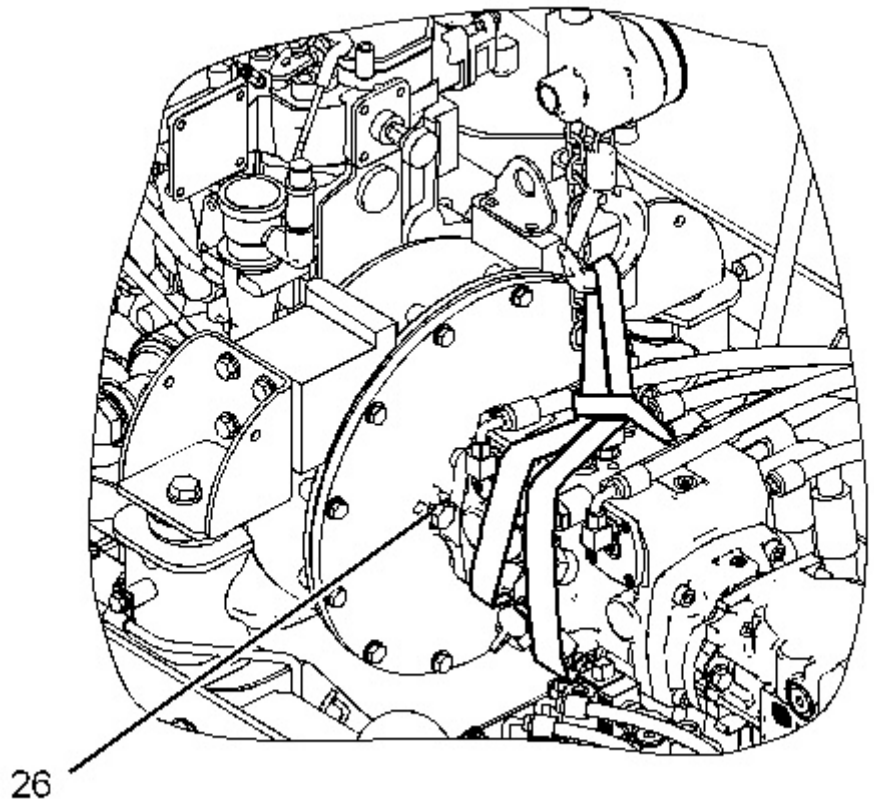


Illustration 12 g01040557

12. Remove two bolts (26) by using Tooling (C) .

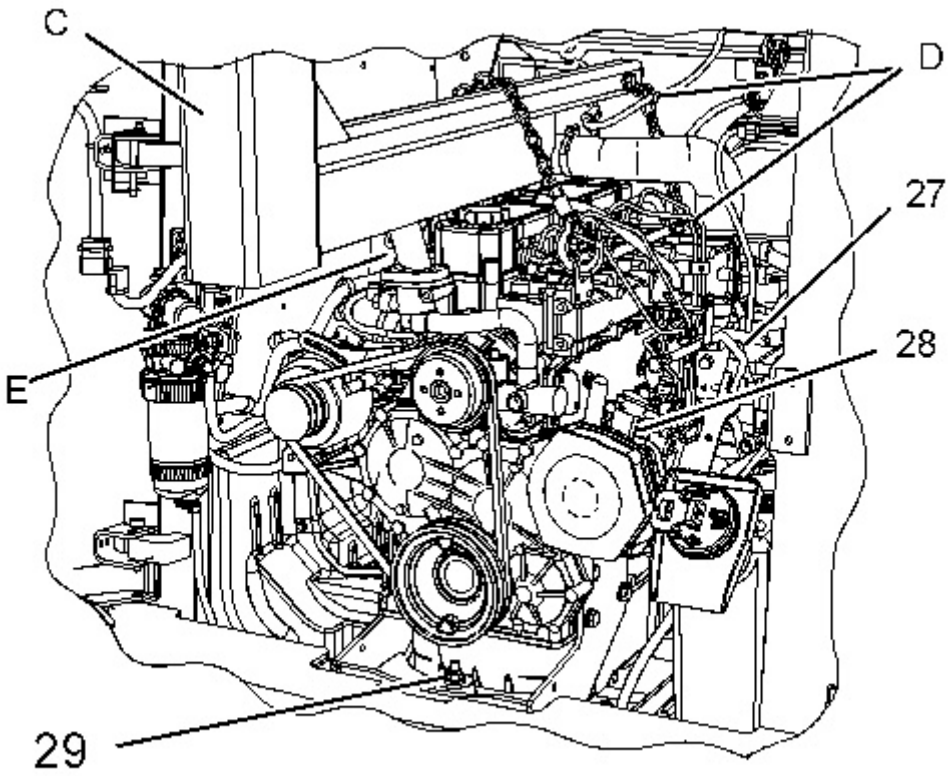


Illustration 13 g02024973

13. Attach Tooling (C) , Tooling (D) , Tooling (E) , and a suitable lifting device to engine (28) . The weight of engine (28) is approximately 320 kg (700 lb). Remove bolt (29) . Remove four bolts (27) from each side of the engine.

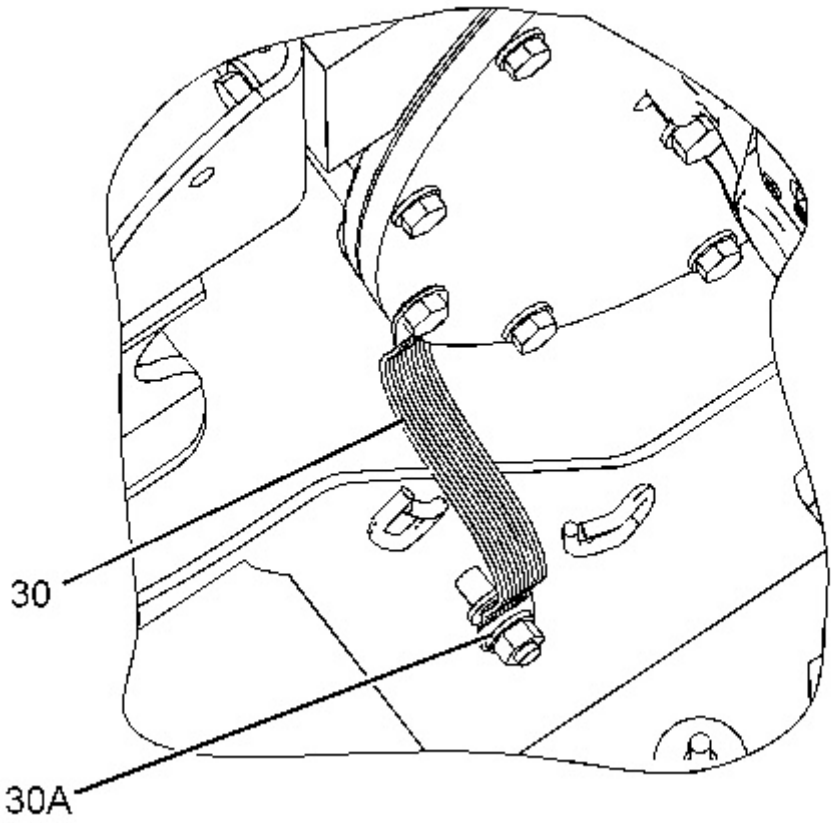


Illustration 14 g01040657

14. Raise the engine far enough so that ground strap (30) can be accessed. Remove the nut and washer (30A) and disconnect the ground strap. Remove the engine.

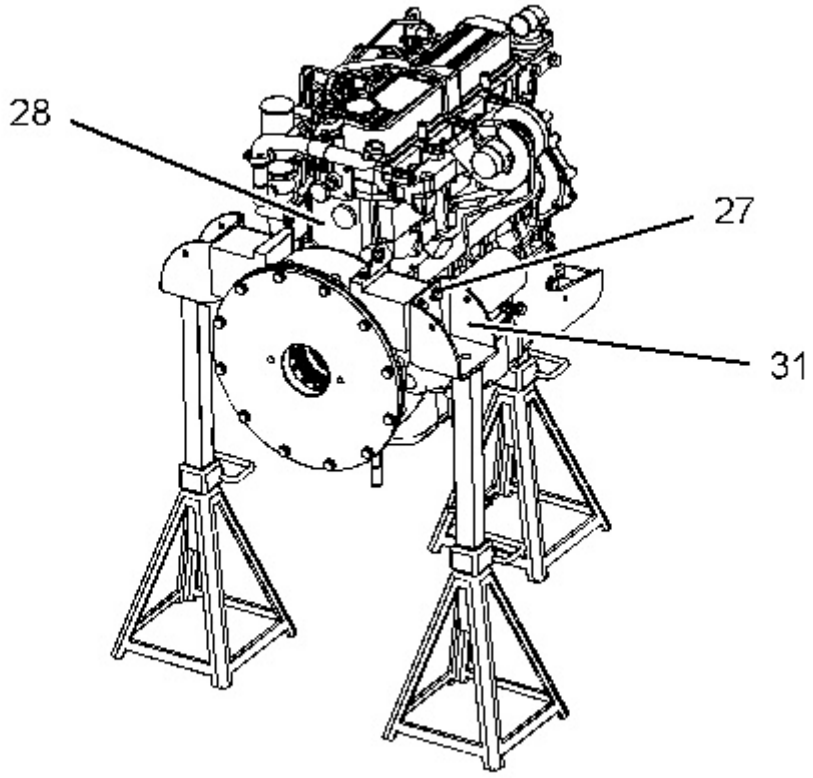


Illustration 15 g01040665

15. Remove both brackets (31) from the machine. Reposition brackets (31) onto engine (28) and install bolts (27) . The engine can now be placed on a suitable support, as shown.

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i04351952

Engine - Install

SMCS - 1000-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-4184	Bolt	2
	8T-4225	Washer	2
	8T-4244	Nut	4
	138-7575	Link Bracket	2
B	1U-9200	Lever Puller Hoist	1
C	368-0005	C-Frame Assembly	1
D	138-7575	Link Bracket	4
E	138-7573	Link Bracket	1

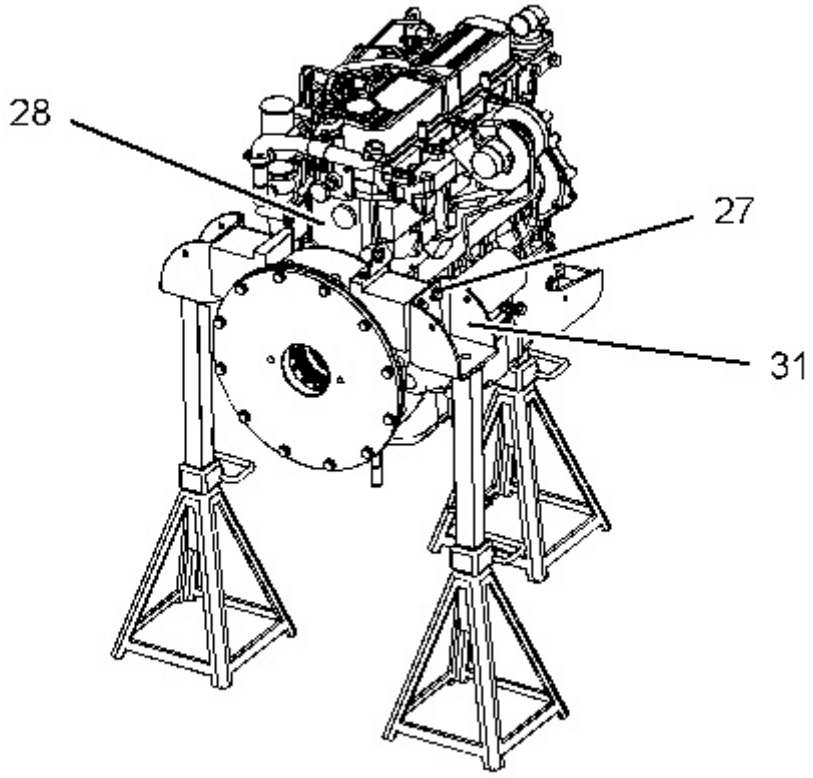


Illustration 1 g01040665

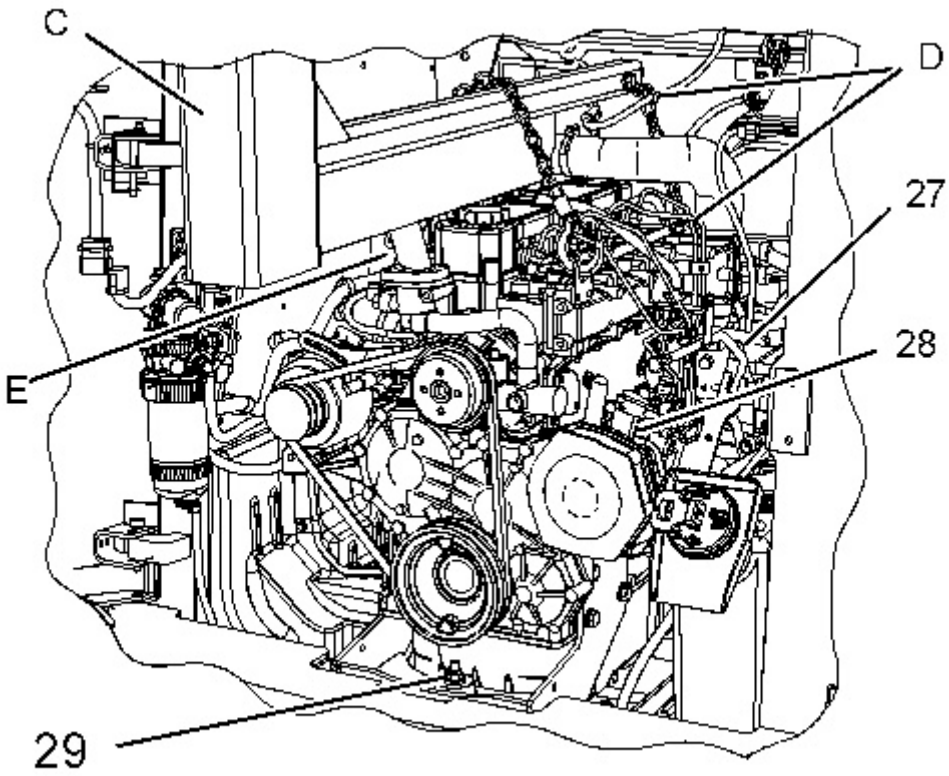


Illustration 2 g02024973

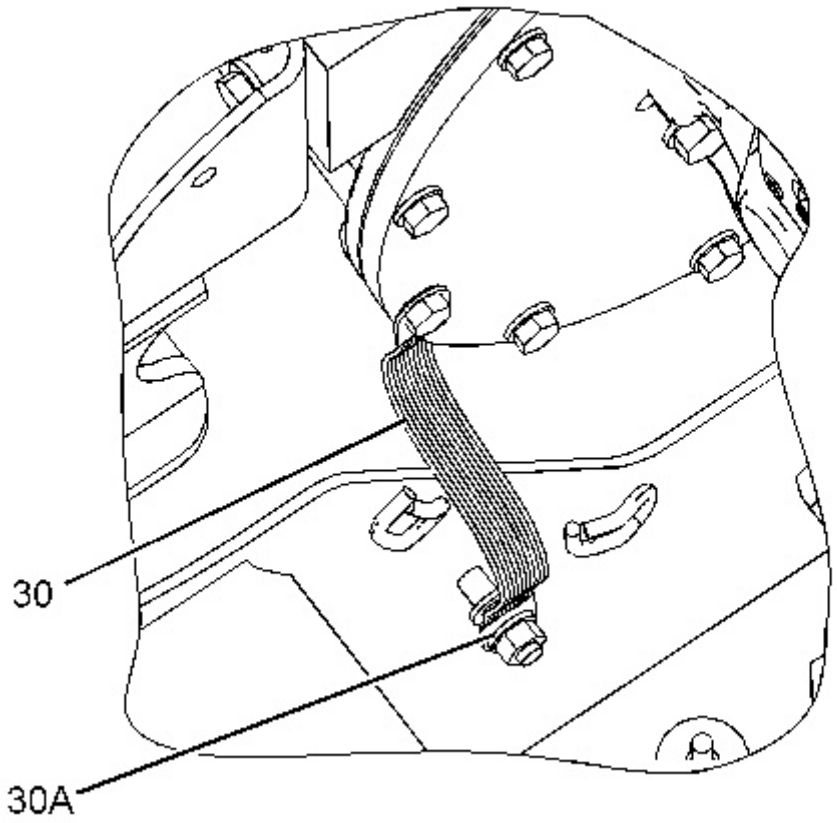


Illustration 3 g01040657

1. Attach Tooling (C) , Tooling (D) , Tooling (E) , and a suitable lifting device to engine (28) . The approximate weight of engine (28) is 320 kg (700 lb). Remove both brackets (31) that are used for mounting the engine.

2. Install the engine. Install the engine far enough so that ground strap (30) can be connected. Connect ground strap (30) and install the nut and washer (30A) . Reposition brackets (31) onto the machine and install bolts (27) . Install bolt (29) . Tighten bolt (29) to a torque of 90 ± 10 N·m (66 ± 7 lb ft).

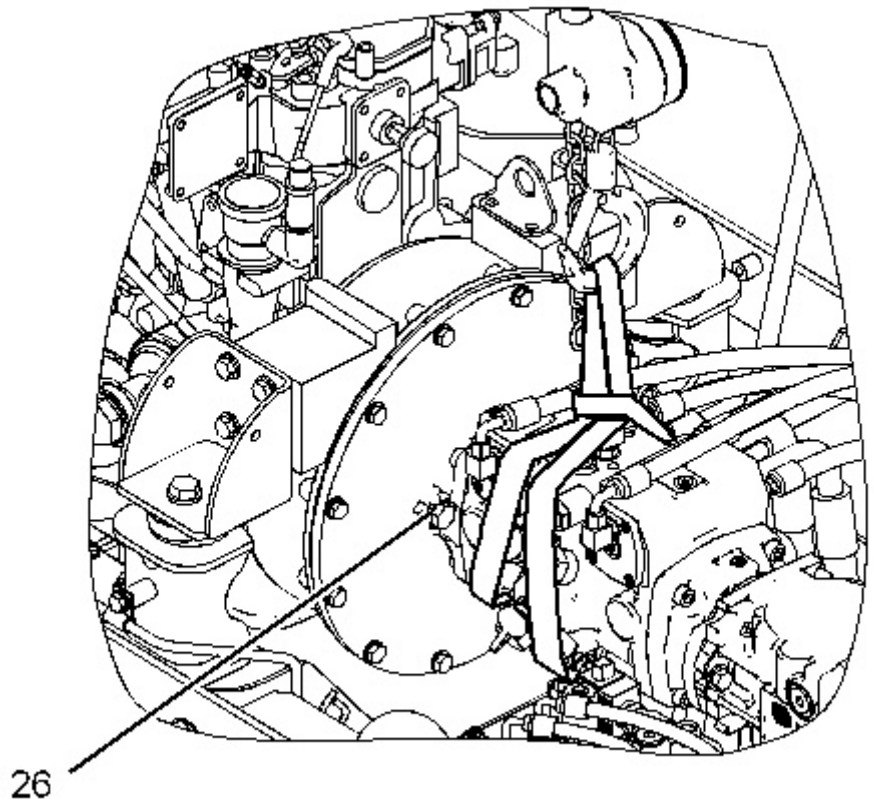


Illustration 4 g01040557

3. Install two bolts (26) by using Tooling (C) .

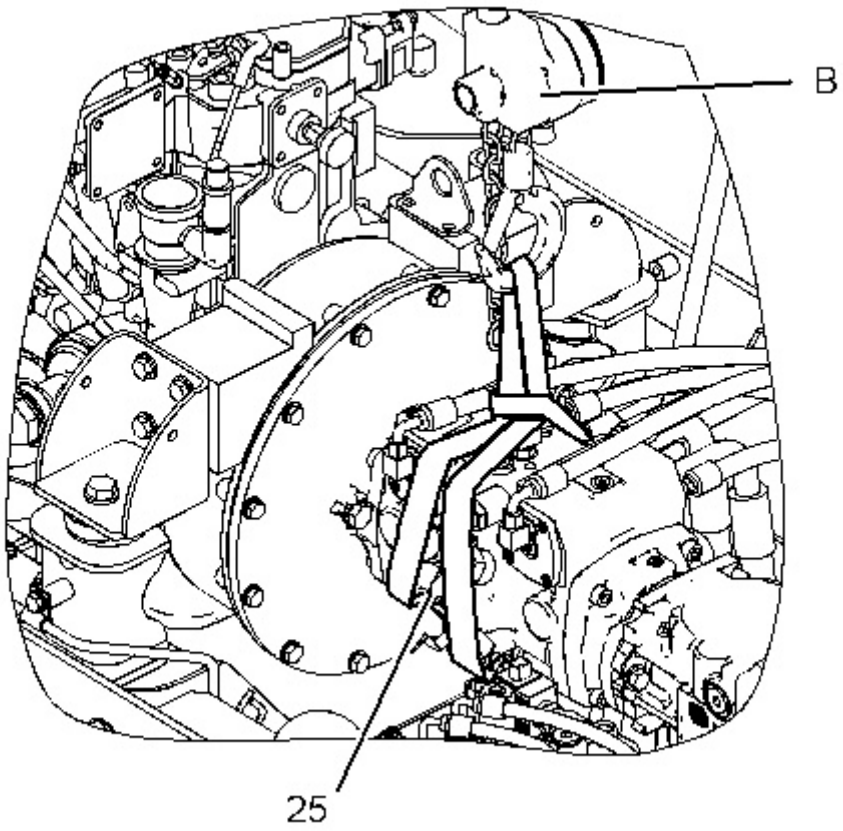


Illustration 5 g01040555

4. Remove the suitable lifting device from pump (25) . Remove Tooling (A) and Tooling (B) .

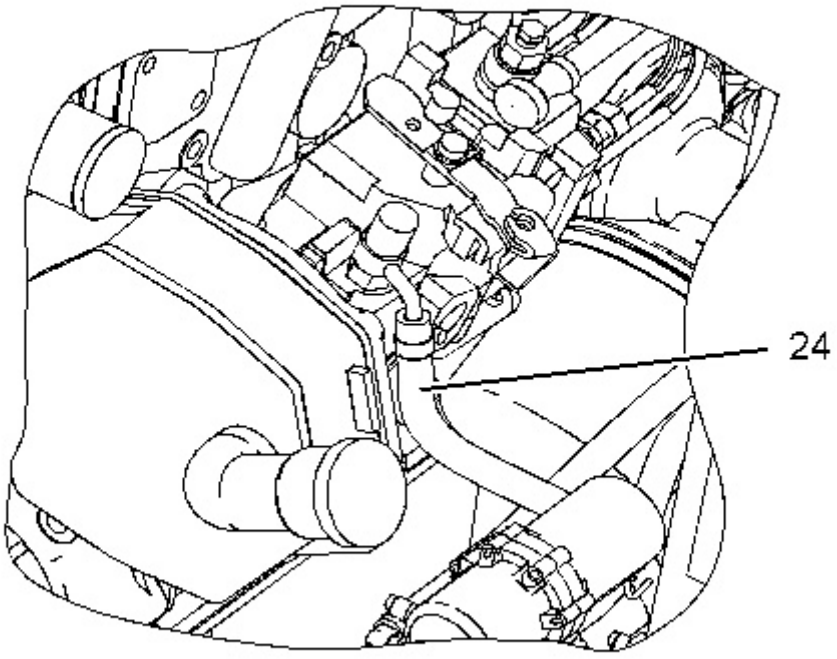


Illustration 6 g01040545

5. Connect hose assembly (24) .

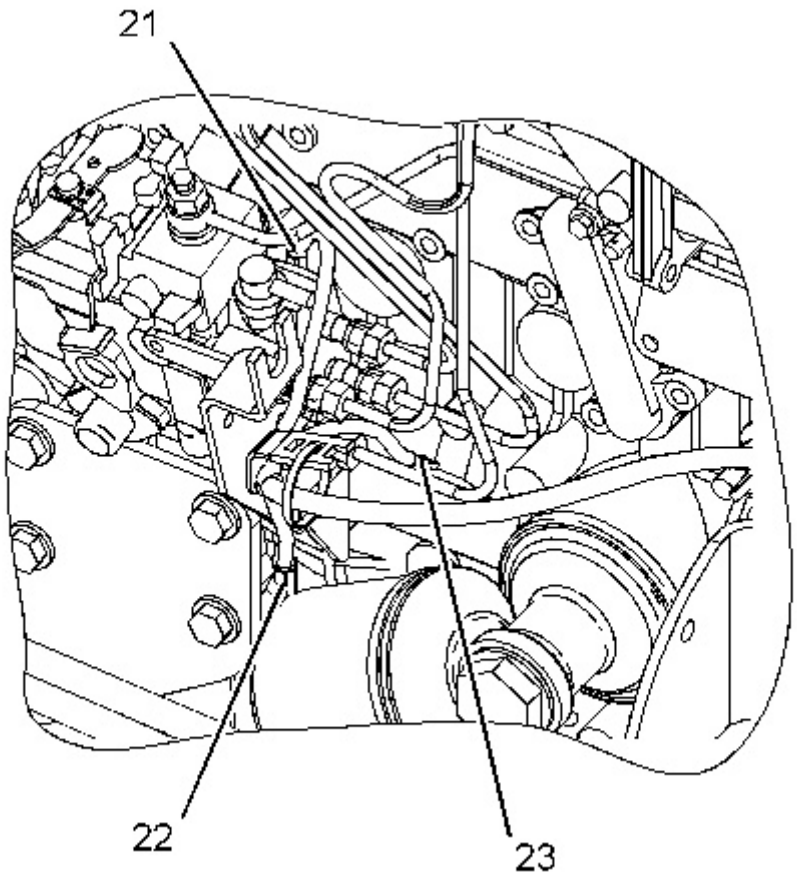


Illustration 7 g01040536

6. Connect harness assemblies (21) , (22) , and (23) .

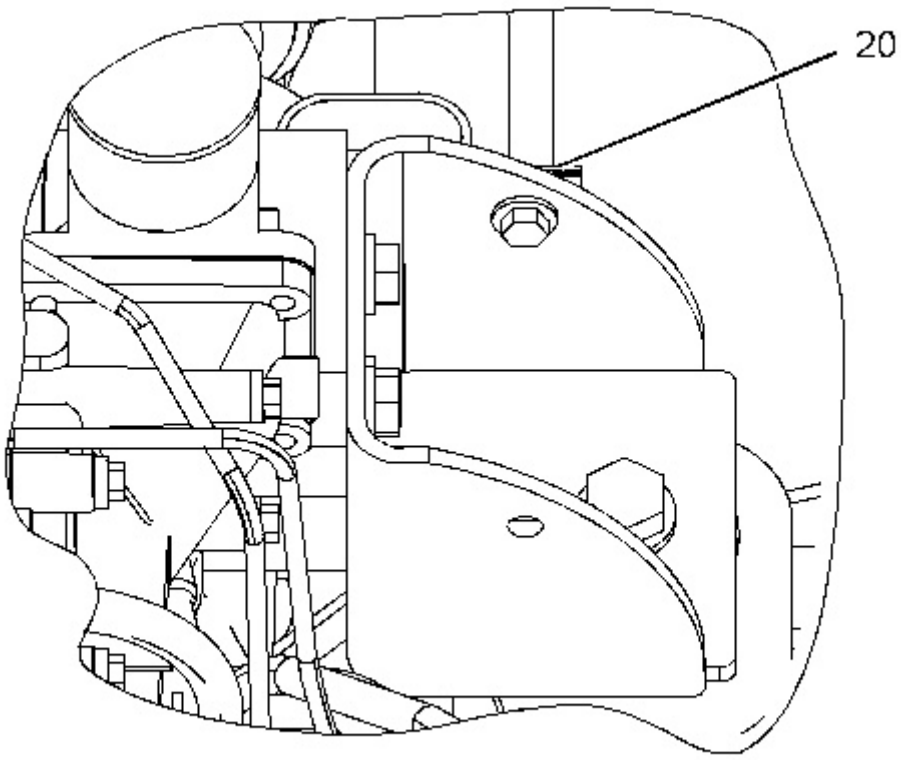


Illustration 8 g01040526

7. Install clip (20) .

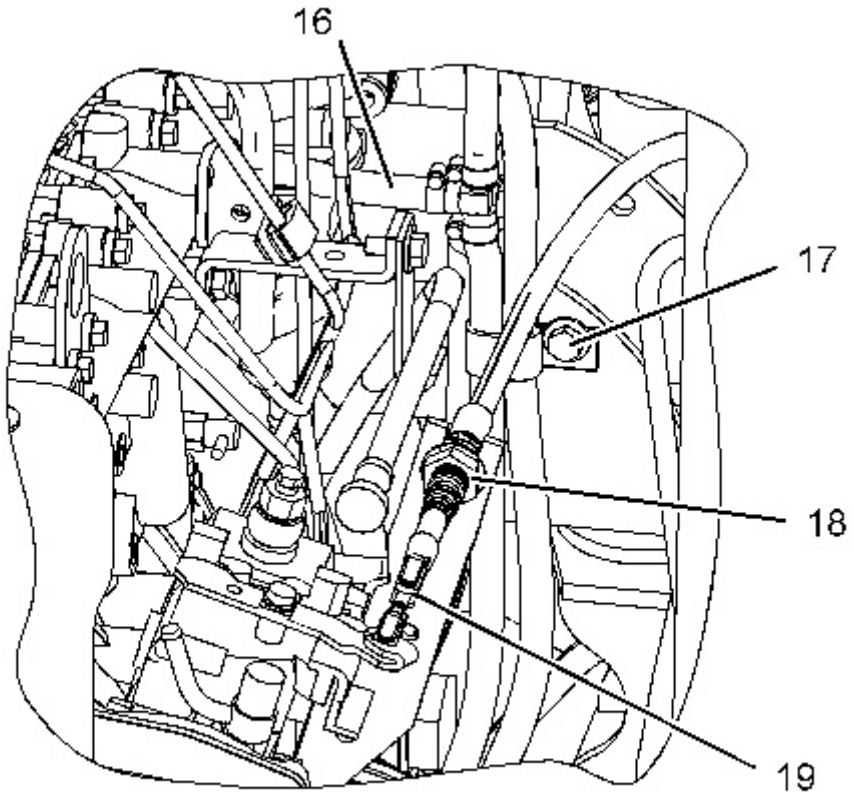


Illustration 9 g01040524

8. Connect hose (16) . Install clip (17) . Connect cable assembly (19) and tighten nut (18) .

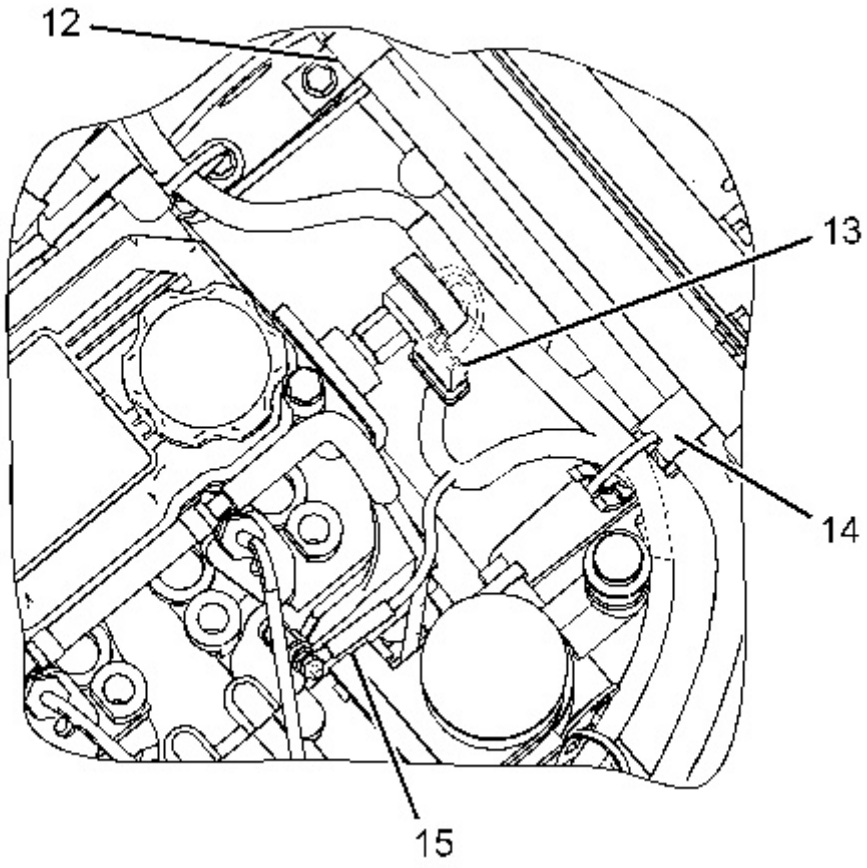


Illustration 10 g01040517

9. Connect harness assembly (13) . Install clamps (12) and (14) . Connect cable assembly (15) .

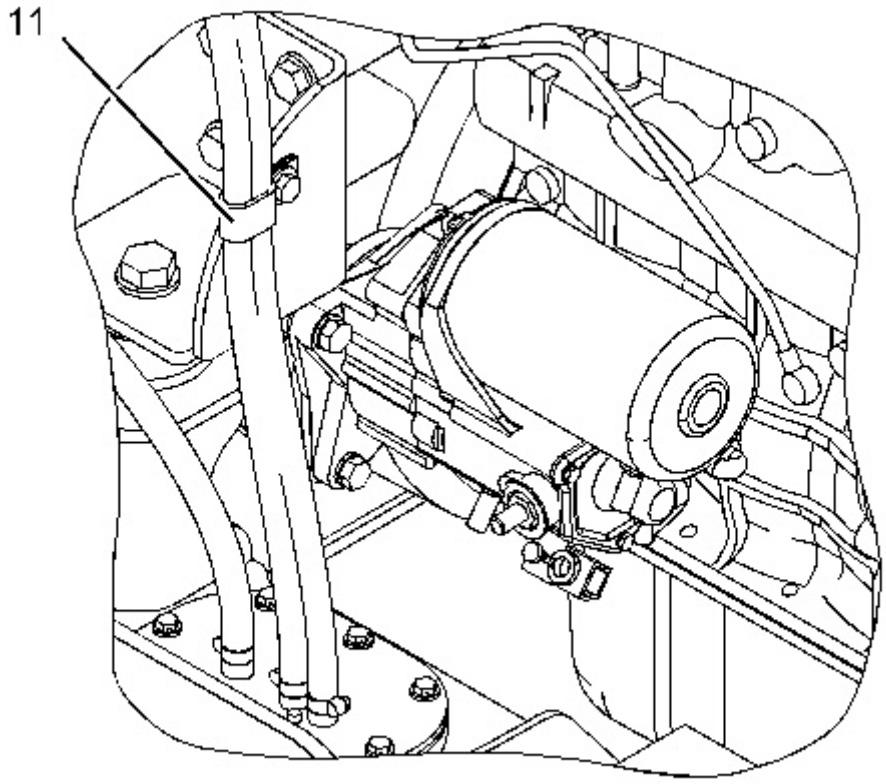


Illustration 11 g01040508

10. Install clip (11) .

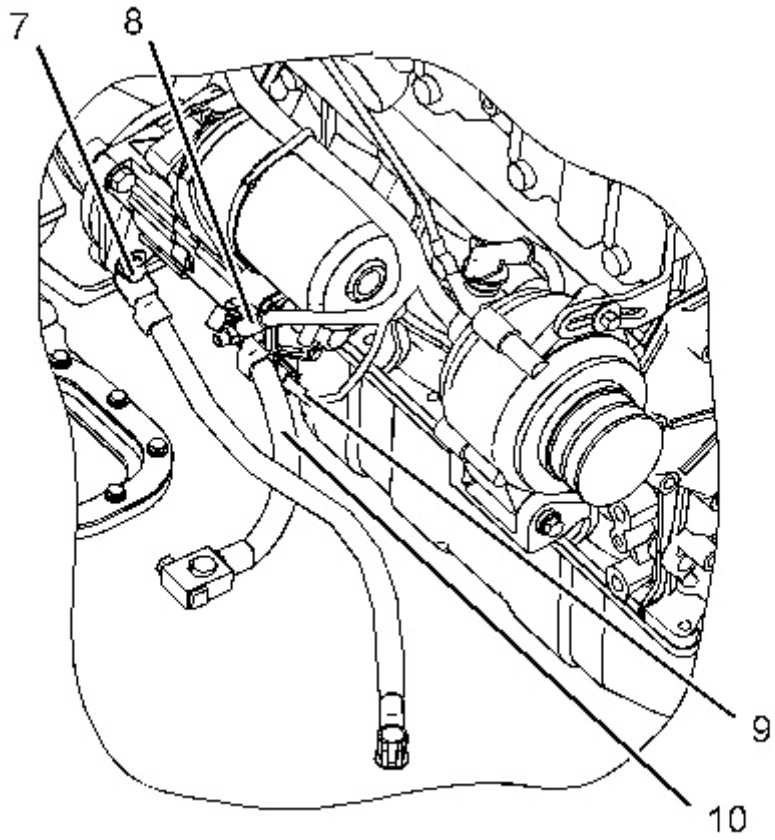


Illustration 12 g01040501

11. Connect cable assemblies (7) and (8) . Connect harness assembly (9) and cable assembly (10) .

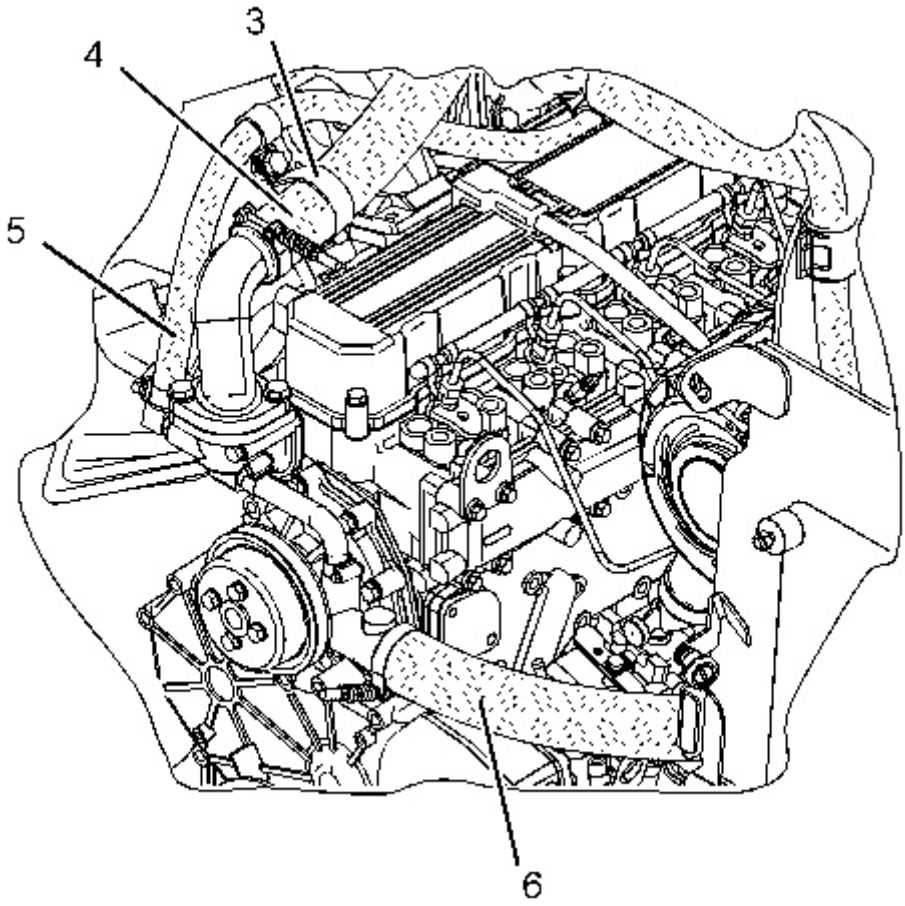


Illustration 13 g01040425

12. Install clamp (3) . Connect hoses (4) , (5) and (6) to the engine.

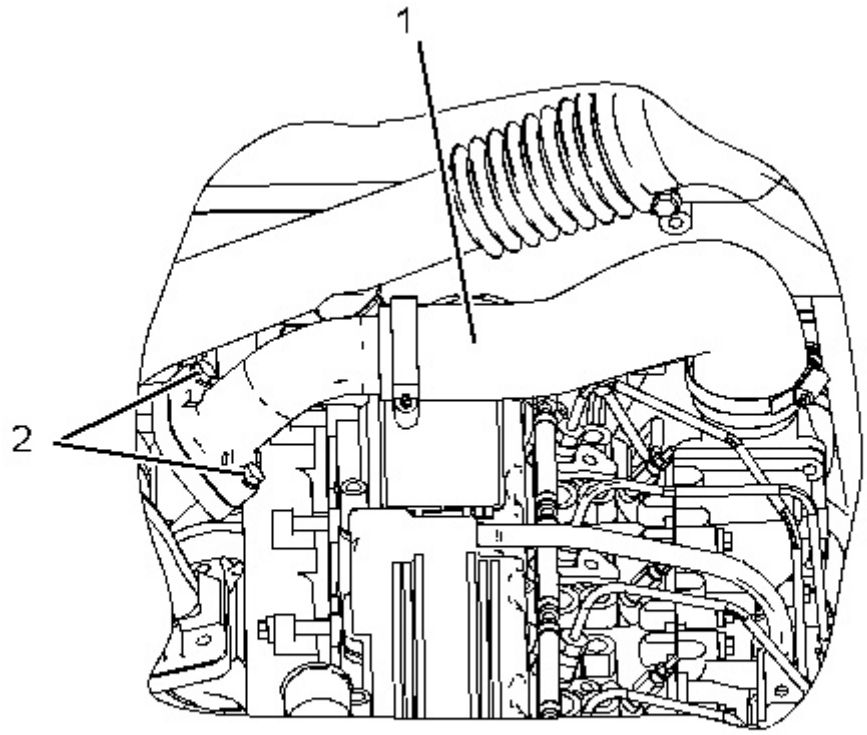


Illustration 14 g01040420

13. Install the tube and hose (1) . Install bolts (2) .

End By:

a. Install the muffler. Refer to Disassembly and Assembly, "Muffler - Remove and Install".
b. Install the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".
c. Install the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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i04351953

Engine - Remove

SMCS - 1000-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-4184	Bolt	2
	8T-4225	Washer	2
	8T-4244	Nut	4
	138-7575	Link Bracket	2
B	1U-9200	Lever Puller Hoist	1
C	368-0005	C-Frame Assembly	1
D	138-7575	Link Bracket	4
E	138-7573	Link Bracket	1

Start By:

A. Remove the muffler. Refer to Disassembly and Assembly, "Muffler - Remove and Install".
B. Remove the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".
C. Remove the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

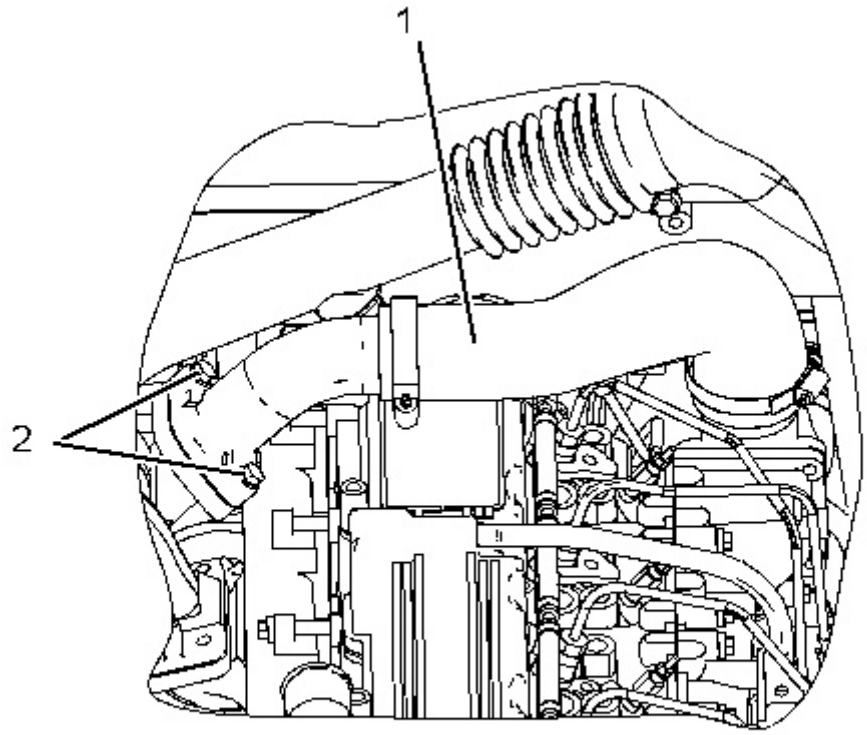


Illustration 1 g01040420

1. Remove bolts (2) . Remove the tube and hose (1) .

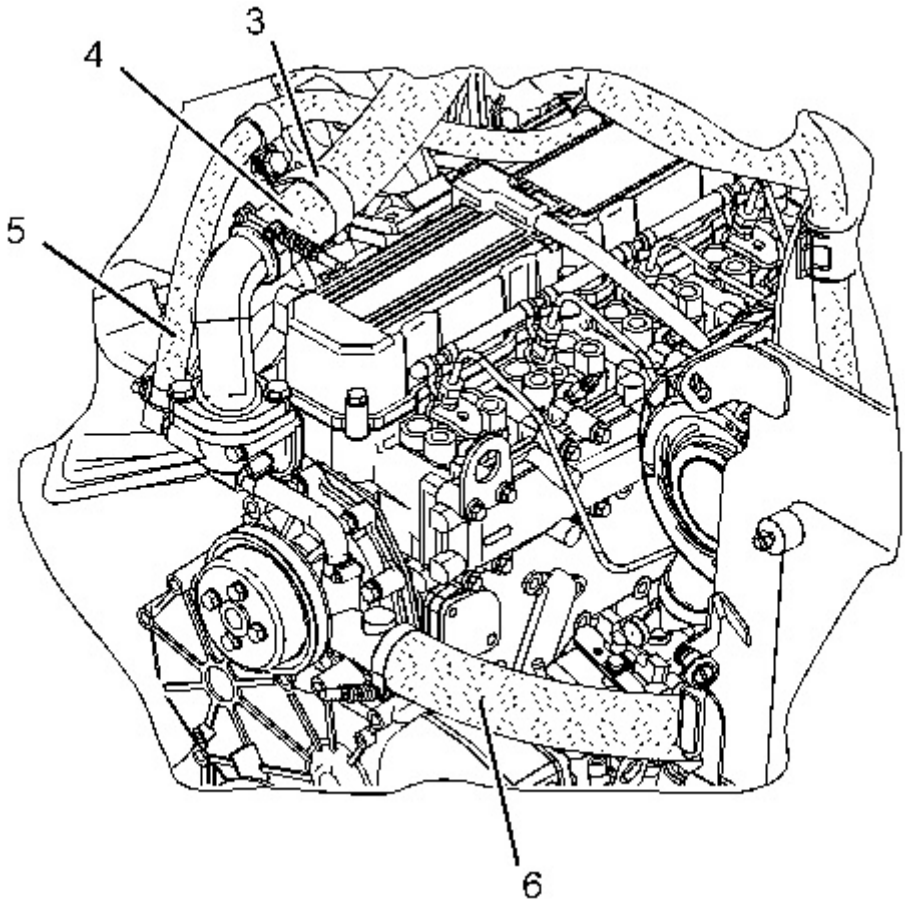


Illustration 2 g01040425

2. Remove clamp (3) . Disconnect hoses (4) , (5) , and (6) from the engine. Position hoses (4) , (5) , and (6) out of the way.

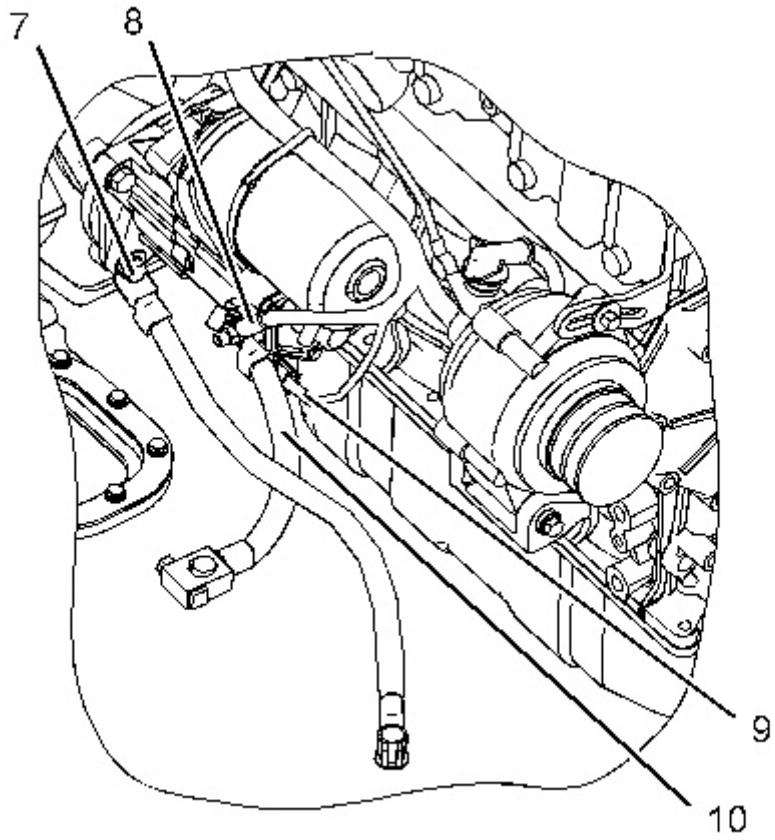


Illustration 3 g01040501

3. Disconnect cable assemblies (7) and (8) . Disconnect harness assembly (9) and cable assembly (10) .

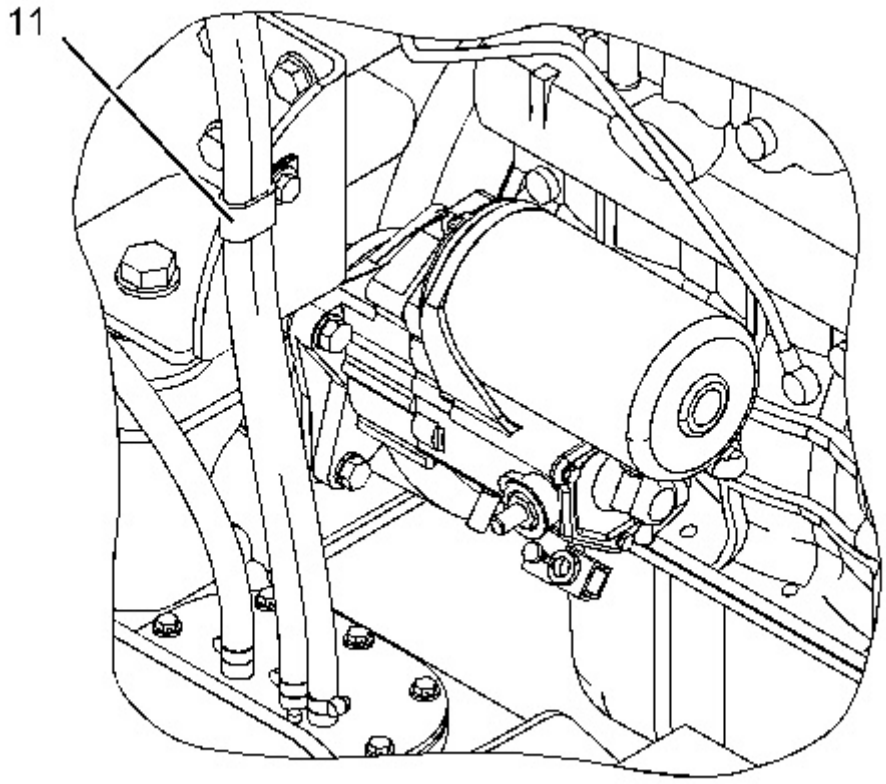


Illustration 4 g01040508

4. Remove clip (11) .

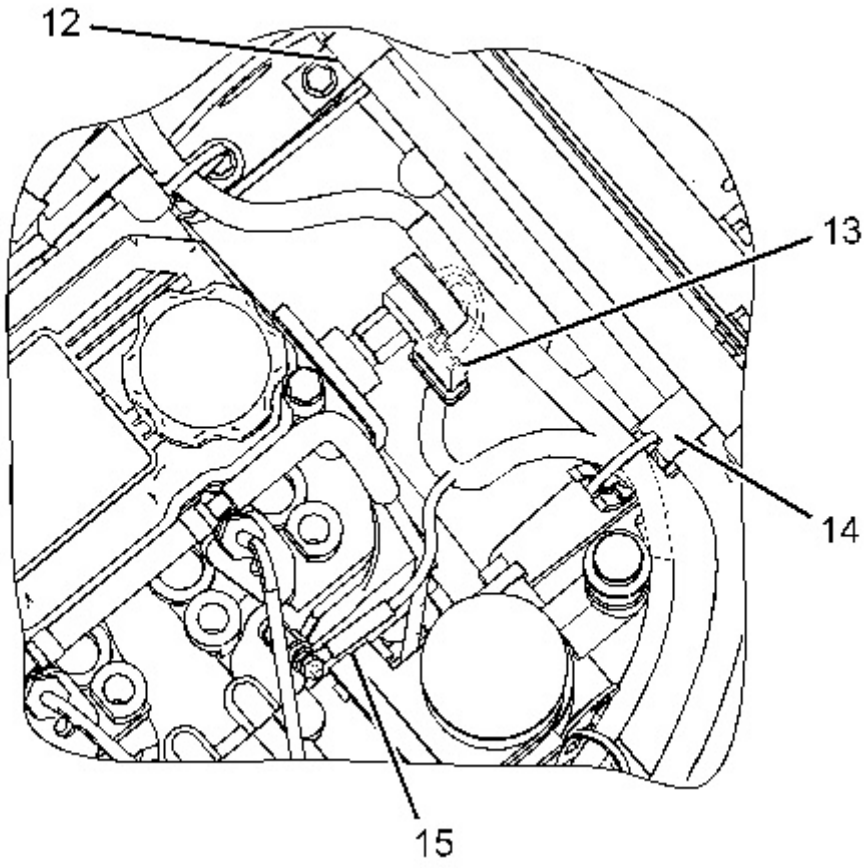


Illustration 5 g01040517

5. Disconnect harness assembly (13) . Remove clamps (12) and (14) . Disconnect cable assembly (15) .

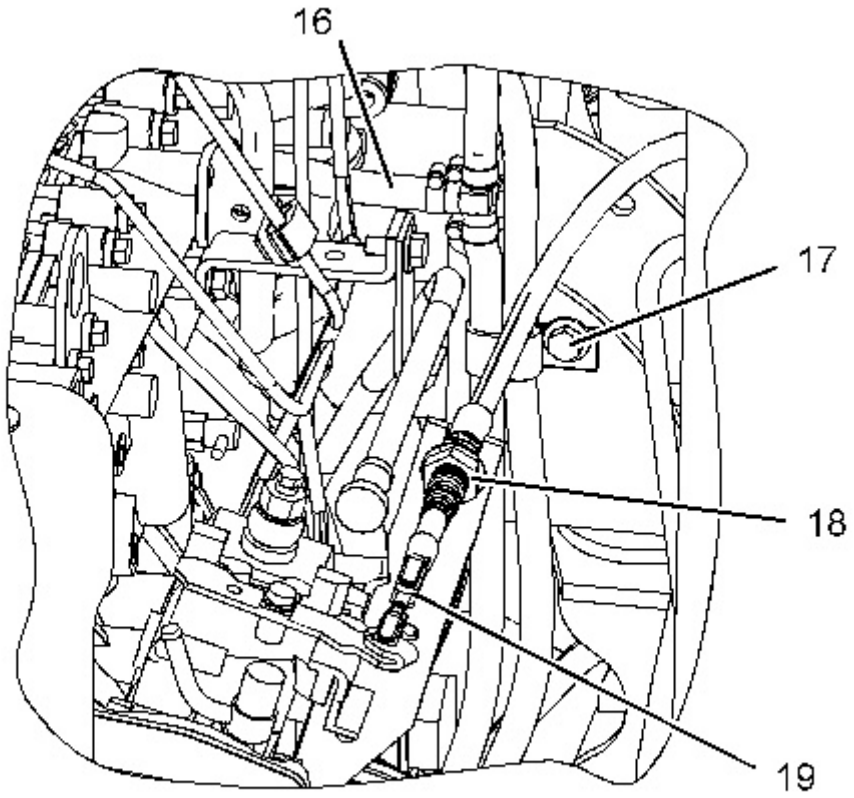


Illustration 6 g01040524

6. Disconnect hose (16) . Remove clip (17) . Loosen nut (18) and disconnect cable assembly (19) .

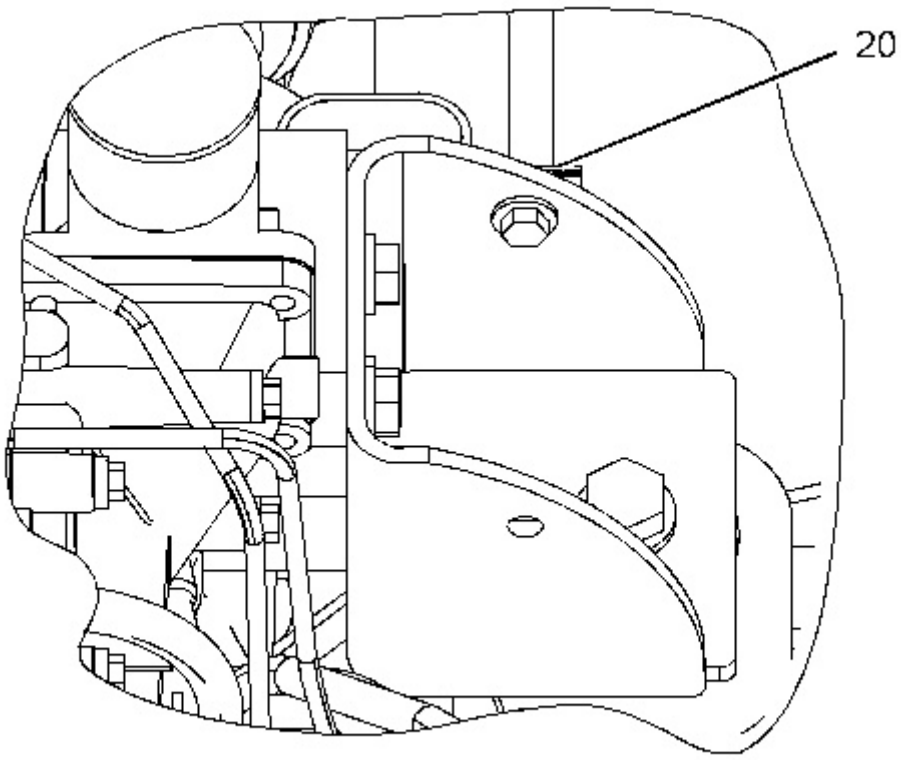


Illustration 7 g01040526

7. Remove clip (20) .

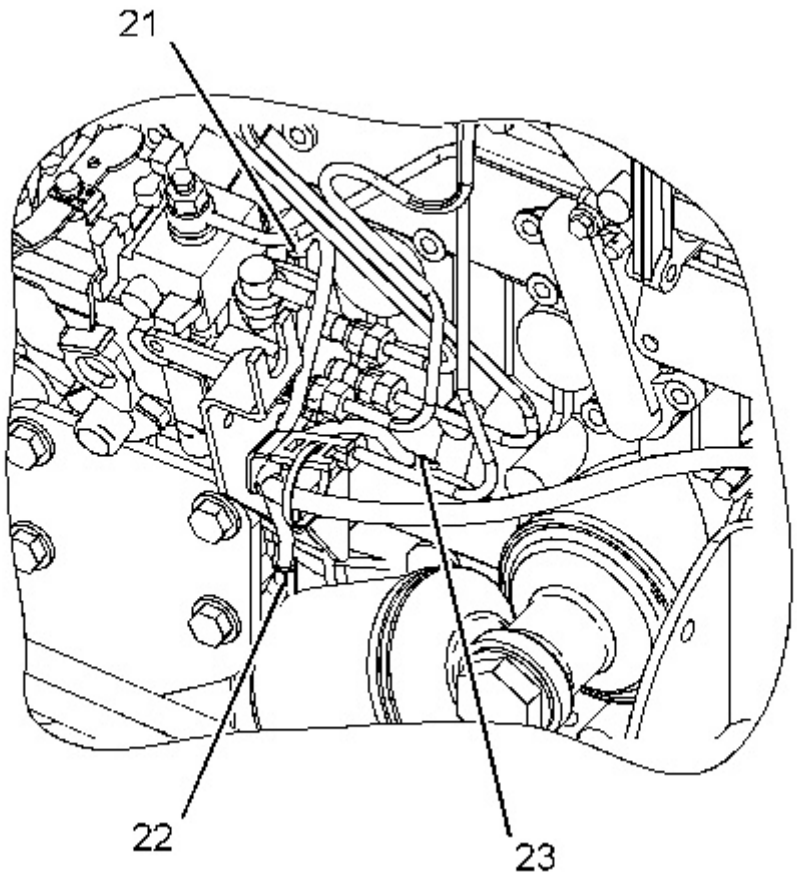


Illustration 8 g01040536

8. Disconnect harness assemblies (21) , (22) , and (23) .

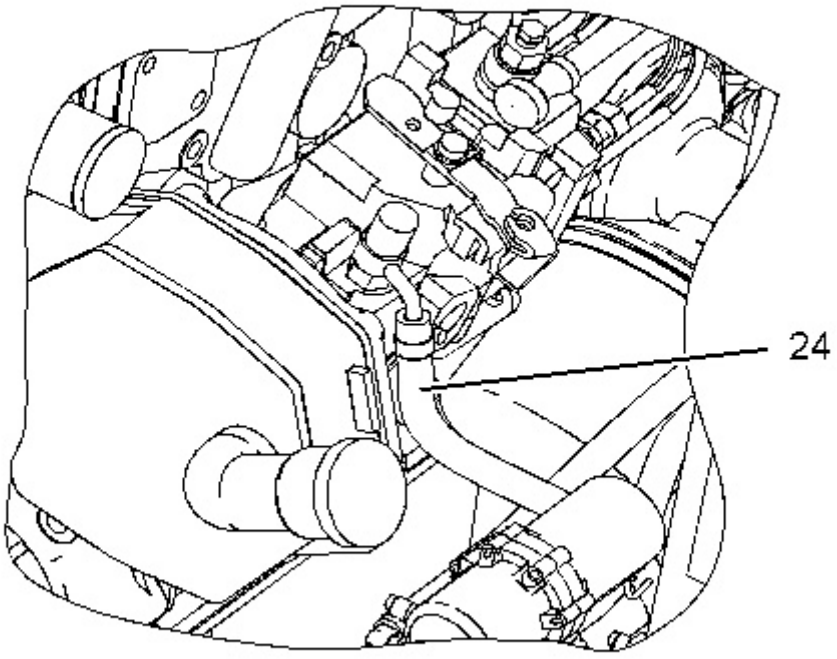


Illustration 9 g01040545

9. Disconnect hose assembly (24) .

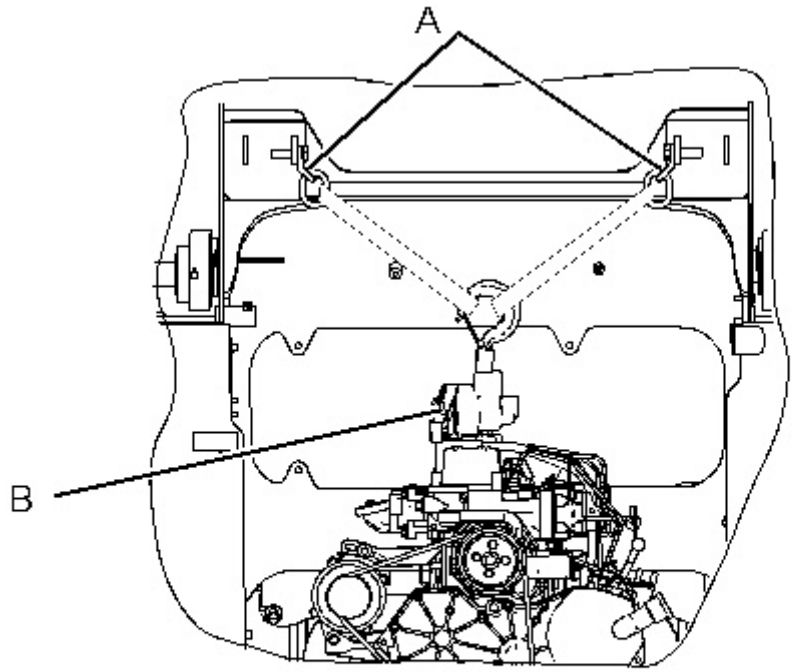


Illustration 10 g01040547

10. Attach Tooling (A) to the frame, as shown. Attach a suitable lifting device to Tooling (A) and Tooling (B) , as shown.

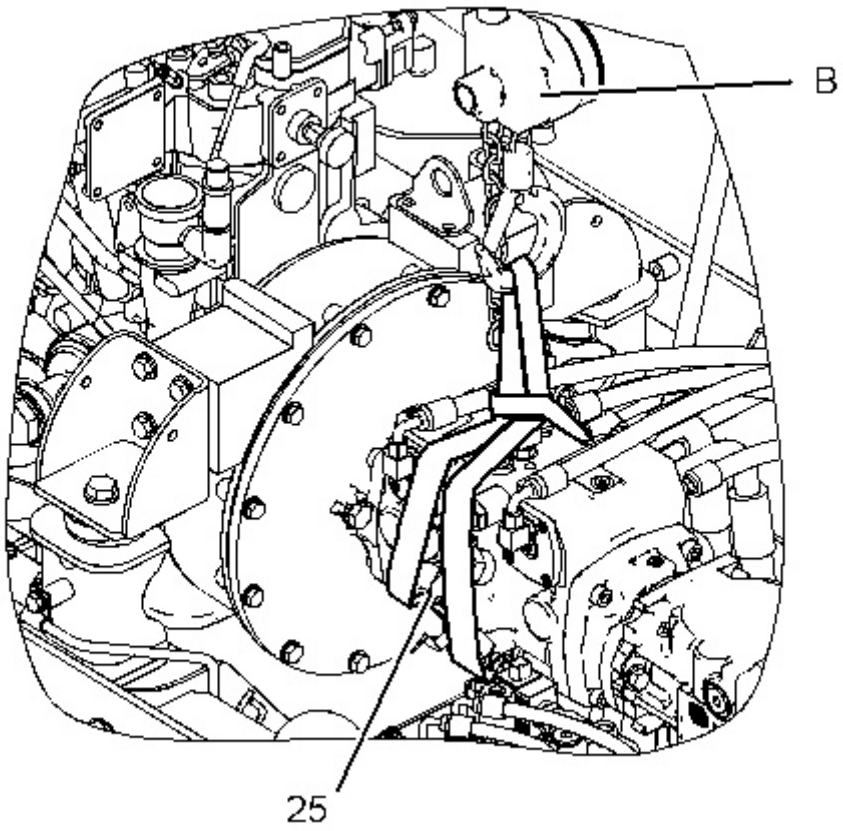


Illustration 11 g01040555

11. Attach a suitable lifting device to pump (25) and Tooling (B) to support the pump when the engine is removed.

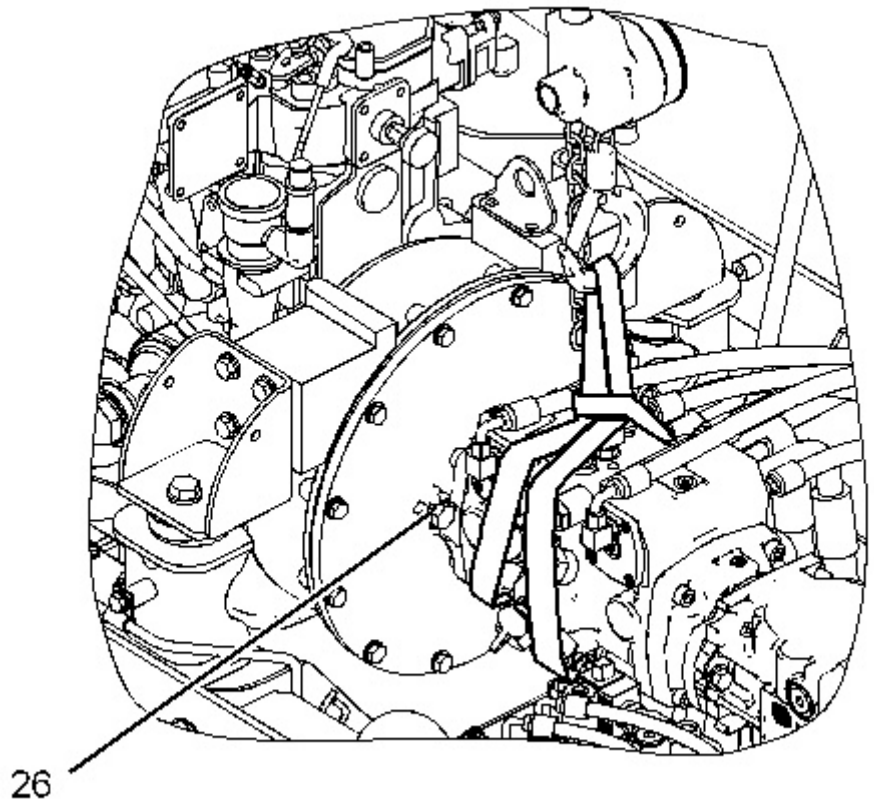


Illustration 12 g01040557

12. Remove two bolts (26) by using Tooling (C) .

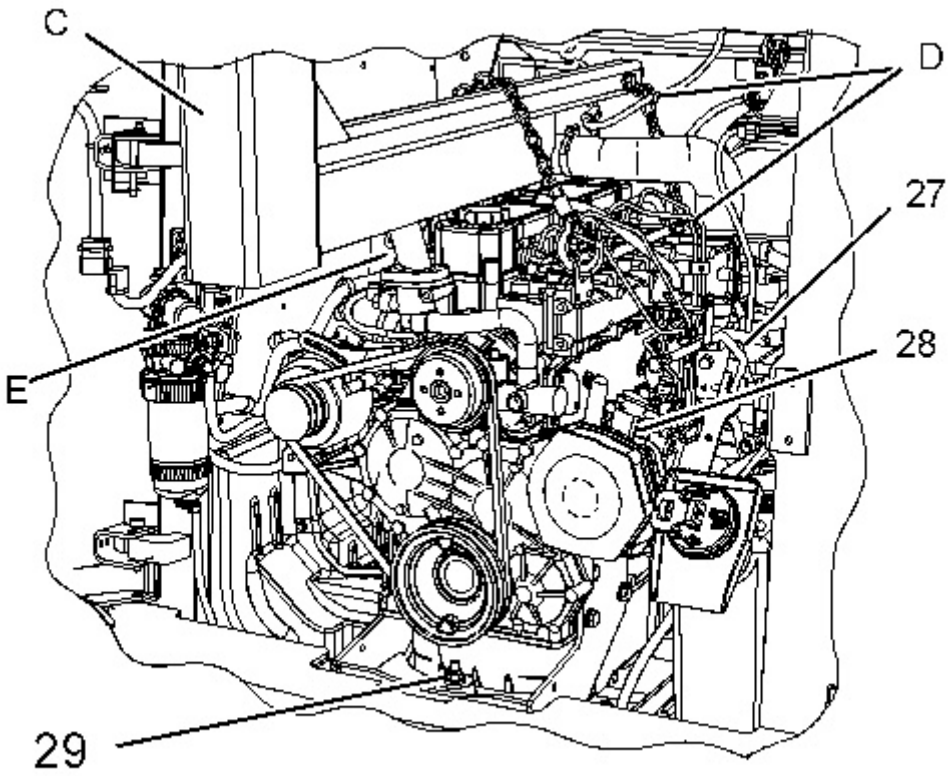


Illustration 13 g02024973

13. Attach Tooling (C) , Tooling (D) , Tooling (E) , and a suitable lifting device to engine (28) . The weight of engine (28) is approximately 320 kg (700 lb). Remove bolt (29) . Remove four bolts (27) from each side of the engine.

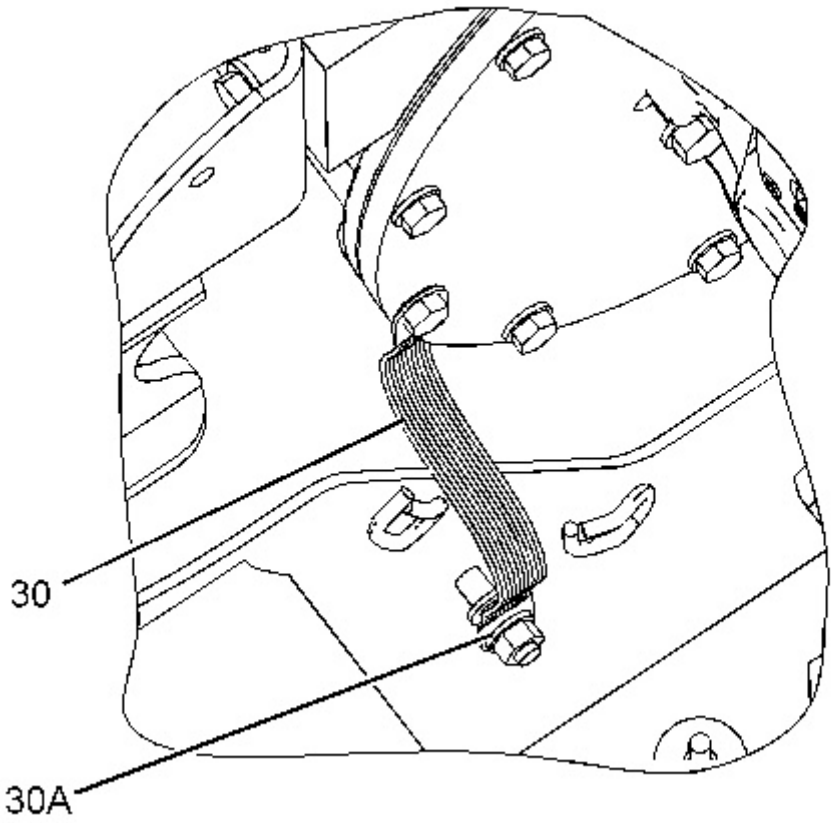


Illustration 14 g01040657

14. Raise the engine far enough so that ground strap (30) can be accessed. Remove the nut and washer (30A) and disconnect the ground strap. Remove the engine.

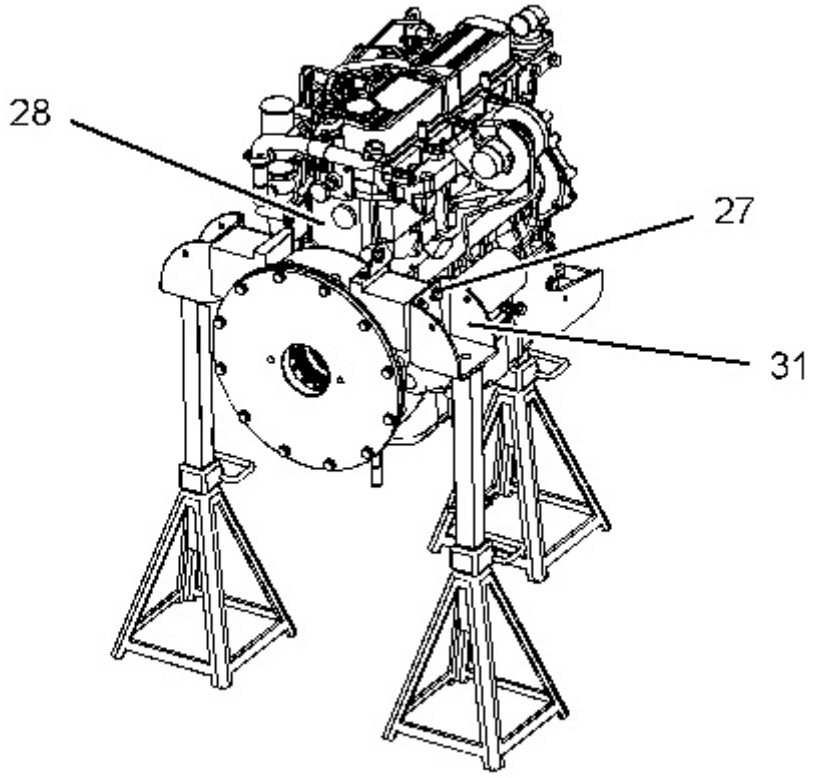


Illustration 15 g01040665

15. Remove both brackets (31) from the machine. Reposition brackets (31) onto engine (28) and install bolts (27) . The engine can now be placed on a suitable support, as shown.

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i04351952

Engine - Install

SMCS - 1000-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-4184	Bolt	2
	8T-4225	Washer	2
	8T-4244	Nut	4
	138-7575	Link Bracket	2
B	1U-9200	Lever Puller Hoist	1
C	368-0005	C-Frame Assembly	1
D	138-7575	Link Bracket	4
E	138-7573	Link Bracket	1

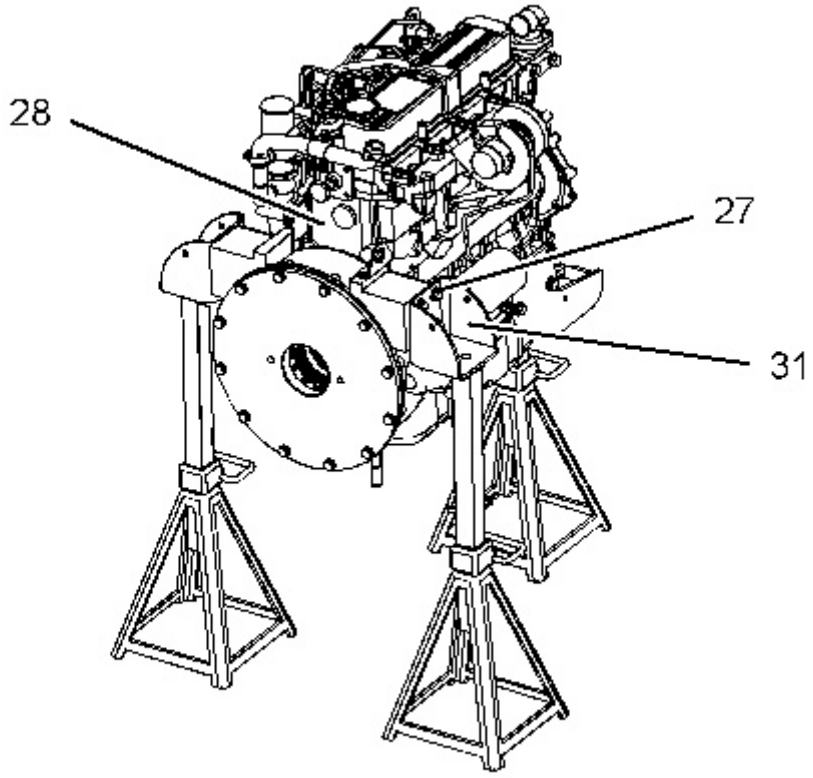


Illustration 1 g01040665

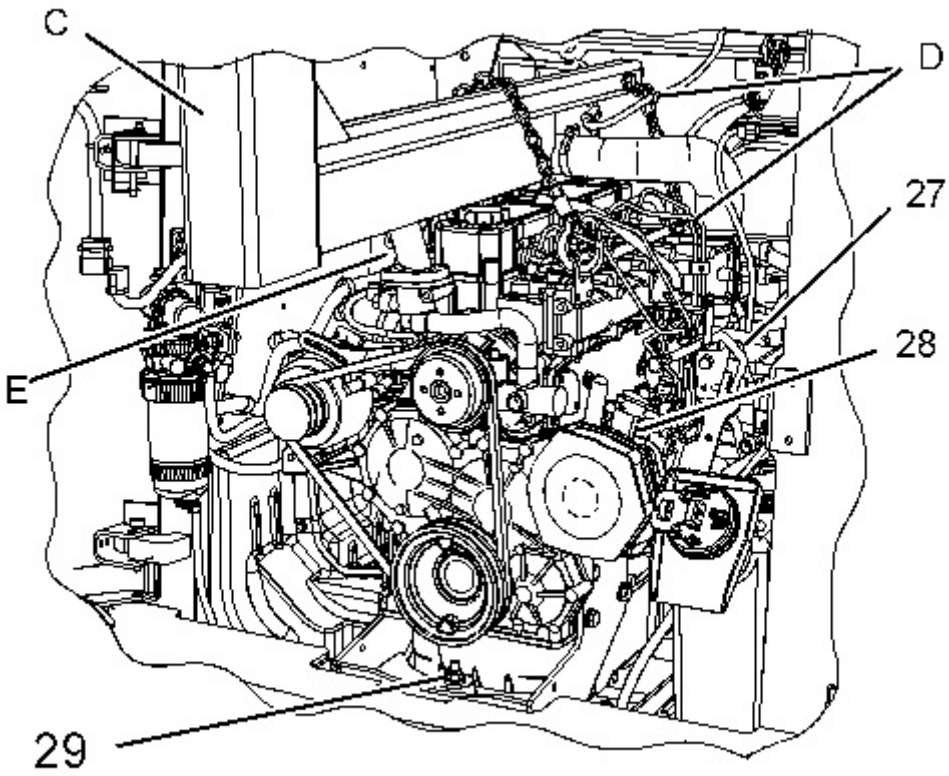


Illustration 2 g02024973

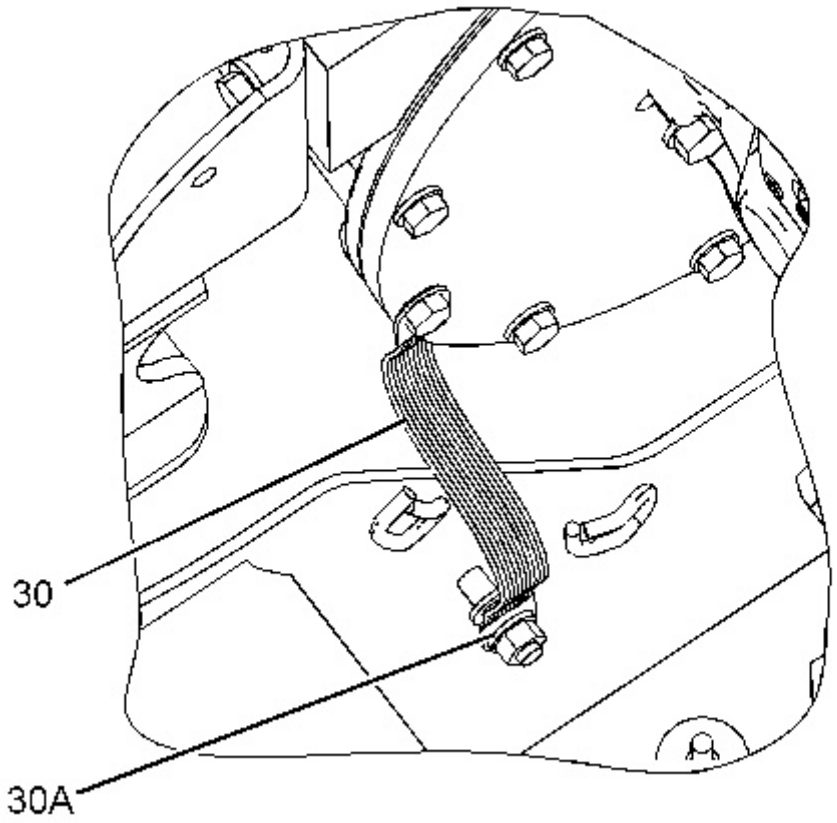


Illustration 3 g01040657

1. Attach Tooling (C) , Tooling (D) , Tooling (E) , and a suitable lifting device to engine (28) . The approximate weight of engine (28) is 320 kg (700 lb). Remove both brackets (31) that are used for mounting the engine.

2. Install the engine. Install the engine far enough so that ground strap (30) can be connected. Connect ground strap (30) and install the nut and washer (30A) . Reposition brackets (31) onto the machine and install bolts (27) . Install bolt (29) . Tighten bolt (29) to a torque of 90 ± 10 N·m (66 ± 7 lb ft).

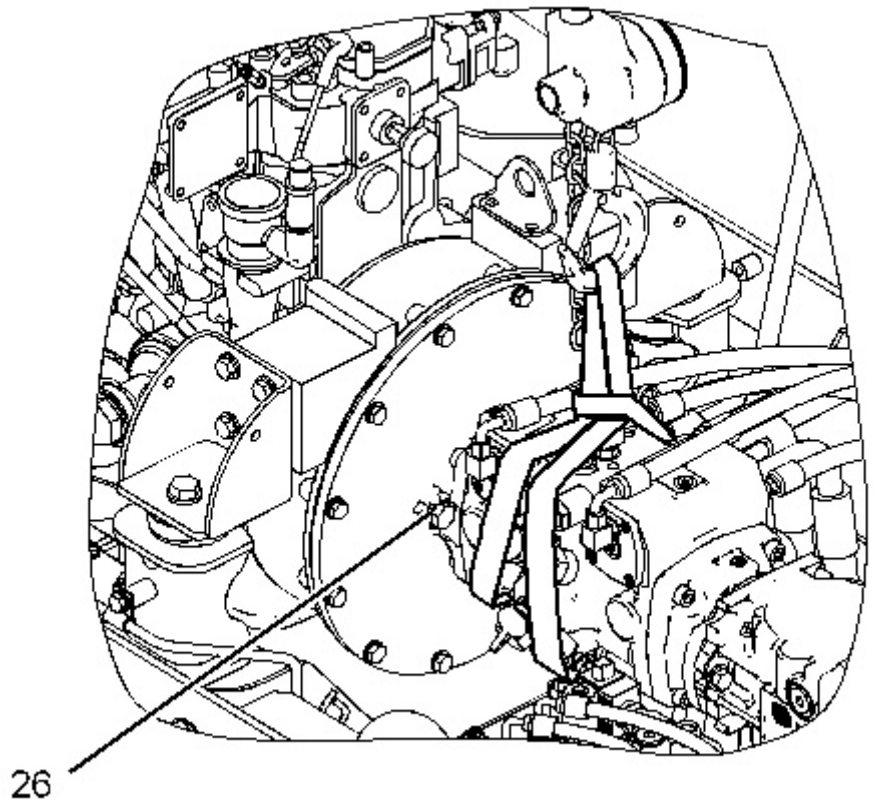


Illustration 4 g01040557

3. Install two bolts (26) by using Tooling (C) .

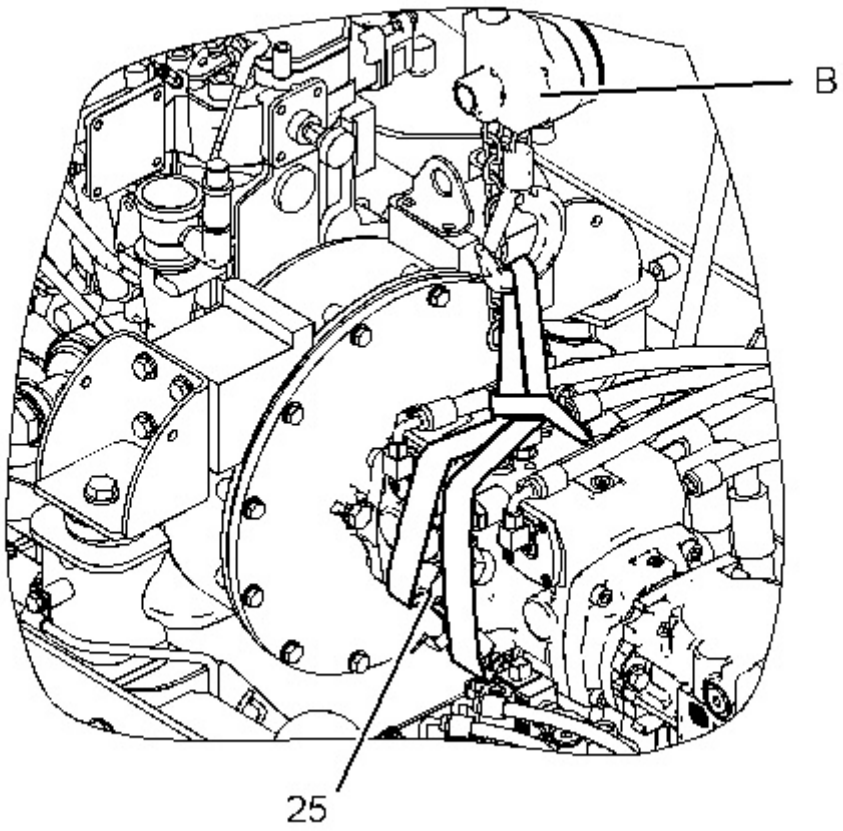


Illustration 5 g01040555

4. Remove the suitable lifting device from pump (25) . Remove Tooling (A) and Tooling (B) .

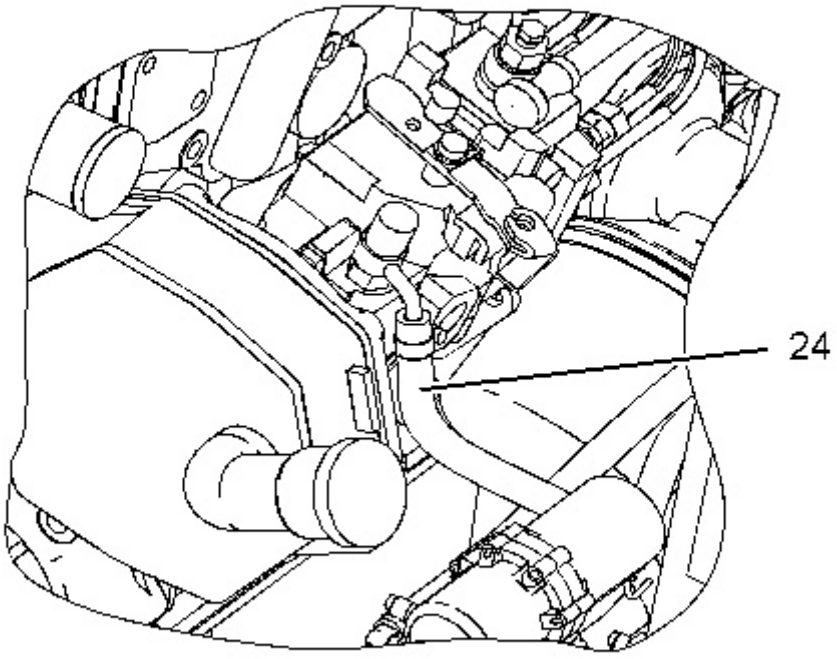


Illustration 6 g01040545

5. Connect hose assembly (24) .

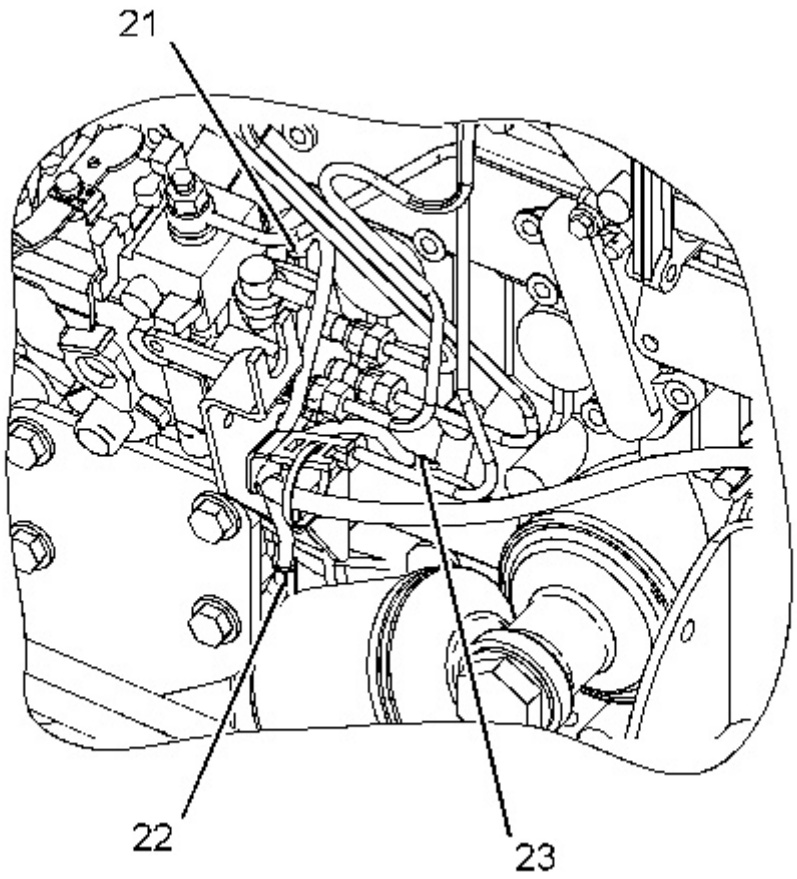


Illustration 7 g01040536

6. Connect harness assemblies (21) , (22) , and (23) .

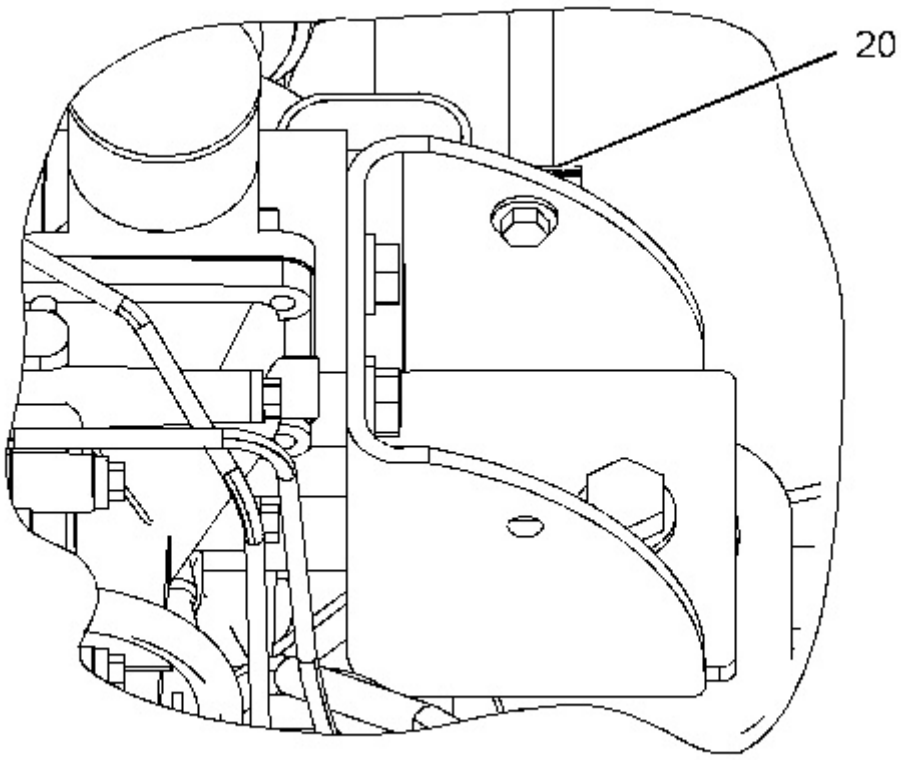


Illustration 8 g01040526

7. Install clip (20) .

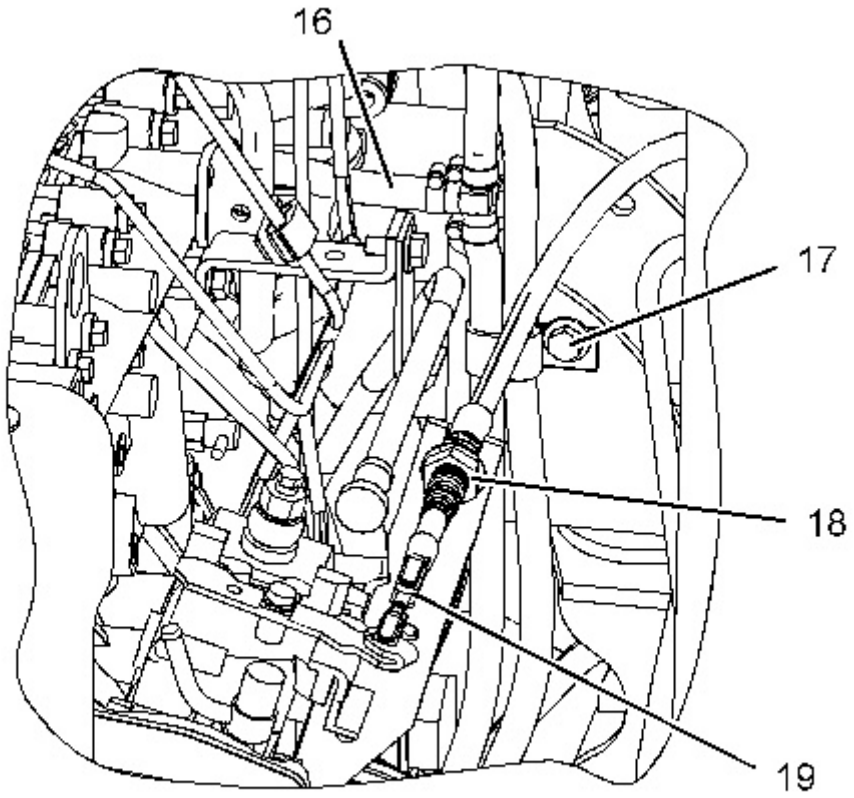


Illustration 9 g01040524

8. Connect hose (16) . Install clip (17) . Connect cable assembly (19) and tighten nut (18) .

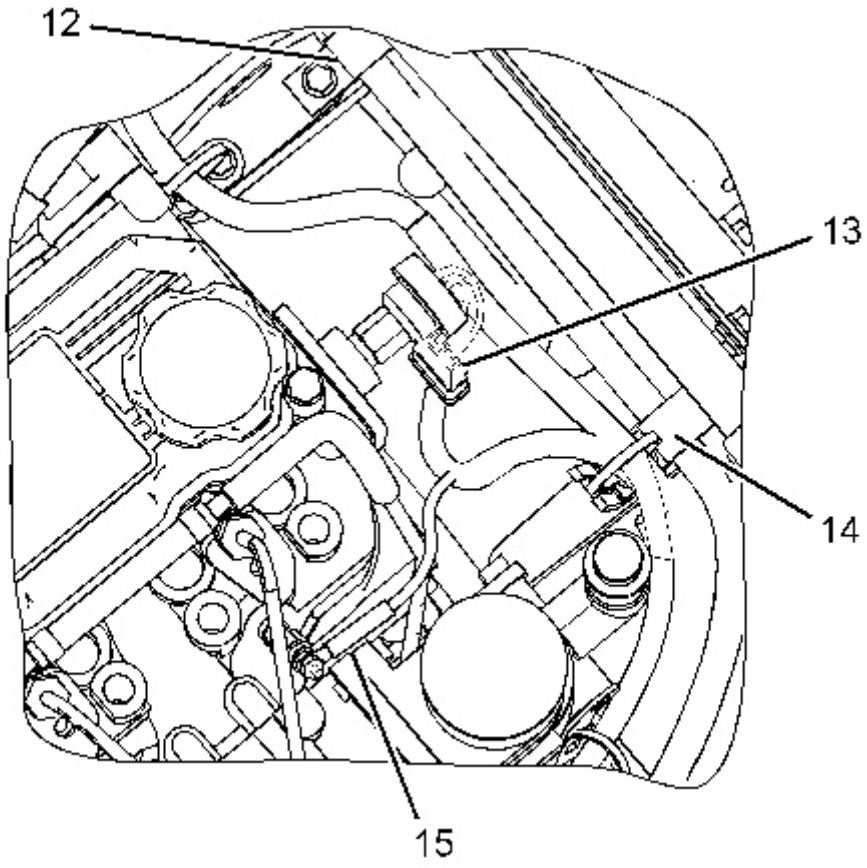


Illustration 10 g01040517

9. Connect harness assembly (13) . Install clamps (12) and (14) . Connect cable assembly (15) .

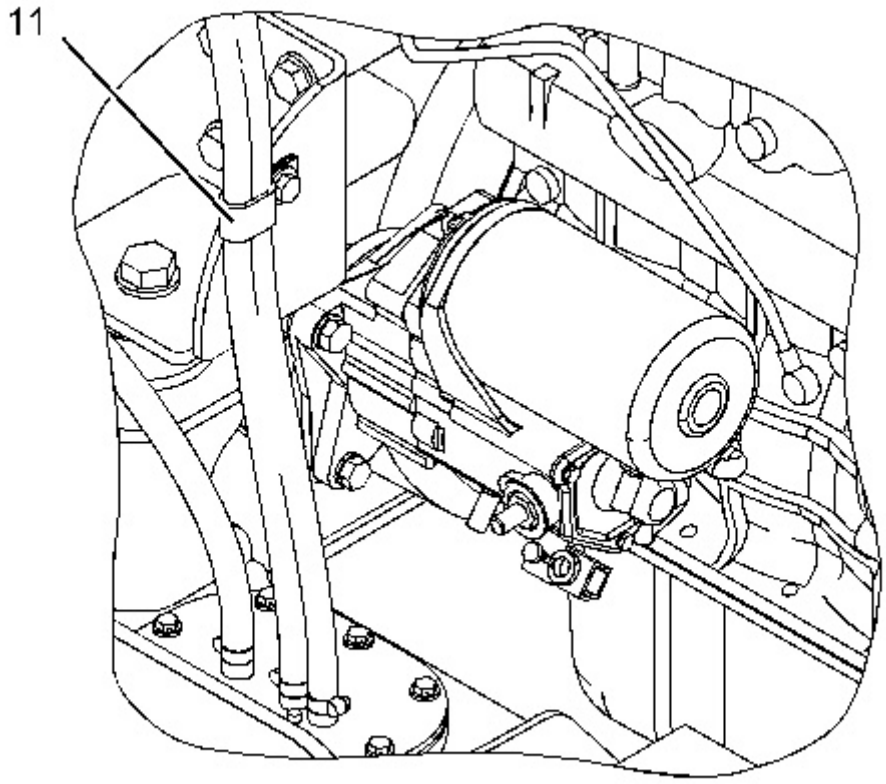


Illustration 11 g01040508

10. Install clip (11) .

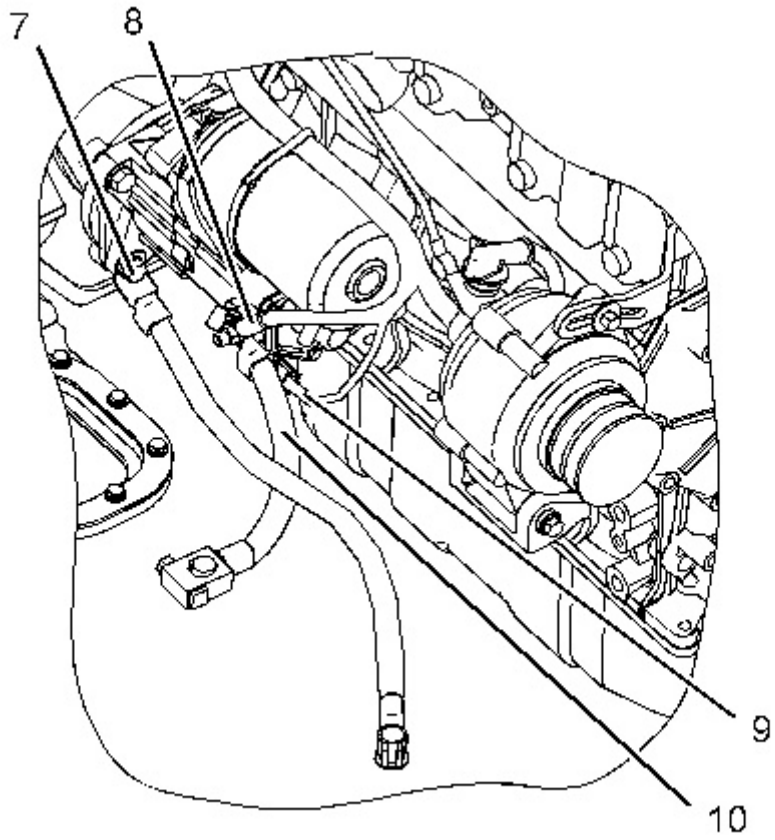


Illustration 12 g01040501

11. Connect cable assemblies (7) and (8) . Connect harness assembly (9) and cable assembly (10) .

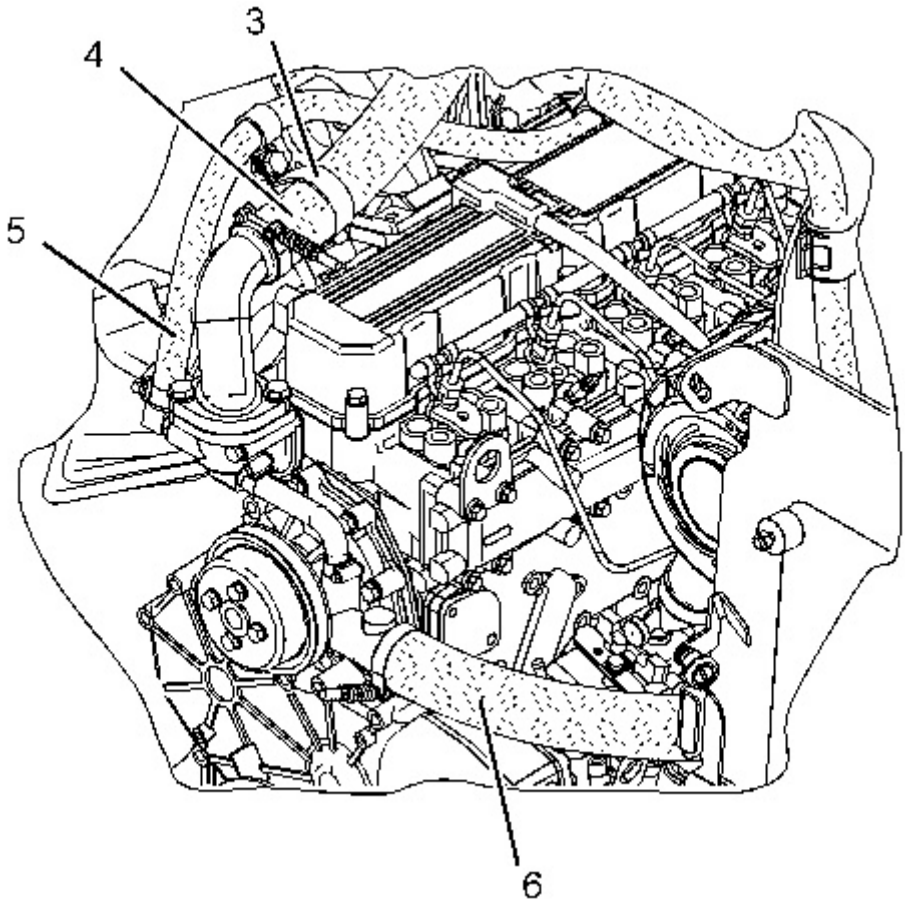


Illustration 13 g01040425

12. Install clamp (3) . Connect hoses (4) , (5) and (6) to the engine.

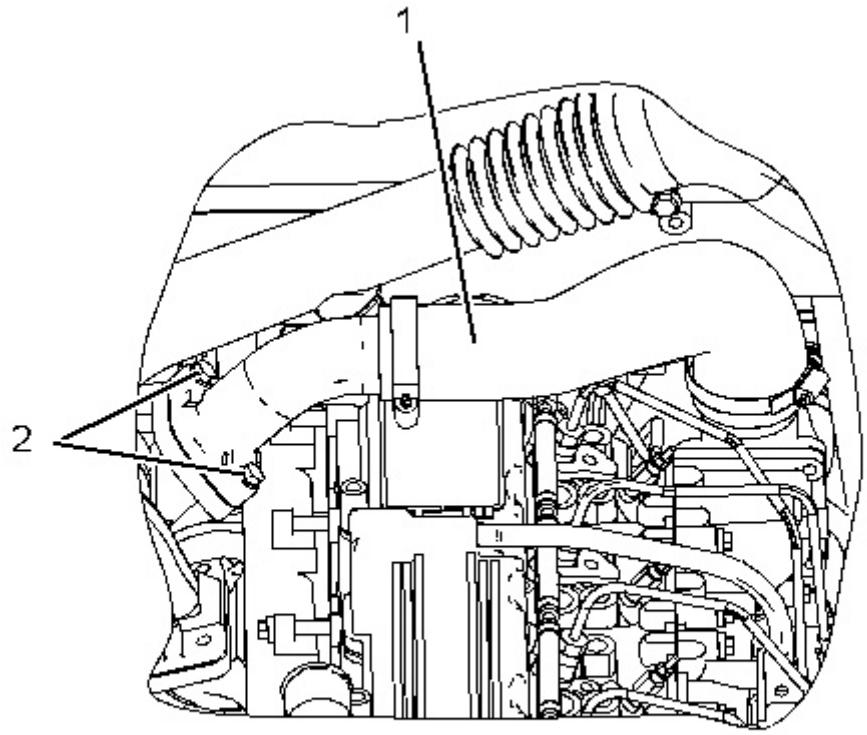


Illustration 14 g01040420

13. Install the tube and hose (1) . Install bolts (2) .

End By:

a. Install the muffler. Refer to Disassembly and Assembly, "Muffler - Remove and Install".
b. Install the air cleaner. Refer to Disassembly and Assembly, "Air Cleaner - Remove and Install".
c. Install the battery. Refer to Disassembly and Assembly, "Battery and Battery Cable - Separate and Connect".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7481-UN

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

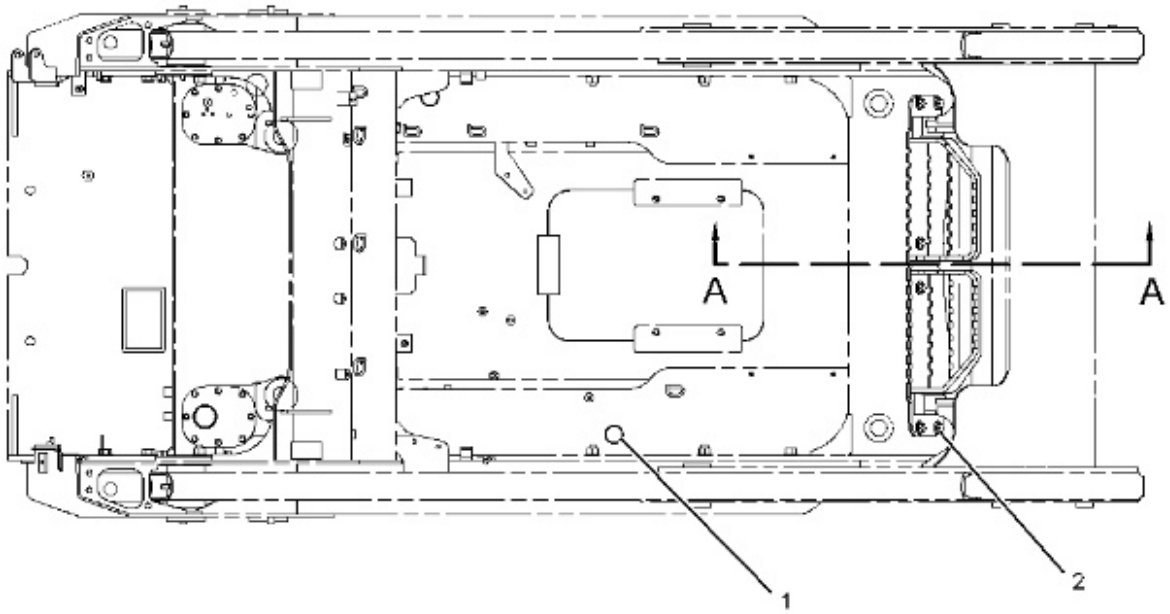


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

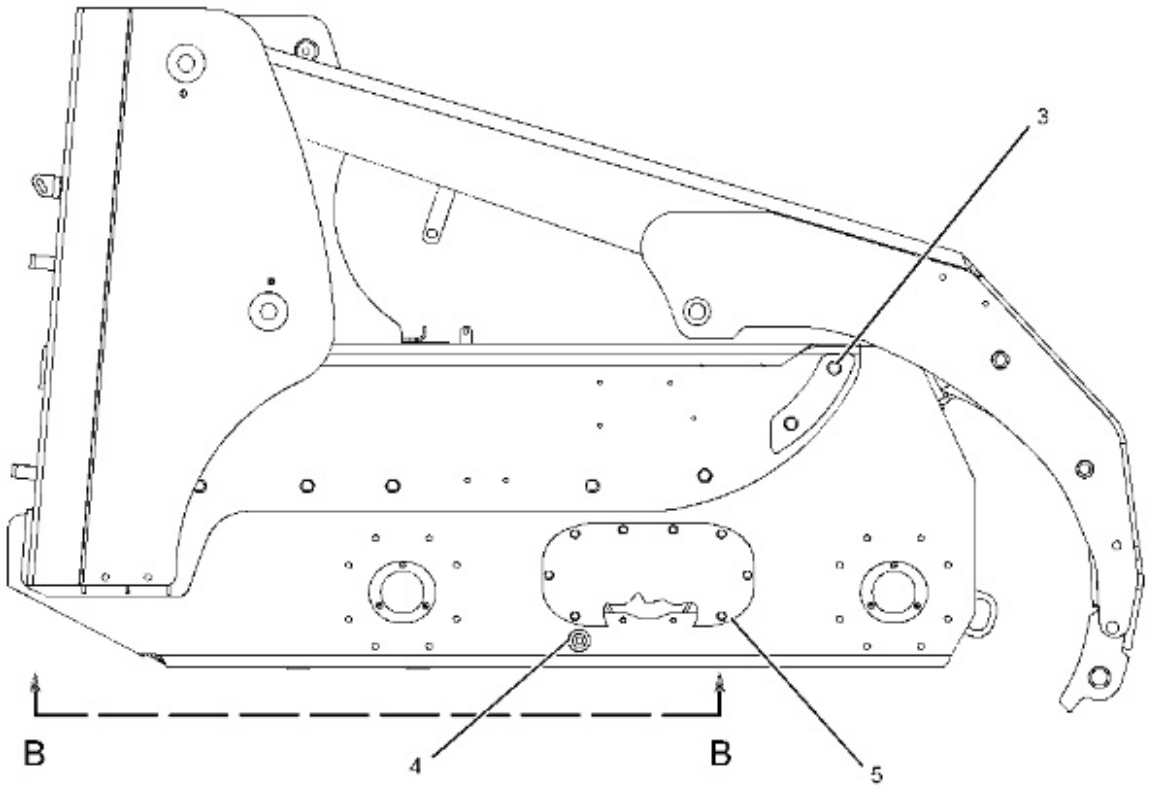


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

(5) Seal the two covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant. Orient the notch of the cover to the top.

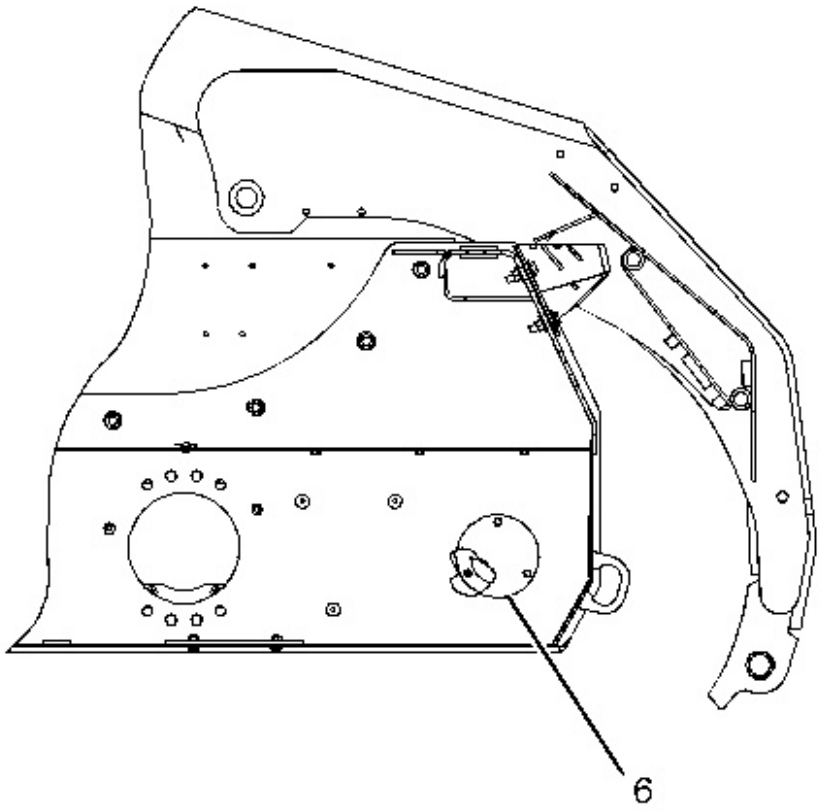


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

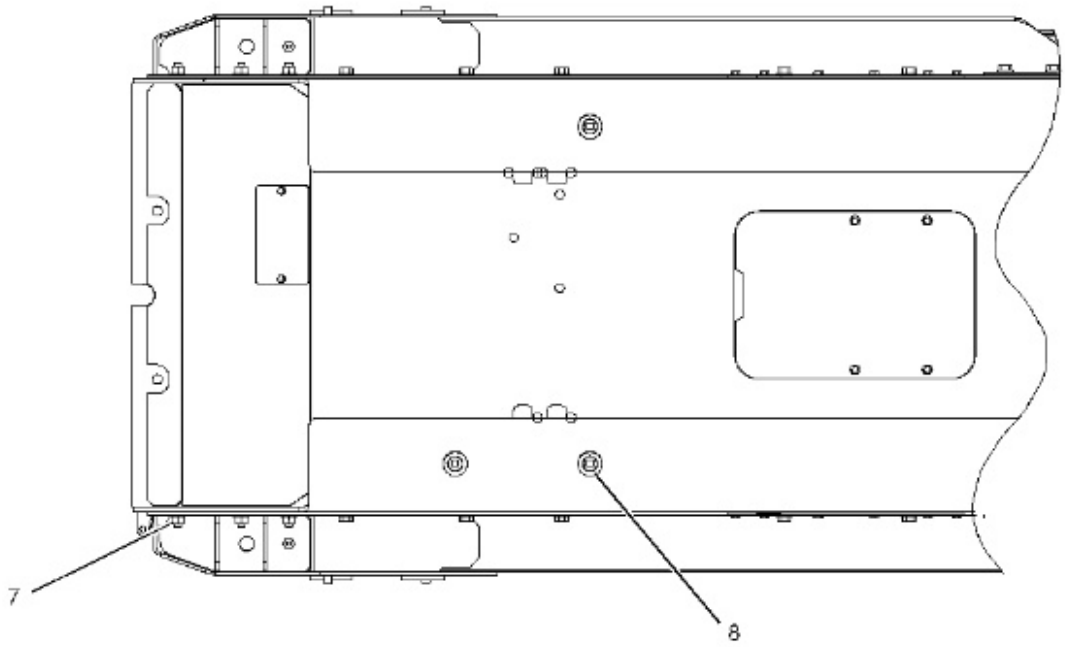


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7481-UN

S/N - HEN6750-UP

S/N - SCP4600-UP

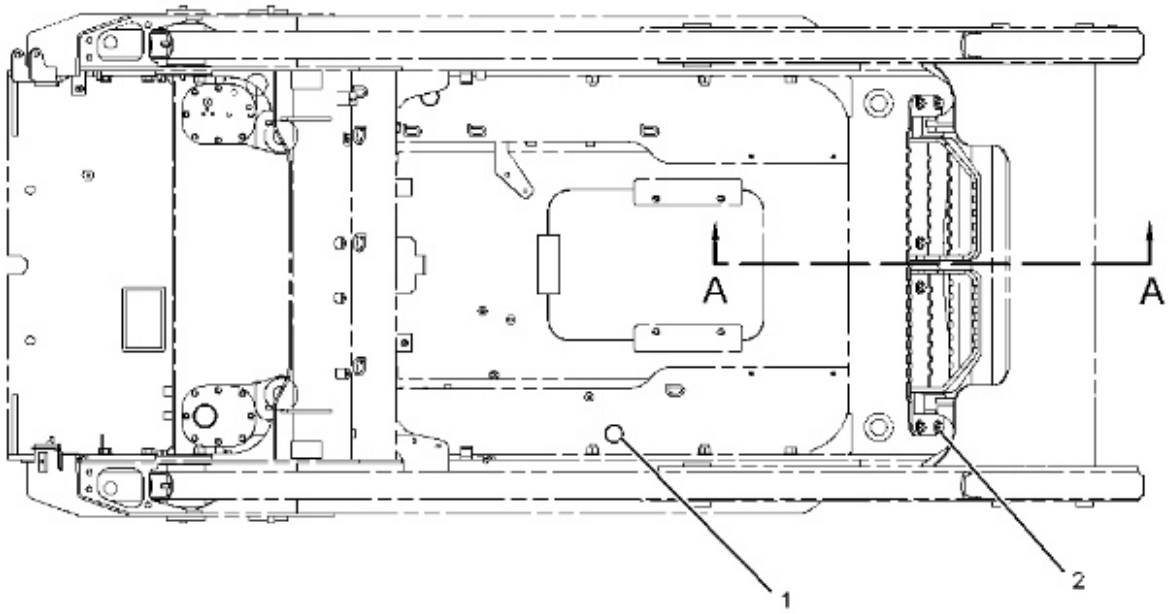


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

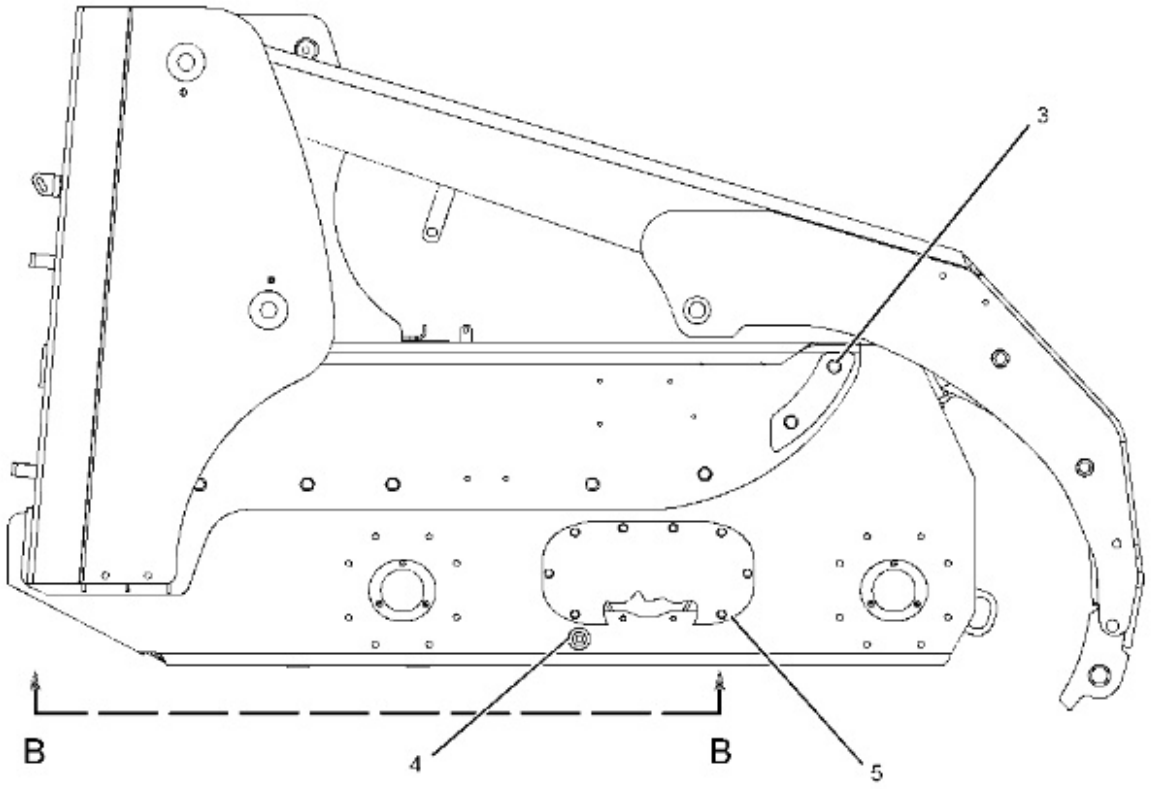


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

(5) Seal the two covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant. Orient the notch of the cover to the top.

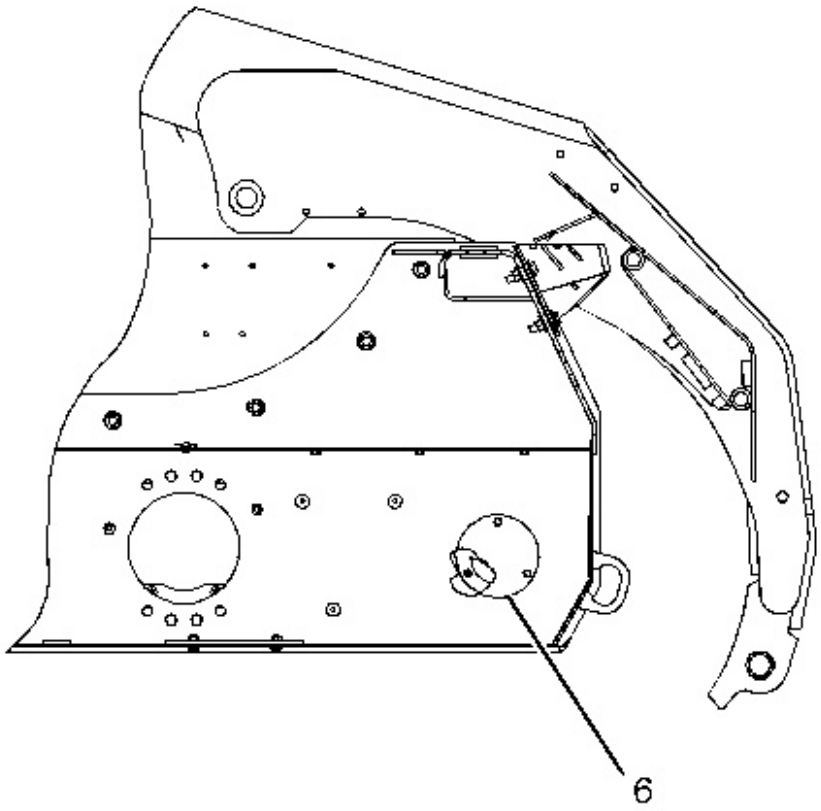


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

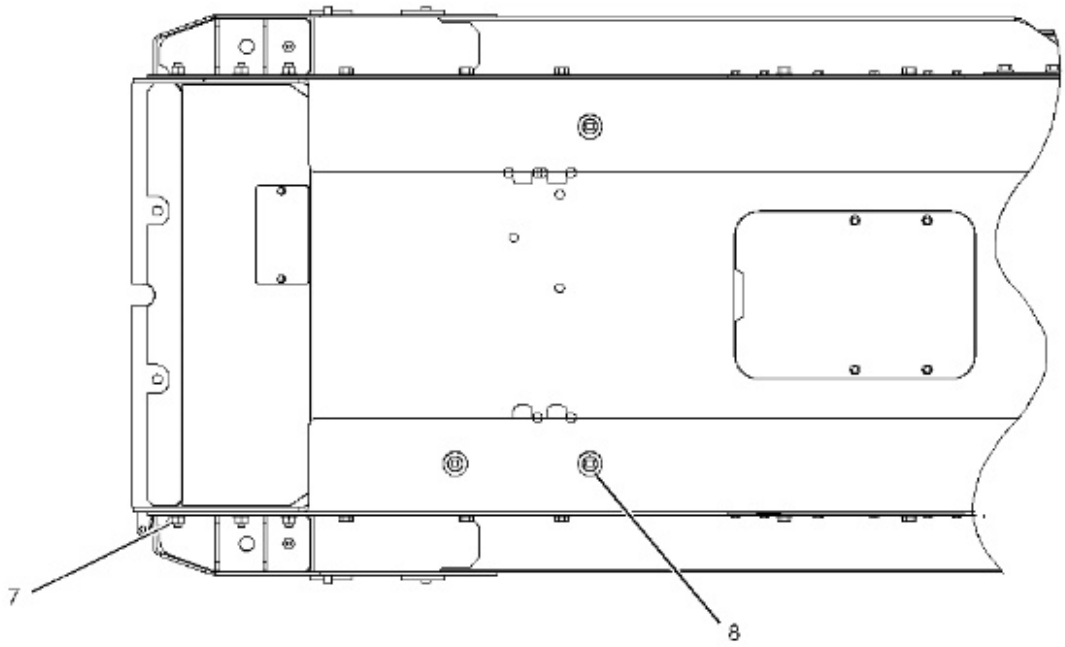


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854813

Engine Enclosure

SMCS - 7272

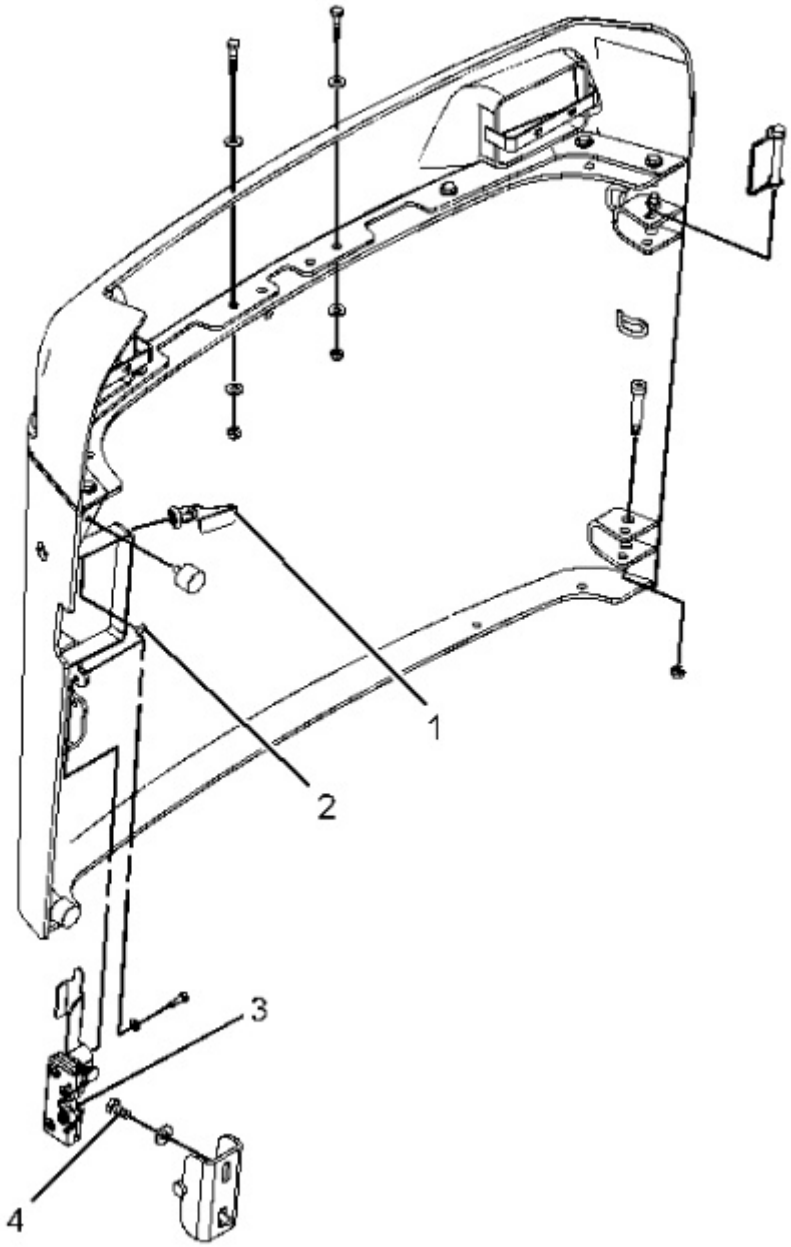


Illustration 1 g01421866

Note: When you move lock (1) to the unlocked position, make sure that door latch (3) can be accessed. Also, make sure that the latch can be operated.

(2) Torque for the two nuts ... 6 ± 1 N·m (55 ± 9 lb in)

(4) Torque for the two bolts ... 60 ± 12 N·m (44 ± 9 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854813

Engine Enclosure

SMCS - 7272

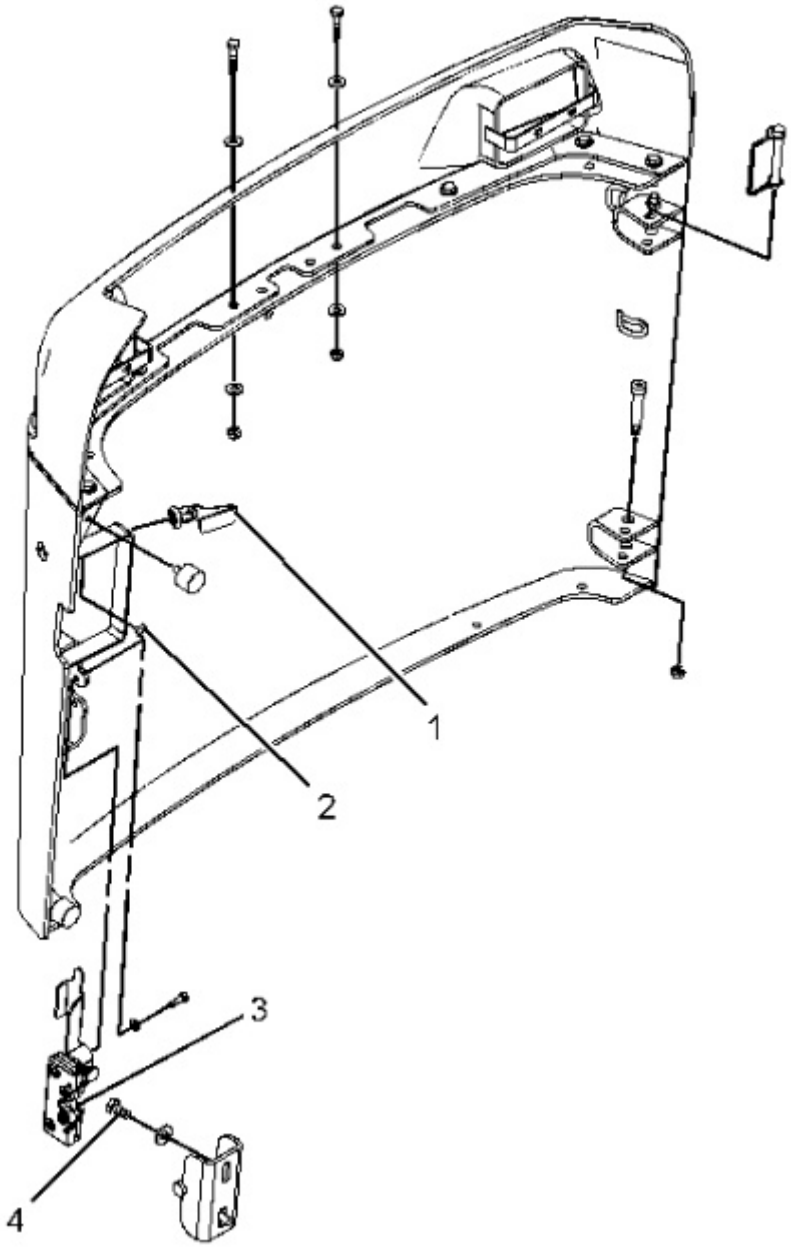


Illustration 1 g01421866

Note: When you move lock (1) to the unlocked position, make sure that door latch (3) can be accessed. Also, make sure that the latch can be operated.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7481-UN

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

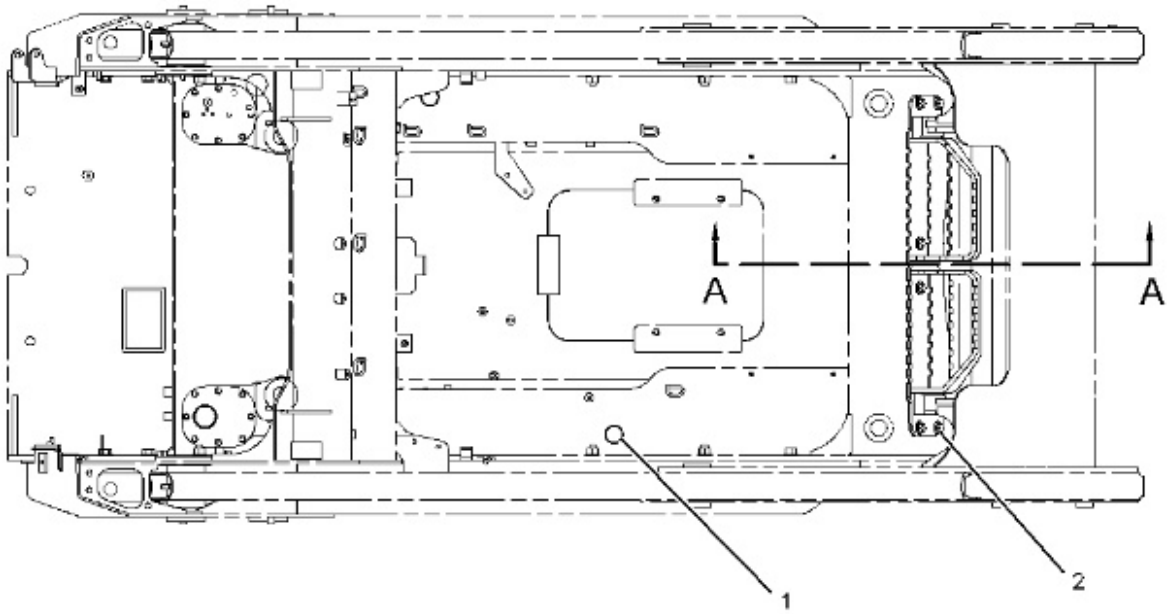


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

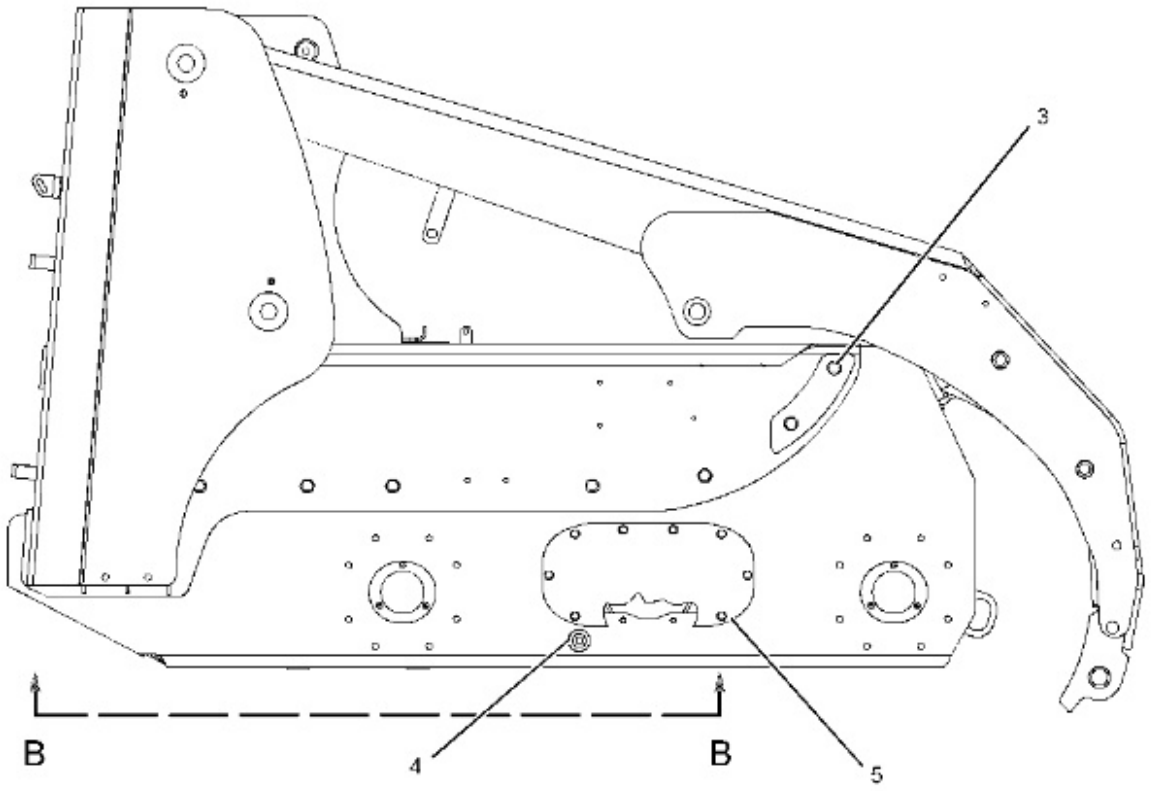


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

(5) Seal the two covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant. Orient the notch of the cover to the top.

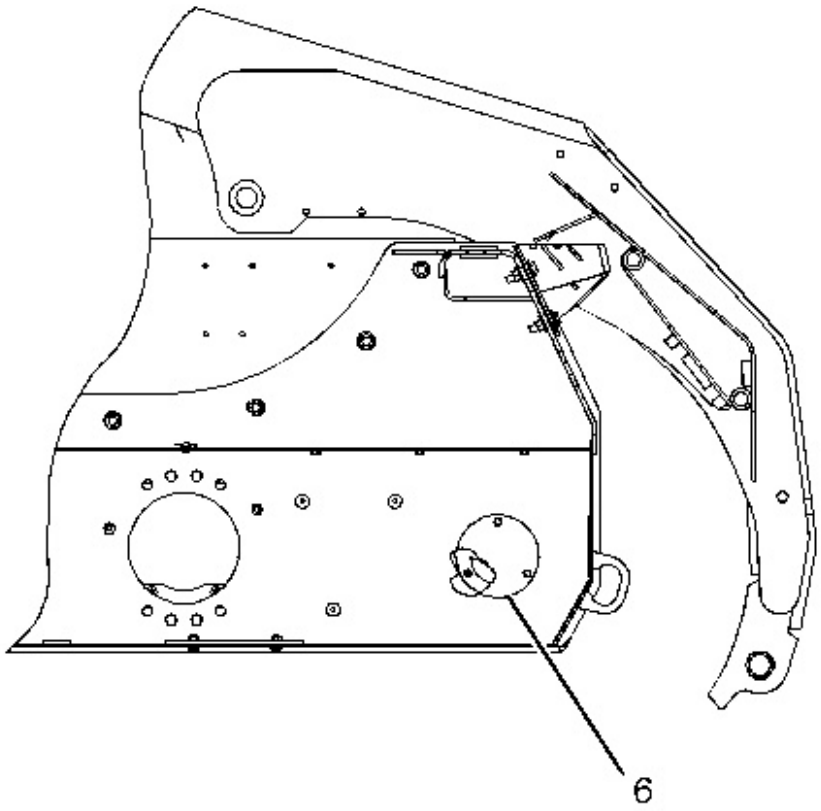


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

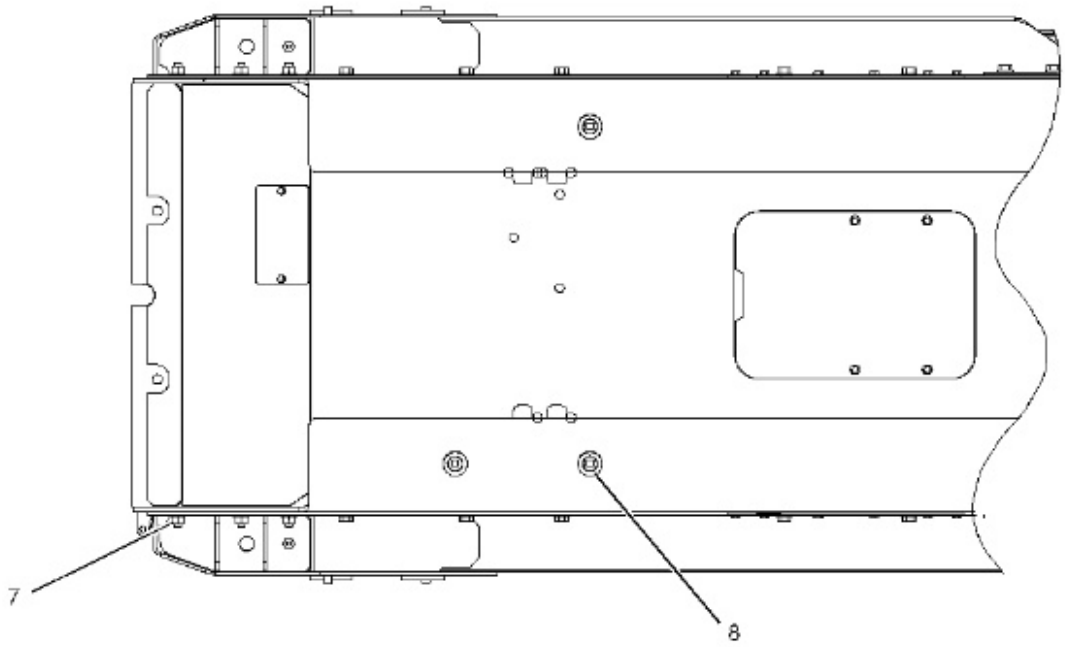


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02867507

Machine Frame and Mounting

SMCS - 6119-MT; 7050-LH; 7050-MT; 7050-UZ; 7481-UN

S/N - HEN6750-UP

S/N - SCP4600-UP

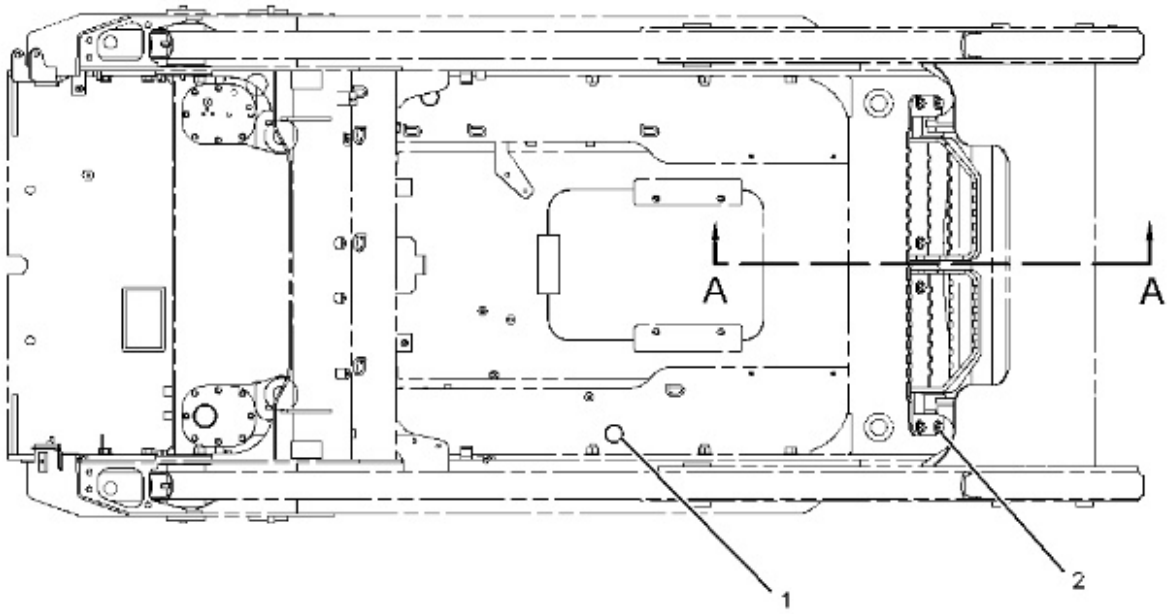


Illustration 1 g01428416

Top view

(1) Apply **5P-3413** Pipe Sealant to the threads of the two breathers.

(2) Torque for the eight bolts ... 105 ± 20 N·m (75 ± 15 lb ft)

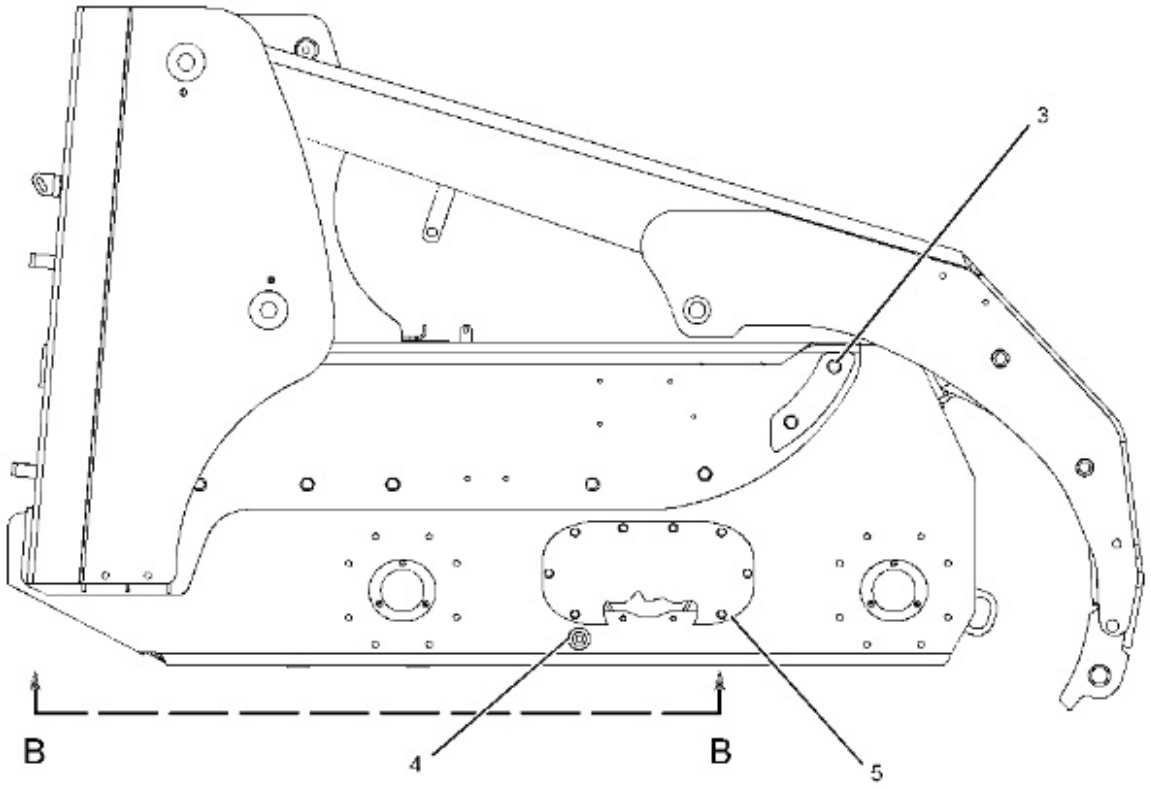


Illustration 2 g01428415

Right side view

(3) Torque for the 12 bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(4) Apply **5P-3413** Pipe Sealant to the threads of the two magnetic plugs prior to assembly.

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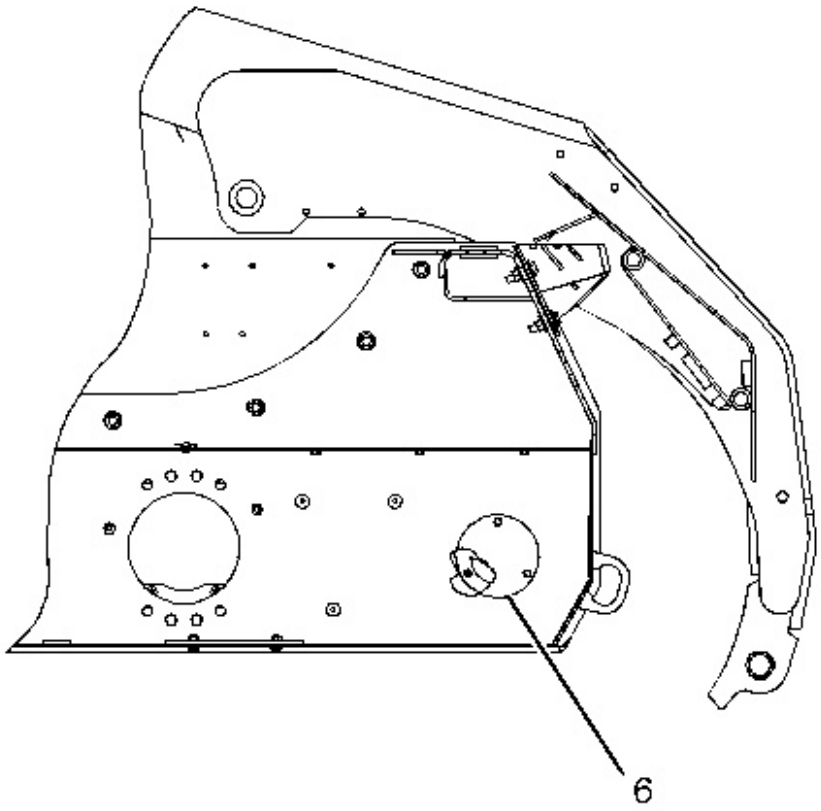


Illustration 3 g01428414

Section A-A

(6) Seal the four covers to the frame by pooling **8T-9022** Silicone Gasket in the bolt holes on the frame. Apply 3.0 ± 1.0 mm (0.12 ± 0.04 inch) continuous bead of sealant at the bolt hole pattern. Assemble the covers within three minutes after applying the sealant.

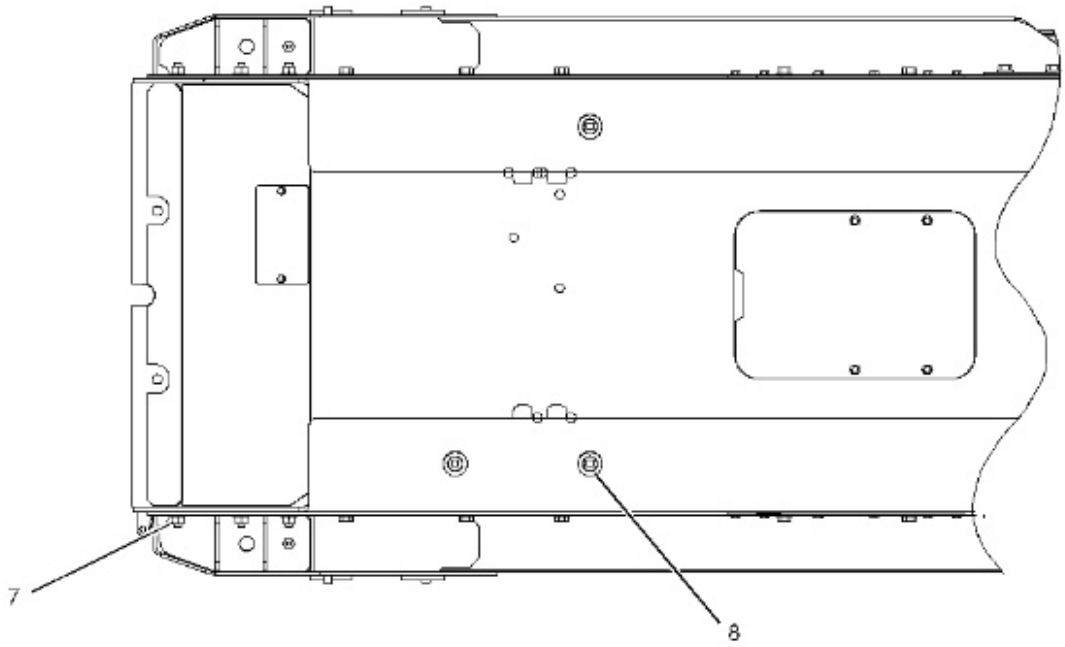


Illustration 4 g01428413

Section B-B

(7) Torque for the six bolts ... 270 ± 40 N·m (200 ± 30 lb ft)

(8) Apply **5P-3413** Pipe Sealant to the threads of three magnetic plugs prior to assembly.

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02015014

Engine Enclosure - Remove and Install

SMCS - 7263-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-7475	M8 Bolt	2
	8T-4224	Hard Washer	2
	138-7573	Link Bracket	2

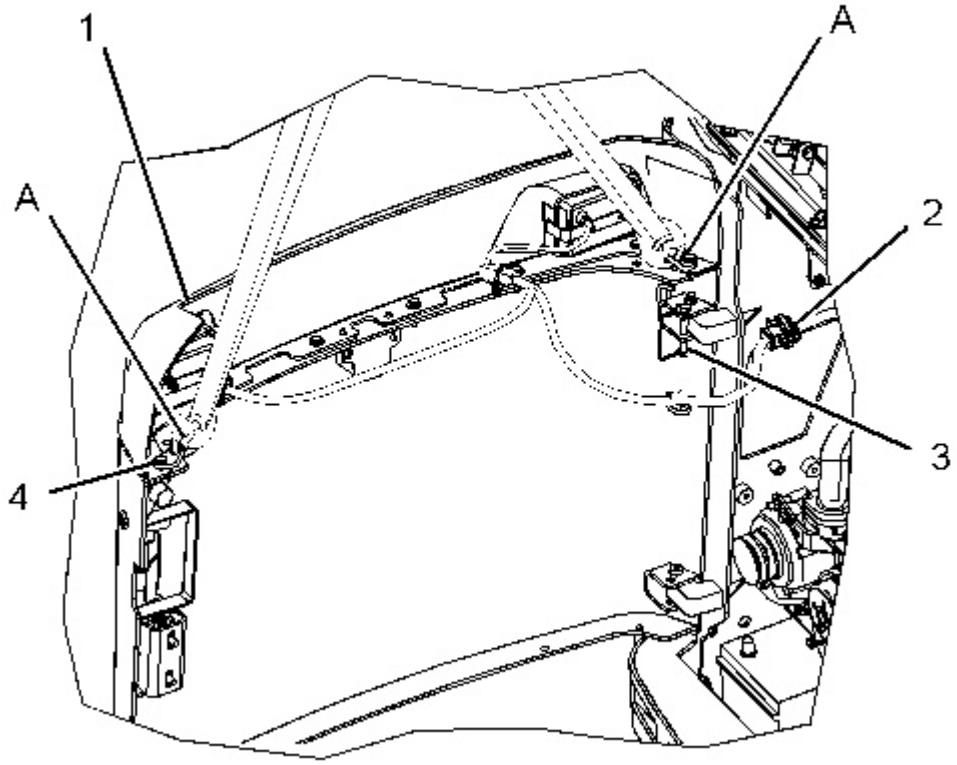


Illustration 1 g01041748

1. Tilt the radiator. Open the engine enclosure (1) and install pin (3). Disconnect harness assembly (2). Remove bolts (4) and install a suitable lifting device with Tooling (A) to the engine enclosure (1), as shown.

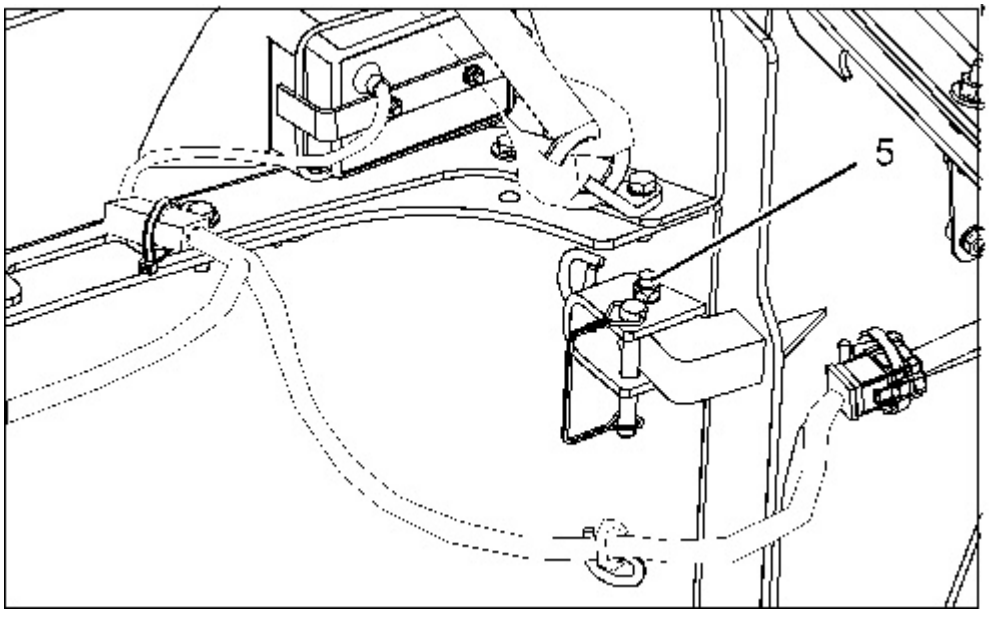


Illustration 2 g01047970

2. Remove hinge bolts (5) and remove the engine enclosure. The weight of the engine enclosure is approximately 58 kg (130 lb).

Installation

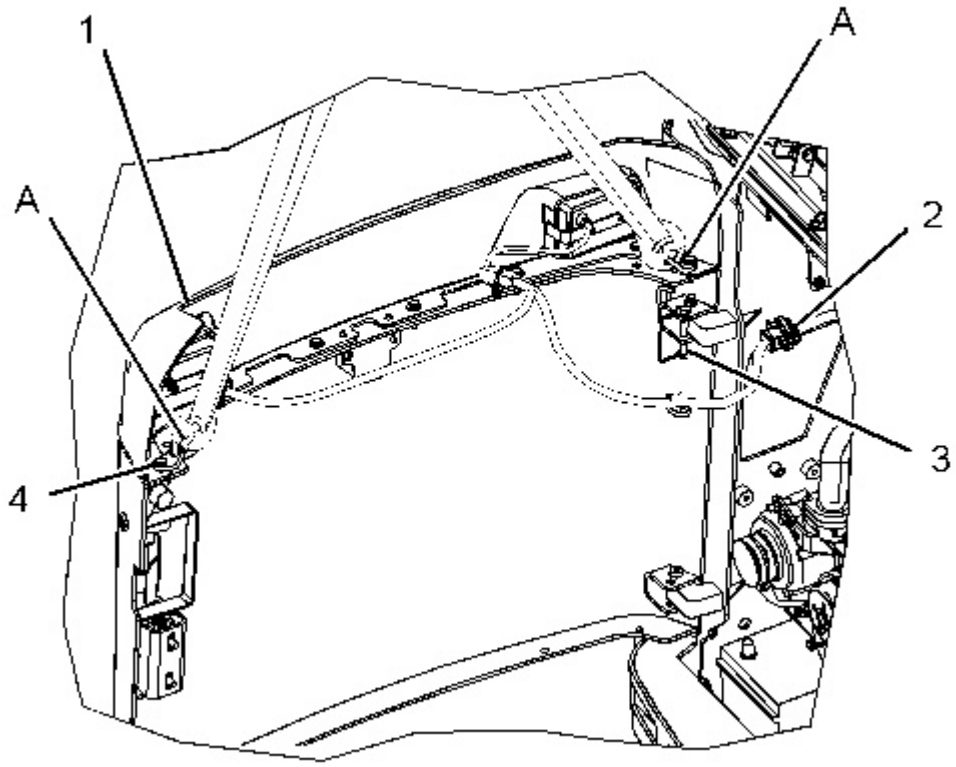


Illustration 3 g01041748

1. Remove bolts (4) and install a suitable lifting device with Tooling (A) to the engine enclosure (1), as shown. Install the engine enclosure. The weight of the engine enclosure is approximately 58 kg (130 lb). Connect harness assembly (2) .

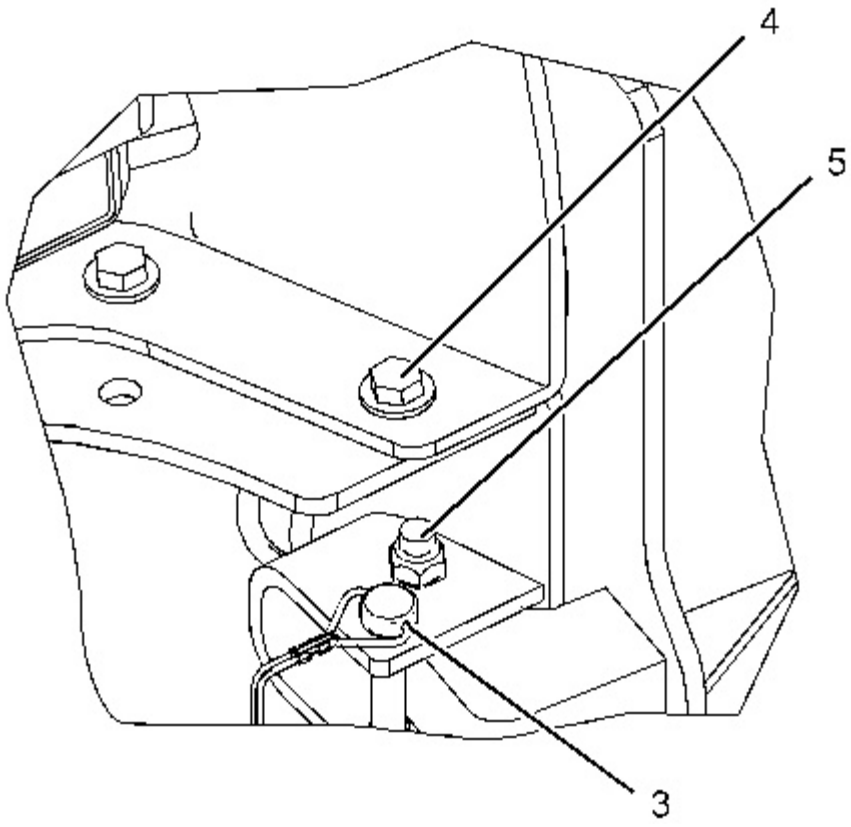


Illustration 4 g01041754

2. Install hinge bolts (5). Remove Tooling (A) and install bolts (4). Tilt the radiator back into the operating position. Remove pin (3) and close the engine enclosure (1).

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i02015014

Engine Enclosure - Remove and Install

SMCS - 7263-010

Removal

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	8T-7475	M8 Bolt	2
	8T-4224	Hard Washer	2
	138-7573	Link Bracket	2

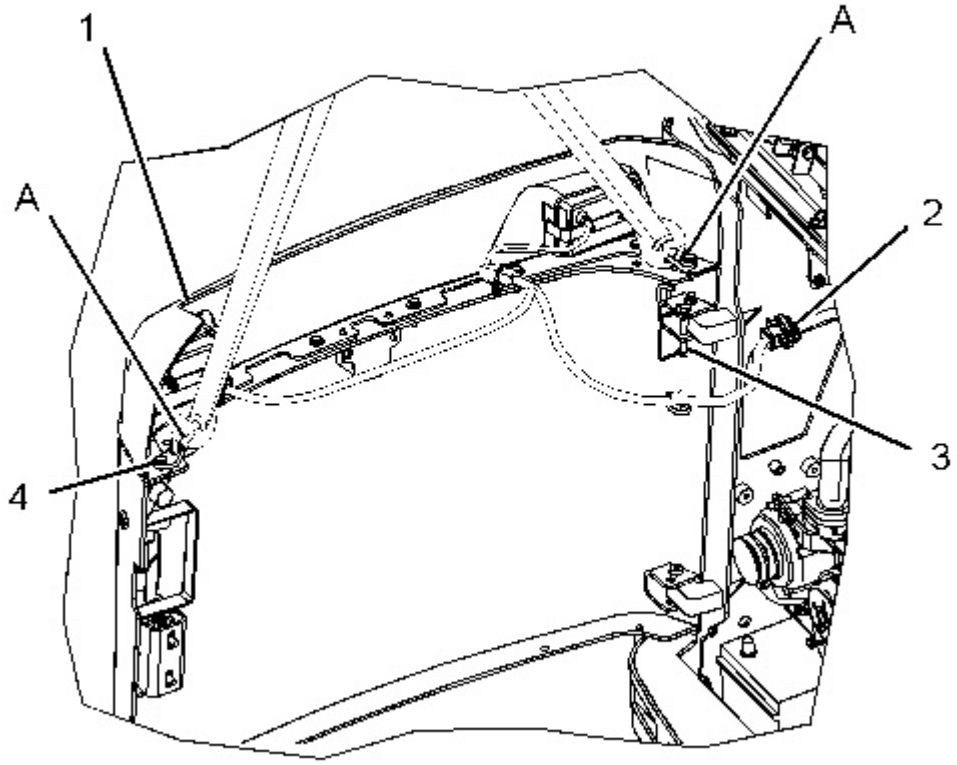


Illustration 1 g01041748

1. Tilt the radiator. Open the engine enclosure (1) and install pin (3). Disconnect harness assembly (2). Remove bolts (4) and install a suitable lifting device with Tooling (A) to the engine enclosure (1), as shown.

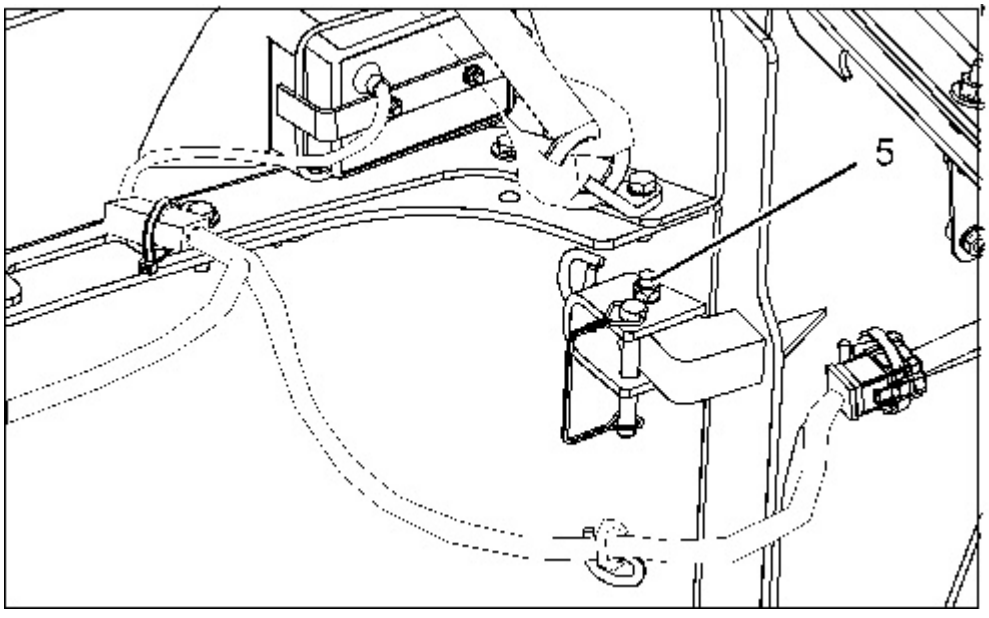


Illustration 2 g01047970

2. Remove hinge bolts (5) and remove the engine enclosure. The weight of the engine enclosure is approximately 58 kg (130 lb).

Installation

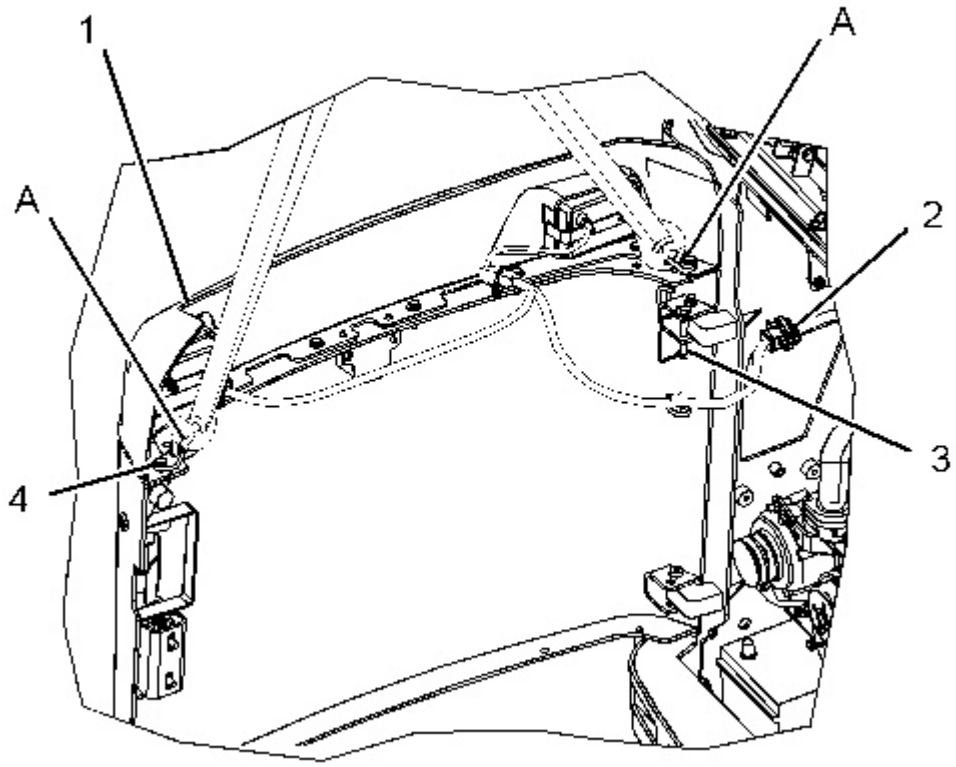


Illustration 3 g01041748

1. Remove bolts (4) and install a suitable lifting device with Tooling (A) to the engine enclosure (1), as shown. Install the engine enclosure. The weight of the engine enclosure is approximately 58 kg (130 lb). Connect harness assembly (2) .

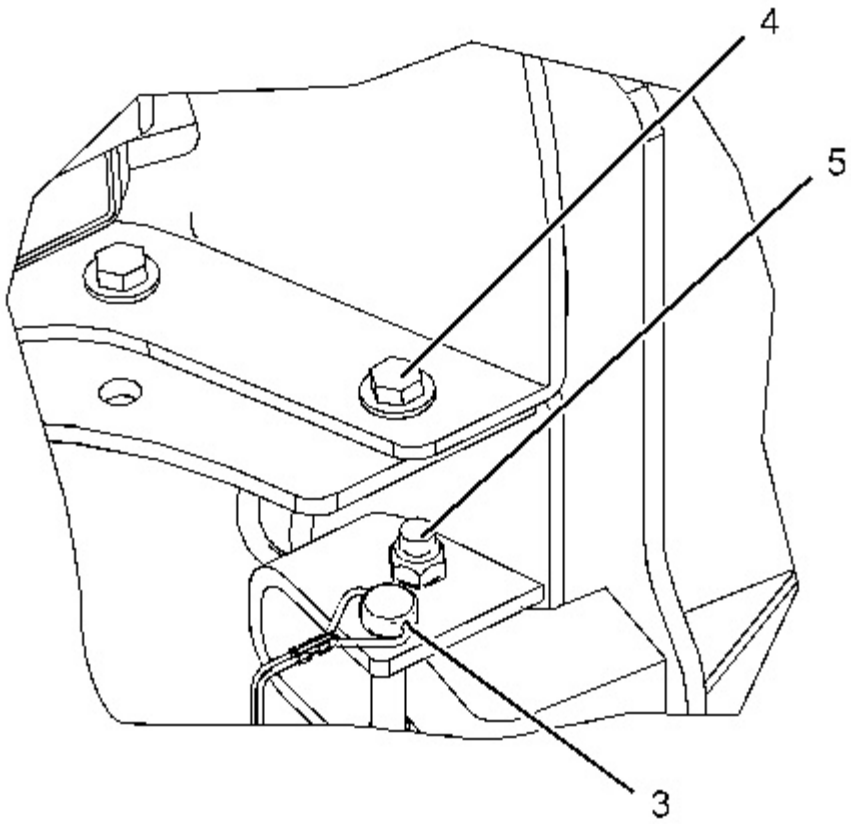


Illustration 4 g01041754

2. Install hinge bolts (5). Remove Tooling (A) and install bolts (4). Tilt the radiator back into the operating position. Remove pin (3) and close the engine enclosure (1).

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865358

Lift Arm Cylinder and Mounting

SMCS - 5102-MT; 5102; 5104-MT; 5104; 6119-S/C

S/N - HEN1-6749

S/N - PAT1-UP

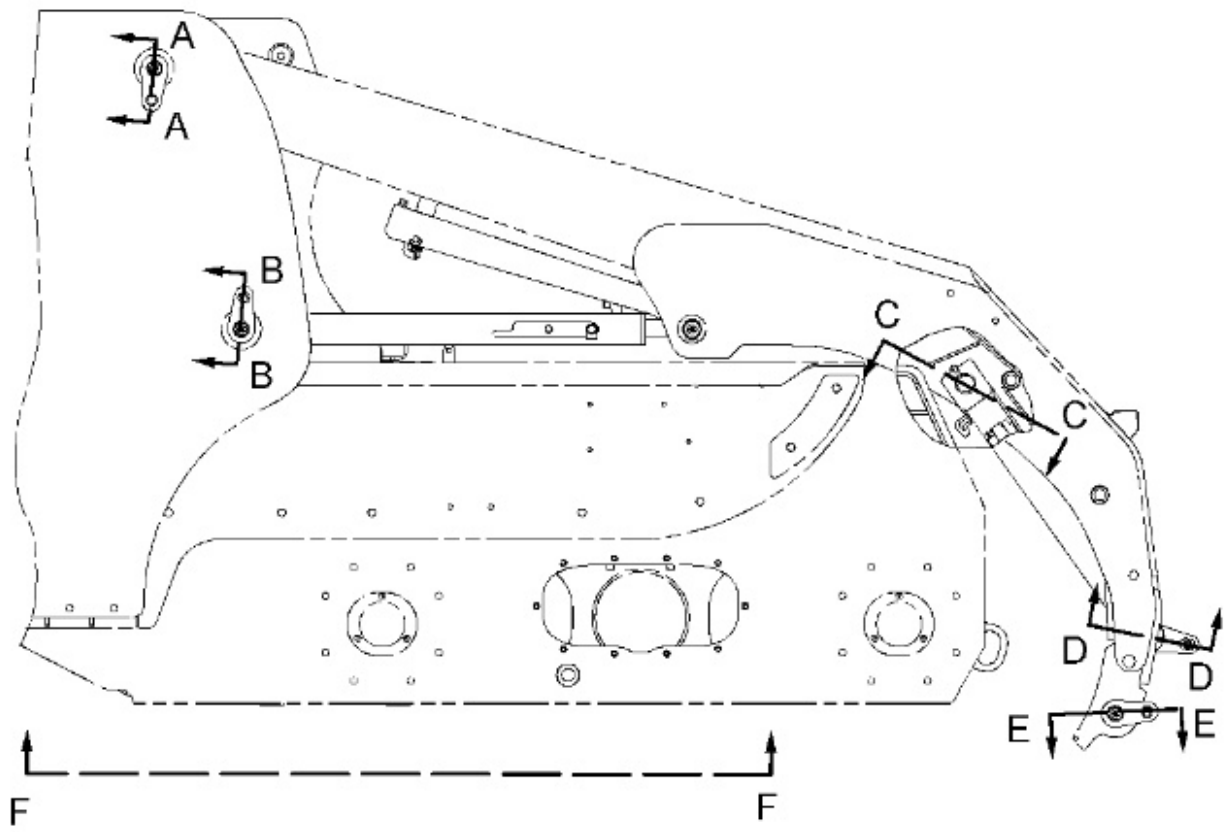


Illustration 1 g01020905

Note: Before assembly, all pins, bores and bearings must be clean. All pins, bores and bearings must be lubricated with the lubricant that is being sealed. Lubricate the entire cylindrical surface of all pins.

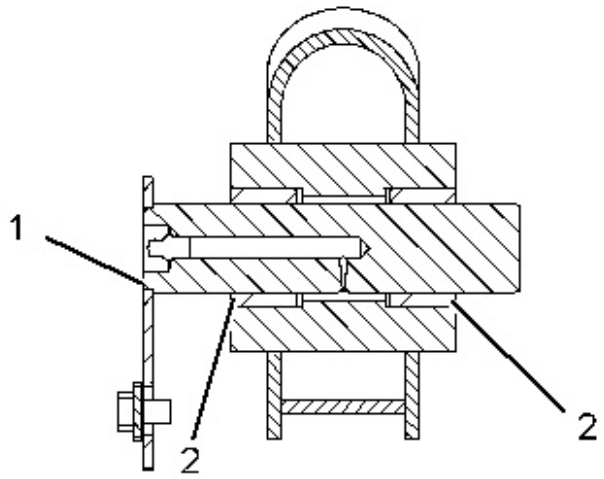


Illustration 2 g01427677

Section A-A

(1) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(2) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

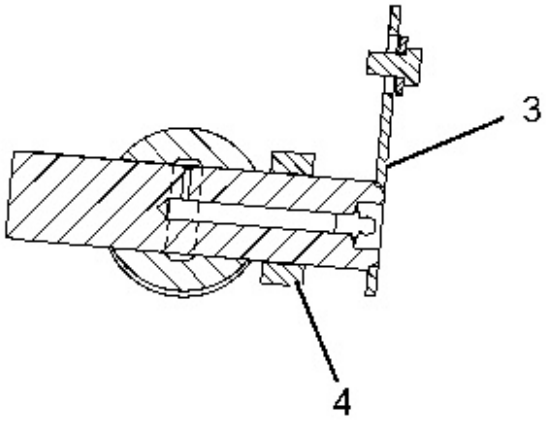


Illustration 3 g01427673

Section B-B

(3) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(4) **142-9142** Spacer

Quantity ... 2
Thickness of one spacer ... 18.0 mm (0.71 inch)

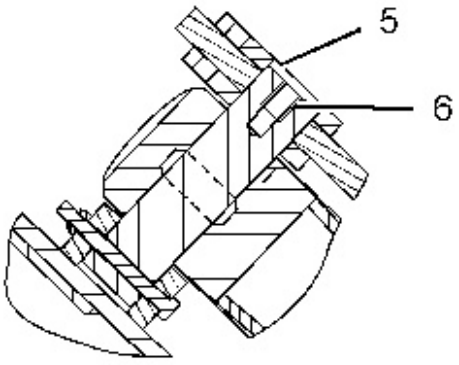


Illustration 4 g01427669

Section C-C

(5) **142-9093** Pin

Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 150.0 ± 1.5 mm (5.91 ± 0.06 inch)
Thread (6) for pin removal ... M12 X 1.75
Depth of threads ... 18.0 ± 1.5 mm (0.71 ± 0.06 inch)

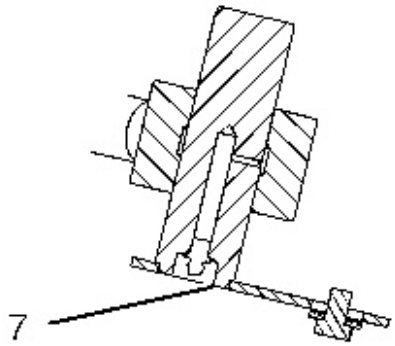


Illustration 5 g01427667

Section D-D

(7) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

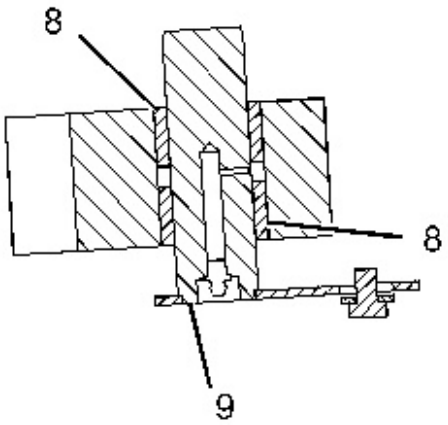


Illustration 6 g01427663

Section E-E

(8) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

(9) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

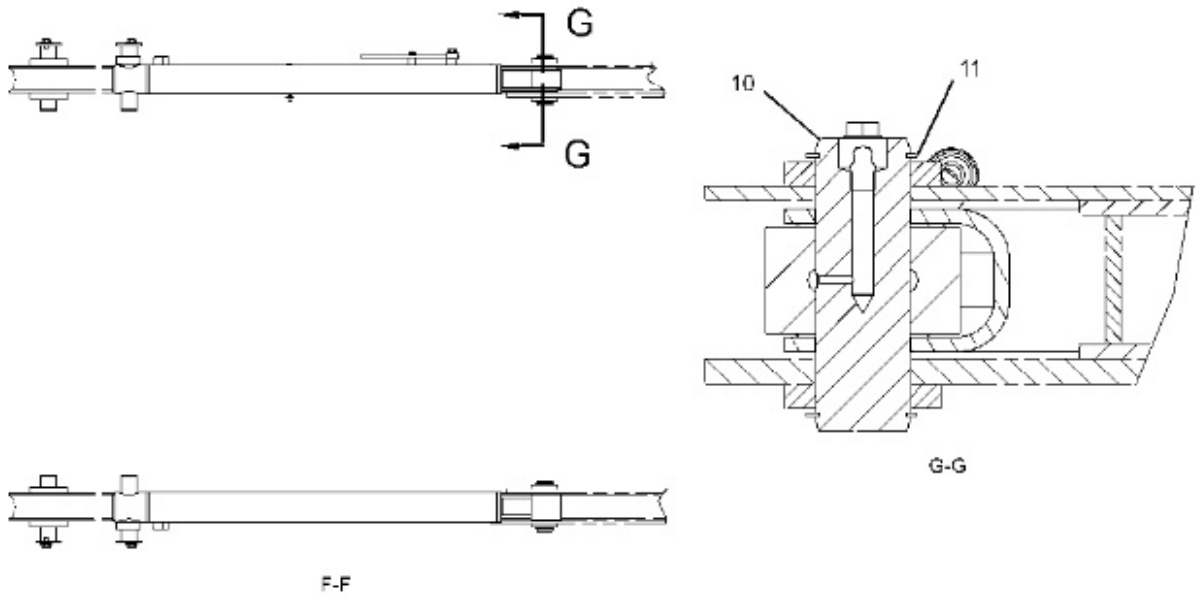


Illustration 7 g01427351

(10) **142-9094** Pin

Quantity ... 2
Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 120.0 ± 1.0 mm (4.72 ± 0.04 inch)
Width of the groove ... 1.52 ± 0.10 mm (0.060 ± 0.004 inch)

(11) **1H-8134** Retaining Ring

Quantity ... 4
Internal diameter ... 35.23 + 0.25 - 0.38 mm (1.387 + 0.010 - 0.015 inch)
Thickness of one retainer ring ... 1.27 ± 0.05 mm (0.050 ± 0.002 inch)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865358

Lift Arm Cylinder and Mounting

SMCS - 5102-MT; 5102; 5104-MT; 5104; 6119-S/C

S/N - HEN6750-UP

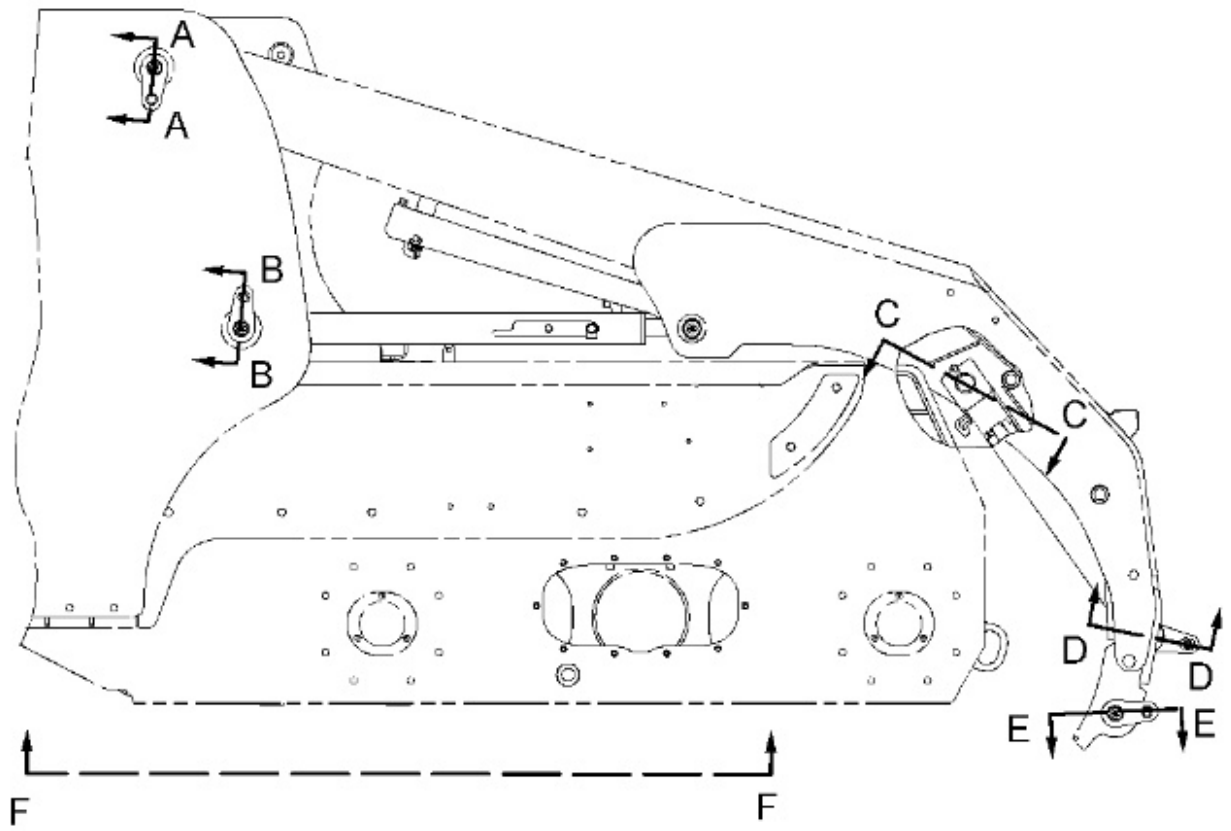


Illustration 1 g01020905

Note: Before assembly, all pins, bores and bearings must be clean. All pins, bores and bearings must be lubricated with the lubricant that is being sealed. Lubricate the entire cylindrical surface of all pins.

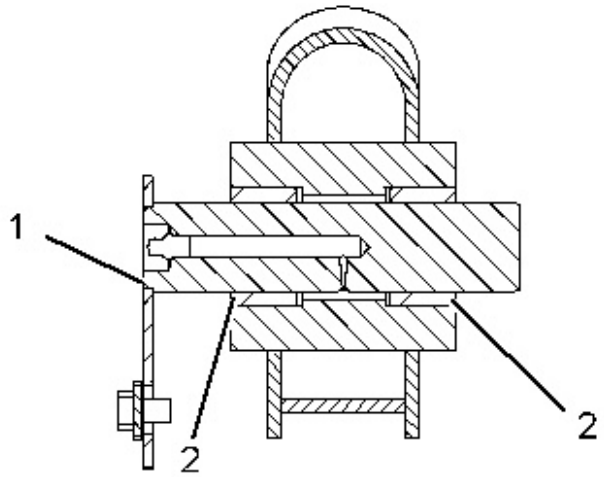


Illustration 2 g01427677

Section A-A

(1) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(2) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

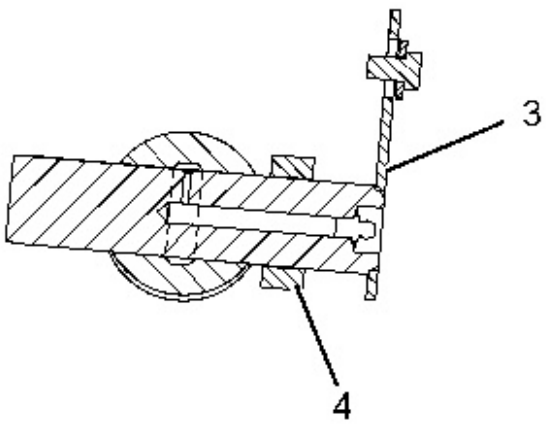


Illustration 3 g01427673

Section B-B

(3) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(4) **142-9142** Spacer

Quantity ... 2
Thickness of one spacer ... 18.0 mm (0.71 inch)

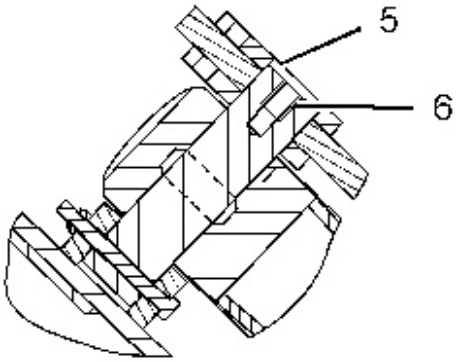


Illustration 4 g01427669

Section C-C

(5) **142-9093** Pin

Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 150.0 ± 1.5 mm (5.91 ± 0.06 inch)
Thread (6) for pin removal ... M12 X 1.75
Depth of threads ... 18.0 ± 1.5 mm (0.71 ± 0.06 inch)

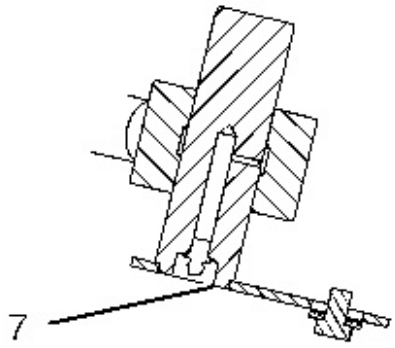


Illustration 5 g01427667

Section D-D

(7) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

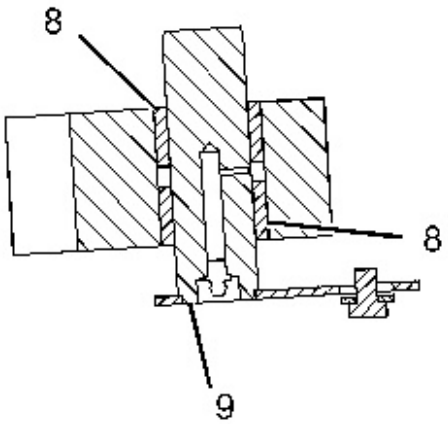


Illustration 6 g01427663

Section E-E

(8) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

(9) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

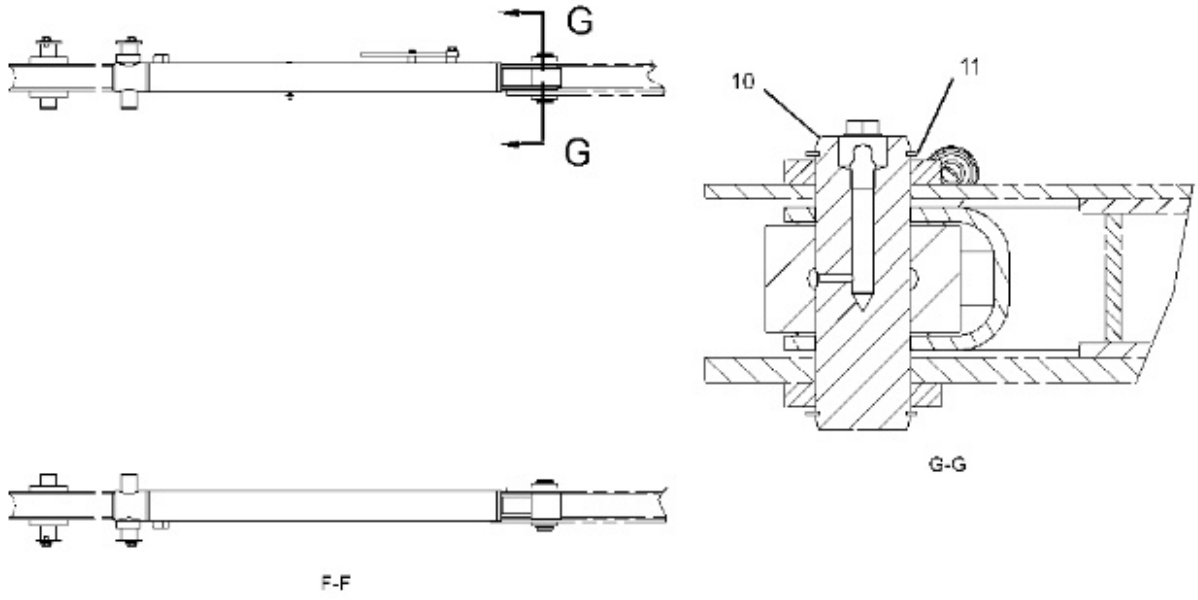


Illustration 7 g01427351

(10) **142-9094** Pin

Quantity ... 2
Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 120.0 ± 1.0 mm (4.72 ± 0.04 inch)
Width of the groove ... 1.52 ± 0.10 mm (0.060 ± 0.004 inch)

(11) **1H-8134** Retaining Ring

Quantity ... 4
Internal diameter ... 35.23 + 0.25 - 0.38 mm (1.387 + 0.010 - 0.015 inch)
Thickness of one retainer ring ... 1.27 ± 0.05 mm (0.050 ± 0.002 inch)

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i02637314

Governor Control

SMCS - 1265; 1276

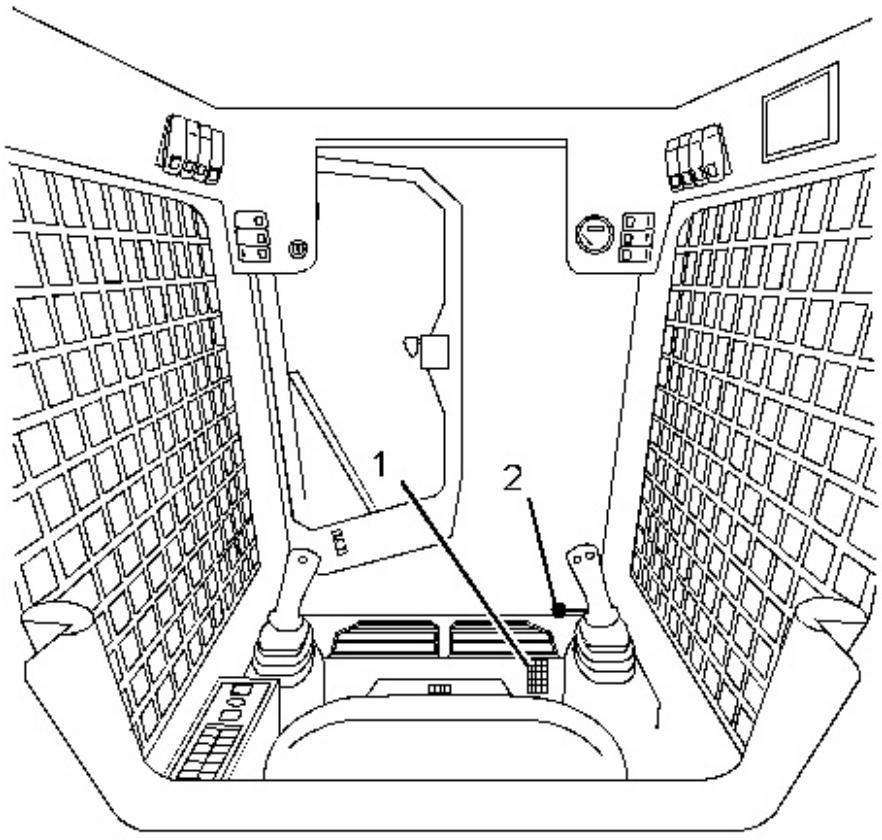


Illustration 1 g01322386

(1) Governor Pedal Group

(2) Governor Lever Group

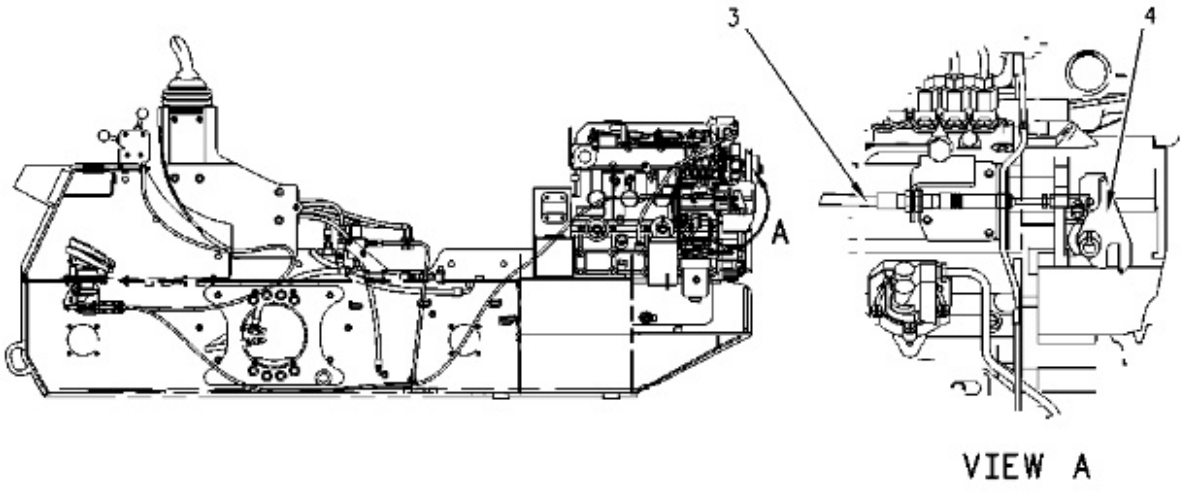


Illustration 2 g00765357

(3) Governor Control Cable

(4) Lever

The Governor Pedal Group (1) is part of the linkage assembly. The linkage assembly connects to an adjustable rod. The adjustable rod connects to the Governor Control Cable (3). The Governor Control Cable actuates the lever (4) on the engine governor.

Push the Governor Pedal Group downward in order to increase the speed of the engine. As the pedal is pushed down, the Governor Control Cable (3) pulls the lever (4) on the governor.

The Governor Lever Group (2) is mechanically coupled with the Governor Pedal Group (1) by a cable. When you push the Governor Lever Group forward, the speed of the engine increases. The Governor Lever Group is used to set the desired low idle speed.

In order to increase the speed of the engine, the operator must depress the Governor Pedal Group. The engine speed will increase regardless of the setting of the Governor Lever Group. When the operator releases the Governor Pedal Group, the position of the Governor Lever Group determines the engine low idle speed.

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i02637314

Governor Control

SMCS - 1265; 1276

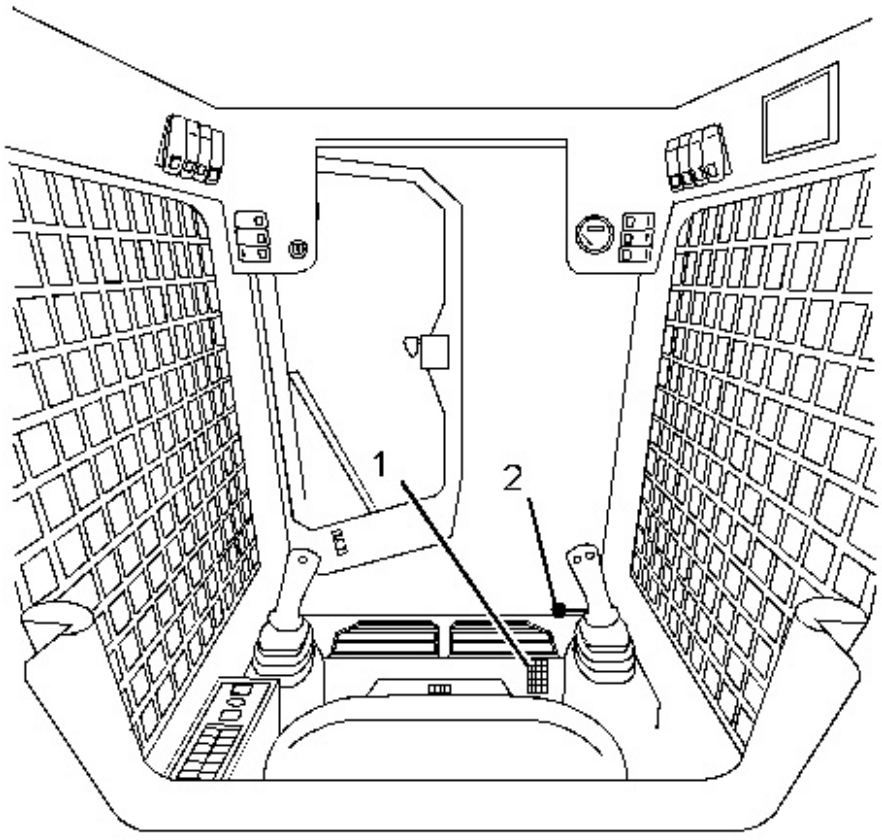


Illustration 1 g01322386

(1) Governor Pedal Group

(2) Governor Lever Group

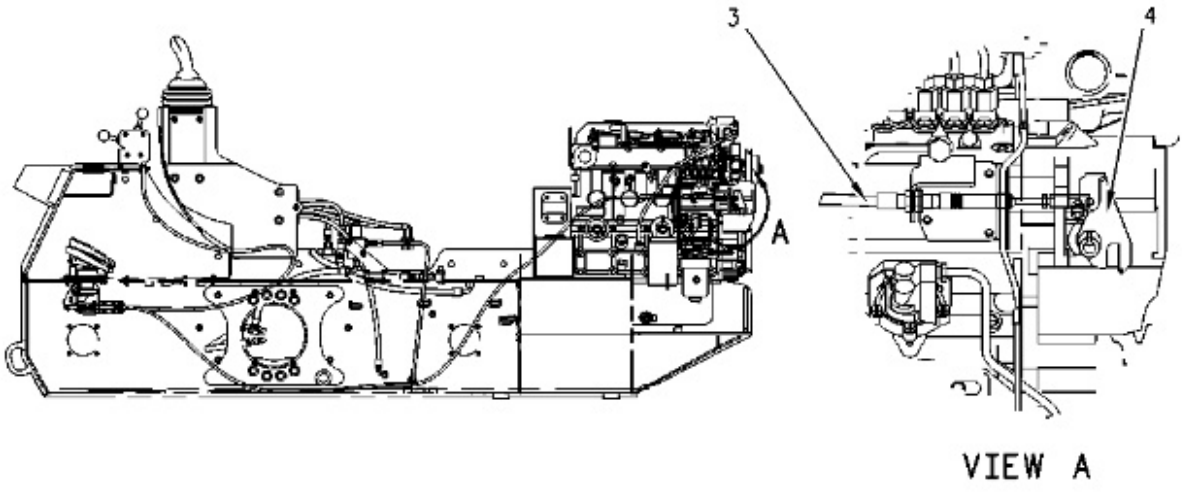


Illustration 2 g00765357

(3) Governor Control Cable

(4) Lever

The Governor Pedal Group (1) is part of the linkage assembly. The linkage assembly connects to an adjustable rod. The adjustable rod connects to the Governor Control Cable (3). The Governor Control Cable actuates the lever (4) on the engine governor.

Push the Governor Pedal Group downward in order to increase the speed of the engine. As the pedal is pushed down, the Governor Control Cable (3) pulls the lever (4) on the governor.

The Governor Lever Group (2) is mechanically coupled with the Governor Pedal Group (1) by a cable. When you push the Governor Lever Group forward, the speed of the engine increases. The Governor Lever Group is used to set the desired low idle speed.

In order to increase the speed of the engine, the operator must depress the Governor Pedal Group. The engine speed will increase regardless of the setting of the Governor Lever Group. When the operator releases the Governor Pedal Group, the position of the Governor Lever Group determines the engine low idle speed.

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i05265761

Fuel System

SMCS - 1250

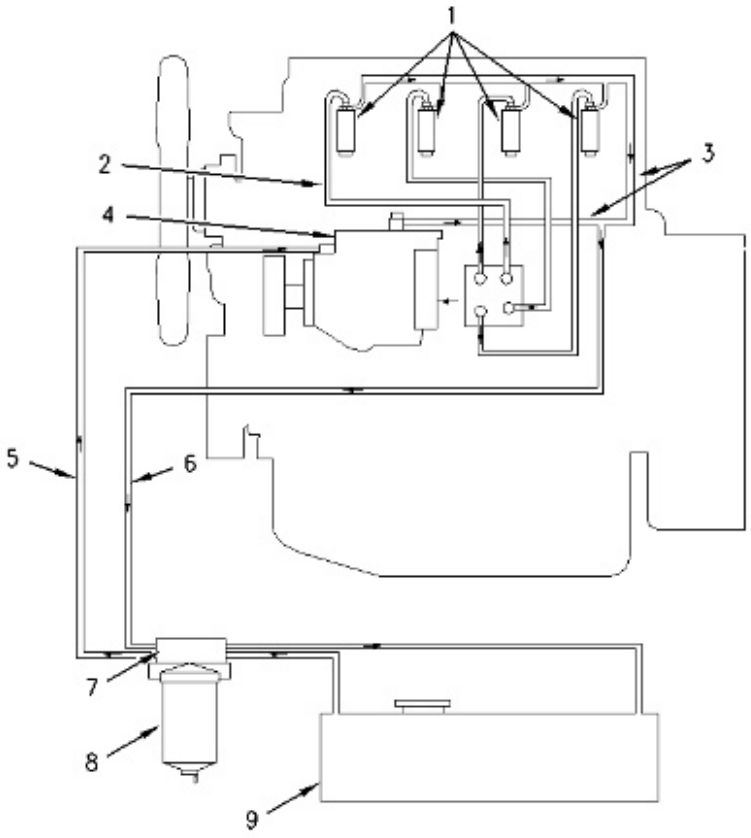


Illustration 1 g00987171

Flow diagram of the fuel system

(1) Fuel injection nozzles

(2) High-pressure fuel lines

(3) Fuel return lines

(4) Fuel injection pump

(5) Fuel supply line

(6) Return line to the fuel tank

(7) Fuel transfer pump

(8) Fuel filter/water separator

(9) Fuel tank

The engine is equipped with an axial piston distributor injection pump that is mechanically governed.

The axial piston distributor injection pump generates injection pressure for all cylinders in a single pump. The injection pump is responsible for the distribution of fuel to the fuel injection nozzles. The injection pressure is generated by an axially moving piston. The movement of the piston is parallel to the fuel injection pump shaft.

When the engine is cranking, the fuel is pulled from fuel tank (9) through the primary fuel filter/water separator (8) by fuel transfer pump (7) . When the fuel passes through the water separator, any water in the fuel will go to the bottom of the bowl. From the fuel transfer pump, the fuel passes through fuel supply line (5) to fuel injection pump (4) .

The fuel is drawn by an internal fuel transfer pump into the fuel injection pump. The fuel is drawn by an internal fuel transfer pump at a pressure of 48 to 83 kPa (7 to 12 psi). A portion of the fuel is routed through the pressure regulator assembly to the suction side of the fuel injection pump. The fuel that is under pressure from the fuel transfer pump flows to the interior of the pump housing. The pressurized fuel is routed to the pumping chamber. As the plunger rotates and as the plunger reciprocates, high-pressure fuel is routed through high-pressure fuel lines (2) to fuel injection nozzles (1) .

The fuel injection nozzles spray atomized fuel into the cylinder. Excess fuel is routed through fuel return lines (3) and (6) and returned to the fuel tank.

Routing excess fuel back to the fuel tank allows air in the fuel to flow back to the fuel tank through the fuel return line. The fuel that flows into the housing of the fuel injection pump performs the following functions:

- Lubricate the internal components.
- Cool the internal components.
- Remove small air bubbles.

The fuel injection pump needs fuel for lubrication. The precision parts of the pump are easily damaged. The engine must not be started until the fuel injection pump is full of fuel. The system must be primed when any part of the system is drained of fuel. The fuel system needs priming when a fuel filter is changed, and/or when a fuel line is removed, and/or when the fuel injection pump is replaced.

Fuel Injection Pump

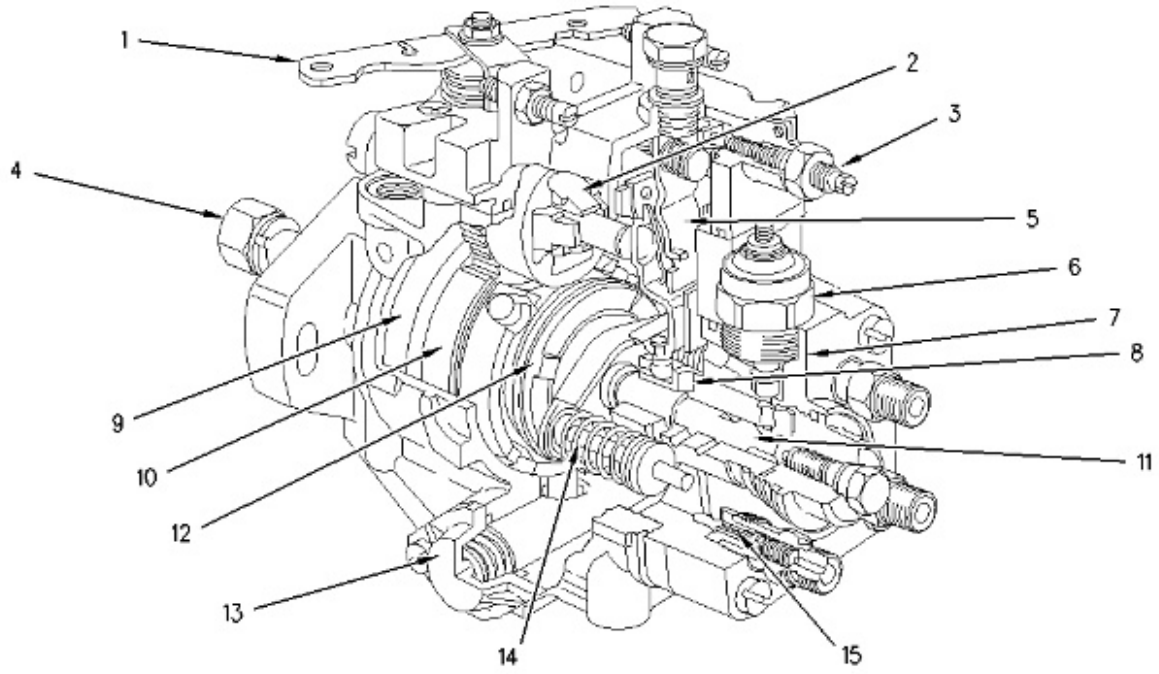


Illustration 2 g00992842

Components of the fuel injection pump (typical example)

(1) Control lever

(2) Flyweights

(3) Screw for adjusting the full load setting

(4) Drive shaft

(5) Governor lever

(6) Fuel shutoff solenoid

(7) Head of the distributor

(8) Control sleeve

(9) Transfer pump

(10) Holder for the rollers

(11) Plunger

(12) Cam

(13) Timer

(14) Plunger spring

(15) Delivery valve

The fuel injection pump is a pressurized system that is enclosed. The pump sends the correct amount of fuel under high pressure at the correct time through the fuel injection nozzles to the individual cylinders. The correct timing occurs near the end of the compression stroke. The fuel injection pump

regulates the amount of fuel that is delivered to the fuel injection nozzles. This action controls the engine rpm by the governor setting or the position of the throttle control.

The fuel lines to the fuel injection nozzles are equal lengths. This ensures even pressure and correct injection timing at each fuel injection nozzle.

During operation, extra fuel is used as coolant and lubricant for pump parts that move. The extra fuel is circulated through the pump housing. The extra fuel is then returned to the fuel tank. Fuel return lines also carry away any air that is trapped in the fuel injection nozzles or in the fuel injection pump housing.

Fuel Delivery

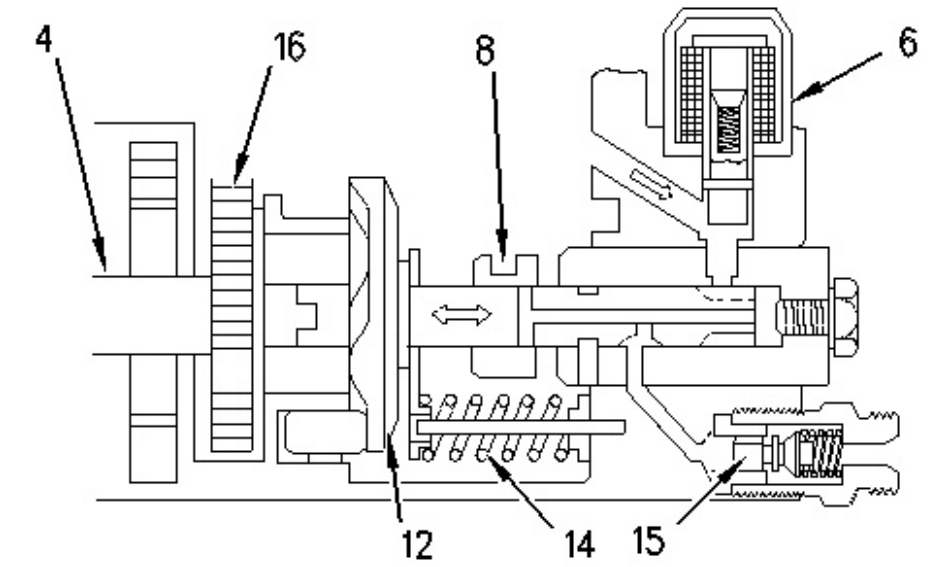


Illustration 3 g00531644

Cross section view of the fuel injection pump (typical example)

(4) Drive shaft

(6) Fuel shutoff solenoid

(8) Control sleeve

(12) Cam

(14) Plunger spring

(15) Delivery valve

(16) Gear

The fuel injection pump transfers fuel to the fuel injection nozzles at high pressure. Cam (12) is driven from the engine by drive shaft (4) . The drive shaft is driven from the front gear group. Lobes on the cam cause the plunger to reciprocate. The reciprocating motion first draws the fuel into the pump. The reciprocating motion then pressurizes the fuel.

The plunger also rotates with the cam in order to sequentially align the discharge groove of the cam with each of the ports on the fuel injection pump. The plunger moves a distance which is established by the lobes of the cam.

The effective stroke is established by the position of the control sleeve. When control sleeve (8) is moved to the left prior to the injection of fuel, the spill port is uncovered. Uncovering the spill port reduces the amount of fuel that is delivered to the cylinder. When the control sleeve is moved to the right prior to the injection of fuel, the spill port is covered. Covering the spill port increases the amount of fuel that is delivered to the fuel injection nozzle.

The pump also includes an internal timer (not shown). The timer allows early fuel injection by advancing the plunger. The plunger is advanced in relation to the camshaft. Fuel shutoff solenoid (6) is normally closed. When a voltage is applied, the plunger in the solenoid moves up in order to allow the fuel delivery which allows the engine to run.

Timing Control System (if equipped)

The timing control system deactivates the load sensing timer when the engine coolant temperature is below 60 °C (140 °F) or when the pump is used at high altitudes.

Fuel Injection Nozzles

Naturally Aspirated Engines (Indirect Injection)

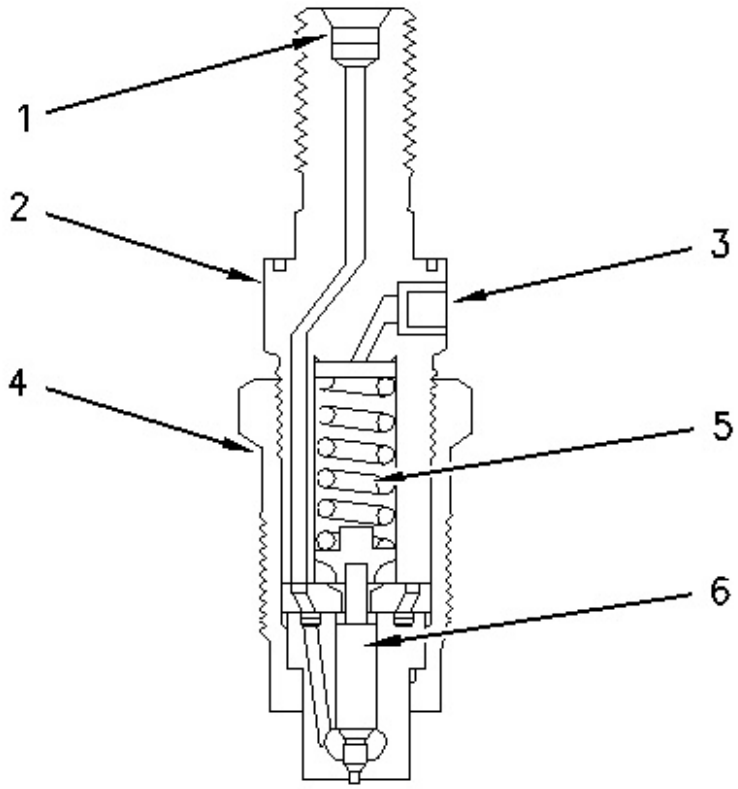


Illustration 4 g00993073

Cross section of the fuel injection nozzle

(1) Fuel inlet

(2) Body

(3) Fuel return

(4) Retaining nut

(5) Pressure spring

(6) Nozzle tip assembly

The fuel injection pump forces the fuel to flow under high pressure to the hole in fuel inlet (1) . The fuel then flows down through body (2) to the underside of the needle in nozzle tip assembly (6) . The pressure of the fuel pushes the needle valve and pressure spring (5) . When the force of the fuel pressure is greater than the force of the pressure spring, the needle valve will lift up.

When the needle valve opens, fuel under high pressure will flow through the single orifice and into the cylinder. The fuel is injected into the cylinder as a very fine spray. When the fuel is injected into the cylinder, the force of the fuel pressure in the nozzle body will decrease. The force of the pressure spring will then be greater than the force of the fuel pressure that is in the nozzle body. The needle valve will move quickly to the closed position.

The seat of the needle valve has a close fit with the inside of the nozzle. This makes a positive seal when the valve is closed.

When the fuel is injected into the cylinder, a small quantity of fuel will leak into the chamber that contains the pressure spring. This fuel lubricates the moving parts of the fuel injection nozzle. This fuel then goes through a passage in the body of the fuel injection nozzle to fuel return (3) . This excess fuel is then returned to the fuel tank.

Turbocharged Engines (Direct Injection)

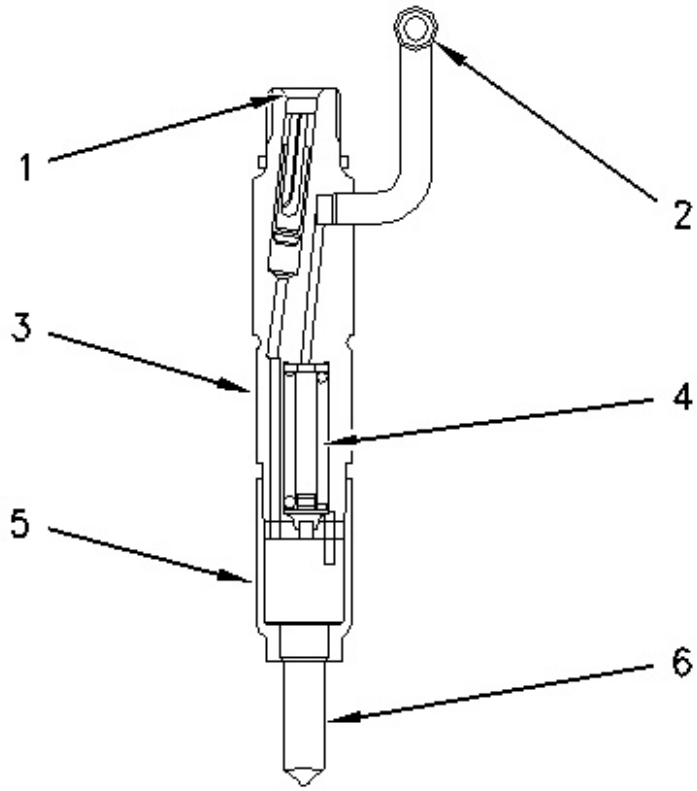


Illustration 5 g00993074

Cross section of the fuel injection nozzle

(1) Fuel inlet

(2) Fuel return

(3) Body

(4) Pressure spring

(5) Retaining nut

(6) Nozzle tip

The fuel injection pump forces the fuel to flow under high pressure to the hole in fuel inlet (1) . The fuel then flows down through body (3) to the underside of the needle in nozzle tip (6) . The pressure of the fuel pushes the needle valve and pressure spring (4) . When the force of the fuel pressure is greater than the force of the pressure spring, the needle valve will lift up.

When the needle valve opens, fuel under high pressure will flow through the multiple orifices in the nozzle tip and into the cylinder. The fuel is injected into the cylinder as a very fine spray. When the fuel is injected into the cylinder, the force of the fuel pressure in the nozzle body will decrease. The force of the pressure spring will then be greater than the force of the fuel pressure that is in the nozzle body. The needle valve will move quickly to the closed position.

The seat of the needle valve has a close fit with the inside of the nozzle. This makes a positive seal when the valve is closed.

When the fuel is injected into the cylinder, a small quantity of fuel will leak into the chamber that contains the pressure spring. This fuel lubricates the moving parts of the fuel injection nozzle. This fuel then goes through a passage in the body of the fuel injection nozzle to fuel return (2) . This excess fuel is then returned to the fuel tank.

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i05265761

Fuel System

SMCS - 1250

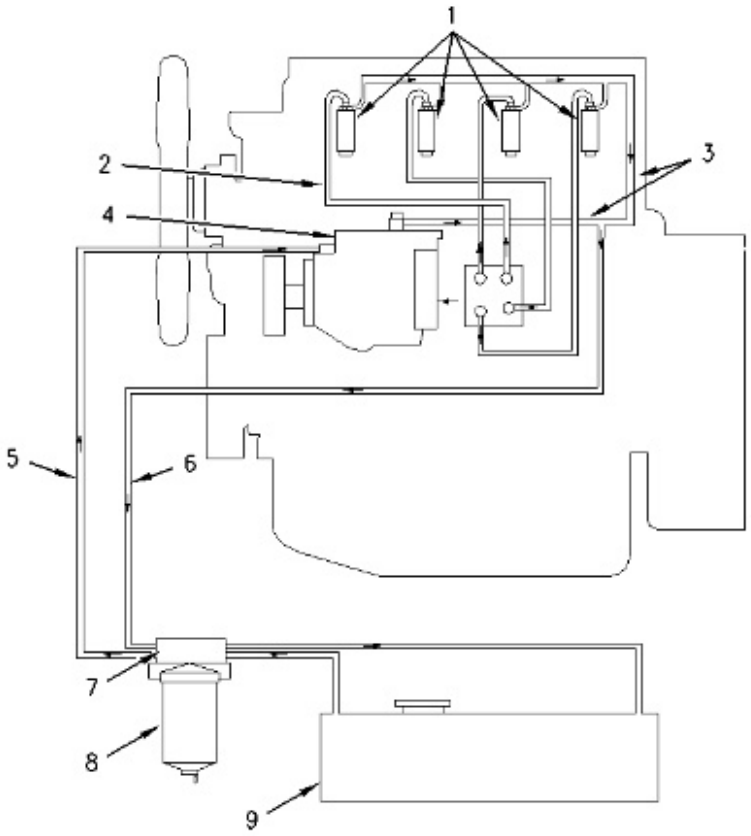


Illustration 1 g00987171

Flow diagram of the fuel system

(1) Fuel injection nozzles

(2) High-pressure fuel lines

(3) Fuel return lines

(4) Fuel injection pump

(5) Fuel supply line

(6) Return line to the fuel tank

(7) Fuel transfer pump

(8) Fuel filter/water separator

(9) Fuel tank

The engine is equipped with an axial piston distributor injection pump that is mechanically governed.

The axial piston distributor injection pump generates injection pressure for all cylinders in a single pump. The injection pump is responsible for the distribution of fuel to the fuel injection nozzles. The injection pressure is generated by an axially moving piston. The movement of the piston is parallel to the fuel injection pump shaft.

When the engine is cranking, the fuel is pulled from fuel tank (9) through the primary fuel filter/water separator (8) by fuel transfer pump (7) . When the fuel passes through the water separator, any water in the fuel will go to the bottom of the bowl. From the fuel transfer pump, the fuel passes through fuel supply line (5) to fuel injection pump (4) .

The fuel is drawn by an internal fuel transfer pump into the fuel injection pump. The fuel is drawn by an internal fuel transfer pump at a pressure of 48 to 83 kPa (7 to 12 psi). A portion of the fuel is routed through the pressure regulator assembly to the suction side of the fuel injection pump. The fuel that is under pressure from the fuel transfer pump flows to the interior of the pump housing. The pressurized fuel is routed to the pumping chamber. As the plunger rotates and as the plunger reciprocates, high-pressure fuel is routed through high-pressure fuel lines (2) to fuel injection nozzles (1) .

The fuel injection nozzles spray atomized fuel into the cylinder. Excess fuel is routed through fuel return lines (3) and (6) and returned to the fuel tank.

Routing excess fuel back to the fuel tank allows air in the fuel to flow back to the fuel tank through the fuel return line. The fuel that flows into the housing of the fuel injection pump performs the following functions:

- Lubricate the internal components.
- Cool the internal components.
- Remove small air bubbles.

The fuel injection pump needs fuel for lubrication. The precision parts of the pump are easily damaged. The engine must not be started until the fuel injection pump is full of fuel. The system must be primed when any part of the system is drained of fuel. The fuel system needs priming when a fuel filter is changed, and/or when a fuel line is removed, and/or when the fuel injection pump is replaced.

Fuel Injection Pump

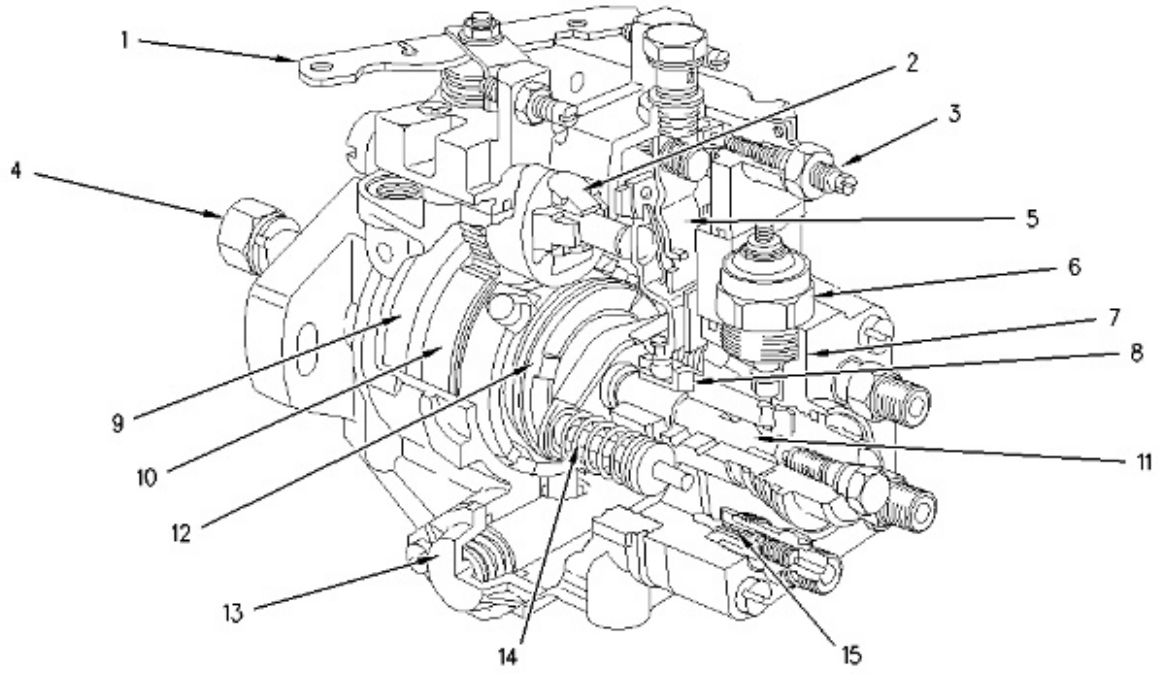


Illustration 2 g00992842

Components of the fuel injection pump (typical example)

(1) Control lever

(2) Flyweights

(3) Screw for adjusting the full load setting

(4) Drive shaft

(5) Governor lever

(6) Fuel shutoff solenoid

(7) Head of the distributor

(8) Control sleeve

(9) Transfer pump

(10) Holder for the rollers

(11) Plunger

(12) Cam

(13) Timer

(14) Plunger spring

(15) Delivery valve

The fuel injection pump is a pressurized system that is enclosed. The pump sends the correct amount of fuel under high pressure at the correct time through the fuel injection nozzles to the individual cylinders. The correct timing occurs near the end of the compression stroke. The fuel injection pump

regulates the amount of fuel that is delivered to the fuel injection nozzles. This action controls the engine rpm by the governor setting or the position of the throttle control.

The fuel lines to the fuel injection nozzles are equal lengths. This ensures even pressure and correct injection timing at each fuel injection nozzle.

During operation, extra fuel is used as coolant and lubricant for pump parts that move. The extra fuel is circulated through the pump housing. The extra fuel is then returned to the fuel tank. Fuel return lines also carry away any air that is trapped in the fuel injection nozzles or in the fuel injection pump housing.

Fuel Delivery

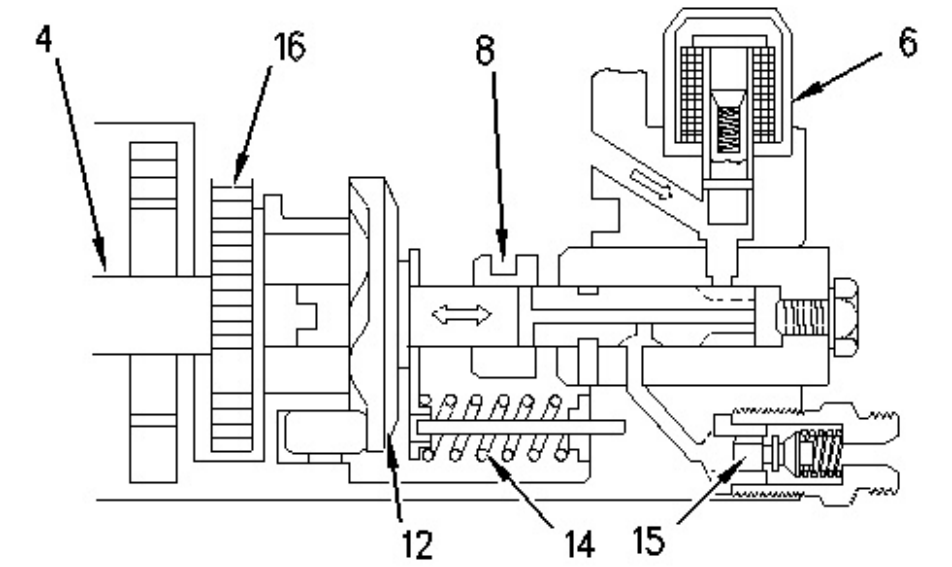


Illustration 3 g00531644

Cross section view of the fuel injection pump (typical example)

(4) Drive shaft

(6) Fuel shutoff solenoid

(8) Control sleeve

(12) Cam

(14) Plunger spring

(15) Delivery valve

(16) Gear

The fuel injection pump transfers fuel to the fuel injection nozzles at high pressure. Cam (12) is driven from the engine by drive shaft (4) . The drive shaft is driven from the front gear group. Lobes on the cam cause the plunger to reciprocate. The reciprocating motion first draws the fuel into the pump. The reciprocating motion then pressurizes the fuel.

The plunger also rotates with the cam in order to sequentially align the discharge groove of the cam with each of the ports on the fuel injection pump. The plunger moves a distance which is established by the lobes of the cam.

The effective stroke is established by the position of the control sleeve. When control sleeve (8) is moved to the left prior to the injection of fuel, the spill port is uncovered. Uncovering the spill port reduces the amount of fuel that is delivered to the cylinder. When the control sleeve is moved to the right prior to the injection of fuel, the spill port is covered. Covering the spill port increases the amount of fuel that is delivered to the fuel injection nozzle.

The pump also includes an internal timer (not shown). The timer allows early fuel injection by advancing the plunger. The plunger is advanced in relation to the camshaft. Fuel shutoff solenoid (6) is normally closed. When a voltage is applied, the plunger in the solenoid moves up in order to allow the fuel delivery which allows the engine to run.

Timing Control System (if equipped)

The timing control system deactivates the load sensing timer when the engine coolant temperature is below 60 °C (140 °F) or when the pump is used at high altitudes.

Fuel Injection Nozzles

Naturally Aspirated Engines (Indirect Injection)

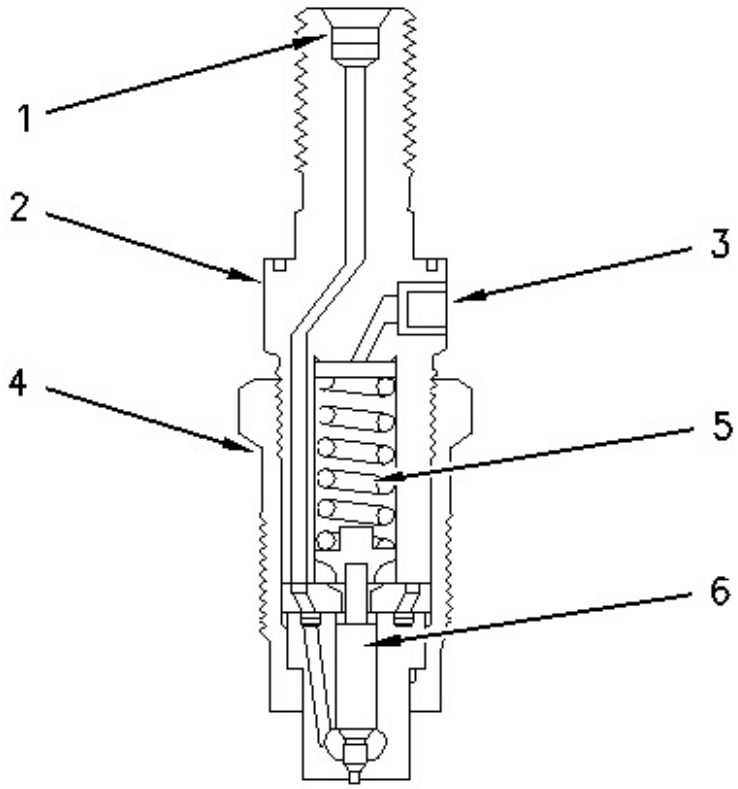


Illustration 4 g00993073

Cross section of the fuel injection nozzle

(1) Fuel inlet

(2) Body

(3) Fuel return

(4) Retaining nut

(5) Pressure spring

(6) Nozzle tip assembly

The fuel injection pump forces the fuel to flow under high pressure to the hole in fuel inlet (1) . The fuel then flows down through body (2) to the underside of the needle in nozzle tip assembly (6) . The pressure of the fuel pushes the needle valve and pressure spring (5) . When the force of the fuel pressure is greater than the force of the pressure spring, the needle valve will lift up.

When the needle valve opens, fuel under high pressure will flow through the single orifice and into the cylinder. The fuel is injected into the cylinder as a very fine spray. When the fuel is injected into the cylinder, the force of the fuel pressure in the nozzle body will decrease. The force of the pressure spring will then be greater than the force of the fuel pressure that is in the nozzle body. The needle valve will move quickly to the closed position.

The seat of the needle valve has a close fit with the inside of the nozzle. This makes a positive seal when the valve is closed.

When the fuel is injected into the cylinder, a small quantity of fuel will leak into the chamber that contains the pressure spring. This fuel lubricates the moving parts of the fuel injection nozzle. This fuel then goes through a passage in the body of the fuel injection nozzle to fuel return (3) . This excess fuel is then returned to the fuel tank.

Turbocharged Engines (Direct Injection)

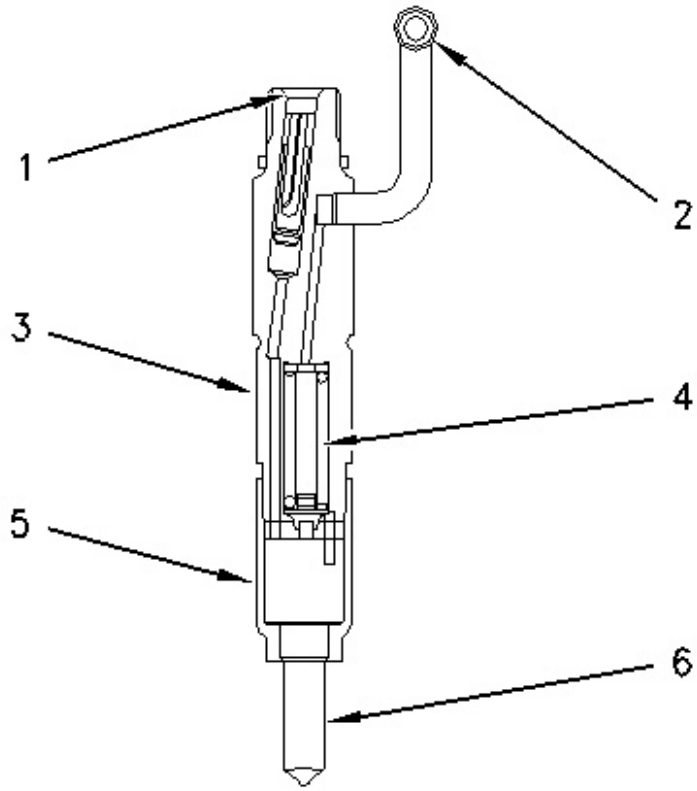


Illustration 5 g00993074

Cross section of the fuel injection nozzle

(1) Fuel inlet

(2) Fuel return

(3) Body

(4) Pressure spring

(5) Retaining nut

(6) Nozzle tip

The fuel injection pump forces the fuel to flow under high pressure to the hole in fuel inlet (1) . The fuel then flows down through body (3) to the underside of the needle in nozzle tip (6) . The pressure of the fuel pushes the needle valve and pressure spring (4) . When the force of the fuel pressure is greater than the force of the pressure spring, the needle valve will lift up.

When the needle valve opens, fuel under high pressure will flow through the multiple orifices in the nozzle tip and into the cylinder. The fuel is injected into the cylinder as a very fine spray. When the fuel is injected into the cylinder, the force of the fuel pressure in the nozzle body will decrease. The force of the pressure spring will then be greater than the force of the fuel pressure that is in the nozzle body. The needle valve will move quickly to the closed position.

The seat of the needle valve has a close fit with the inside of the nozzle. This makes a positive seal when the valve is closed.

When the fuel is injected into the cylinder, a small quantity of fuel will leak into the chamber that contains the pressure spring. This fuel lubricates the moving parts of the fuel injection nozzle. This fuel then goes through a passage in the body of the fuel injection nozzle to fuel return (2) . This excess fuel is then returned to the fuel tank.

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i05182667

Fuel System - Inspect

SMCS - 1250-040

Introduction

A problem with the components that send fuel to the engine can cause low fuel pressure. This can decrease engine performance. Use the following procedure to inspect the fuel system.

Check Procedure

1. Check the fuel level in the fuel tank. Ensure that the vent in the fuel cap is not filled with dirt.
2. Check all fuel lines for fuel leakage. The fuel lines must be free from restrictions and faulty bends. Verify that the fuel return line is not collapsed.
3. Inspect the fuel filter for excess contamination. If necessary, install a new fuel filter. Determine the source of the contamination. Make the necessary repairs.
4. Service the primary fuel filter (if equipped).
5. Remove any air that may be in the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime".

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i05367478

Air in Fuel - Test

SMCS - 1280-081

Introduction

This procedure checks for air in the fuel system. This procedure also assists in finding the source of the air.

Required Tools

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
2P-8278	Tube As (Sight Gauge)	1

Test Procedure

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

1. Examine the fuel system for leaks. Ensure that the fuel line fittings are properly tightened. Check the fuel level in the fuel tank. Air can enter the fuel system on the suction side between the fuel transfer pump and the fuel tank.

2. Install a **2P-8278** Tube As (Sight Gauge) in the fuel return line. When possible, install the sight gauge in a straight section of the fuel line that is at least 304.8 mm (12 inch) long. Do not install the sight gauge near the following devices that create turbulence:

- Elbows
- Relief valves
- Check valves

Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If there is no fuel that is present in the sight gauge, prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for more information. If the engine starts, check for air in the fuel at varying engine speeds. When possible, operate the engine under the conditions which have been suspect.

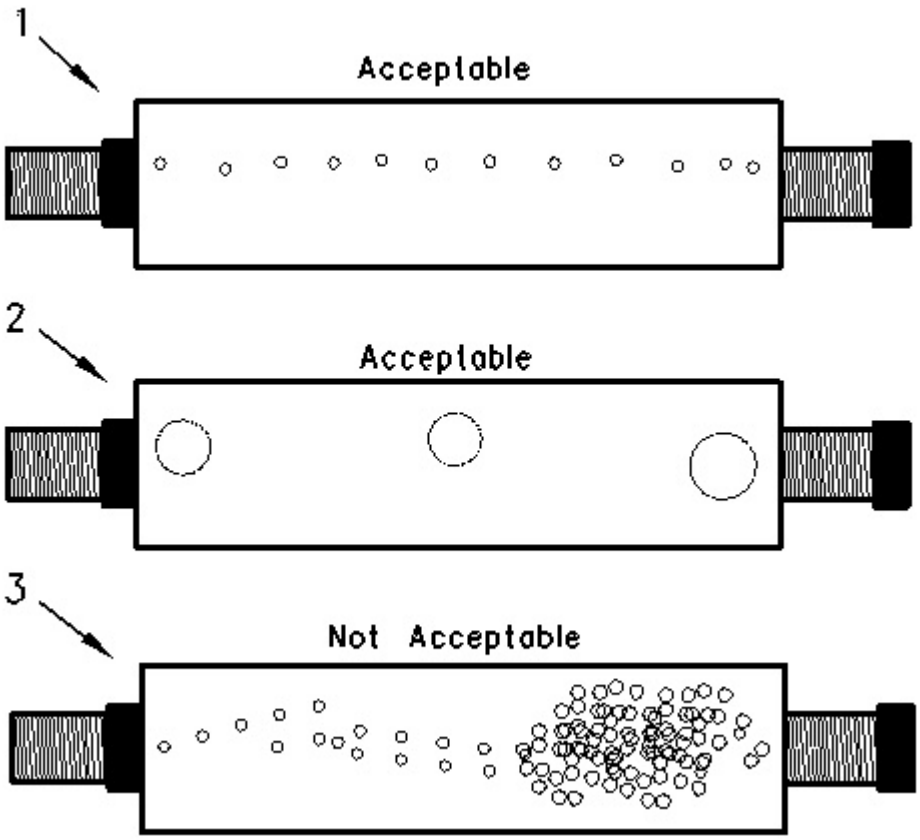


Illustration 1 g00578151

2P-8278 Tube As (Sight Gauge)

(1) A steady stream of small bubbles with a diameter of approximately 1.60 mm (0.063 inch) is an acceptable amount of air in the fuel.

(2) Bubbles with a diameter of approximately 6.35 mm (0.250 inch) are also acceptable if there are 2 seconds to 3 seconds intervals between bubbles.

(3) Excessive air bubbles in the fuel are not acceptable.

3. If excessive air is seen in the sight gauge in the fuel return line, install a second sight gauge at the inlet to the fuel transfer pump. If a second sight gauge is not available, move the sight

gauge from the fuel return line and install the sight gauge at the inlet to the fuel transfer pump. Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If there is no fuel that is present in the sight gauge, prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for more information. If the engine starts, check for air in the fuel at varying engine speeds.

If excessive air is not seen at the inlet to the fuel transfer pump, the air is entering the system after the fuel transfer pump. Refer to the Testing and Adjusting, "Fuel System - Prime".

If excessive air is seen at the inlet to the fuel transfer pump, air is entering through the suction side of the fuel system.

WARNING

To avoid personal injury, always wear eye and face protection when using pressurized air.

NOTICE

To avoid damage, do not use more than 55 kPa (8 psi) to pressurize the fuel tank.

4. Pressurize the fuel tank to 35 kPa (5 psi). Do not use more than 55 kPa (8 psi) in order to avoid damage to the fuel tank. Check for leaks in the fuel lines between the fuel tank and the fuel transfer pump. Repair any leaks that are found. Check the fuel pressure in order to ensure that the fuel transfer pump is operating properly. For information about checking the fuel pressure, see Testing and Adjusting, "Fuel System Pressure - Test"

5. If the source of the air is not found, disconnect the supply line from the fuel tank and connect an external fuel supply to the inlet of the fuel transfer pump. If this corrects the problem, repair the fuel tank or the stand pipe in the fuel tank.

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Testing and Adjusting
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Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02707221

Fuel Injection Nozzle - Test

SMCS - 1254-081

Test the Fuel Injection Nozzles

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-4150	Nozzle Testing Group	1
5P-7448	Adapter	1
6V-2170	Tube Assembly	1
8S-2270	Fuel Collector	1
1U-8857	Extension	1
6V-6068	SAE J-967 Calibration Fluid	1

Perform the following procedures in order to determine if a fuel injection nozzle does not work correctly.

Bench test the fuel injection nozzles at a temperature of 18° to 20 °C (64° to 70 °F).

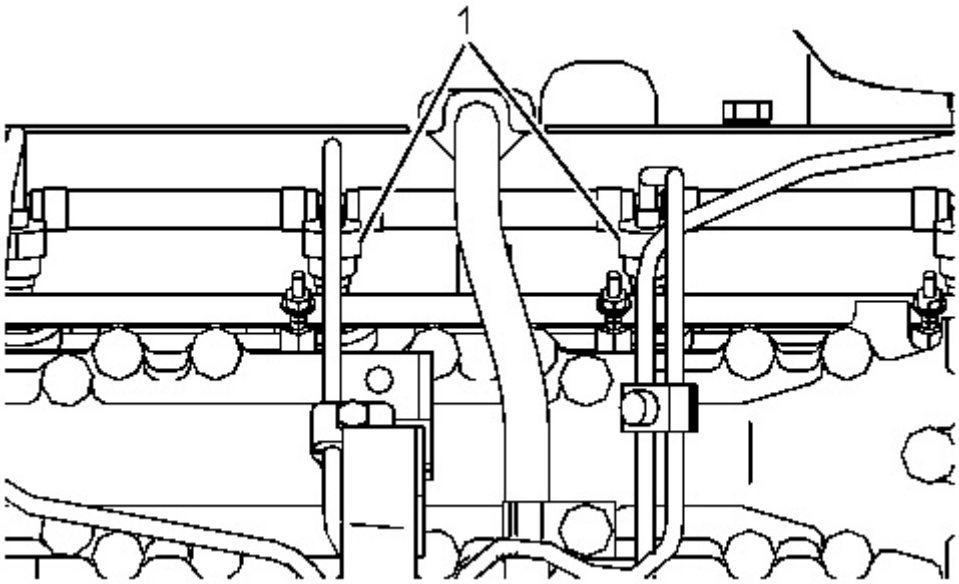


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

1. Run the engine at low idle.
2. Loosen the connection for the high pressure fuel line (1) at the fuel injection nozzle on No. 1 cylinder. Do not loosen the nut more than half of a turn. Listen for the low idle to decrease or become rough. Tighten the nut for the fuel supply line on No. 1 cylinder. Perform this test on each cylinder.
3. The fuel injection nozzle is faulty when the nut for the fuel supply line is loosened and the following events occur:
   - The engine rpm does not decrease.
   - The engine does not idle roughly.
4. Remove the fuel injection nozzle for additional testing.

   Note: If leakage occurs at the nut for the fuel supply line, make sure that fuel supply line and the nut are correctly aligned with the inlet connection of fuel injection nozzle. Do not tighten the nut for the fuel supply line on the high pressure fuel line more than the recommended torque. If the nut is tightened more, the fuel line may become restricted or the threads of the fuel injection nozzle and the nut may be damaged.

Cleaning of the Fuel Injection Nozzles

Before a fuel injection nozzle is tested, remove any loose carbon from the tip of the fuel injection nozzle. Do not use abrasive material or a wire brush in order to clean the nozzle.

The fuel injection nozzle is not a serviceable part. Disassembling or adjusting the nozzle will violate the standards for emissions.

Note: Extra care should be used in handling the fuel injection nozzle in order to prevent damage to the nozzle tip. A scratch or a burr could cause needle leakage or spray distortion. Dirt in the orifices of the nozzle tip can damage engine components. Dirt can also distort the spray pattern of the nozzle.

Pressure Test

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

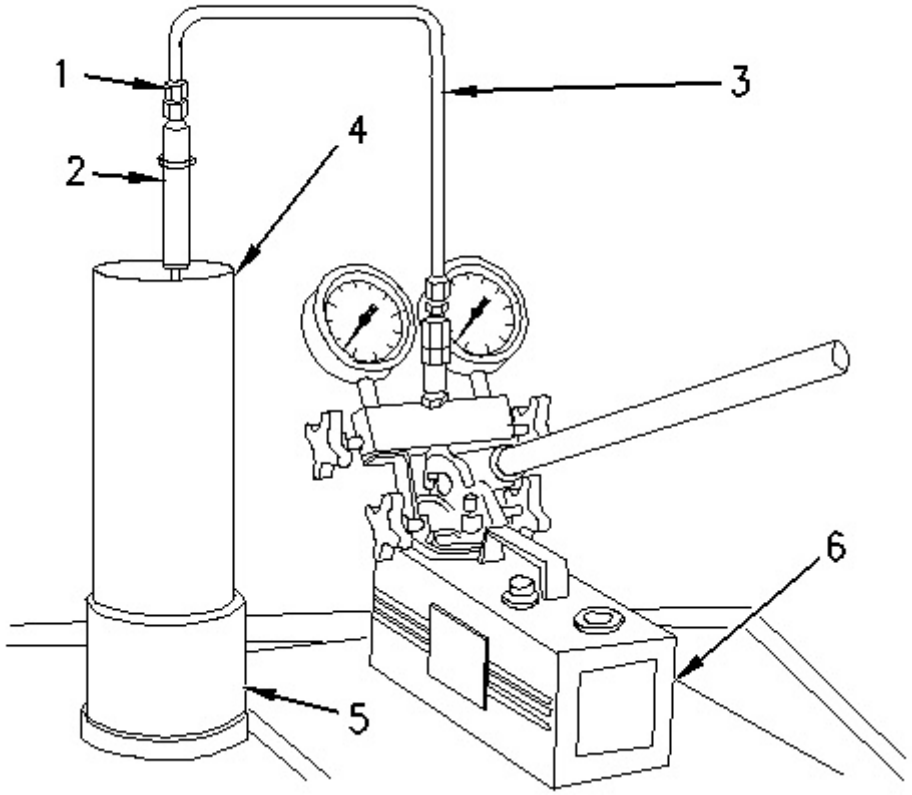


Illustration 2 g00804566

5P-4150 Nozzle Testing Group

(1) 5P-7448 Adapter

(2) Fuel injection nozzle

(3) 6V-2170 Tube assembly

(4) 1U-8857 Extension

(5) 8S-2270 Fuel collector

(6) 8T-5313 Filter

NOTICE

Do not use dirty test fluids when you test fuel injection nozzles. Also, do not test fuel injection nozzles unless you have the correct service tools.The use of dirty test fluids and the use of incorrect service tools will result in damage to fuel injection nozzles.

---

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

   Use clean **6V-6068** Calibration Fluid when the fuel injection nozzles are tested. The calibration fluid is equivalent to SAE J-967 (ISO 4113) oil.

2. Close the gauge protector valve. Close the shutoff valve. Open the pump isolator valve. In order to flush the fuel injection nozzle, operate the nozzle tester for 10 to 15 strokes at a rate of approximately 60 strokes per minute.

3. Open the gauge protector valve. Slowly increase the pressure until the valve in the fuel injection nozzle opens. Note the highest pressure indication on the dial indicator before the pointer moves to 0 kPa (0 psi). This highest pressure indication is the opening pressure of the fuel injection nozzle. The opening pressure is defined when the valve needle is lifted from the valve seat.

4. Refer to Specifications, "Fuel Injection Nozzles" for the correct pressure settings.

   If the opening pressure is not within the range of the setting that is given, the fuel injection nozzle must be replaced.

Back Leakage Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure to about 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

Release the handle. When the pressure begins to decrease, note the time that is required for the pressure to decrease to approximately 0 kPa (0 psi). If the fuel injection nozzle is not faulty, the time will not be less than 5 seconds or more than 45 seconds.

3. When the test in Step 2 is done, look for any leakage from the pressure faces of the holder and the retaining nut of the fuel injection nozzle. If leaks are visible, make sure that the components are tightened to the correct torque. Do not overtighten the components in order to stop the leakage. Instead, a pressure test on the fuel injection nozzle must be conducted. This test may force any foreign particles out of the nozzle. Replace the fuel injection nozzle if there is excessive fuel leakage.

4. If the pressure decreases to 0 kPa (0 psi) in less than 5 seconds, too much fuel is leaking around the valve needle. The valve needle or the fuel injection nozzle must be replaced in order to correct the problem.

Fuel Injection Nozzle and Seat Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure of the nozzle tester to approximately 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

   Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

   A drop of fuel should not form on the tip of the fuel injection nozzle for at least ten seconds. A light dampness is acceptable. If the results of the tests are not acceptable, clean the fuel injection nozzle. After you clean the fuel injection nozzle and the fuel leakage still occurs, the nozzle must be replaced.

Test the Spray Pattern

The pressure adjustment must be correct before the spray pattern is tested.

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

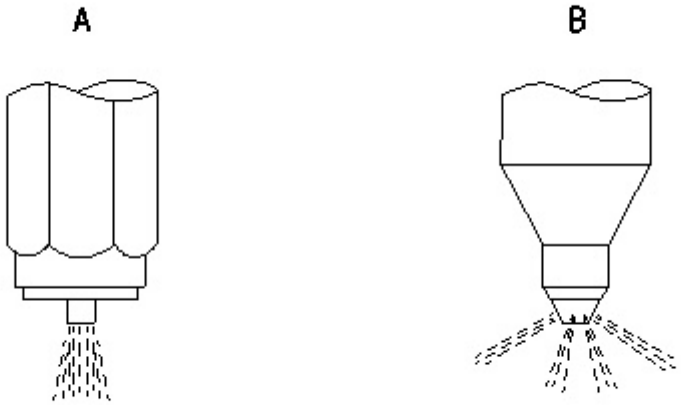


Illustration 3 g01007931

Spray patterns of the fuel injection nozzles

(A) Spray pattern for indirect injection

(B) Spray pattern for direct injection

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Close the gauge protector valve and the shutoff valve. Open the pump isolator valve.

3. Quickly pump the nozzle tester and look at the spray pattern when the fluid begins to flow through the orifices of the fuel injection nozzle.

   The spray, which flows from all of the orifices, must have the same pattern. The fuel injection nozzle is faulty if there is a difference in the vertical patterns or a difference in the horizontal patterns. Refer to the correct spray pattern in Illustration 3.

   Note: Be sure that the gauge protector valve is closed before the fuel injection nozzle is removed from the nozzle tester. Closing the valve will prevent damage to the pressure gauge.

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Fuel Injection Timing - Check - Distributor Pump

SMCS - 1251-036

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
192-3331	Timing Gauge (Fuel Injection Pump)	1
6V-3075	Dial Indicator	1

Improper fuel injection timing can cause poor engine performance.

Fuel injection timing ... 5° BTC

1. Remove the valve mechanism cover. Rotate the crankshaft in the normal direction of the engine rotation until the inlet valve of the rear cylinder has just opened and the exhaust valve of the rear cylinder has not completely closed.

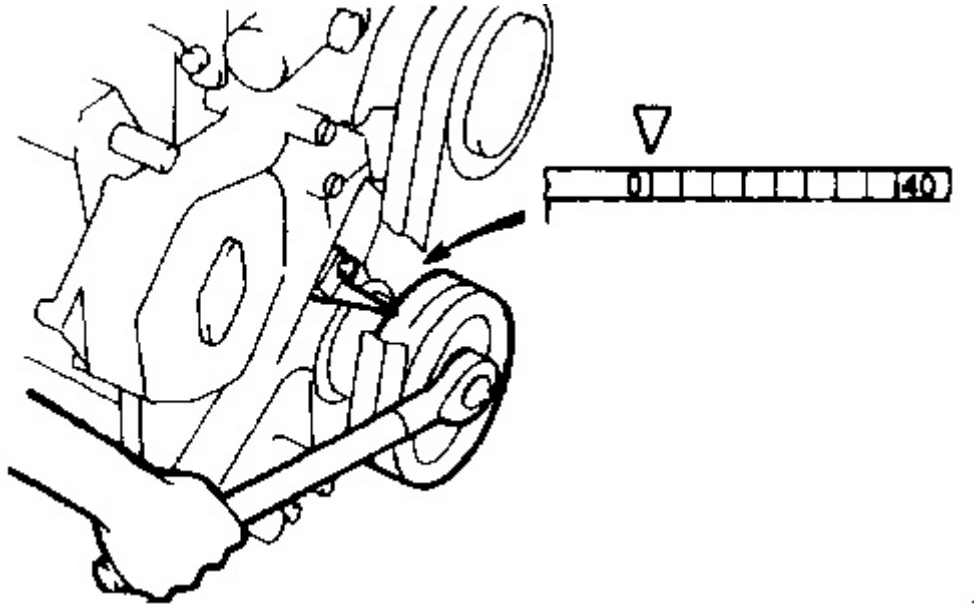


Illustration 1 g00565561

Turning the engine

2. Align the TC mark on the crankshaft pulley with the pointer on the timing case.

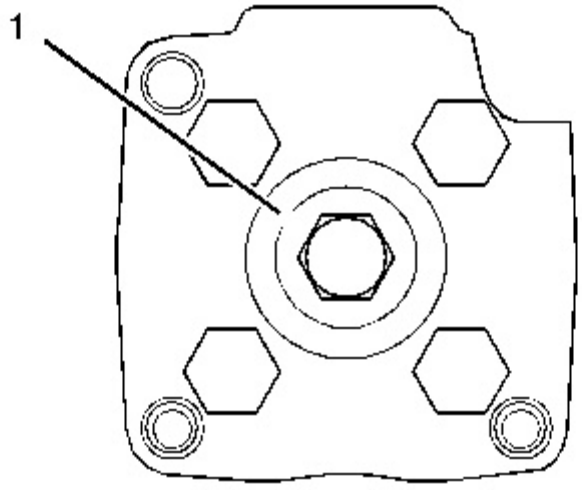


Illustration 2 g00994700

(1) Bolt

3. Remove bolt (1) that is located at the center of the rear face of the fuel injection pump. Install the **192-3331** Timing Gauge with the **6V-3075** Dial Indicator with approximately 10 mm (0.39 inch) of preload in order to measure cam lift. Refer to Illustration 3.

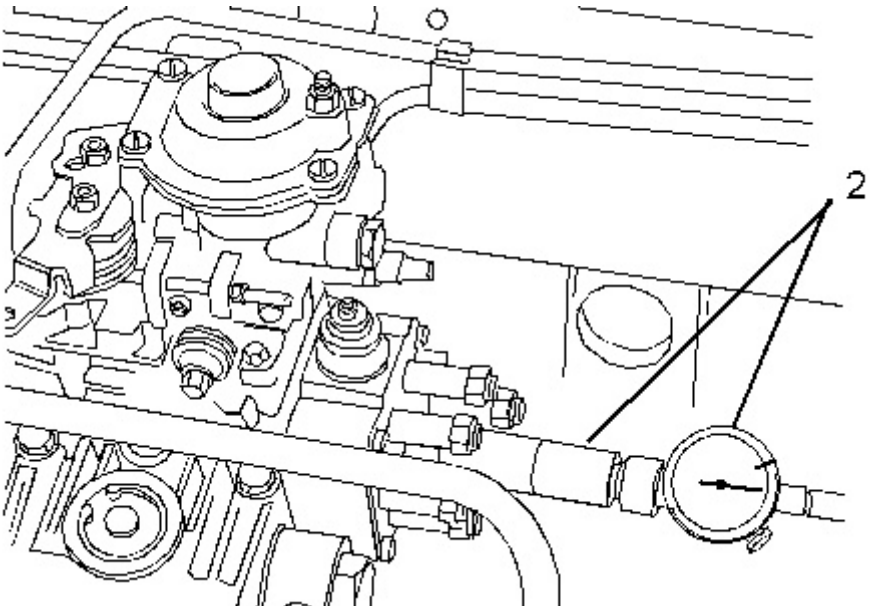


Illustration 3 g01037576

Typical example

(2) Timing tools

4. Rotate the crankshaft in the opposite direction of the engine rotation until the reading on the dial indicator stabilizes at the bottom of the lift of the plunger in the pump. Set the dial indicator to zero.

   Note: The needle of the dial indicator will stop moving when the bottom of the lift of the plunger has been reached.

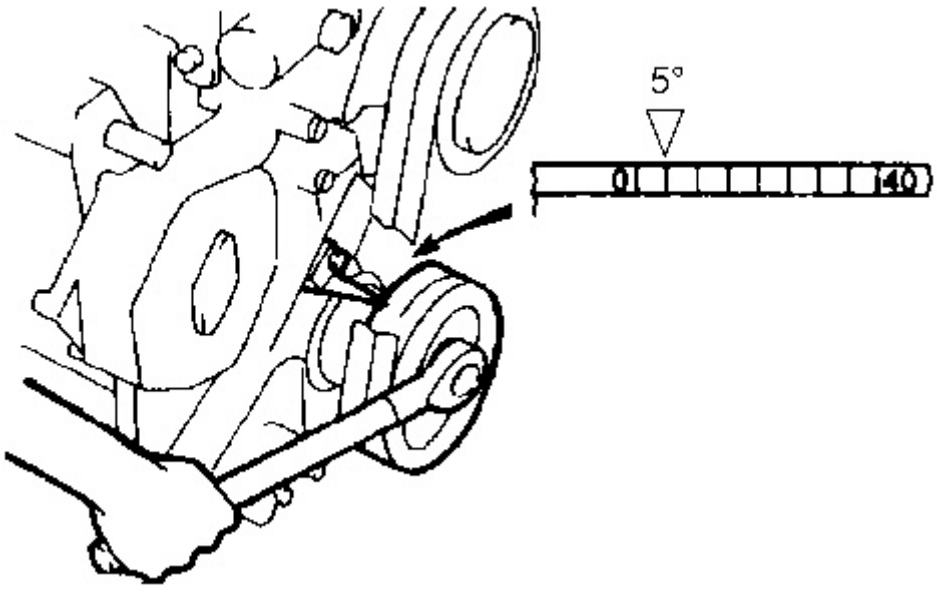


Illustration 4 g01011407

5. Rotate the crankshaft in the normal direction of the engine until the 5° mark on the crankshaft pulley is aligned with the pointer on the timing case.
6. Record the reading on the dial indicator. The reading should be 0.5 mm (0.020 inch).

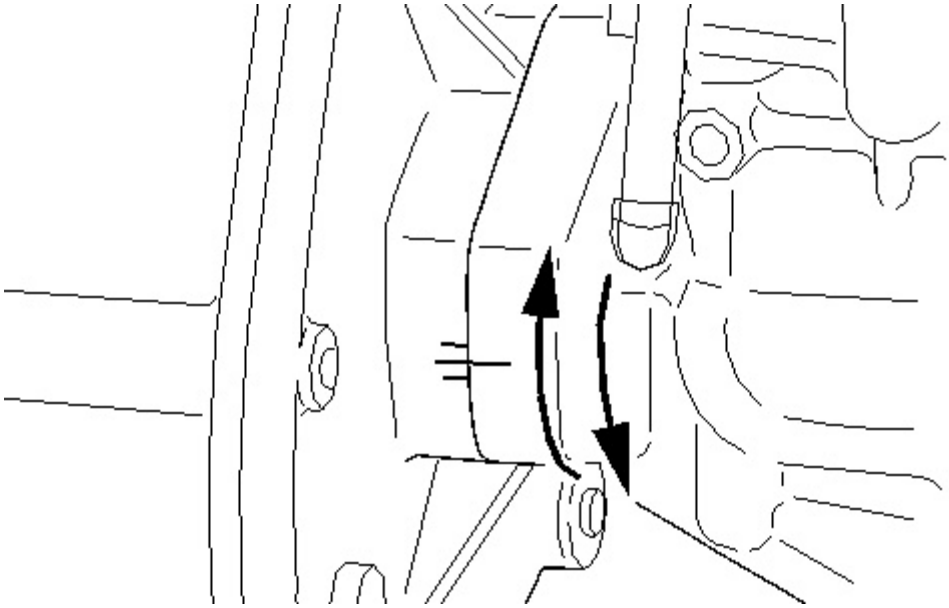


Illustration 5 g00994703

Positioning the fuel injection pump

7. If the reading on the dial indicator is not within the specification, then the pump needs to be rotated. To adjust the timing of the fuel injection pump, loosen the flange nuts and move the pump in order to achieve a reading of 0.5 mm (0.020 inch).
8. With the cam lift at 0.5 mm (0.020 inch), secure the pump in position.
9. Remove timing tools (2) from the fuel injection pump.
10. Before installing bolt (1) , replace the copper gasket that is on the bolt with a new gasket. Install bolt (1) and tighten securely. Install the valve mechanism cover.

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i05182810

Fuel Quality - Test

SMCS - 1280-081

Introduction

This test checks for problems regarding fuel quality. Refer to Diesel Fuels and Your Engine, SEBD0717 for additional details.

Use the following procedure to test for problems regarding fuel quality:

Required Tools

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-2712	Thermometer/Hydrometer	1

Test Procedure

1. Determine if water and/or contaminants are present in the fuel. Check the water separator (if equipped). If a water separator is not present, proceed to Step 2. Drain the water separator, if necessary. A full fuel tank minimizes the potential for overnight condensation.

   Note: A water separator can appear to be full of fuel when the water separator is actually full of water.

2. Determine if contaminants are present in the fuel. Remove a sample of fuel from the bottom of the fuel tank. Visually inspect the fuel sample for contaminants. The color of the fuel is not necessarily an indication of fuel quality. However, fuel that is black, brown, and/or similar to sludge can be an indication of the growth of bacteria or oil contamination. In cold temperatures, cloudy fuel indicates that the fuel may not be suitable for operating conditions. The following methods can be used to prevent wax from clogging the fuel filter:

   - Fuel heaters

- Blending fuel with additives
- Utilizing fuel with a low cloud point such as kerosene

Refer to Operation and Maintenance Manual, "Fuel Recommendations" for more information.

3. Check fuel API with a **5P-2712** Thermometer/Hydrometer for low-power complaints. The acceptable range of the fuel API is 30 to 45 when the API is measured at 15 °C (60 °F), but there is a significant difference in energy within this range.

Table 2

Fuel Density (API) [1] Correction Factors	
API at 16 °C (60 °F)	**Correction Factor**
32.0	0.987
35.0	1.000
40.0	1.022
45.0	1.044

[1] The measured fuel API rating and the corresponding temperature must be corrected to 16 °C (60 °F) before selecting a fuel correction factor. Use the chart for the fuel density correction factor in order to determine the fuel API rating at 16 °C (60 °F).

Note: A correction factor that is greater than 1.000 may be the cause of low power and/or poor fuel consumption.

4. If fuel quality is still suspected as a possible cause to problems regarding engine performance, disconnect the fuel inlet line, and temporarily operate the engine from a separate source of fuel that is known to be good. This will determine if the problem is caused by fuel quality. If fuel quality is determined to be the problem, drain the fuel system and replace the fuel filters. Engine performance can be affected by the following characteristics:
   - Cetane number of the fuel
   - Air in the fuel
   - Other fuel characteristics

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i02707223

Fuel System - Prime - Distributor Pump

SMCS - 1258-548

If air enters the fuel system, the air must be purged before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the tank has been partially drained during normal operation.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system during engine operation.
- The fuel filter or the fuel pump is replaced.
- The high pressure fuel lines are disconnected.

Use the following procedure in order to remove air from the fuel system:

1. Turn the ignition key to the RUN position for three minutes in order to energize the electric fuel transfer pump. Do not start the engine.
2. Turn the ignition key to the OFF position.

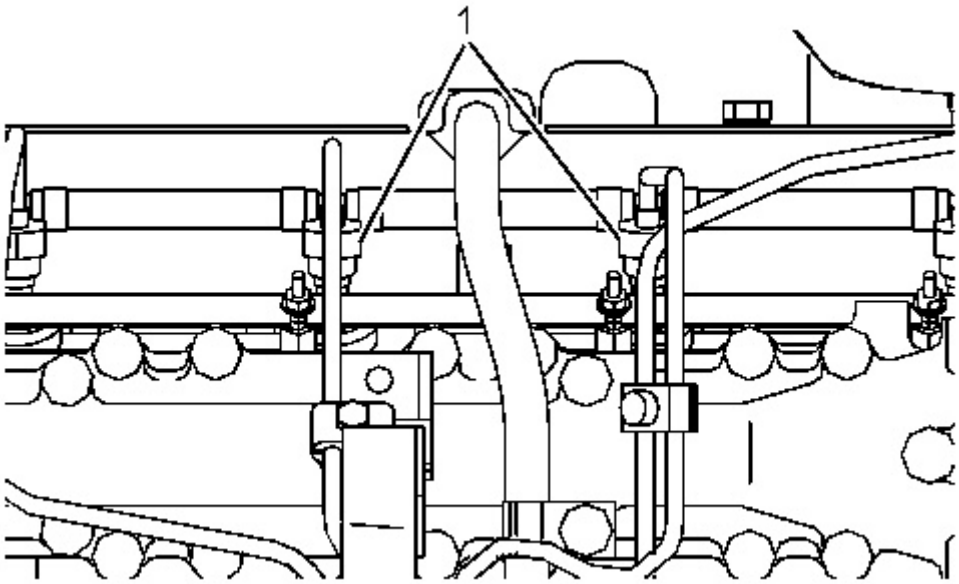


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

3. Loosen the connections for the high pressure fuel lines (1) .
4. Operate the electric starting motor until fuel that is free of air comes from the connections.
5. Tighten the connections for the high pressure fuel lines. Refer to Specifications, "Fuel Injection lines" for the correct torque.
6. Start the engine and check for leaks.

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i05182667

Fuel System - Inspect

SMCS - 1250-040

Introduction

A problem with the components that send fuel to the engine can cause low fuel pressure. This can decrease engine performance. Use the following procedure to inspect the fuel system.

Check Procedure

1. Check the fuel level in the fuel tank. Ensure that the vent in the fuel cap is not filled with dirt.
2. Check all fuel lines for fuel leakage. The fuel lines must be free from restrictions and faulty bends. Verify that the fuel return line is not collapsed.
3. Inspect the fuel filter for excess contamination. If necessary, install a new fuel filter. Determine the source of the contamination. Make the necessary repairs.
4. Service the primary fuel filter (if equipped).
5. Remove any air that may be in the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime".

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i05367478

Air in Fuel - Test

SMCS - 1280-081

Introduction

This procedure checks for air in the fuel system. This procedure also assists in finding the source of the air.

Required Tools

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
2P-8278	Tube As (Sight Gauge)	1

Test Procedure

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

1. Examine the fuel system for leaks. Ensure that the fuel line fittings are properly tightened. Check the fuel level in the fuel tank. Air can enter the fuel system on the suction side between the fuel transfer pump and the fuel tank.

2. Install a **2P-8278** Tube As (Sight Gauge) in the fuel return line. When possible, install the sight gauge in a straight section of the fuel line that is at least 304.8 mm (12 inch) long. Do not install the sight gauge near the following devices that create turbulence:

- Elbows
- Relief valves
- Check valves

Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If there is no fuel that is present in the sight gauge, prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for more information. If the engine starts, check for air in the fuel at varying engine speeds. When possible, operate the engine under the conditions which have been suspect.

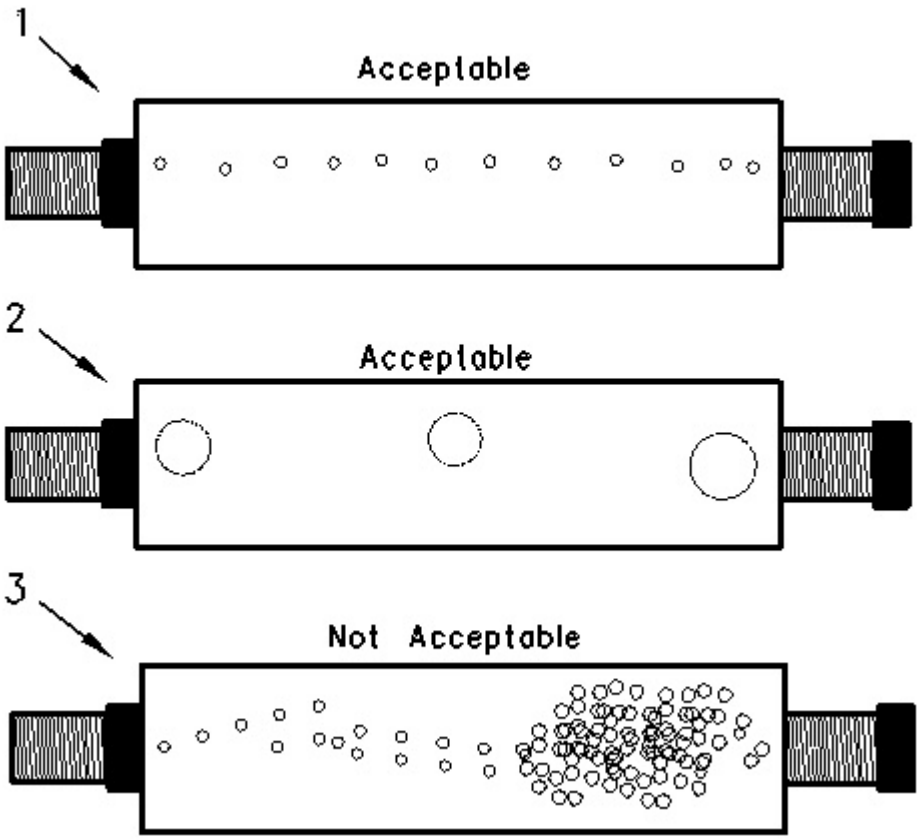


Illustration 1 g00578151

2P-8278 Tube As (Sight Gauge)

(1) A steady stream of small bubbles with a diameter of approximately 1.60 mm (0.063 inch) is an acceptable amount of air in the fuel.

(2) Bubbles with a diameter of approximately 6.35 mm (0.250 inch) are also acceptable if there are 2 seconds to 3 seconds intervals between bubbles.

(3) Excessive air bubbles in the fuel are not acceptable.

3. If excessive air is seen in the sight gauge in the fuel return line, install a second sight gauge at the inlet to the fuel transfer pump. If a second sight gauge is not available, move the sight

gauge from the fuel return line and install the sight gauge at the inlet to the fuel transfer pump. Observe the fuel flow during engine cranking. Look for air bubbles in the fuel. If there is no fuel that is present in the sight gauge, prime the fuel system. Refer to Testing and Adjusting, "Fuel System - Prime" for more information. If the engine starts, check for air in the fuel at varying engine speeds.

If excessive air is not seen at the inlet to the fuel transfer pump, the air is entering the system after the fuel transfer pump. Refer to the Testing and Adjusting, "Fuel System - Prime".

If excessive air is seen at the inlet to the fuel transfer pump, air is entering through the suction side of the fuel system.

WARNING

To avoid personal injury, always wear eye and face protection when using pressurized air.

NOTICE

To avoid damage, do not use more than 55 kPa (8 psi) to pressurize the fuel tank.

4. Pressurize the fuel tank to 35 kPa (5 psi). Do not use more than 55 kPa (8 psi) in order to avoid damage to the fuel tank. Check for leaks in the fuel lines between the fuel tank and the fuel transfer pump. Repair any leaks that are found. Check the fuel pressure in order to ensure that the fuel transfer pump is operating properly. For information about checking the fuel pressure, see Testing and Adjusting, "Fuel System Pressure - Test"

5. If the source of the air is not found, disconnect the supply line from the fuel tank and connect an external fuel supply to the inlet of the fuel transfer pump. If this corrects the problem, repair the fuel tank or the stand pipe in the fuel tank.

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i02707221

Fuel Injection Nozzle - Test

SMCS - 1254-081

Test the Fuel Injection Nozzles

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-4150	Nozzle Testing Group	1
5P-7448	Adapter	1
6V-2170	Tube Assembly	1
8S-2270	Fuel Collector	1
1U-8857	Extension	1
6V-6068	SAE J-967 Calibration Fluid	1

Perform the following procedures in order to determine if a fuel injection nozzle does not work correctly.

Bench test the fuel injection nozzles at a temperature of 18° to 20 °C (64° to 70 °F).

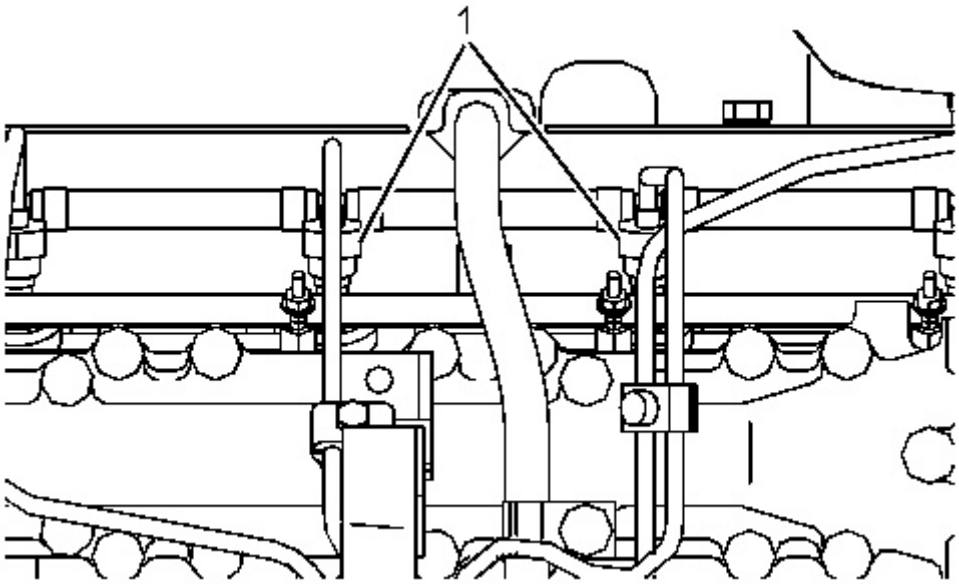


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

1. Run the engine at low idle.
2. Loosen the connection for the high pressure fuel line (1) at the fuel injection nozzle on No. 1 cylinder. Do not loosen the nut more than half of a turn. Listen for the low idle to decrease or become rough. Tighten the nut for the fuel supply line on No. 1 cylinder. Perform this test on each cylinder.
3. The fuel injection nozzle is faulty when the nut for the fuel supply line is loosened and the following events occur:
   - The engine rpm does not decrease.
   - The engine does not idle roughly.
4. Remove the fuel injection nozzle for additional testing.

   Note: If leakage occurs at the nut for the fuel supply line, make sure that fuel supply line and the nut are correctly aligned with the inlet connection of fuel injection nozzle. Do not tighten the nut for the fuel supply line on the high pressure fuel line more than the recommended torque. If the nut is tightened more, the fuel line may become restricted or the threads of the fuel injection nozzle and the nut may be damaged.

Cleaning of the Fuel Injection Nozzles

Before a fuel injection nozzle is tested, remove any loose carbon from the tip of the fuel injection nozzle. Do not use abrasive material or a wire brush in order to clean the nozzle.

The fuel injection nozzle is not a serviceable part. Disassembling or adjusting the nozzle will violate the standards for emissions.

Note: Extra care should be used in handling the fuel injection nozzle in order to prevent damage to the nozzle tip. A scratch or a burr could cause needle leakage or spray distortion. Dirt in the orifices of the nozzle tip can damage engine components. Dirt can also distort the spray pattern of the nozzle.

Pressure Test

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

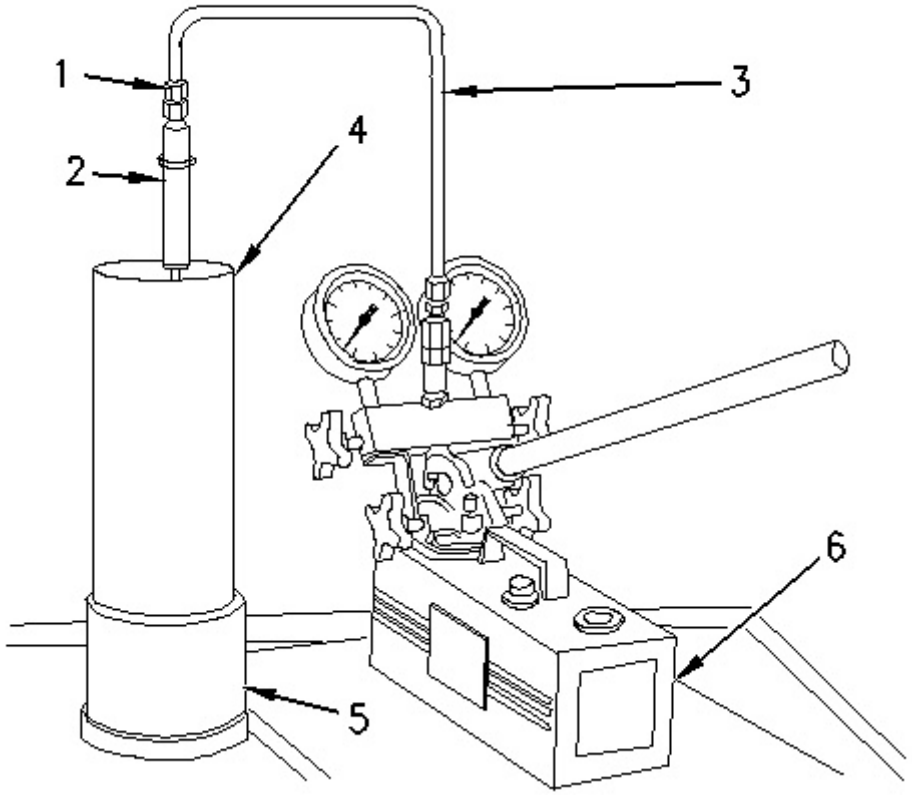


Illustration 2 g00804566

5P-4150 Nozzle Testing Group

(1) 5P-7448 Adapter

(2) Fuel injection nozzle

(3) 6V-2170 Tube assembly

(4) 1U-8857 Extension

(5) 8S-2270 Fuel collector

(6) 8T-5313 Filter

NOTICE

Do not use dirty test fluids when you test fuel injection nozzles. Also, do not test fuel injection nozzles unless you have the correct service tools.The use of dirty test fluids and the use of incorrect service tools will result in damage to fuel injection nozzles.

---

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

   Use clean **6V-6068** Calibration Fluid when the fuel injection nozzles are tested. The calibration fluid is equivalent to SAE J-967 (ISO 4113) oil.

2. Close the gauge protector valve. Close the shutoff valve. Open the pump isolator valve. In order to flush the fuel injection nozzle, operate the nozzle tester for 10 to 15 strokes at a rate of approximately 60 strokes per minute.

3. Open the gauge protector valve. Slowly increase the pressure until the valve in the fuel injection nozzle opens. Note the highest pressure indication on the dial indicator before the pointer moves to 0 kPa (0 psi). This highest pressure indication is the opening pressure of the fuel injection nozzle. The opening pressure is defined when the valve needle is lifted from the valve seat.

4. Refer to Specifications, "Fuel Injection Nozzles" for the correct pressure settings.

   If the opening pressure is not within the range of the setting that is given, the fuel injection nozzle must be replaced.

Back Leakage Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure to about 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

Release the handle. When the pressure begins to decrease, note the time that is required for the pressure to decrease to approximately 0 kPa (0 psi). If the fuel injection nozzle is not faulty, the time will not be less than 5 seconds or more than 45 seconds.

3. When the test in Step 2 is done, look for any leakage from the pressure faces of the holder and the retaining nut of the fuel injection nozzle. If leaks are visible, make sure that the components are tightened to the correct torque. Do not overtighten the components in order to stop the leakage. Instead, a pressure test on the fuel injection nozzle must be conducted. This test may force any foreign particles out of the nozzle. Replace the fuel injection nozzle if there is excessive fuel leakage.

4. If the pressure decreases to 0 kPa (0 psi) in less than 5 seconds, too much fuel is leaking around the valve needle. The valve needle or the fuel injection nozzle must be replaced in order to correct the problem.

Fuel Injection Nozzle and Seat Test

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Pump the pressure of the nozzle tester to approximately 1030 kPa (150 psi) below the opening pressure of the fuel injection nozzle.

   Refer to Specifications, "Fuel Injection Nozzles" for the correct setting of the opening pressure.

   A drop of fuel should not form on the tip of the fuel injection nozzle for at least ten seconds. A light dampness is acceptable. If the results of the tests are not acceptable, clean the fuel injection nozzle. After you clean the fuel injection nozzle and the fuel leakage still occurs, the nozzle must be replaced.

Test the Spray Pattern

The pressure adjustment must be correct before the spray pattern is tested.

WARNING

Ensure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

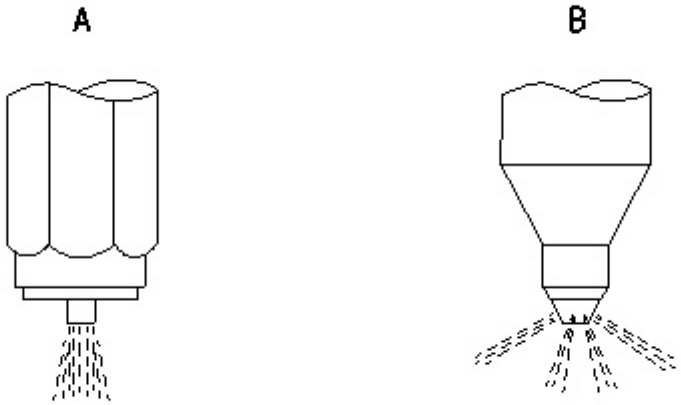


Illustration 3 g01007931

Spray patterns of the fuel injection nozzles

(A) Spray pattern for indirect injection

(B) Spray pattern for direct injection

1. Connect fuel injection nozzle (2) to the tooling that is shown in Illustration 2.

   Position the fuel injection nozzle so that the fuel spray is directed into the **1U-8857** Extension (4) and the **8S-2270** Fuel Collector (5) .

2. Close the gauge protector valve and the shutoff valve. Open the pump isolator valve.

3. Quickly pump the nozzle tester and look at the spray pattern when the fluid begins to flow through the orifices of the fuel injection nozzle.

   The spray, which flows from all of the orifices, must have the same pattern. The fuel injection nozzle is faulty if there is a difference in the vertical patterns or a difference in the horizontal patterns. Refer to the correct spray pattern in Illustration 3.

   Note: Be sure that the gauge protector valve is closed before the fuel injection nozzle is removed from the nozzle tester. Closing the valve will prevent damage to the pressure gauge.

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i04976851

Fuel Injection Timing - Check - Distributor Pump

SMCS - 1251-036

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
192-3331	Timing Gauge (Fuel Injection Pump)	1
6V-3075	Dial Indicator	1

Improper fuel injection timing can cause poor engine performance.

Fuel injection timing (47 kW) ... 9° BTC

Fuel injection timing (55 kW) ... 3° BTC

Fuel injection timing (62 kW) ... 6° BTC

Fuel injection timing (69 kW) ... 5° BTC

1. Remove the valve mechanism cover. Rotate the crankshaft in the normal direction of the engine rotation until the inlet valve of the rear cylinder has opened and the exhaust valve of the rear cylinder has not closed.

2. The 62 kW and 69kW engines are installed with a Water Cold Start Device (CSD). In order to ensure that the fuel injection pump timing is correct, follow the procedure below. See 2.a and 2.b.

    a. Install a 10 mm shim (H) between the Lever shaft (A) and the piston (B) on the CSD (C) .

    b. Time the fuel injection pump to 6° BTC for a 62 kW engine. Time the fuel injection pump to 5° BTC for a 69 kW engine. Refer to steps 4 to 12. When the timing has been set, remove the 10 mm shim.

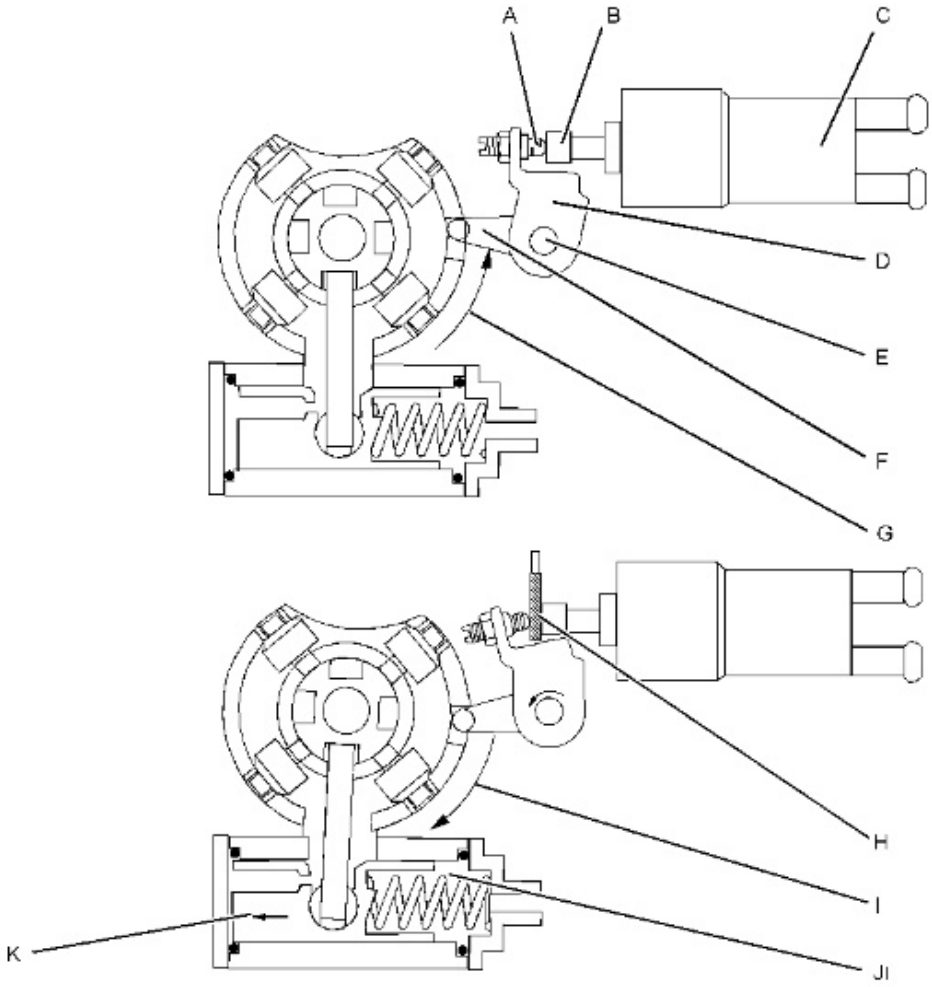


Illustration 1 g01393232

(A) Adjustment screw

(B) Piston

(C) Cold Start Device (CSD)

(D) Lever

(E) Lever shaft

(F) Side lever

(G) Advance

(H) "10mm" Shim

(I) Retard

(J) Low-pressure side

(K) High-pressure side

3.

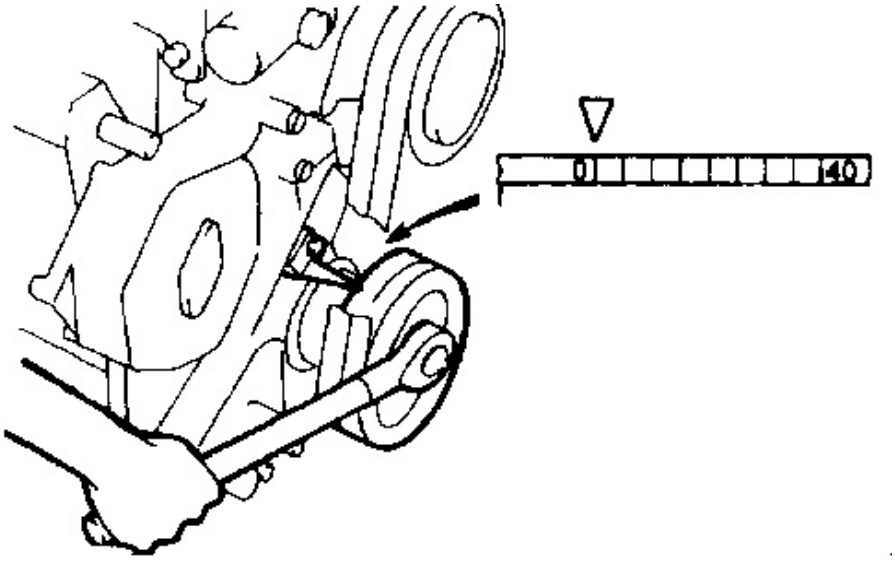


Illustration 2 g00565561

Turning the engine

4. Align the TC mark on the crankshaft pulley with the pointer on the timing case.

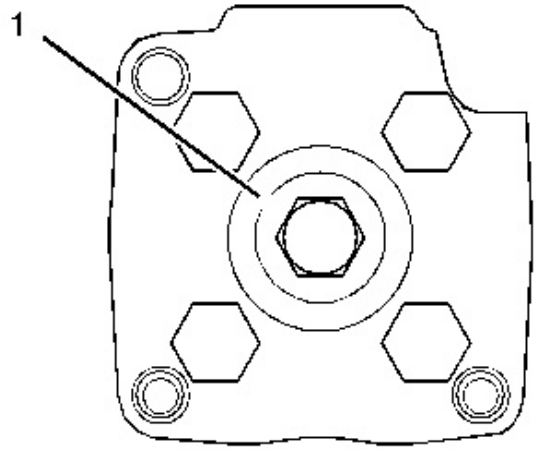


Illustration 3 g00994700

(1) Bolt

5. Remove bolt (1) that is located at the center of the rear face of the fuel injection pump. Install the **192-3331** Timing Gauge with the **6V-3075** Dial Indicator with approximately 10 mm (0.39 inch) of preload in order to measure cam lift. Refer to Illustration 4.

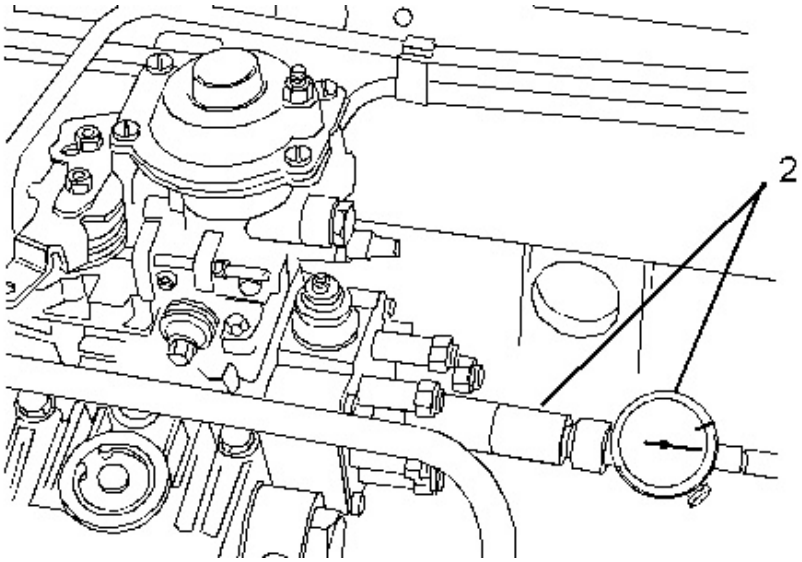


Illustration 4 g01037576

Typical example

(2) Timing tools

6. Rotate the crankshaft in the opposite direction of the engine rotation. Rotate the crankshaft until the reading on the dial indicator stabilizes at the bottom of the lift of the plunger in the pump. Set the dial indicator to zero.

   Note: The needle of the dial indicator will stop moving when the bottom of the lift of the plunger has been reached.

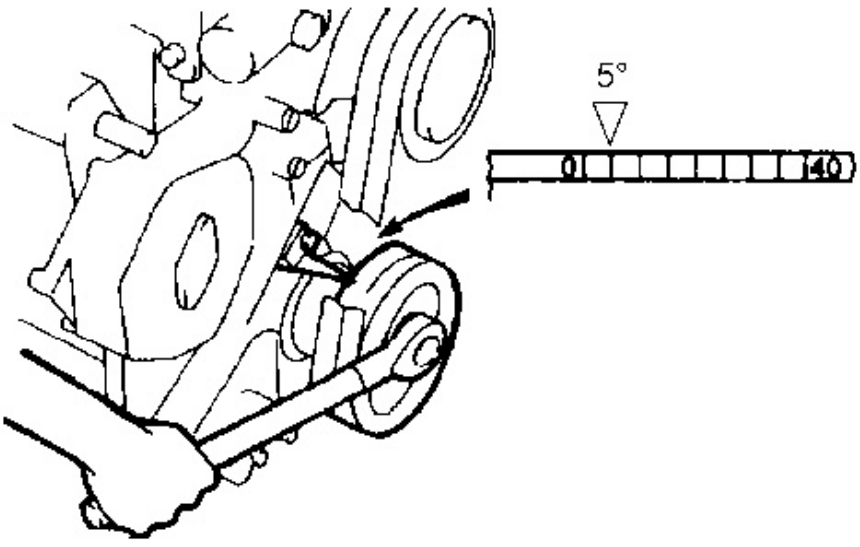


Illustration 5 g01011407

7. Rotate the crankshaft in the normal direction of the engine until the mark for the correct degree on the crankshaft pulley is aligned with the pointer on the timing case.

8. Record the reading on the dial indicator. The reading should be 0.5 mm (0.0197 inch).

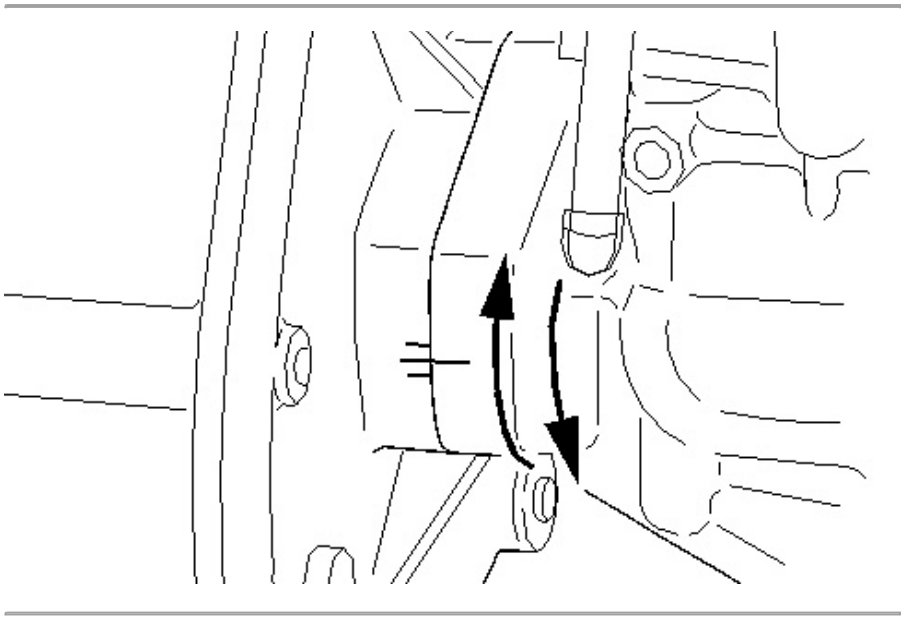


Illustration 6 g00994703

Positioning the fuel injection pump

9. If the reading on the dial indicator is not within the specification, then the pump needs to be rotated. To adjust the timing of the fuel injection pump, loosen the flange nuts and move the pump in order to achieve a reading of 0.5 mm (0.0197 inch).
10. With the cam lift at 0.5 mm (0.0197 inch), secure the pump in position.
11. Remove timing tools (2) from the fuel injection pump.
12. Before installing bolt (1) , replace the copper gasket that is on the bolt with a new gasket. Install bolt (1) and tighten securely. Install the valve mechanism cover.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05182810

Fuel Quality - Test

SMCS - 1280-081

Introduction

This test checks for problems regarding fuel quality. Refer to Diesel Fuels and Your Engine, SEBD0717 for additional details.

Use the following procedure to test for problems regarding fuel quality:

Required Tools

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
5P-2712	Thermometer/Hydrometer	1

Test Procedure

1. Determine if water and/or contaminants are present in the fuel. Check the water separator (if equipped). If a water separator is not present, proceed to Step 2. Drain the water separator, if necessary. A full fuel tank minimizes the potential for overnight condensation.

   Note: A water separator can appear to be full of fuel when the water separator is actually full of water.

2. Determine if contaminants are present in the fuel. Remove a sample of fuel from the bottom of the fuel tank. Visually inspect the fuel sample for contaminants. The color of the fuel is not necessarily an indication of fuel quality. However, fuel that is black, brown, and/or similar to sludge can be an indication of the growth of bacteria or oil contamination. In cold temperatures, cloudy fuel indicates that the fuel may not be suitable for operating conditions. The following methods can be used to prevent wax from clogging the fuel filter:

   - Fuel heaters

- Blending fuel with additives
- Utilizing fuel with a low cloud point such as kerosene

Refer to Operation and Maintenance Manual, "Fuel Recommendations" for more information.

3. Check fuel API with a **5P-2712** Thermometer/Hydrometer for low-power complaints. The acceptable range of the fuel API is 30 to 45 when the API is measured at 15 °C (60 °F), but there is a significant difference in energy within this range.

Table 2

Fuel Density (API) [1] Correction Factors	
API at 16 °C (60 °F)	**Correction Factor**
32.0	0.987
35.0	1.000
40.0	1.022
45.0	1.044

[1] The measured fuel API rating and the corresponding temperature must be corrected to 16 °C (60 °F) before selecting a fuel correction factor. Use the chart for the fuel density correction factor in order to determine the fuel API rating at 16 °C (60 °F).

Note: A correction factor that is greater than 1.000 may be the cause of low power and/or poor fuel consumption.

4. If fuel quality is still suspected as a possible cause to problems regarding engine performance, disconnect the fuel inlet line, and temporarily operate the engine from a separate source of fuel that is known to be good. This will determine if the problem is caused by fuel quality. If fuel quality is determined to be the problem, drain the fuel system and replace the fuel filters. Engine performance can be affected by the following characteristics:
   - Cetane number of the fuel
   - Air in the fuel
   - Other fuel characteristics

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Fuel System - Prime - Distributor Pump

SMCS - 1258-548

If air enters the fuel system, the air must be purged before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the tank has been partially drained during normal operation.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system during engine operation.
- The fuel filter or the fuel pump is replaced.
- The high pressure fuel lines are disconnected.

Use the following procedure in order to remove air from the fuel system:

1. Turn the ignition key to the RUN position for three minutes in order to energize the electric fuel transfer pump. Do not start the engine.
2. Turn the ignition key to the OFF position.

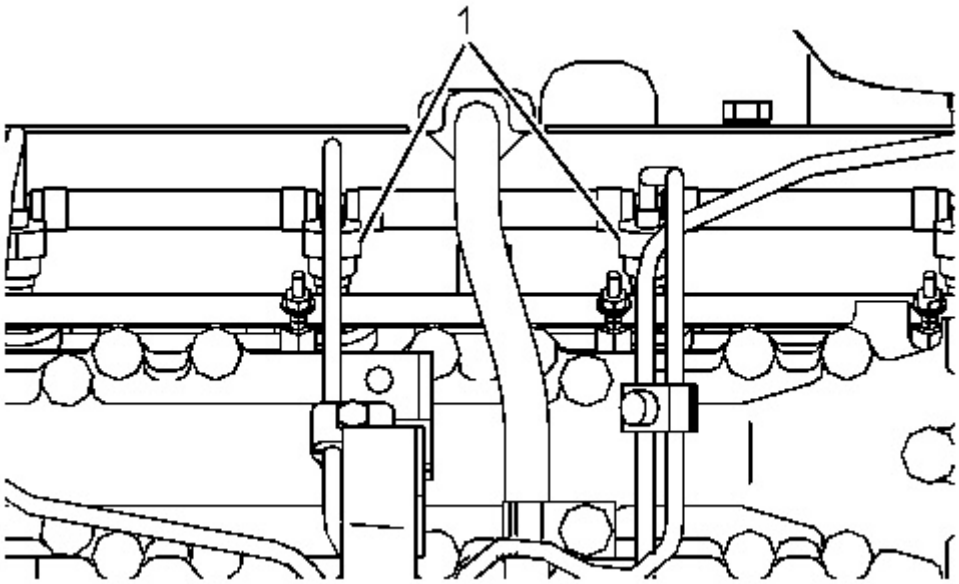


Illustration 1 g01358092

(1) Connections for the high pressure fuel lines

3. Loosen the connections for the high pressure fuel lines (1) .
4. Operate the electric starting motor until fuel that is free of air comes from the connections.
5. Tighten the connections for the high pressure fuel lines. Refer to Specifications, "Fuel Injection lines" for the correct torque.
6. Start the engine and check for leaks.

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i03898085

Disconnecting Snap To Connect Fittings

SMCS - 7554-X6

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disconnection Procedure

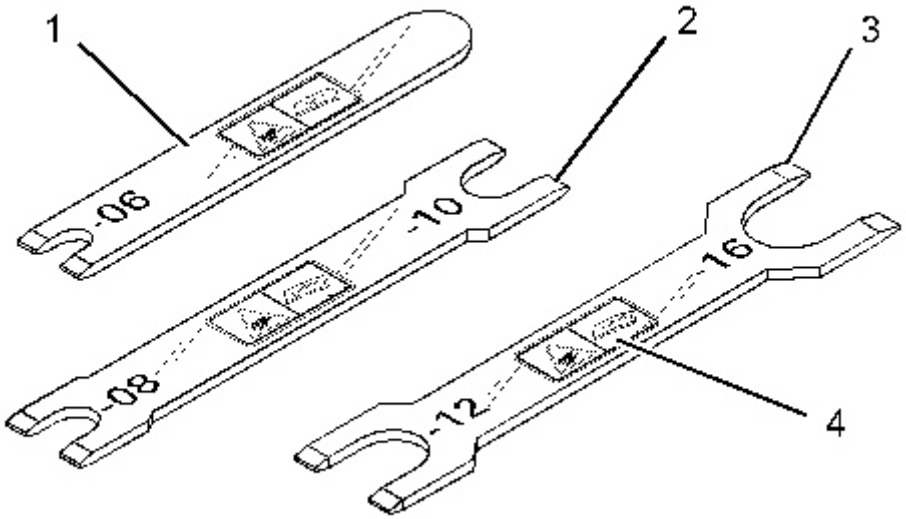


Illustration 1 g02145423

Table 1

304-1165 Tool Kit			
Item	**Part No.**	**description**	**Fitting Size**
1	304-1166	STC Wrench	-06
2	304-1167	STC Wrench	-08 and -10
3	304-1168	STC Wrench	-12 and -16
4	341-2603	Warning Film	-
-	304-2721	Tool Pouch	-

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

NOTICE

Using the incorrect size snap to connect (STC) wrench can cause slippage, resulting in personal injury. Always verify that the STC wrench size matches the size fitting to be disconnected.

1. Lower all work tools and attachments to the ground.
2. Release the system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".
3. Clean the connection that is to be disassembled. Clean the surrounding area in order to ensure that the connection is free of all dirt, dust, and grit.
4. Pressure can be trapped in circuits after the engine has stopped. Personal injury or death can result if all pressures are not released. Ensure that the pressure is zero in the line that is being disconnected.

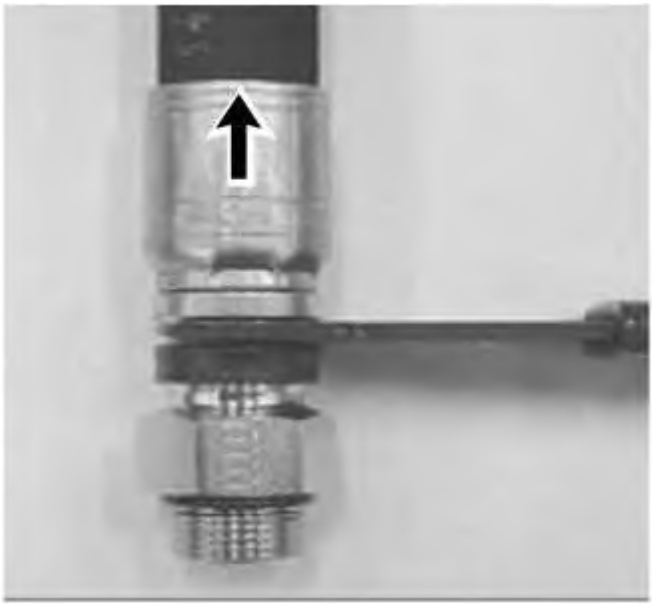


Illustration 2 g02141795

5. Select the designated release tool for the size of the connection. Using the wrong tool may result in damage to the coupling, or cause slippage, resulting in unsafe conditions.

   Note: Prying on the connection may result in damage to the release sleeve, requiring hose replacement.

6. Insert the release tool behind the release sleeve, so that the release tool is perpendicular to the connection. Fully insert the release tool in order to cause the release sleeve to move and separate the retaining ring. The coupling may now be separated.

7. Pull on the hose in the direction parallel to the axis of connection while keeping the release tool engaged. Pulling the hose at an angle may result in extra force required to disconnect the connection.

8. Cover both ends of the connection with recommended plugs or caps in order to avoid contamination.

Connection Procedure

1. Clean the connection that is to be assembled. Ensure that the connection is free of all dirt, dust, and grit.



Illustration 3 g02141956

Note: If the release sleeve is damaged during the connection or disconnection of the STC connection, the male portion must be replaced with new parts.

Note: Do not use the rubber sleeve as leverage to push the male half into the female half of the STC connection.

2. Align the STC fitting on the hose assembly with the STC connector. Push the hose fitting into the mating connector until you feel a definite snap and a solid stop.
3. Pull straight back on the connection. An improperly made connection will disconnect.

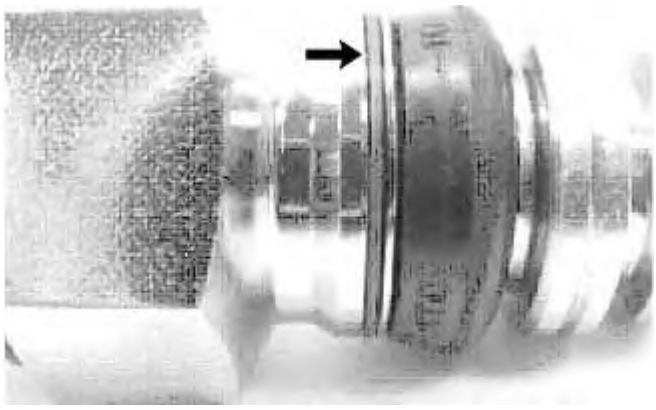


Illustration 4 g02141958

Red ring, on an improper connection.

4. Check for a visible red ring. An improper assembly shows the red ring.

Note: For more information on the operation and the maintenance of Snap to Connect wrenches, refer to Tool Operating Manual, NEHS1083.

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1261-010; 1263-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

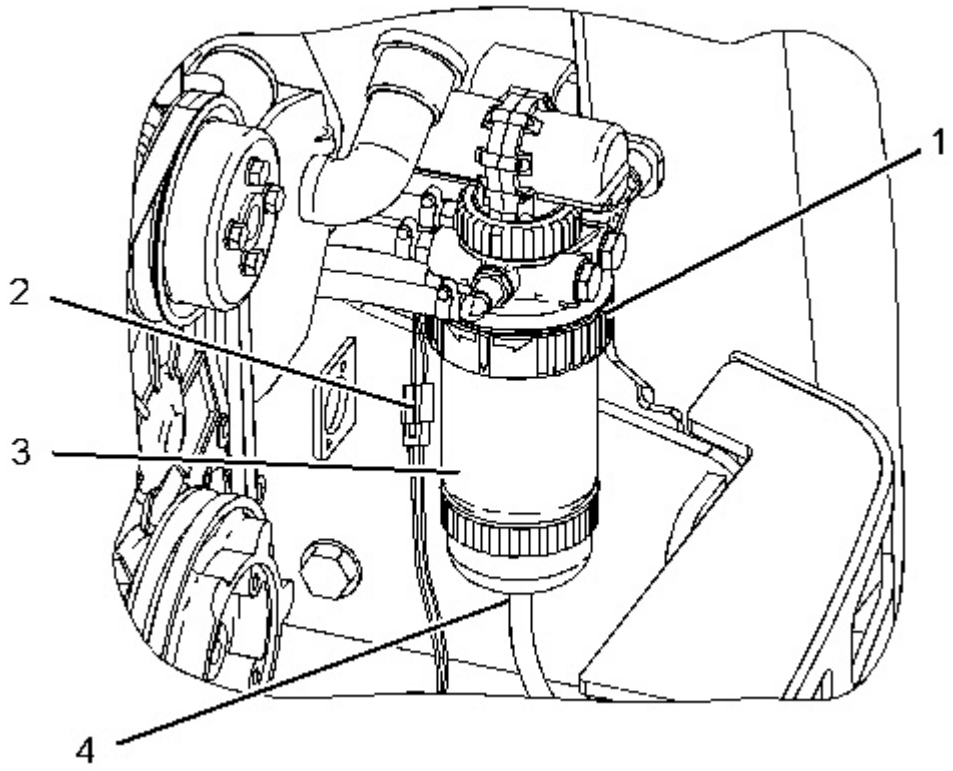


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

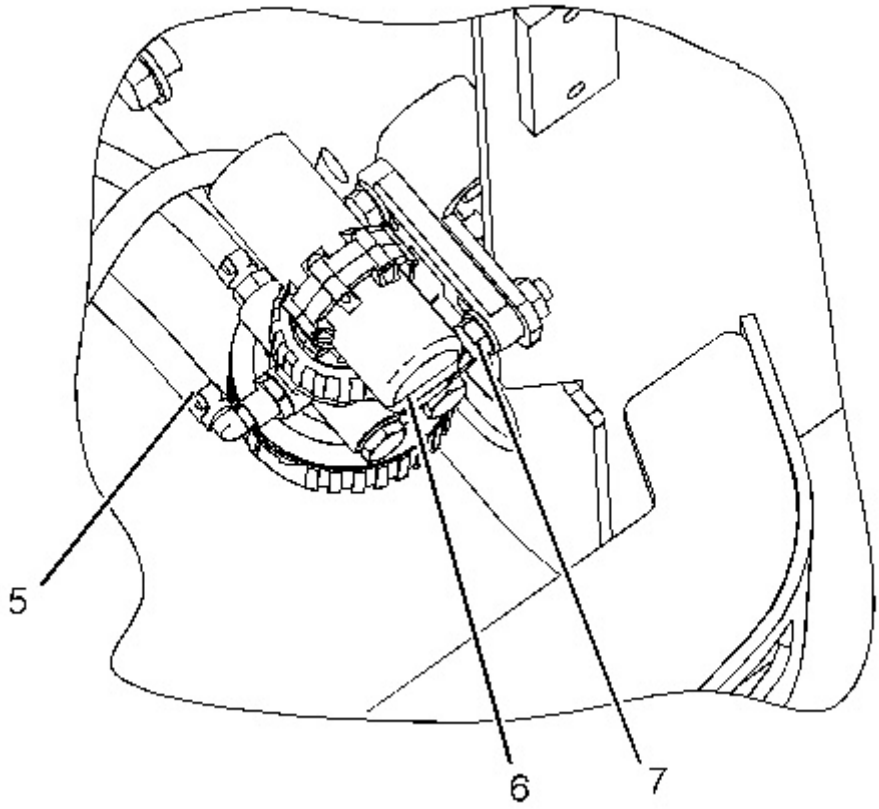


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

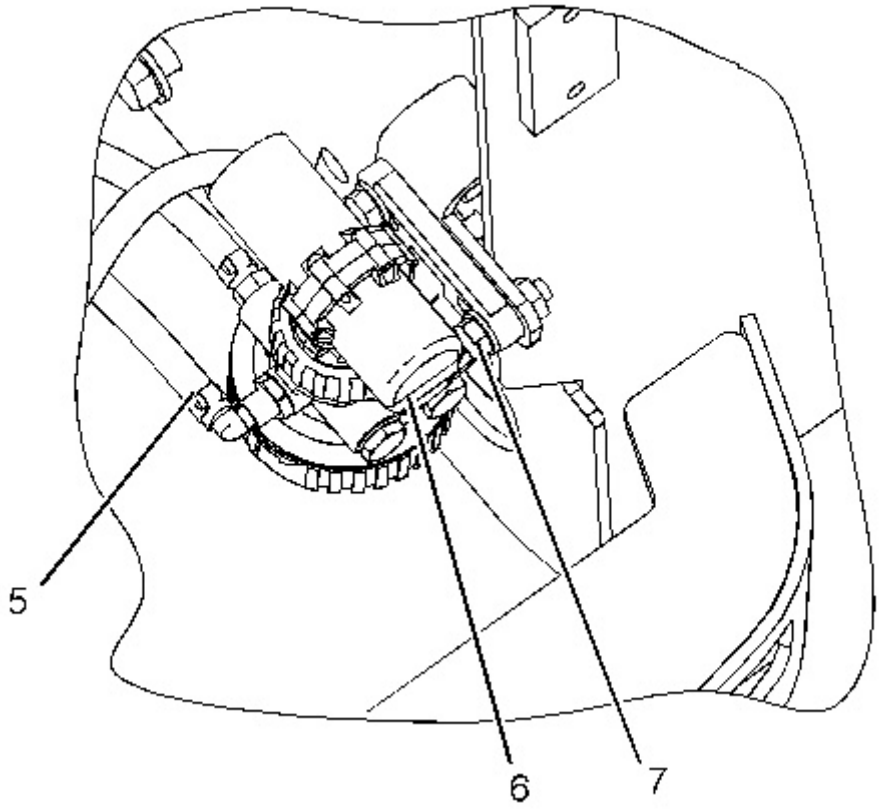


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

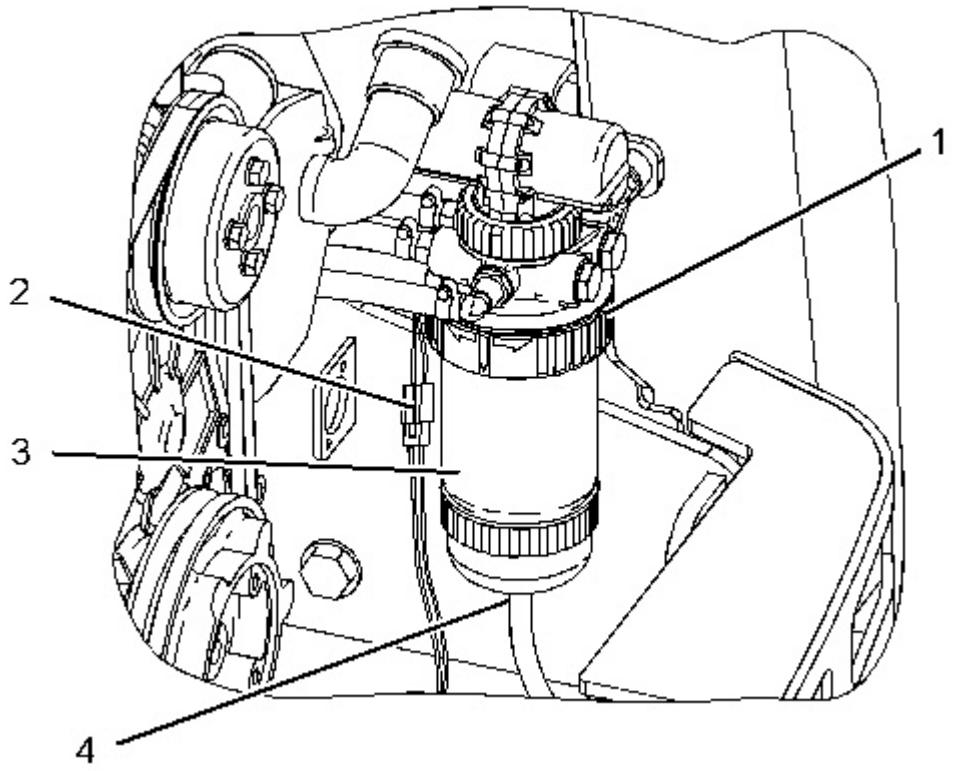


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1260-010; 1263-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

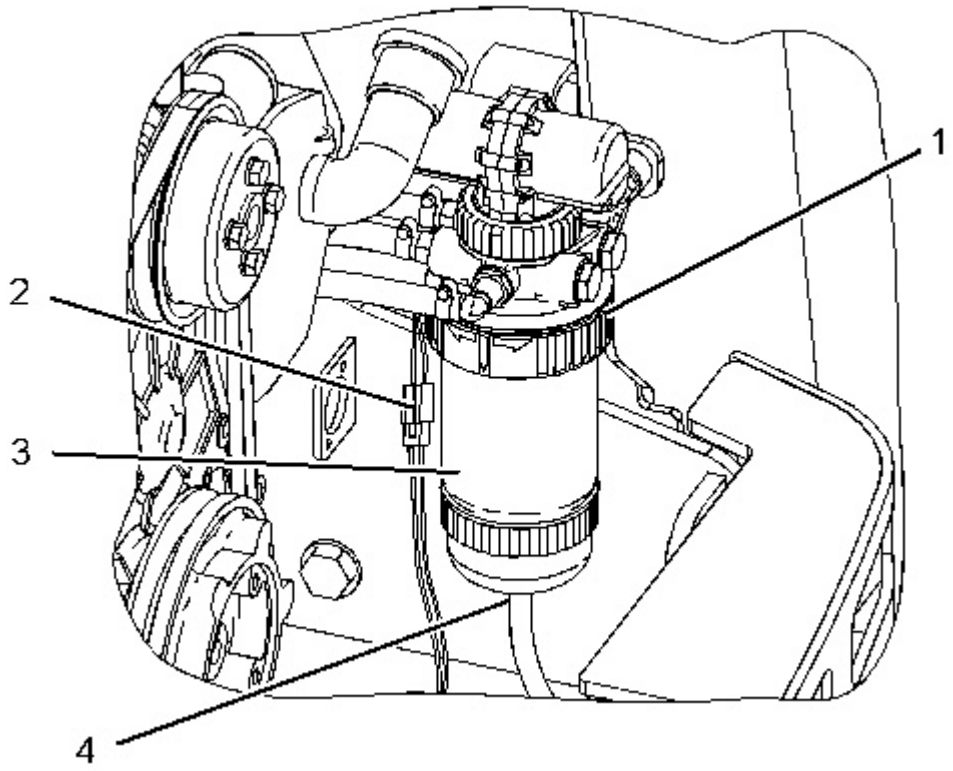


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

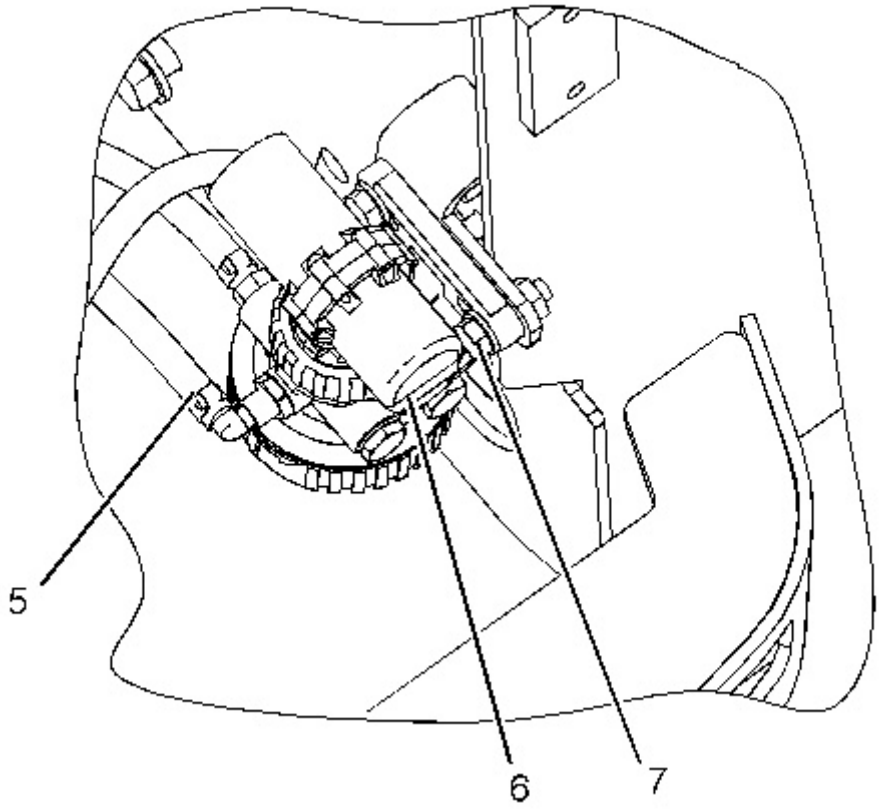


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

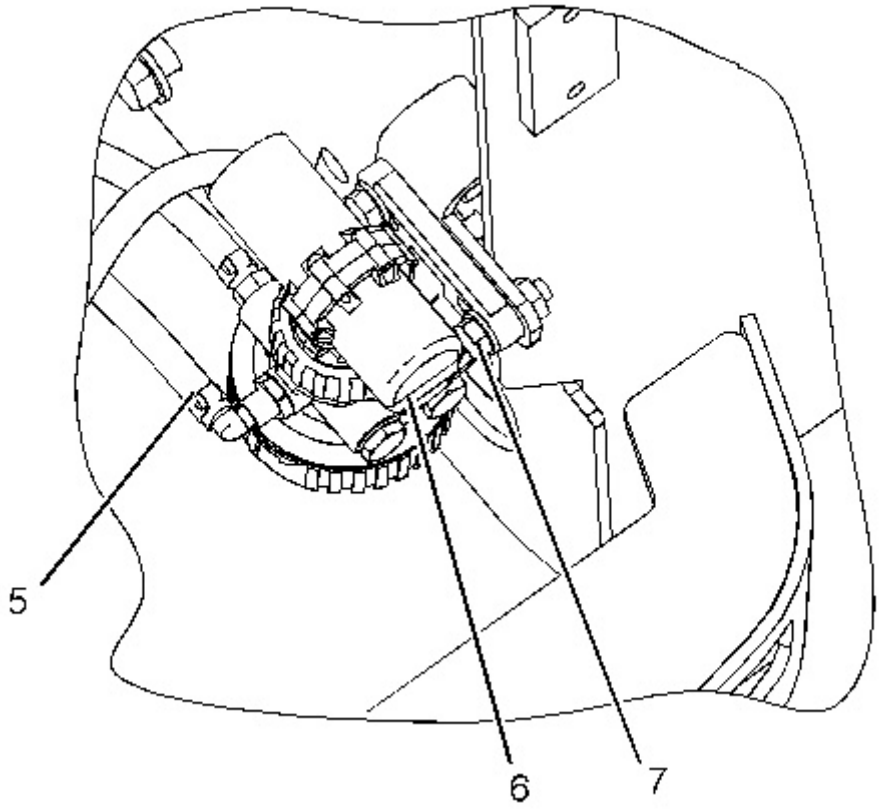


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

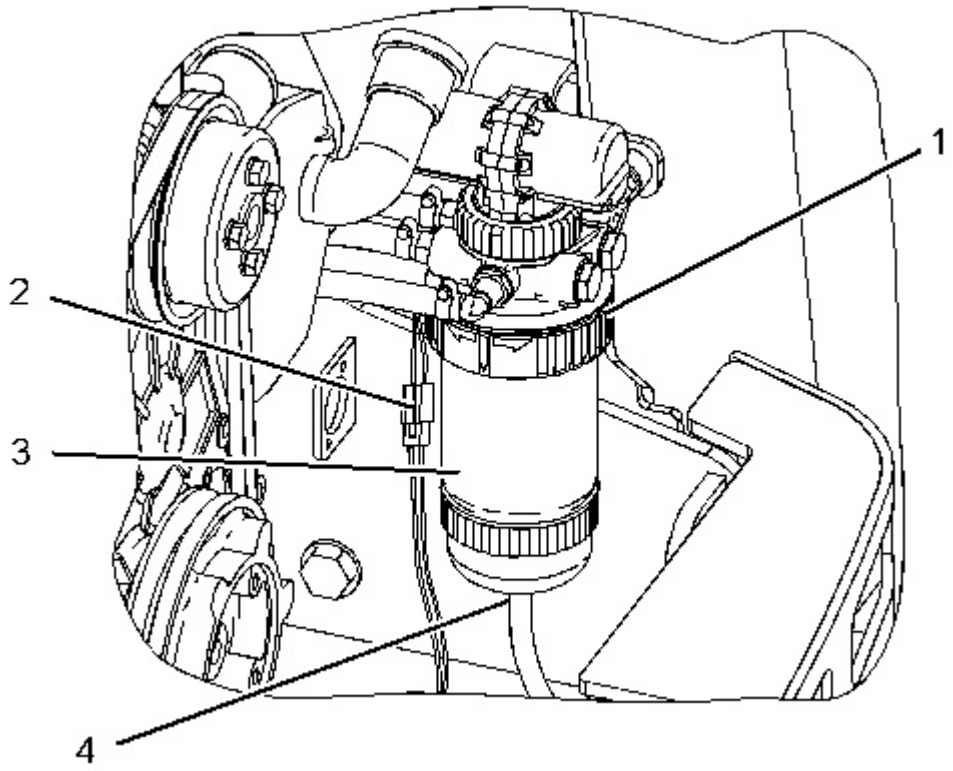


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638539

Fuel Priming Pump and Fuel Filter Base - Remove and Install

SMCS - 1258-010; 1260-010; 1261-010-SE; 1262-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hose assemblies and on all tube assemblies for installation purposes. Plug all hose assemblies and tube assemblies. This helps prevent fluid loss, and this helps to keep contaminants from entering the system.

1. Turn the fuel supply to the OFF position.
2. Turn the battery disconnect switch to the OFF position.

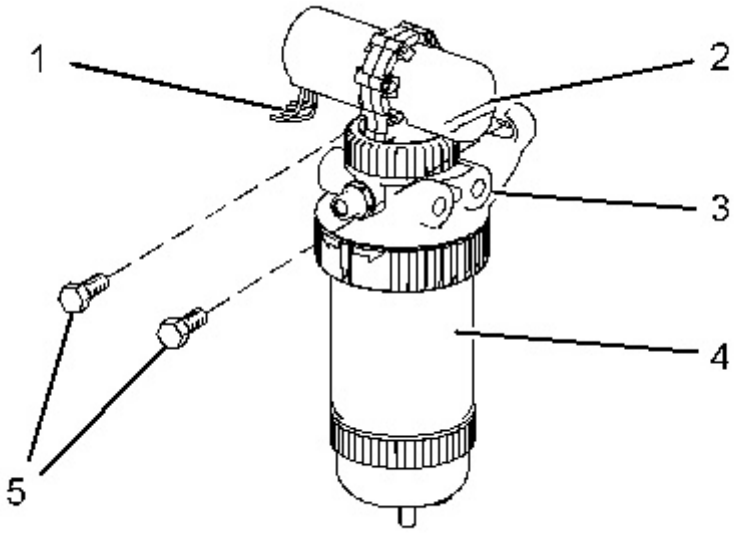


Illustration 1 g01324908

Typical example

3. Drain fuel filter (4). Refer to Operation and Maintenance Manual, "Fuel System Primary Filter/Water Seperator - Drain".
4. Disconnect harness assembly (1) from fuel priming pump (2) .
5. Disconnect the tube assemblies (not shown) from fuel filter base (3) .
6. Remove bolts (5) and remove fuel filter base (3) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the assembly of the fuel priming pump and the fuel filter base is clean and free from damage. If necessary, replace any components that are damaged.

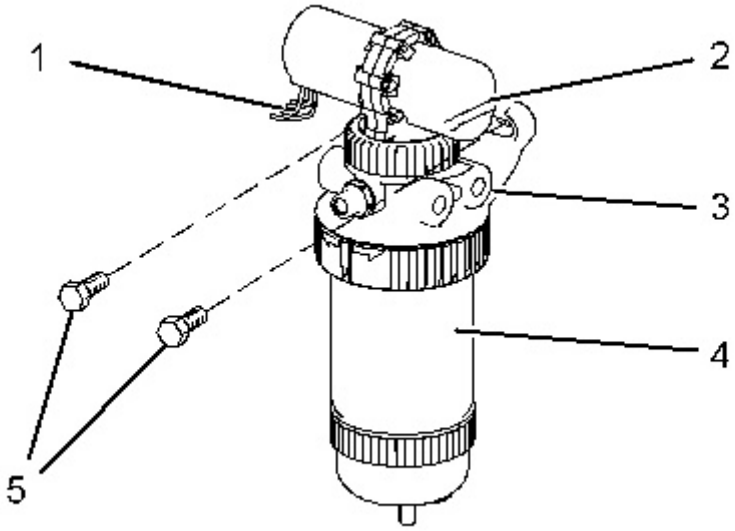


Illustration 2 g01324908

Typical example

2. Position fuel filter base (3) on the mounting bracket. Install bolts (5) to the fuel filter base. Tighten the bolts to a torque of 35 N·m (26 lb ft).
3. Connect the tube assemblies for the fuel inlet and the fuel outlet (not shown) to fuel filter base (3) .
4. If necessary, install a new fuel filter (4) to fuel filter base (3). Refer to Operation and Maintenance Manual, "Fuel System Primary Filter/Water Seperator - Drain".
5. Connect harness assembly (1) to fuel priming pump (2) .
6. Turn the fuel supply to the ON position.
7. Turn the battery disconnect switch to the ON position.
8. Remove the air from the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01891782

Fuel Injection Lines

SMCS - 1252

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

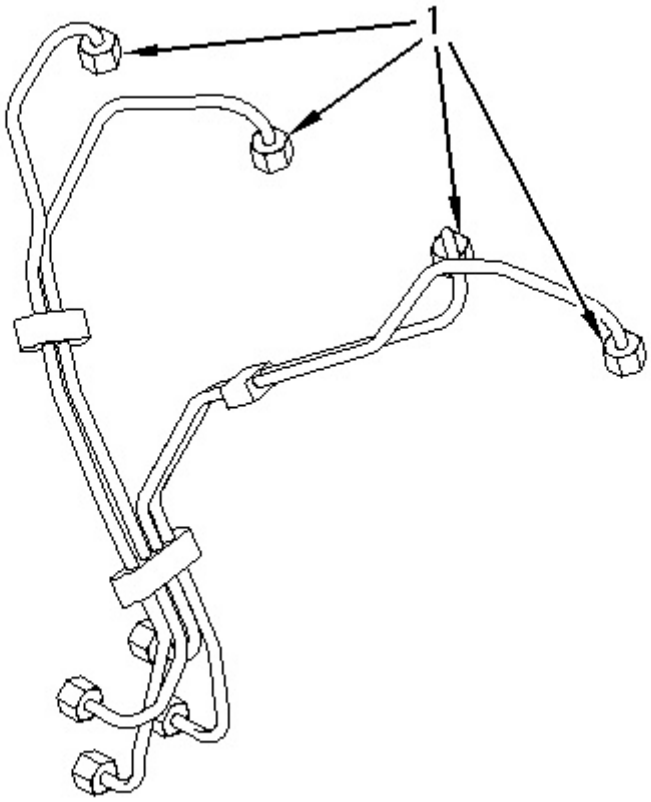


Illustration 1 g00993243

(1) Tighten the nuts for the fuel injection lines to the following torque. ... 27 to 32 N·m (20 to 24 lb ft)

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i01891782

Fuel Injection Lines

SMCS - 1252

S/N - -

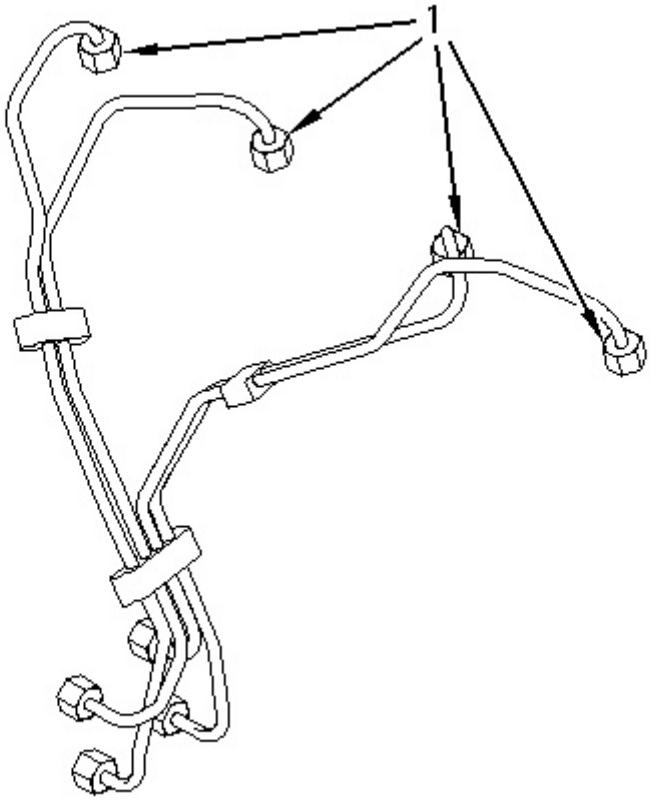


Illustration 1 g00993243

(1) Tighten the nuts for the fuel injection lines to the following torque. ... 27 to 32 N·m (20 to 24 lb ft)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001805

Fuel Injection Lines - Remove and Install - Turbocharged Engines

SMCS - 1252-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7068	Tapered Cap/Plug	16
	9U-7070	Tapered Cap/Plug	4

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

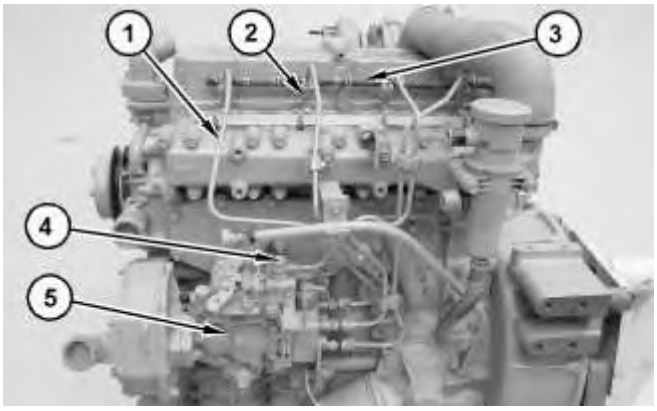


Illustration 1 g01035888

1. Disconnect fuel injection lines (1) from fuel injection nozzles (2). Plug all openings immediately.
2. Disconnect fuel injection lines (1) from fuel injection pump (5). Plug all openings immediately.

   Note: Secure the delivery valves with a wrench when you remove fuel injection lines (1) at fuel injection pump (5) .
3. Remove fuel injection lines (1) from the engine.

   Note: Loosen the clamps that tie the fuel injection lines together in order to maneuver the lines off the engine, if necessary.
4. Disconnect fuel return line (3) from overflow valve (4) on fuel injection pump (5). Remove the sealing washers from overflow valve (4) .
5. Remove fuel return line (3) from fuel injection nozzles (2) .

   Note: Loosen the hose clamps and remove the individual fuel hoses between the fuel injection nozzles.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

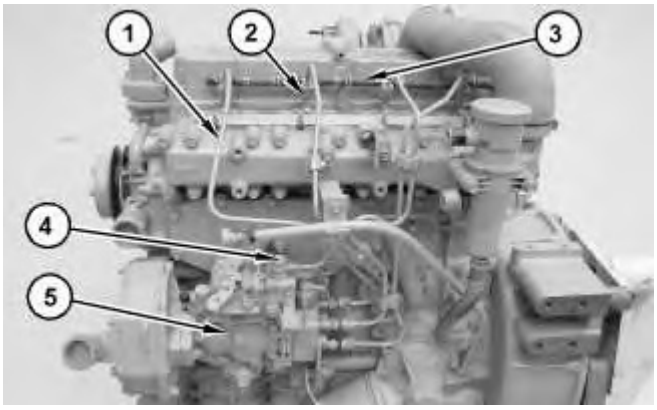


Illustration 2 g01035888

Note: Install the individual fuel hoses between the fuel injection nozzles. Tighten the hose clamps securely.

1. Install fuel return line (3) on fuel injection nozzles (2) and fuel injection pump (5). Position the sealing washers on overflow valve (4). Tighten overflow valve (4) to a torque of 22 to 31 N·m (16 to 23 lb ft).
2. Position the fuel injection lines on the engine.
3. Connect fuel injection lines (1) at fuel injection pump (5). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).

   Note: Secure the delivery valves with a wrench when you install fuel injection lines (1) to fuel injection pump (5) .
4. Connect fuel injection lines (1) to fuel injection nozzles (2). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).
5. If the clamps that tie the fuel injection lines together were loosened for removal purposes, tighten the clamps securely.

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i02001805

Fuel Injection Lines - Remove and Install - Turbocharged Engines

SMCS - 1252-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	9U-7068	Tapered Cap/Plug	16
	9U-7070	Tapered Cap/Plug	4

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

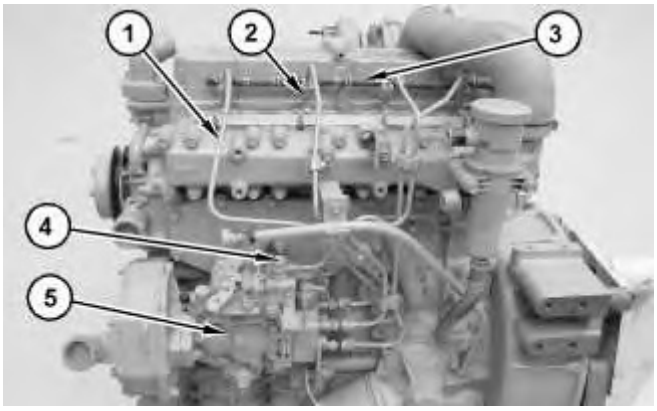


Illustration 1 g01035888

1. Disconnect fuel injection lines (1) from fuel injection nozzles (2). Plug all openings immediately.
2. Disconnect fuel injection lines (1) from fuel injection pump (5). Plug all openings immediately.

   Note: Secure the delivery valves with a wrench when you remove fuel injection lines (1) at fuel injection pump (5) .
3. Remove fuel injection lines (1) from the engine.

   Note: Loosen the clamps that tie the fuel injection lines together in order to maneuver the lines off the engine, if necessary.
4. Disconnect fuel return line (3) from overflow valve (4) on fuel injection pump (5). Remove the sealing washers from overflow valve (4) .
5. Remove fuel return line (3) from fuel injection nozzles (2) .

   Note: Loosen the hose clamps and remove the individual fuel hoses between the fuel injection nozzles.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

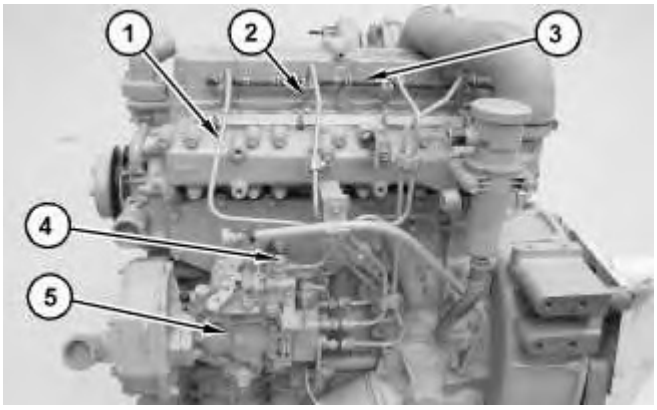


Illustration 2 g01035888

Note: Install the individual fuel hoses between the fuel injection nozzles. Tighten the hose clamps securely.

1. Install fuel return line (3) on fuel injection nozzles (2) and fuel injection pump (5). Position the sealing washers on overflow valve (4). Tighten overflow valve (4) to a torque of 22 to 31 N·m (16 to 23 lb ft).
2. Position the fuel injection lines on the engine.
3. Connect fuel injection lines (1) at fuel injection pump (5). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).

   Note: Secure the delivery valves with a wrench when you install fuel injection lines (1) to fuel injection pump (5) .
4. Connect fuel injection lines (1) to fuel injection nozzles (2). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).
5. If the clamps that tie the fuel injection lines together were loosened for removal purposes, tighten the clamps securely.

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i02552009

Fuel Injection Lines - Remove and Install - Naturally Aspirated Engines

SMCS - 1252-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

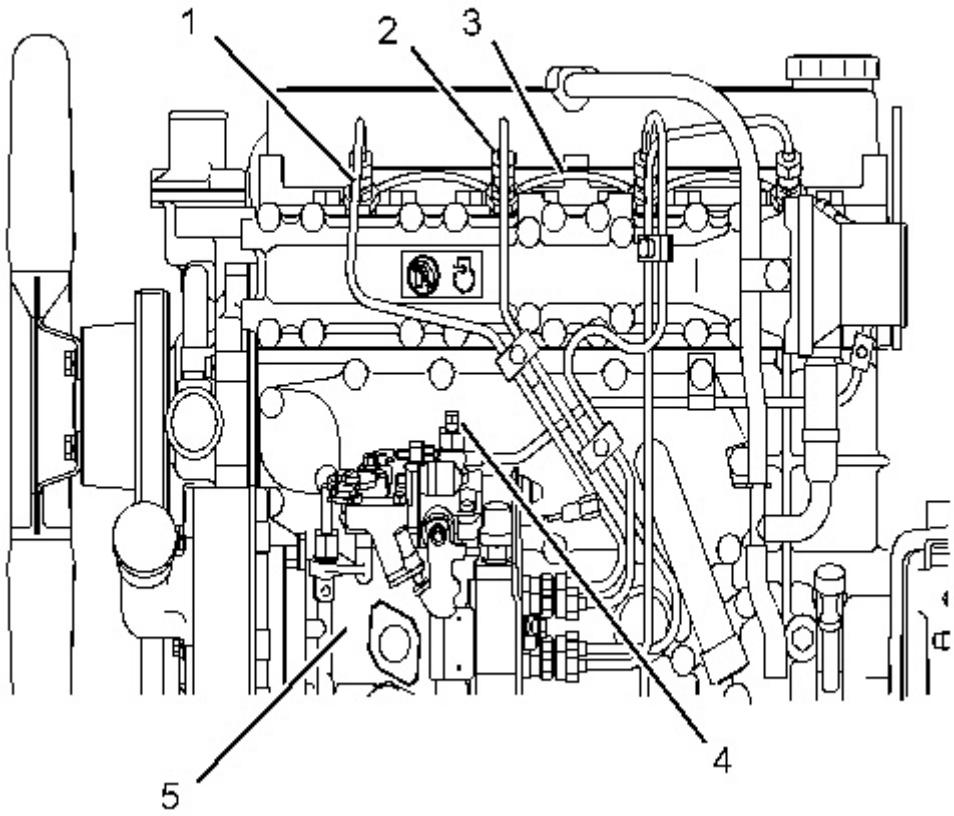


Illustration 1 g01277541

1. Disconnect fuel injection lines (1) from fuel injection nozzles (2). Plug all openings immediately.
2. Disconnect fuel injection lines (1) from fuel injection pump (5). Plug all openings immediately.

   Note: Secure the delivery valves with a wrench when you remove fuel injection lines (1) at fuel injection pump (5) .
3. Remove fuel injection lines (1) from the engine.
4. Disconnect fuel return line (3) from overflow valve (4) on fuel injection pump (5). Remove the sealing washers from overflow valve (4) .

   Note: Check the condition of the sealing washers on the overflow valve. Replace the sealing washers, if necessary.
5. Remove fuel return line (3) from fuel injection nozzles (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

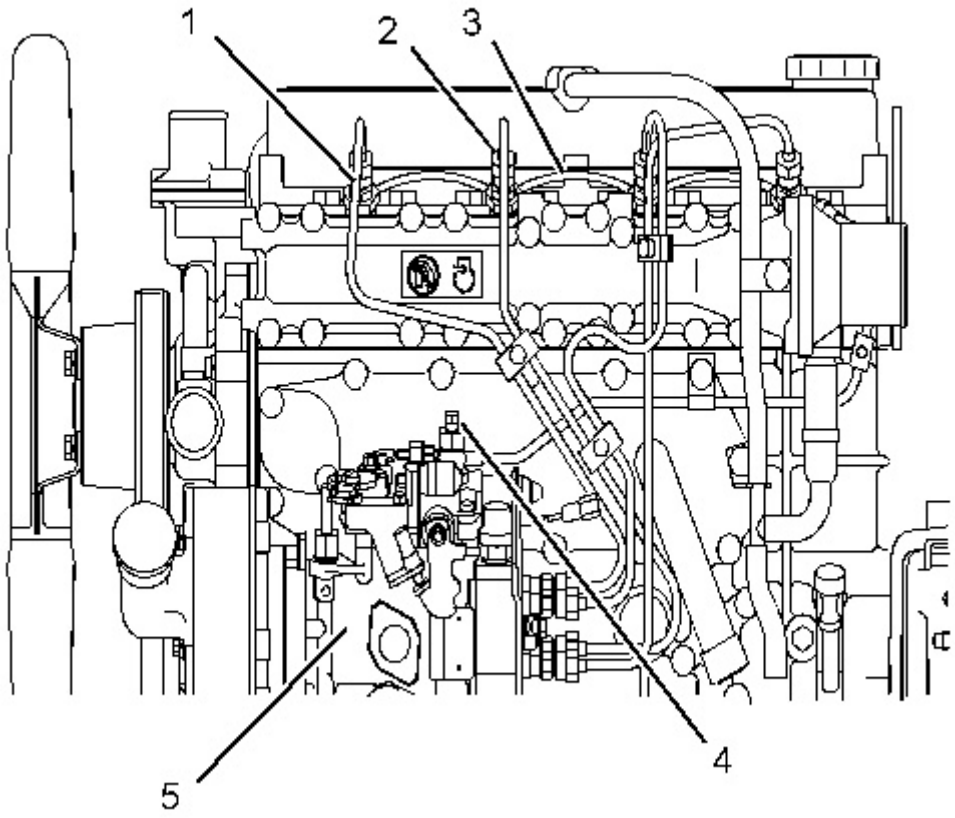


Illustration 2 g01277541

1. Install fuel return line (3) on fuel injection nozzles (2) and on fuel injection pump (5). Position the sealing washers on overflow valve (4). Tighten overflow valve (4) to a torque of 22 to 31 N·m (16 to 23 lb ft).
2. Position the fuel injection lines on the engine.
3. Connect fuel injection lines (1) at fuel injection pump (5). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).

   Note: Secure the delivery valves with a wrench when you install fuel injection lines (1) to fuel injection pump (5) .
4. Connect fuel injection lines (1) to fuel injection nozzles (2). Tighten the union nuts to a torque of 27 to 32 N·m (20 to 24 lb ft).

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638543

Fuel Injection Lines - Remove and Install - Turbocharged Engines

SMCS - 1252-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Place identification marks on all tube assemblies for installation. Plug all lines and tube assemblies in order to prevent contamination.

1. Turn the fuel supply to the OFF position.

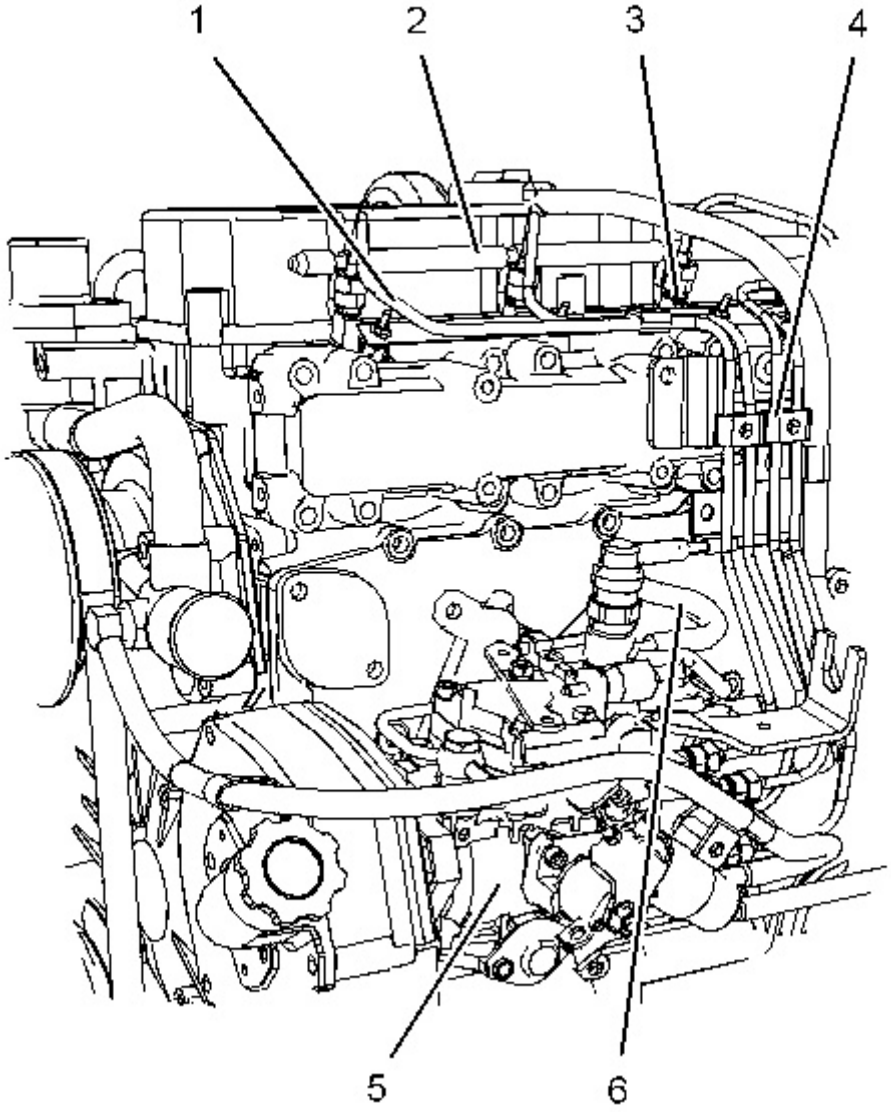


Illustration 1 g01332532

Typical example

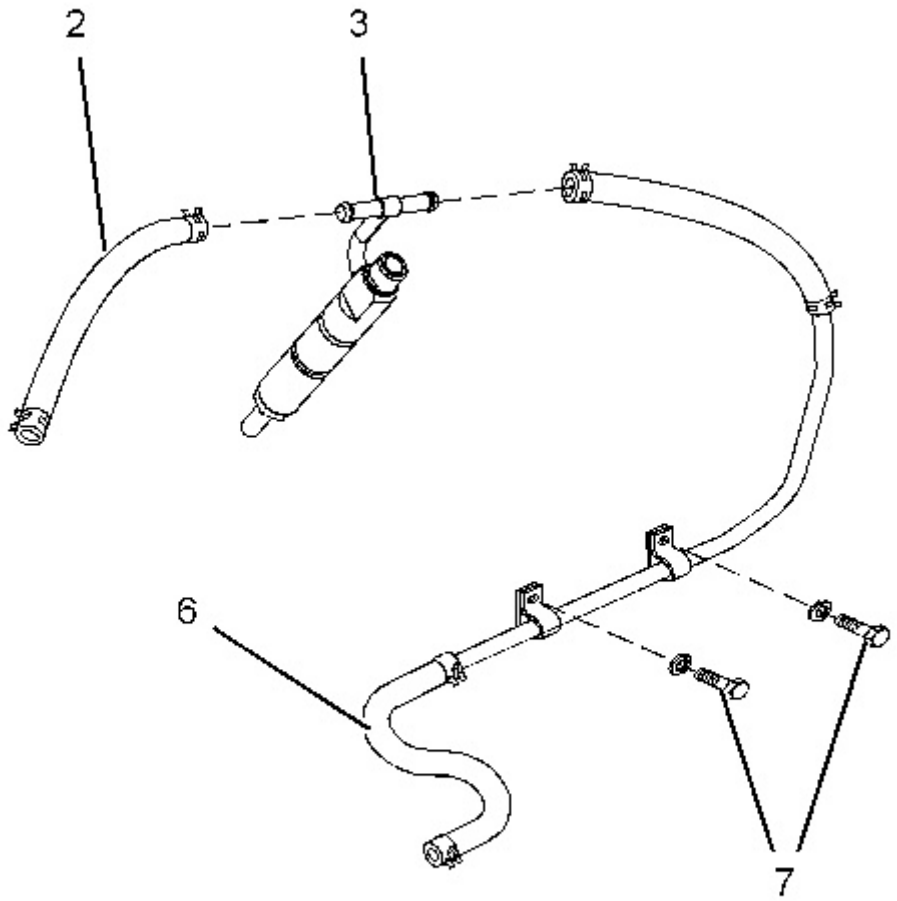


Illustration 2 g01324910

Typical example

2. If necessary, loosen the dipstick tube (not shown).
3. Disconnect fuel injection lines (1) from fuel injectors (3) .
4. Disconnect fuel injection lines (1) from fuel injection pump (5) .

   Note: Do not allow the unions to turn in the fuel injection pump when the fuel line nuts are loosened. Use two wrenches in order to disconnect the fuel injection lines from the fuel injection pump.
5. Remove clamps (4) and remove fuel injection lines (1) .
6. Use suitable caps in order to plug the open ports of the fuel injection pump and the fuel injectors immediately.

7. Disconnect tube assembly (6) from fuel injector (3). Disconnect tube assembly (6) from fuel injection pump (5). Remove bolts (7) and remove tube assembly (6) .
8. Remove hoses (2) from fuel injectors (3) .

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	276-1216	Injector Pipe Nut Tool	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

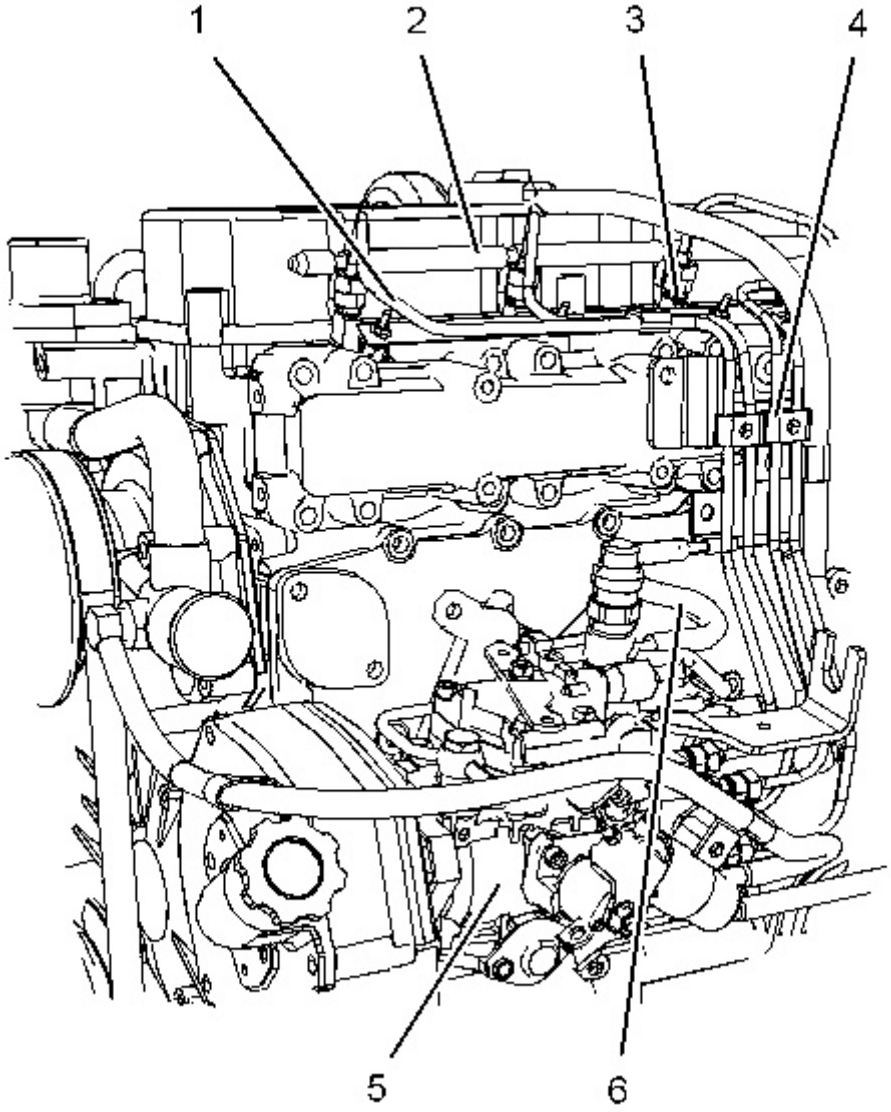


Illustration 3 g01332532

Typical example

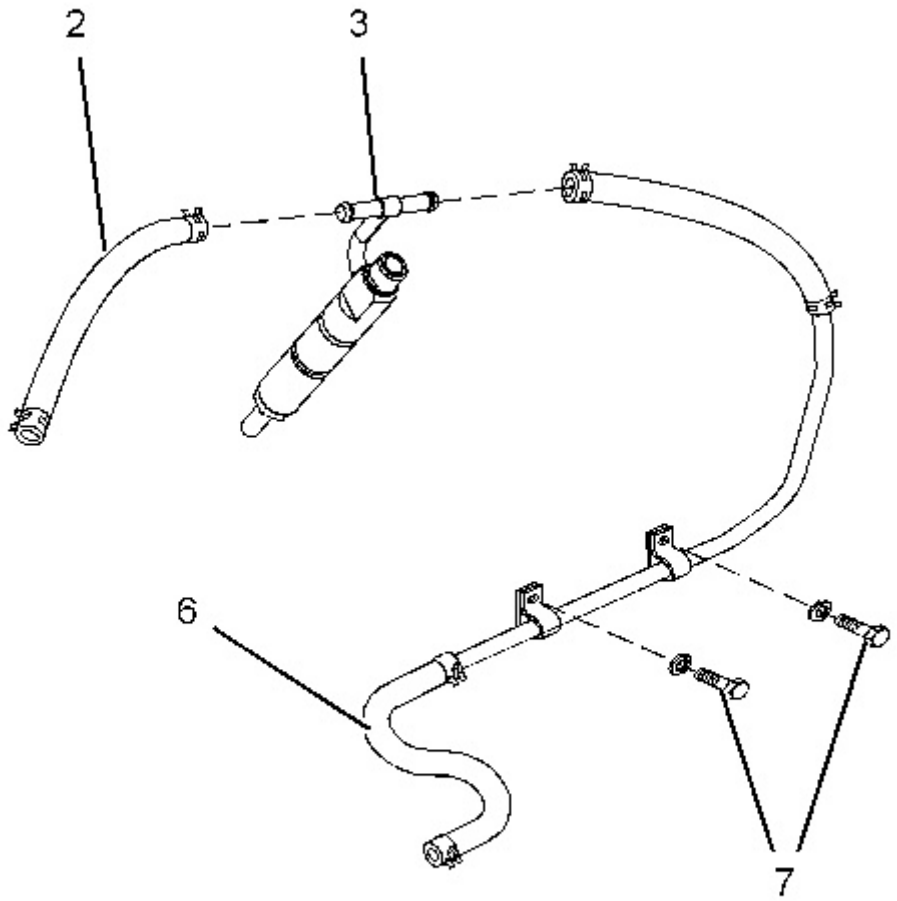


Illustration 4 g01324910

Typical example

1. Install hoses (2) to fuel injectors (3) .
2. Position tube assembly (6) onto the engine and install bolts (7). Tighten the bolts to a torque of 18 N·m (13 lb ft).
3. Connect tube assembly (6) to fuel injectors (3). Connect tube assembly (6) to fuel injection pump (5) .
4. Remove the caps from fuel injectors and from the fuel injection pump. Loosely install fuel injection lines (1) to fuel injection pump (5) and to fuel injectors (3) .
5. Install clamps (4). Tighten the clamps securely.

6. Use Tooling (A) to tighten the nuts on fuel injection lines (1) to a torque of 30 N·m (22 lb ft).

   Note: Do not allow the unions to turn in the fuel injection pump when the fuel line nuts are tightened.

7. If necessary, tighten the dipstick tube (not shown) to a torque of 9 N·m (80 lb in).

8. Turn the fuel supply to the ON position.

9. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime" for more information.

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638542

Fuel Injection Lines - Remove and Install - Naturally Aspirated Engines

SMCS - 1252-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Place identification marks on all tube assemblies for installation. Plug all lines and tube assemblies in order to prevent contamination.

1. Turn the fuel supply to the OFF position.
2. If necessary, loosen the dipstick tube (not shown).

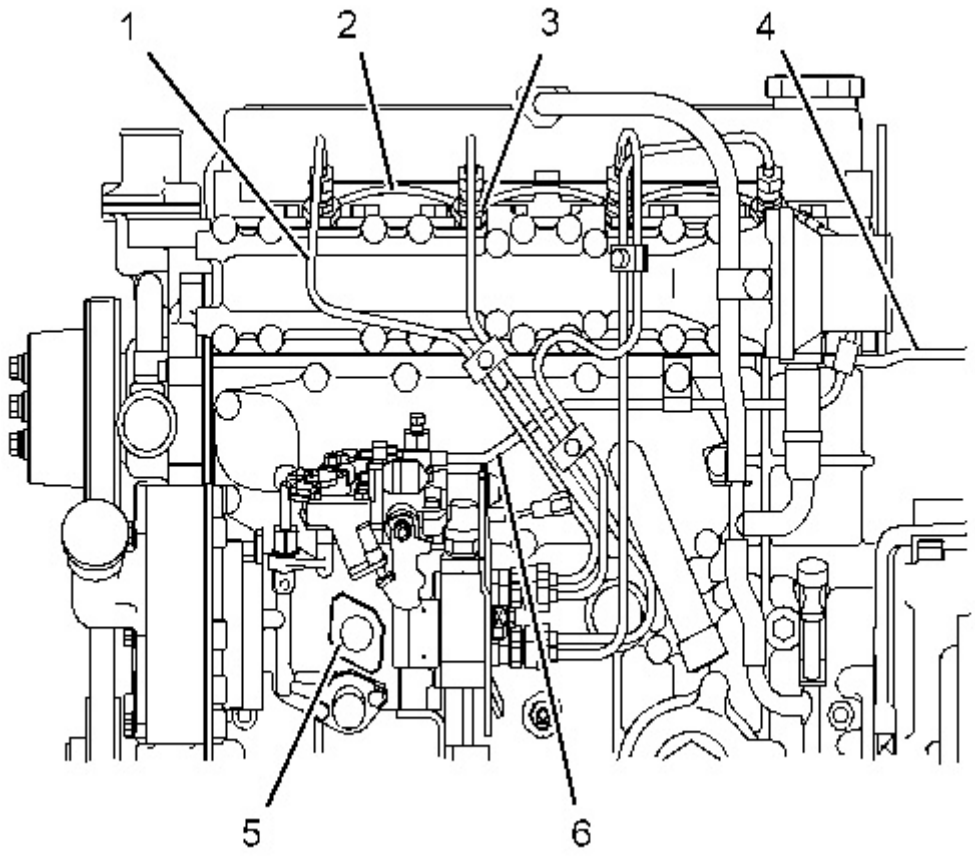


Illustration 1 g01332971

Typical example

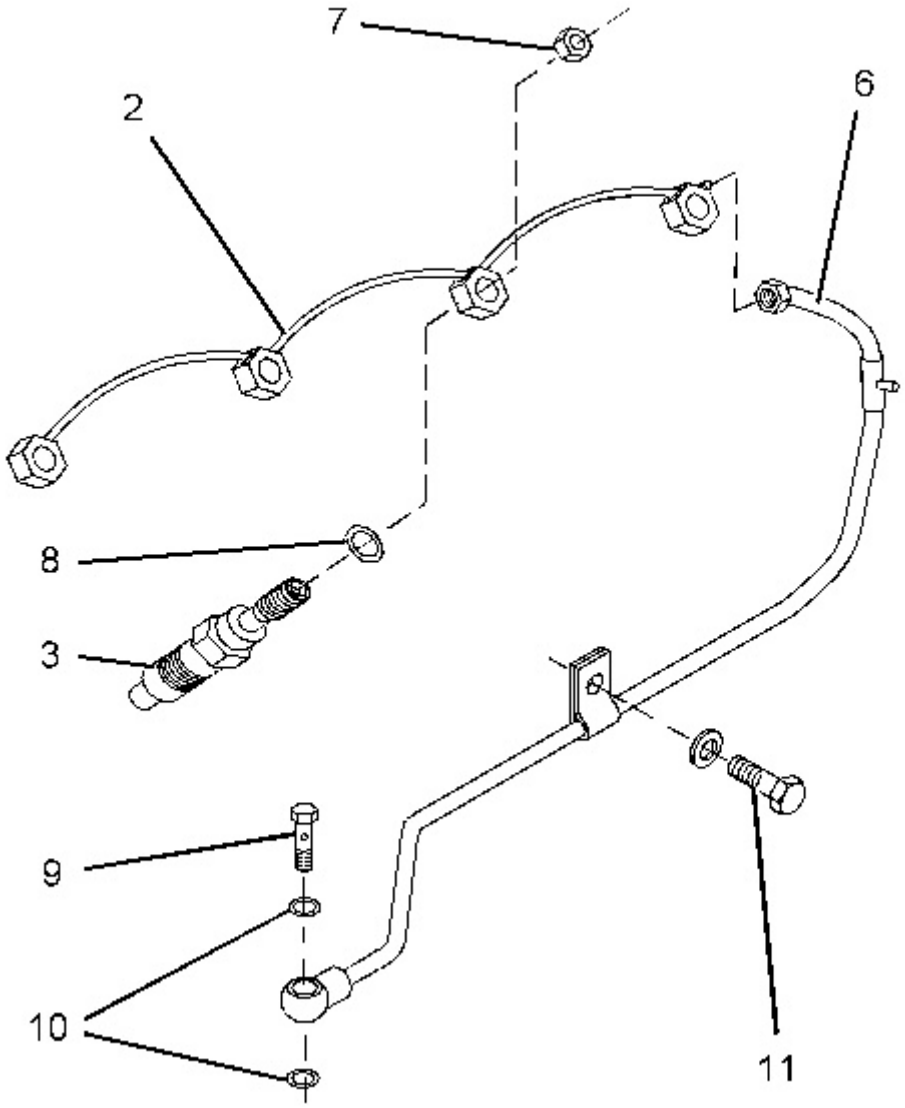


Illustration 2 g01332972

Typical example

3. Disconnect hose (4) from tube assembly (6) .
4. Disconnect fuel injection lines (1) from fuel injectors (3) .
5. Disconnect fuel injection lines (1) from fuel injection pump (5) .

   Note: Do not allow the unions to turn in the fuel injection pump when the fuel line nuts are loosened. Use two wrenches in order to disconnect the fuel injection lines from the fuel injection pump.
6. Remove fuel injection lines (1) .
7. Use suitable caps in order to plug the open ports of the fuel injection pump immediately.
8. Disconnect tube assembly (6) from fuel return line (2) .

9. Remove banjo bolt (9) and sealing washers (10) from fuel injection pump (5) .
10. Remove bolt (11) and remove tube assembly (6) .
11. Remove nuts (7) from fuel injectors (3). Remove fuel return line (2) and sealing washers (8) from fuel injectors (3) .
12. Use suitable caps in order to plug the open ports of the fuel injectors immediately.

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	276-1216	Injector Pipe Nut Tool	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

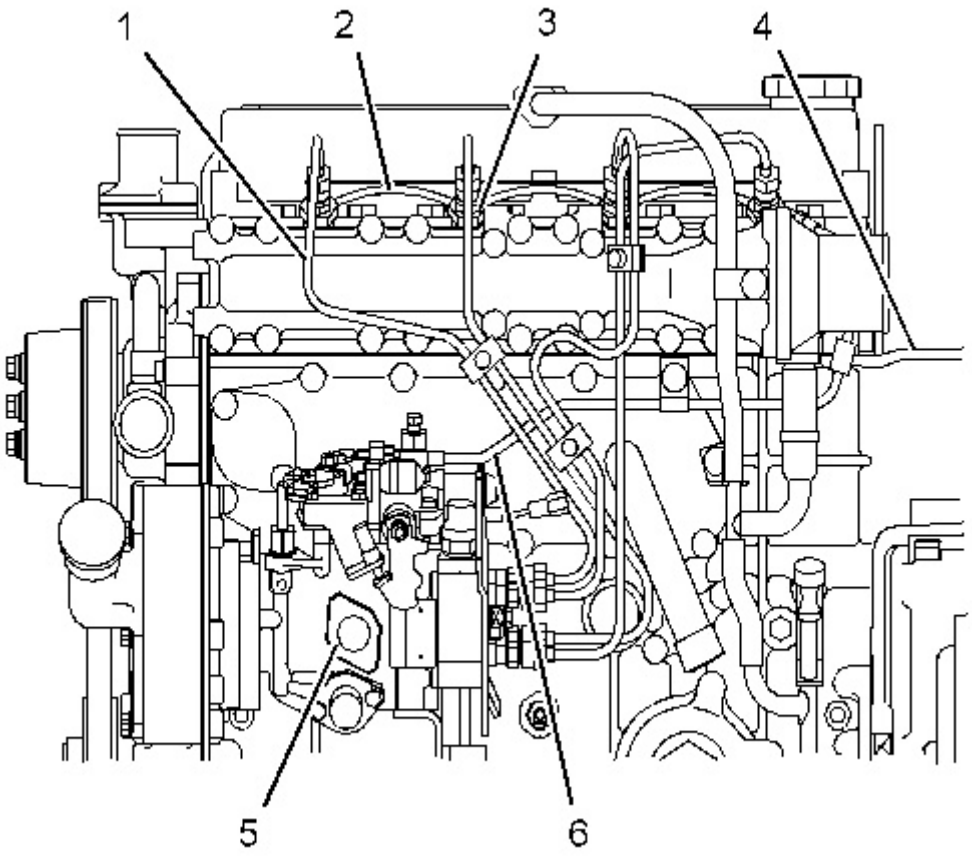


Illustration 3 g01332971

Typical example

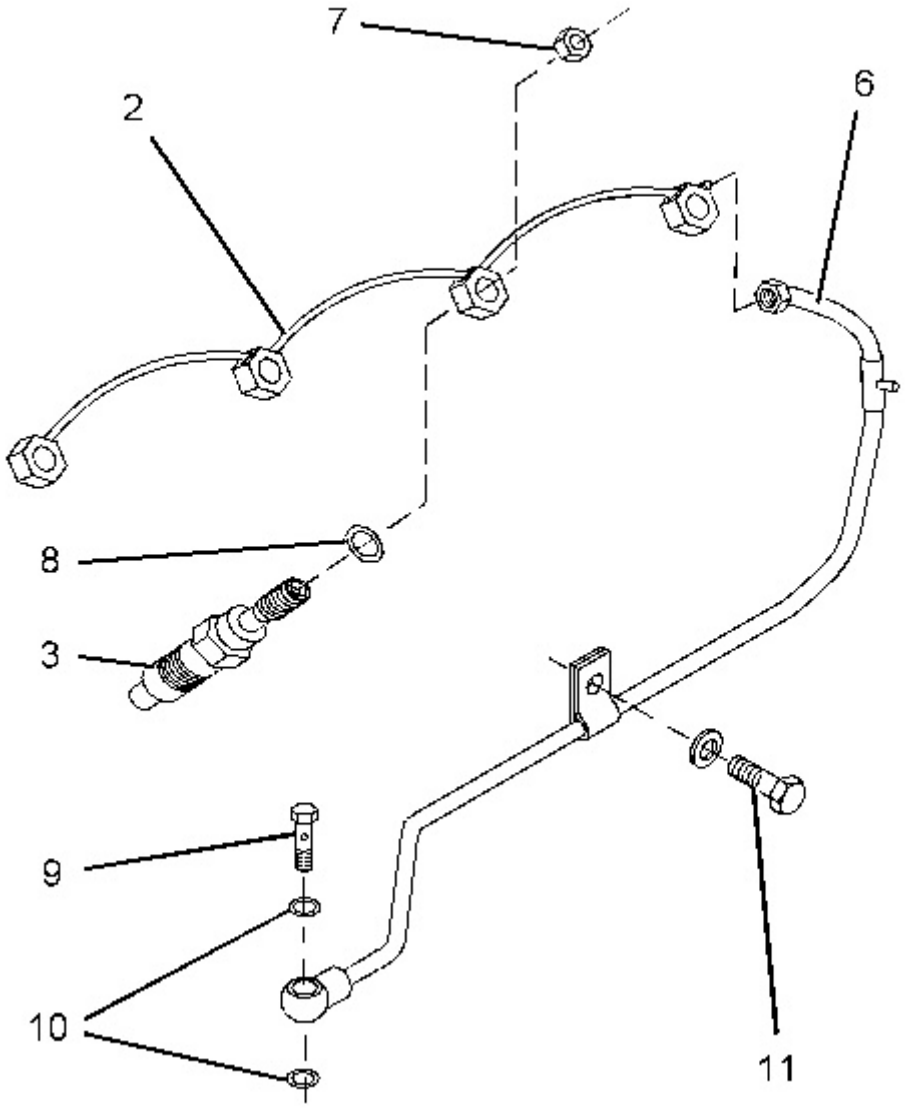


Illustration 4 g01332972

Typical example

1. Remove the caps from fuel injectors (3) and install new sealing washers (8) to the fuel injectors.

   Note: Washers (8) have two small holes. The position of the holes is not important.

2. Position fuel return line (2) onto fuel injectors (3) .
3. Install nuts (7) onto each fuel injector. Tighten the nuts to a torque of 23 N·m (17 lb ft).
4. Position tube assembly (6) onto the engine. Loosely connect the tube assembly to fuel return line (2) .
5. Install banjo bolt (9) and new sealing washers (10) to fuel injection pump (5) .
6. Install bolt (11). Tighten the bolt to a torque of 11 N·m (97 lb in).

7. Tighten banjo bolt (9) to a torque of 18 N·m (13 lb ft). Tighten the nut to fuel return line (2) to a torque of 20 N·m (15 lb ft).

8. Remove the caps from the fuel injection pump. Install fuel injection lines (1) to fuel injection pump (5) and to fuel injectors (3) .

9. Use Tooling (A) to tighten the nuts on fuel injection lines (1) to a torque of 30 N·m (22 lb ft).

   Note: Do not allow the unions to turn in the fuel injection pump when the fuel line nuts are tightened.

10. Connect hose (4) to tube assembly (6) .

11. If necessary, tighten the dipstick tube (not shown) to a torque of 9 N·m (80 lb in).

12. Turn the fuel supply to the ON position.

13. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime" for more information.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01906880

Fuel Injection Pump

SMCS - 1251; 1290

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Note: The engine is equipped with an axial piston distributor injection pump that is mechanically governed. Parts that are inside of the fuel injection pump are only serviceable by an authorized dealer.

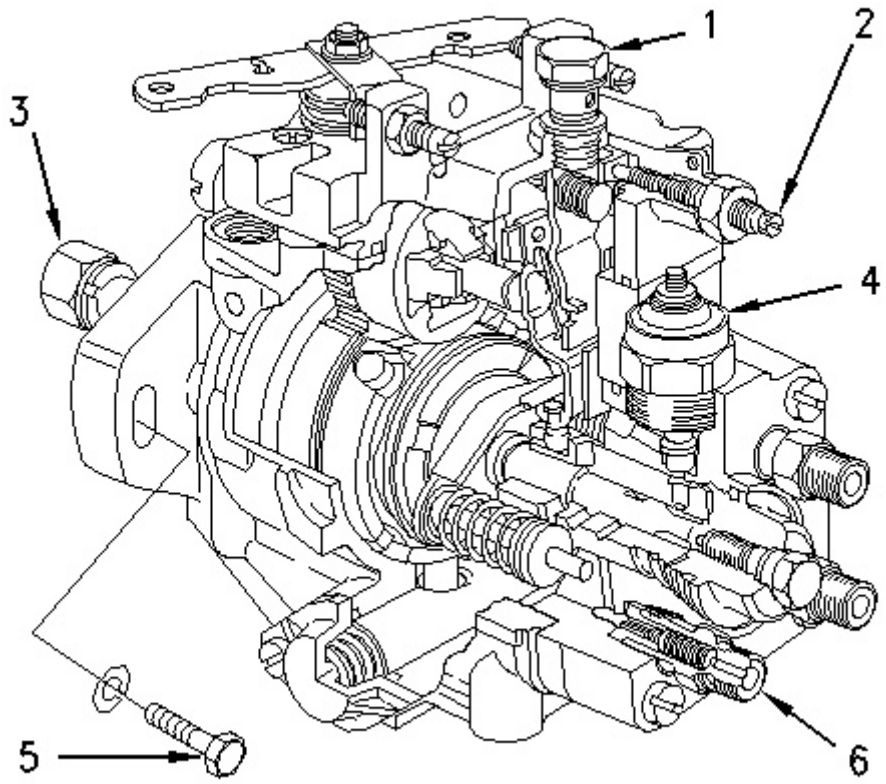


Illustration 1 g00993641

(1) Tighten the overflow valve for the fuel injection pump to the following torque. ... 22 to 31 N·m (16 to 23 lb ft)

(2) Screw for adjusting the full load setting

(3) Tighten the nut for the fuel injection pump gear to the following torque.

Naturally aspirated engines ... 59 to 69 N·m (43 to 51 lb ft)
Turbocharged engines ... 83 to 98 N·m (62 to 72 lb ft)

(4) Fuel shutoff solenoid

(5) Bolt for attaching to the gear case cover

(6) Delivery valves for the fuel

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02507999

Fuel Injection Nozzles

SMCS - 1254

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Naturally Aspirated Engines

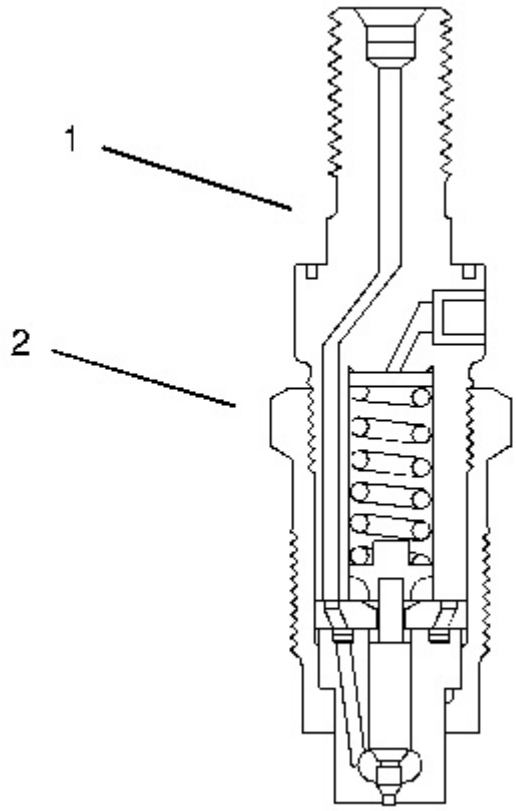


Illustration 1 g01010241

(1) Tighten the body in the retaining nut to the following torque. ... 34 to 39 N·m (25 to 29 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

(2) Tighten the fuel injection nozzle in the engine to the following torque. ... 53 to 65 N·m (39 to 48 lb ft)

Type of fuel injection nozzle ... single orifice

Injection pressure

Standard at assembly ... 11.77 to 12.75 MPa (1707 to 1849 psi)

Turbocharged Engines

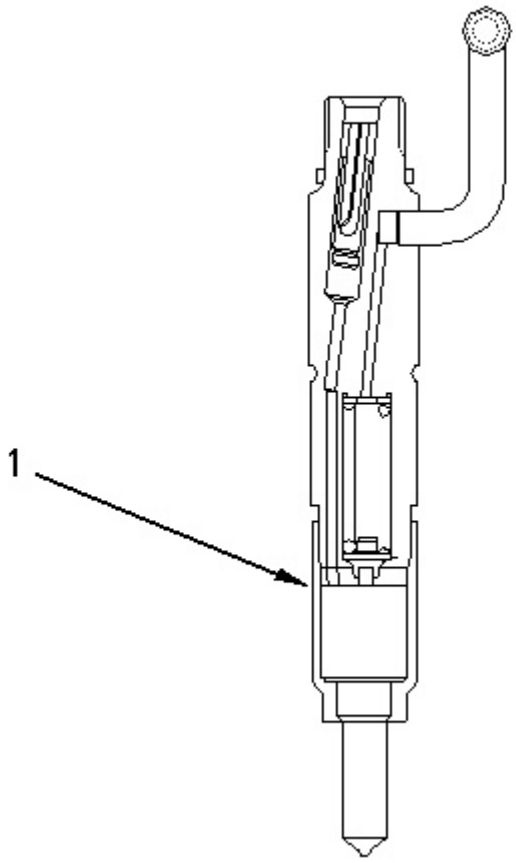


Illustration 2 g00993511

(1) Tighten the retaining nut to the following torque. ... 25 to 34 N·m (18 to 25 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

Tighten the clamp bolt that secures the fuel injection nozzle in the cylinder head to the following torque. ... 21 to 23 N·m (15 to 17 lb ft)

Type of fuel injection nozzle ... multiple orifice

Injection pressure

Standard at assembly ... 18.14 to 19.12 MPa (2631 to 2773 psi)

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i02723707

Fuel Injection Pump

SMCS - 1251; 1290

S/N - -

Note: The engine is equipped with an axial piston distributor injection pump that is mechanically governed. Parts that are inside of the fuel injection pump are only serviceable by an authorized dealer.

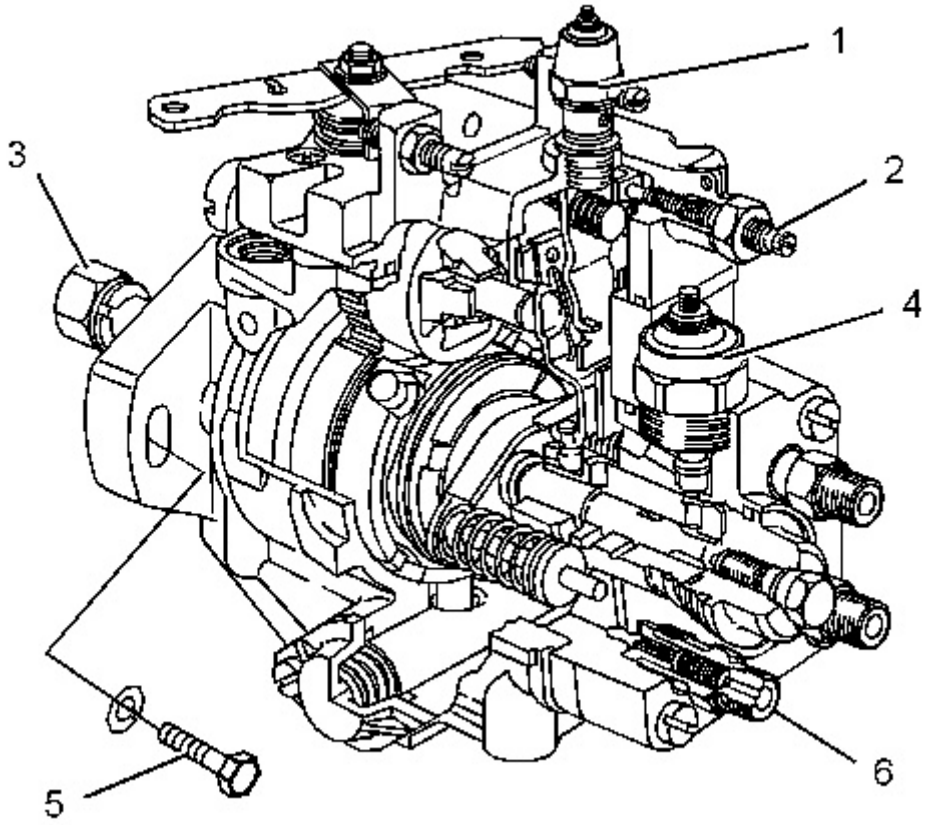


Illustration 1 g01366244

Typical example

(1) Tighten the overflow valve for the fuel injection pump to the following torque. ... 15 to 20 N·m (11 to 15 lb ft)

(2) Screw for adjusting the full load setting

(3) Tighten the nut for the fuel injection pump gear to the following torque.

Naturally aspirated engines ... 59 to 69 N·m (43 to 51 lb ft)
Turbocharged engines ... 83 to 98 N·m (62 to 72 lb ft)

(4) Fuel shutoff solenoid

(5) Bolt for attaching to the gear case cover

(6) Delivery valves for the fuel

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02507999

Fuel Injection Nozzles

SMCS - 1254

S/N - -

Naturally Aspirated Engines

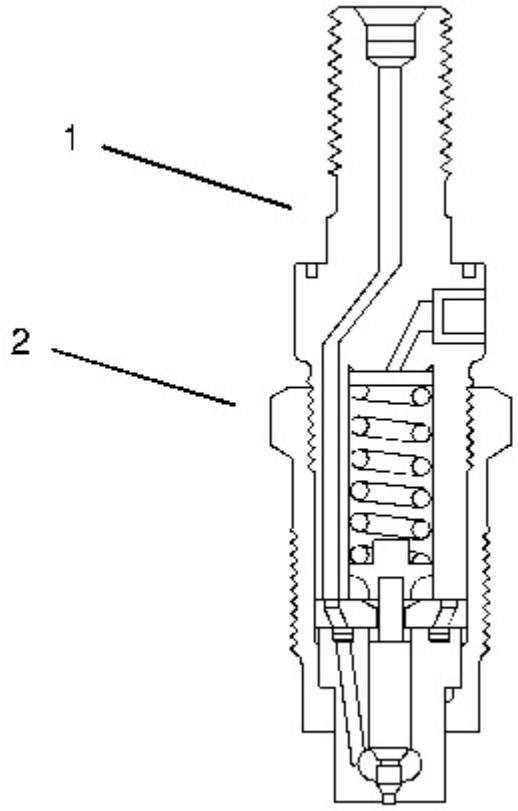


Illustration 1 g01010241

(1) Tighten the body in the retaining nut to the following torque. ... 34 to 39 N·m (25 to 29 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

(2) Tighten the fuel injection nozzle in the engine to the following torque. ... 53 to 65 N·m (39 to 48 lb ft)

Type of fuel injection nozzle ... single orifice

Injection pressure

Standard at assembly ... 11.77 to 12.75 MPa (1707 to 1849 psi)

Turbocharged Engines

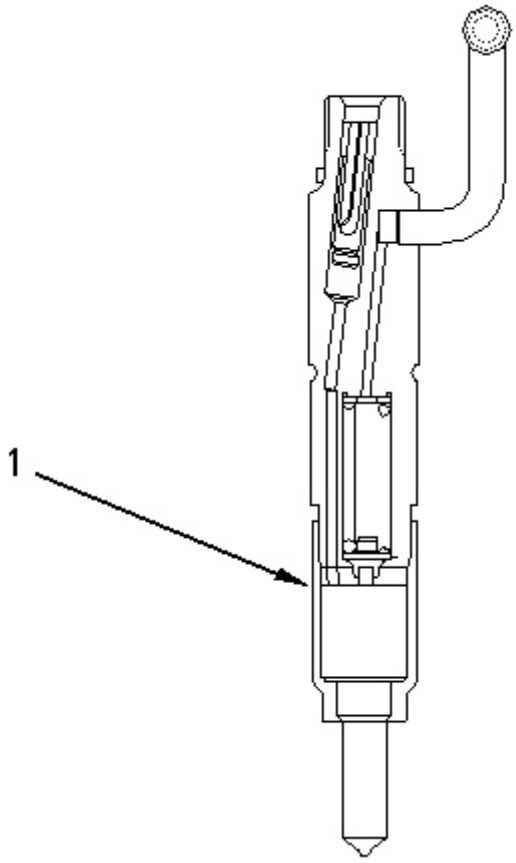


Illustration 2 g00993511

(1) Tighten the retaining nut to the following torque. ... 25 to 34 N·m (18 to 25 lb ft)

Note: The fuel injection nozzles should only be disassembled and assembled by personnel with the proper training.

Tighten the clamp bolt that secures the fuel injection nozzle in the cylinder head to the following torque. ... 21 to 23 N·m (15 to 17 lb ft)

Type of fuel injection nozzle ... multiple orifice

Injection pressure

Standard at assembly ... 18.14 to 19.12 MPa (2631 to 2773 psi)

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001634

Fuel Injection Nozzles - Remove - Turbocharged Engines

SMCS - 1254-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

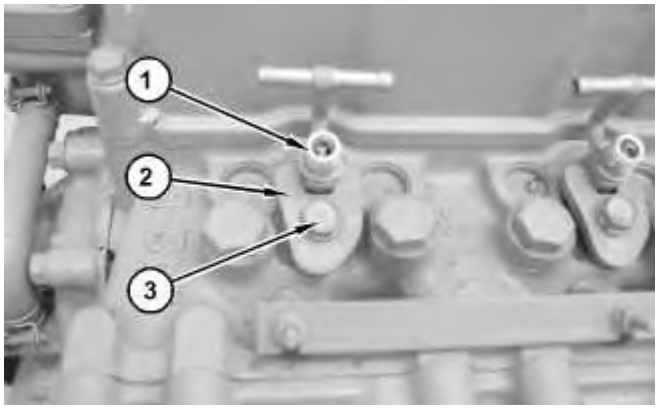


Illustration 1 g01035842

1. Remove bolt (3) and clamp (2). Remove fuel injection nozzle (1) .

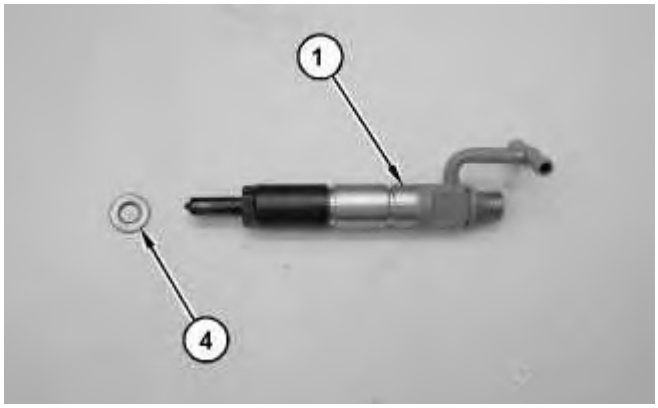


Illustration 2 g01035843

2. Remove gasket (4) from fuel injection nozzle (1) .
3. Repeat Steps 1 through 2 in order to remove the remaining fuel injection nozzles.

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001656

Fuel Injection Nozzles - Install - Turbocharged Engines

SMCS - 1254-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

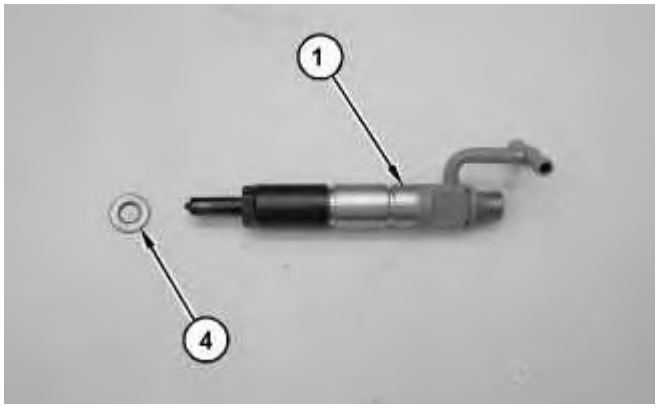


Illustration 1 g01035843

1. Position gasket (4) on fuel injection nozzle (1) .

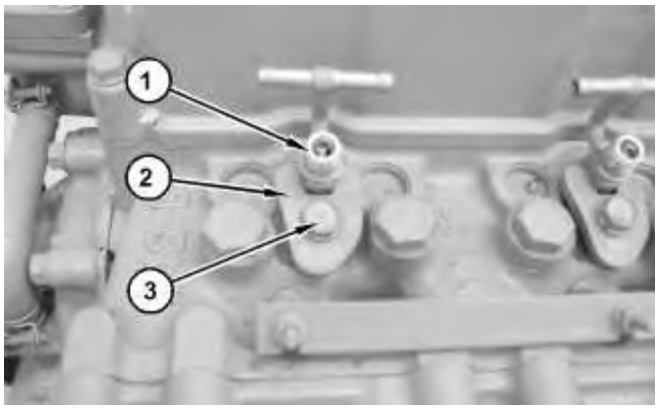


Illustration 2 g01035842

2. Position fuel injection nozzle (1). Position clamp (2) and install bolt (3). Tighten bolt (3) to a torque of 21 to 23 N·m (16 to 17 lb ft).

3. Repeat Steps 1 through 2 in order to install the remaining fuel injection nozzles.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02000757

Fuel Injection Pump - Remove

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

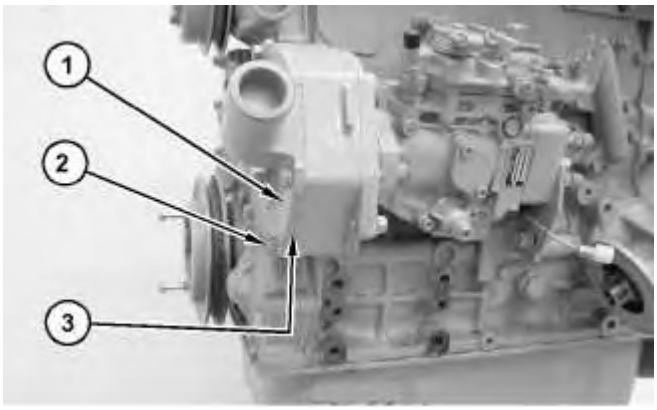


Illustration 1 g01035206

2. Remove bolts (2). Remove cover (1) and O-ring seal (3) .



Illustration 2 g01035208

3. Mark gear teeth (4) for timing purposes.

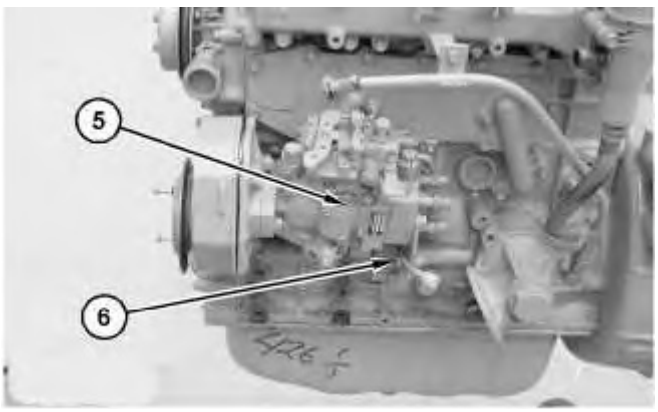


Illustration 3 g01035221

4. Remove bolt (6). Remove fuel injection pump (5) .

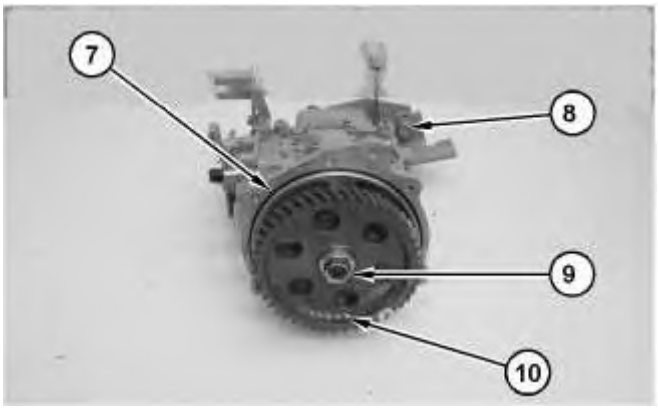


Illustration 4 g01035230

5. Remove O-ring seal (7). Remove the bolt and bracket (8). Remove nut (9) from gear (10) .

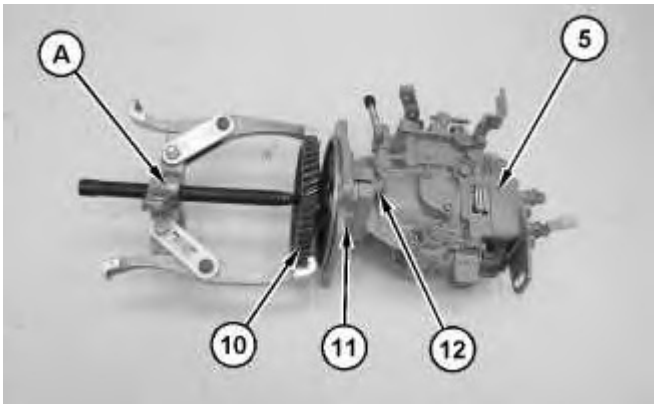


Illustration 5 g01035232

6. Use Tooling (A) to remove gear (10). Mark housing (11) and fuel injection pump (5) for installation purposes. Remove bolts (12) and housing (11) .

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02000821

Fuel Injection Pump - Install

SMCS - 1251-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

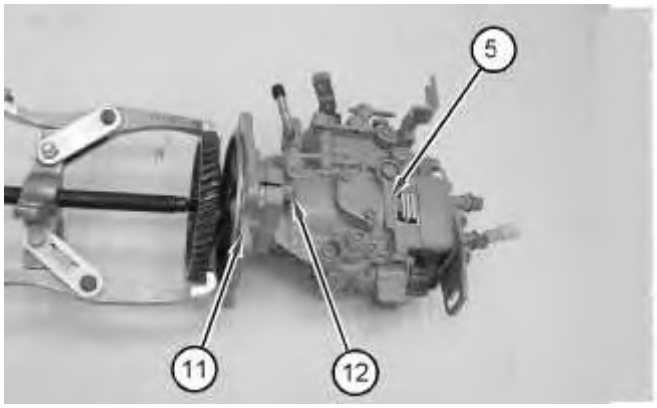


Illustration 1 g01035265

1. Clean all mating surfaces. Position housing (11) on fuel injection pump (5). Ensure that the mark is in the proper position. Install bolts (12) .

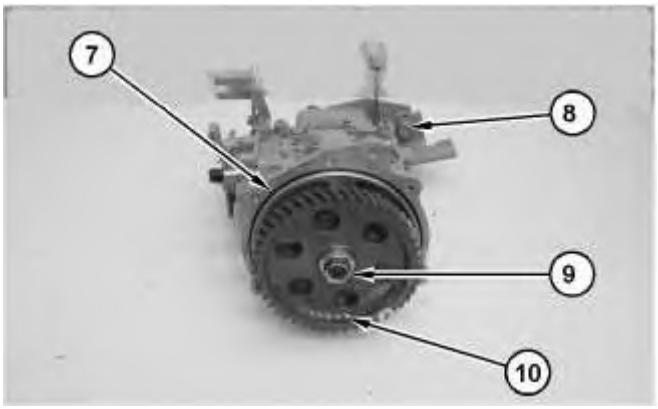


Illustration 2 g01035230

2. Install gear (10). Install nut (9). Tighten nut (9) to a torque of 83 to 98 N·m (61 to 72 lb ft). Install the bolt and bracket (8). Install O-ring seal (7) .

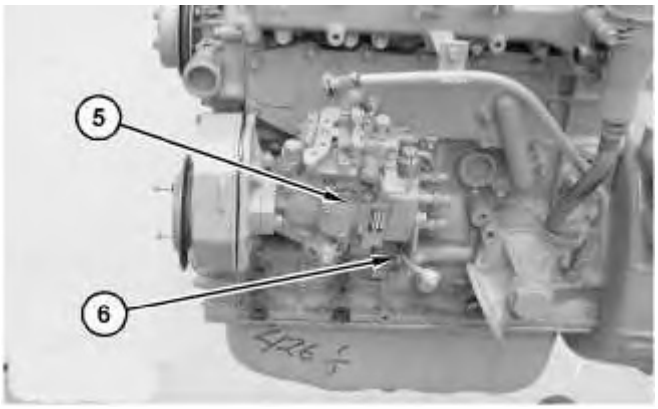


Illustration 3 g01035221

3. Position fuel injection pump (5) and install bolt (6) .

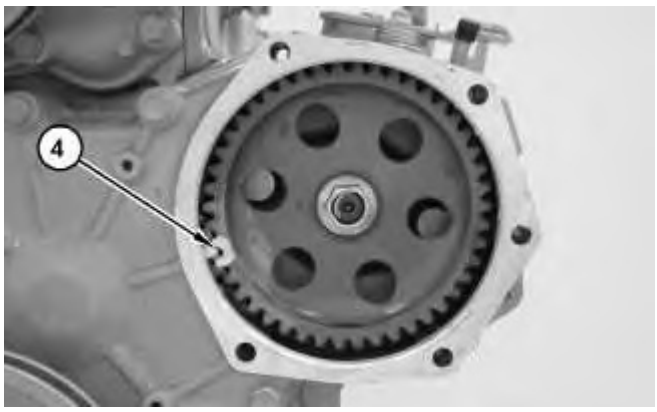


Illustration 4 g01035208

4. Ensure that timing marks on teeth (4) are in the correct position.

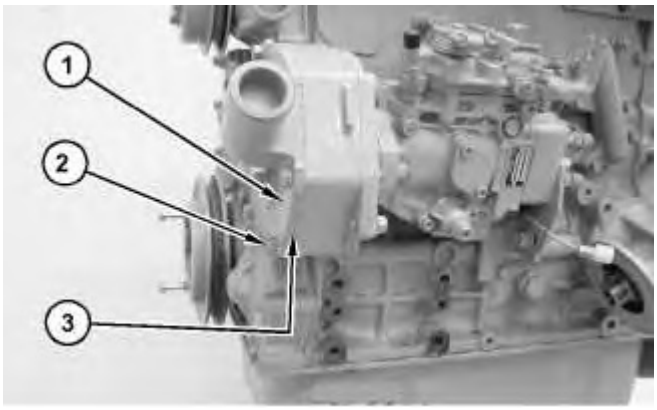


Illustration 5 g01035206

5. Install O-ring seal (3) and cover (1). Install bolts (2) .

6. Check the fuel injection timing. Refer to Testing and Adjusting, "Fuel Injection Timing - Check - Distributor Pump".

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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i01926155

Fuel Injection Nozzles - Remove - Naturally Aspirated Engines

SMCS - 1254-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

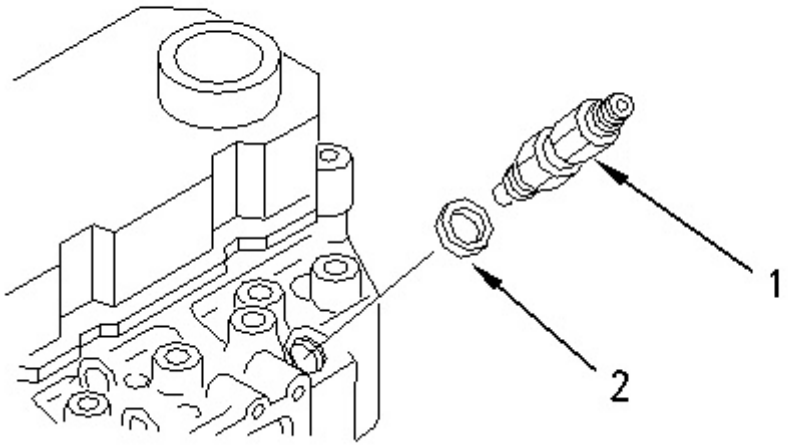


Illustration 1 g01002452

1. Remove fuel injection nozzle (1) and gasket (2) from the cylinder head.
2. Repeat the procedure in order to remove the remaining fuel injection nozzles.

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Disassembly and Assembly
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7582-07 **Publication Date -01/01/2010** **Date Updated -26/02/2010**

i02001634

Fuel Injection Nozzles - Remove - Turbocharged Engines

SMCS - 1254-011

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

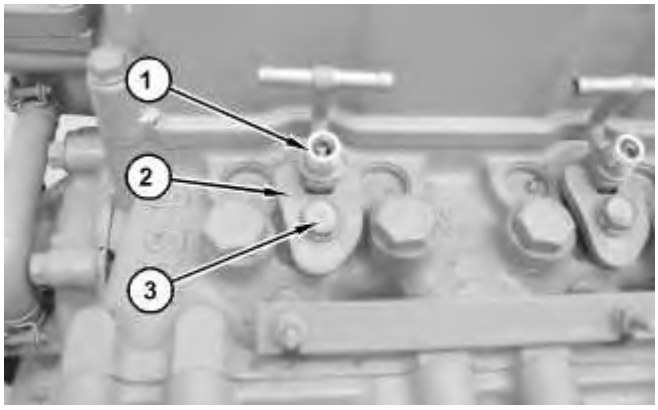


Illustration 1 g01035842

1. Remove bolt (3) and clamp (2). Remove fuel injection nozzle (1) .

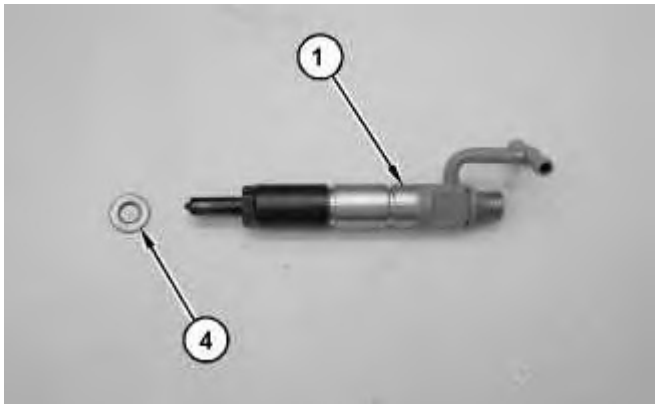


Illustration 2 g01035843

2. Remove gasket (4) from fuel injection nozzle (1) .
3. Repeat Steps 1 through 2 in order to remove the remaining fuel injection nozzles.

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i02001656

Fuel Injection Nozzles - Install - Turbocharged Engines

SMCS - 1254-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

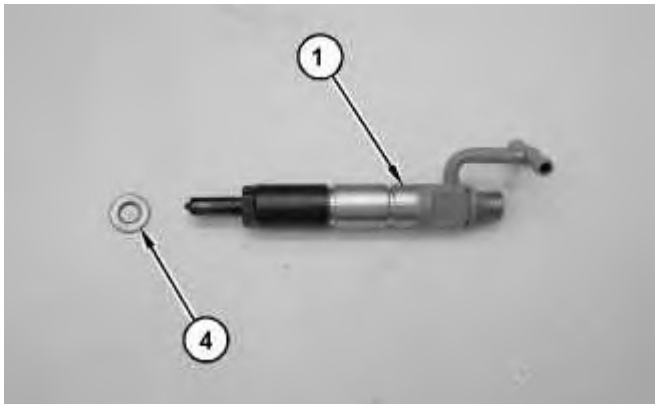


Illustration 1 g01035843

1. Position gasket (4) on fuel injection nozzle (1) .

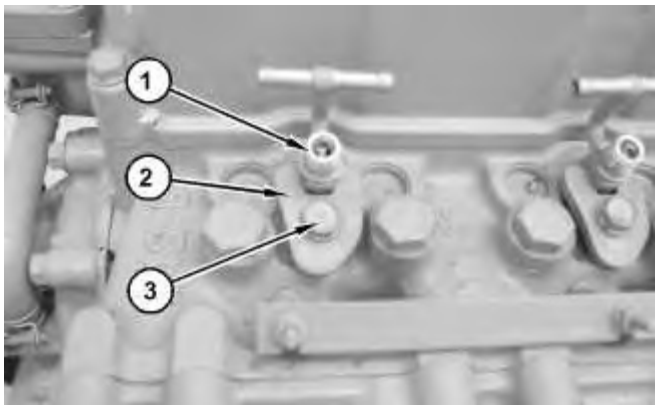


Illustration 2 g01035842

2. Position fuel injection nozzle (1). Position clamp (2) and install bolt (3). Tighten bolt (3) to a torque of 21 to 23 N·m (16 to 17 lb ft).

3. Repeat Steps 1 through 2 in order to install the remaining fuel injection nozzles.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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i01926200

Fuel Injection Nozzles - Install - Naturally Aspirated Engines

SMCS - 1254-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

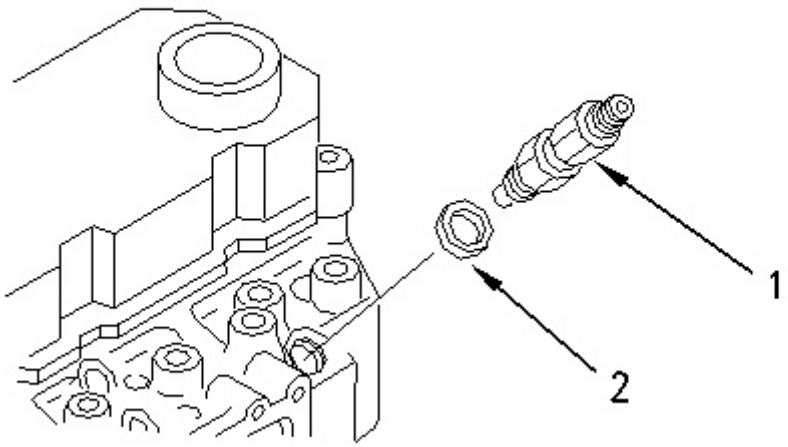


Illustration 1 g01002452

1. Position gasket (2) on fuel injection nozzle (1) .

2. Install fuel injection nozzle (1) in the cylinder head and tighten to a torque of 53 to 65 N·m (40 to 48 lb ft).

3. Repeat the procedure in order to install the remaining fuel injection nozzles.

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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i02000757

Fuel Injection Pump - Remove

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

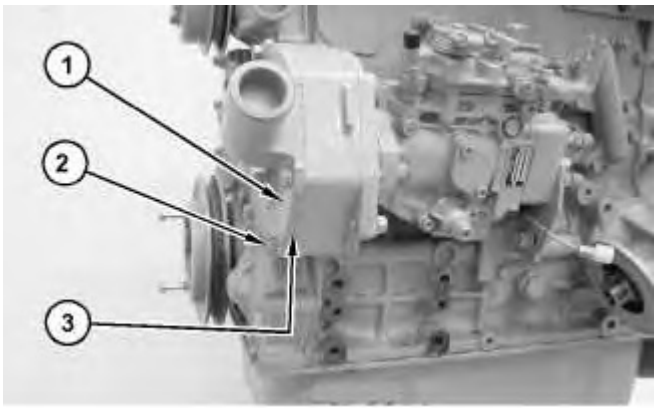


Illustration 1 g01035206

2. Remove bolts (2). Remove cover (1) and O-ring seal (3) .



Illustration 2 g01035208

3. Mark gear teeth (4) for timing purposes.

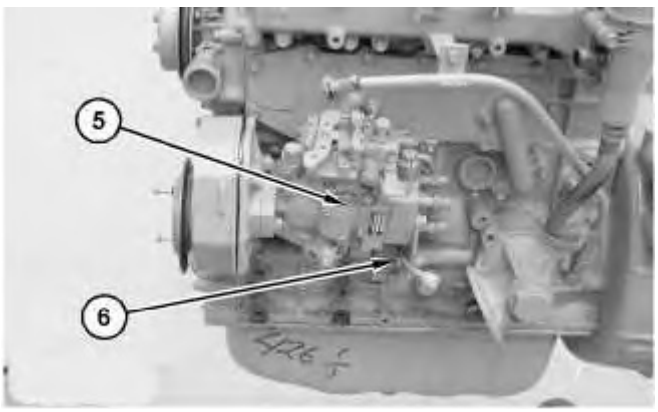


Illustration 3 g01035221

4. Remove bolt (6). Remove fuel injection pump (5) .

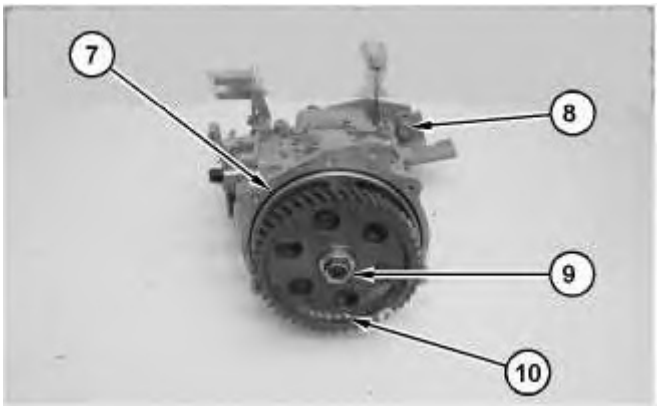


Illustration 4 g01035230

5. Remove O-ring seal (7). Remove the bolt and bracket (8). Remove nut (9) from gear (10) .

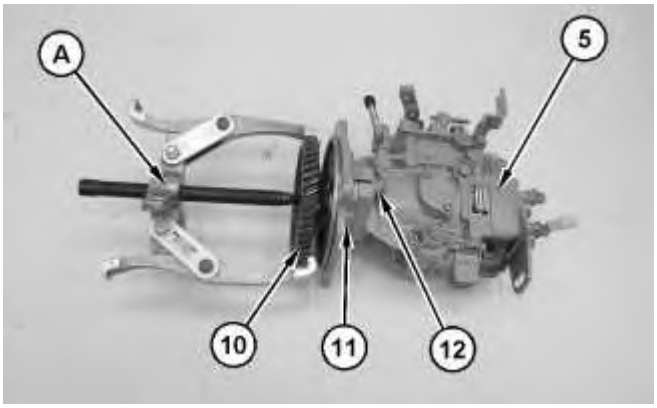


Illustration 5 g01035232

6. Use Tooling (A) to remove gear (10). Mark housing (11) and fuel injection pump (5) for installation purposes. Remove bolts (12) and housing (11) .

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i02000821

Fuel Injection Pump - Install

SMCS - 1251-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

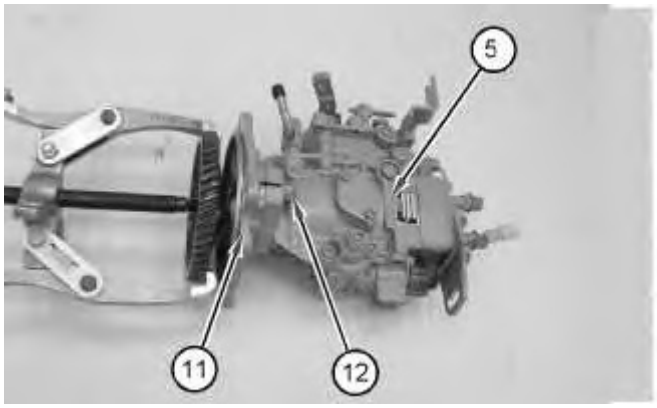


Illustration 1 g01035265

1. Clean all mating surfaces. Position housing (11) on fuel injection pump (5). Ensure that the mark is in the proper position. Install bolts (12) .

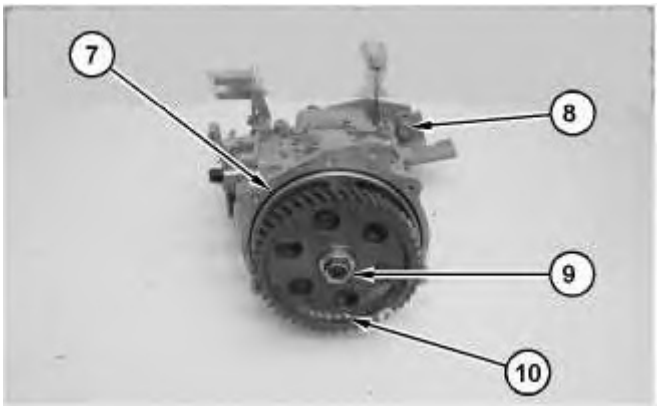


Illustration 2 g01035230

2. Install gear (10). Install nut (9). Tighten nut (9) to a torque of 83 to 98 N·m (61 to 72 lb ft). Install the bolt and bracket (8). Install O-ring seal (7) .

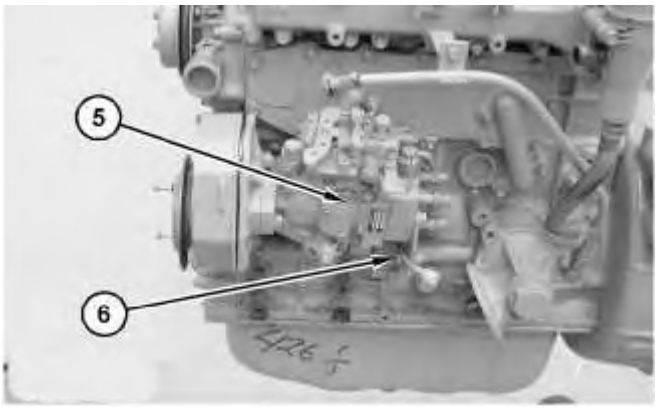


Illustration 3 g01035221

3. Position fuel injection pump (5) and install bolt (6) .

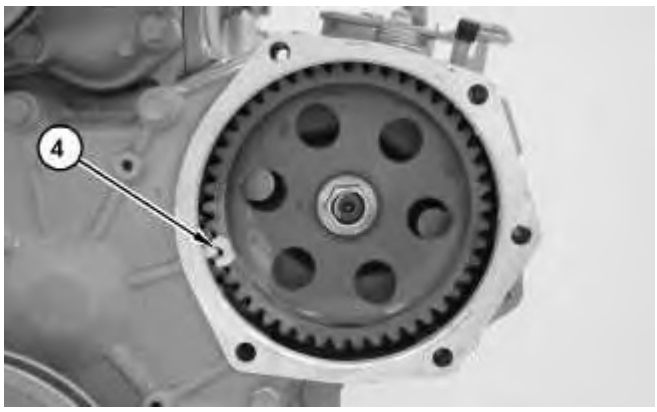


Illustration 4 g01035208

4. Ensure that timing marks on teeth (4) are in the correct position.

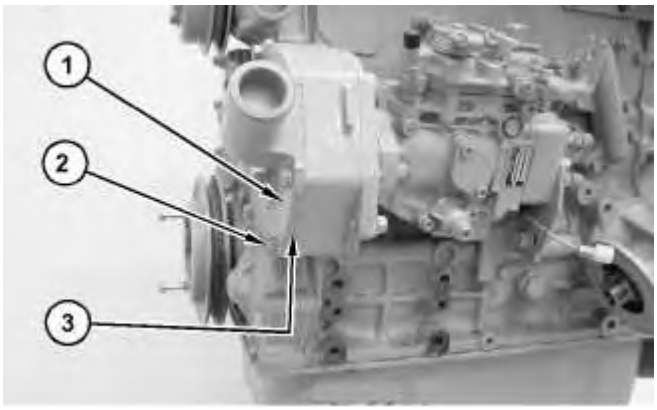


Illustration 5 g01035206

5. Install O-ring seal (3) and cover (1). Install bolts (2) .

6. Check the fuel injection timing. Refer to Testing and Adjusting, "Fuel Injection Timing - Check - Distributor Pump".

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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i02719942

Fuel Injection Pump - Remove - Fuel Injection Pumps With a Water Heated Cold Start Device

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Drain the coolant from the cooling system into a suitable container for storage or disposal. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for more information.

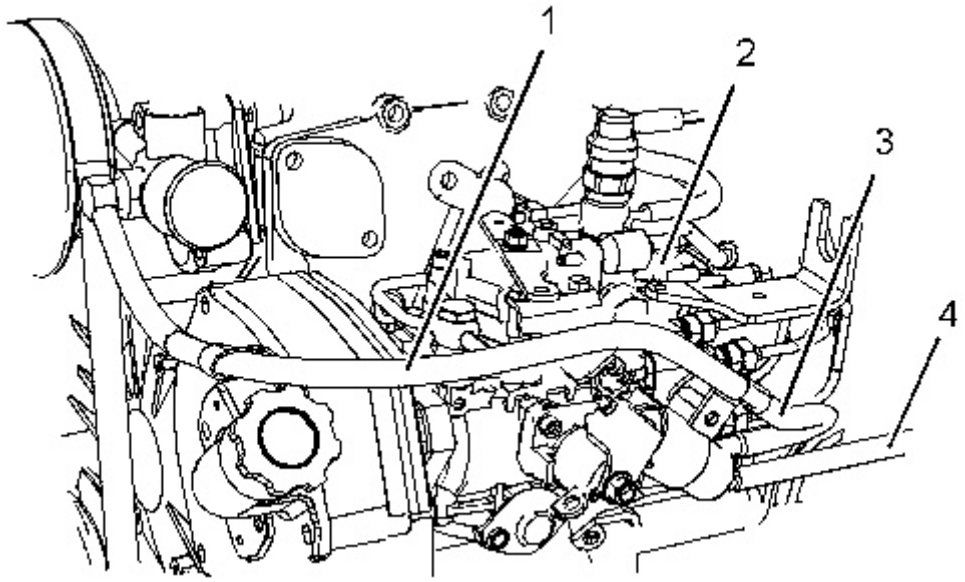


Illustration 1 g01366198

Typical example

2. Loosen the hose clamps and disconnect hoses (1) and (4) from fuel injection pump (2) .
3. Loosen the hose clamps and remove hose (3) from fuel injection pump (2) .
4. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

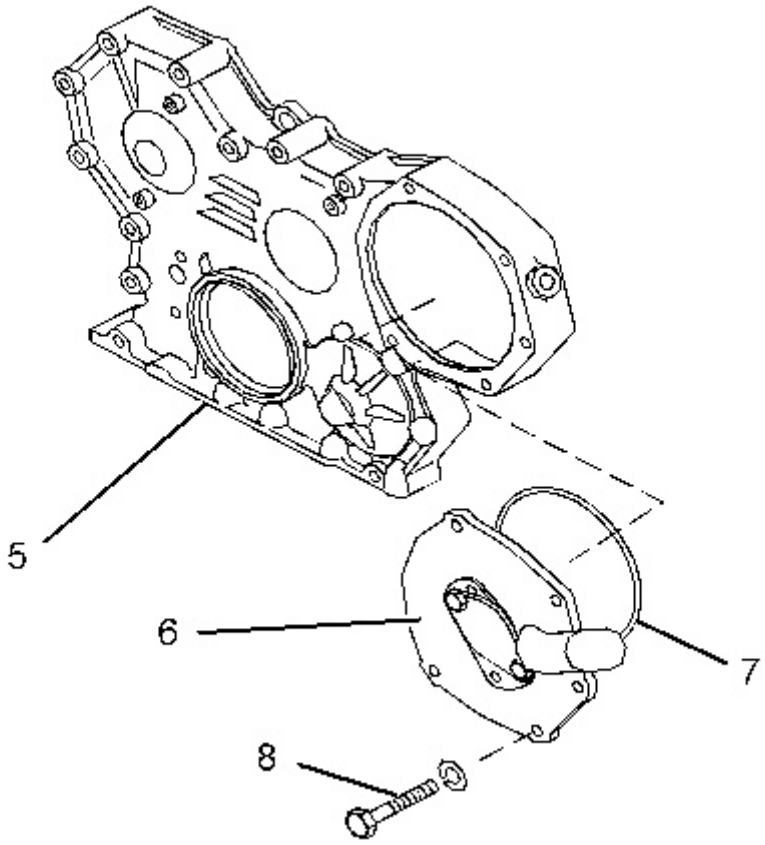


Illustration 2 g01366190

Typical example

5. Remove bolts (8) .
6. Remove plate (6) from front housing (5) .
7. Remove O-ring seal (7) from plate (6) .

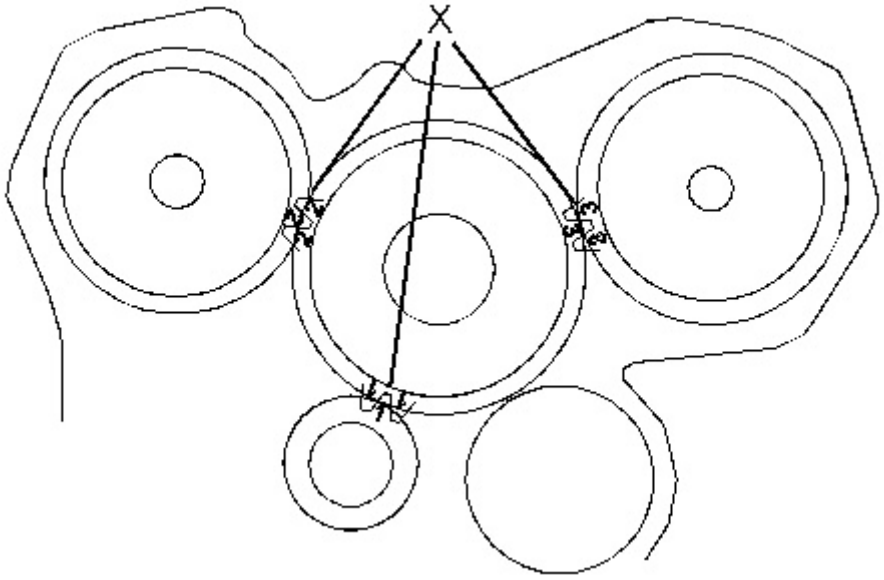


Illustration 3 g01375914

Timing marks on the gears

8. Ensure that Timing marks (X) on the teeth of the gears are aligned or make temporary marks on the gears for installation purposes.

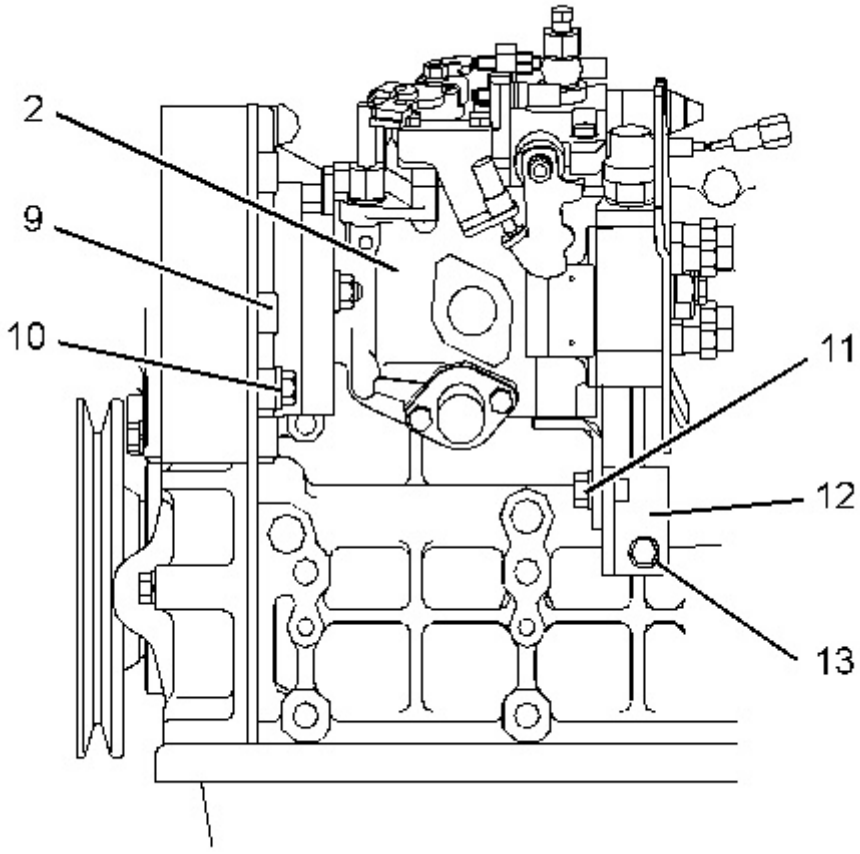


Illustration 4 g01375476

Typical example

9. Loosen bolt (10) .
10. Remove fasteners (11), bolt (13) and bracket (12) .
11. Support fuel injection pump (2) and remove bolt (10) .
12. Remove the assembly of housing (9) and fuel injection pump (2) .

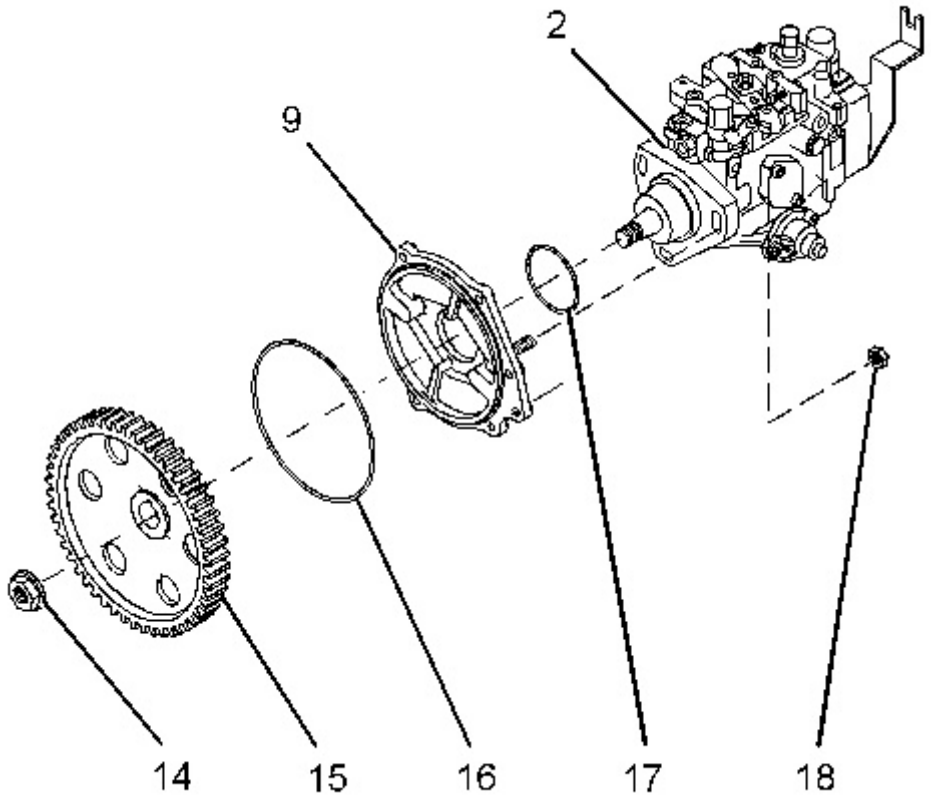


Illustration 5 g01375949

Typical example

13. Remove O-ring seal (16) from housing (9) .
14. Loosen nut (14) .

    Note: Do not remove the nut at this time.
15. Use Tooling (A) to loosen gear (15). Remove nut (14) and gear (15) .

16. If the original fuel injection pump will be installed, mark the flange of fuel injection pump (2) and housing (9). Remove nuts (18) .

    Note: Refer to Systems Operation, Testing and Adjusting, "Fuel Injection Timing - Check" for the correct method of setting the fuel injection pump timing after installation.

17. Remove housing (9) from fuel injection pump (2). Remove O-ring seal (17) from housing (9) .

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i02638544

Fuel Injection Pump - Remove

SMCS - 1251-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-2320	Combination Puller	1

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

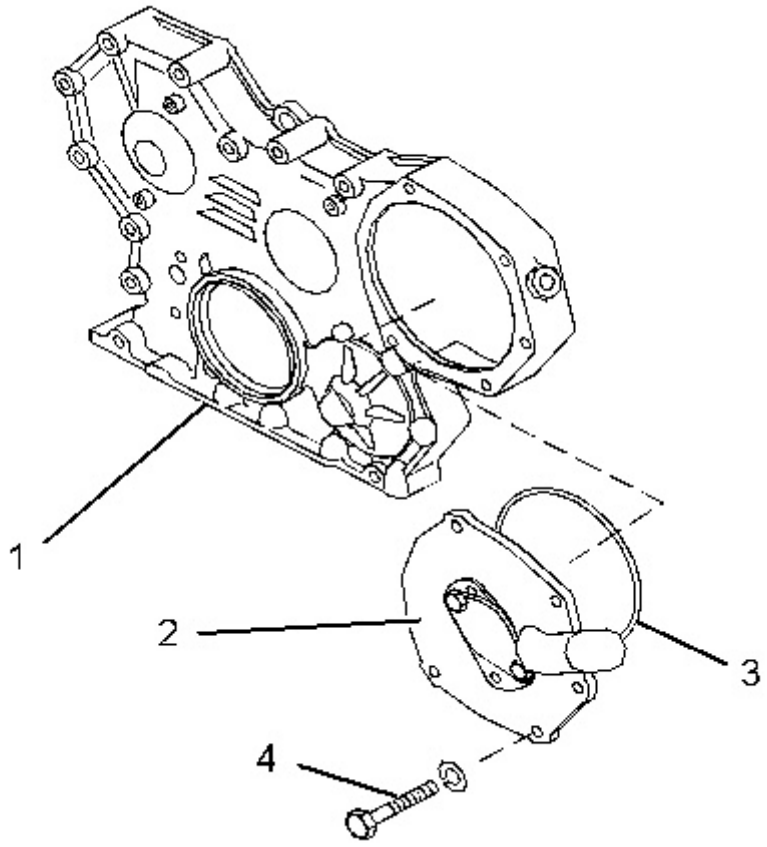


Illustration 1 g01335768

Typical example

2. Remove bolts (4) .
3. Remove plate (2) from front housing (1) .
4. Remove O-ring seal (3) from plate (2) .

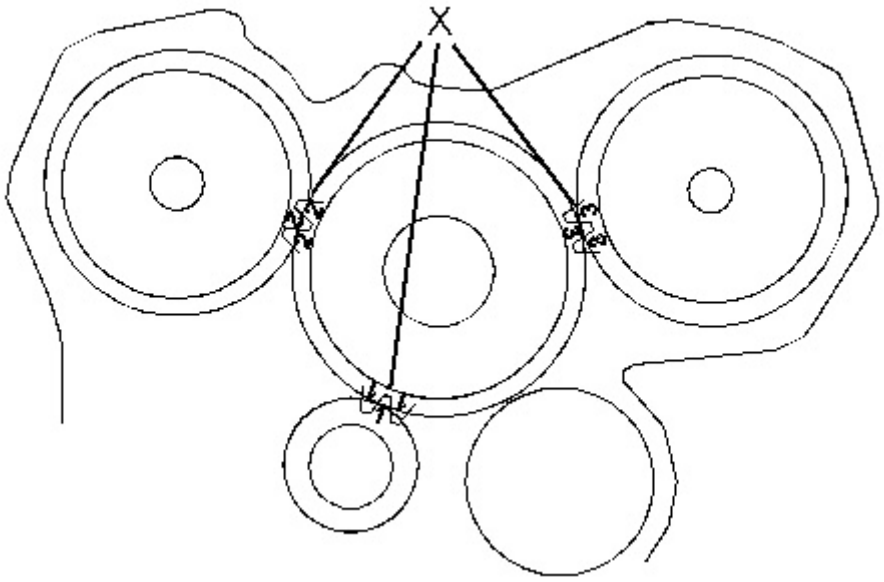


Illustration 2 g01375914

Timing marks on the gears

5. Ensure that Timing marks (X) on the teeth of the gears are aligned or make temporary marks on the gears for installation purposes.

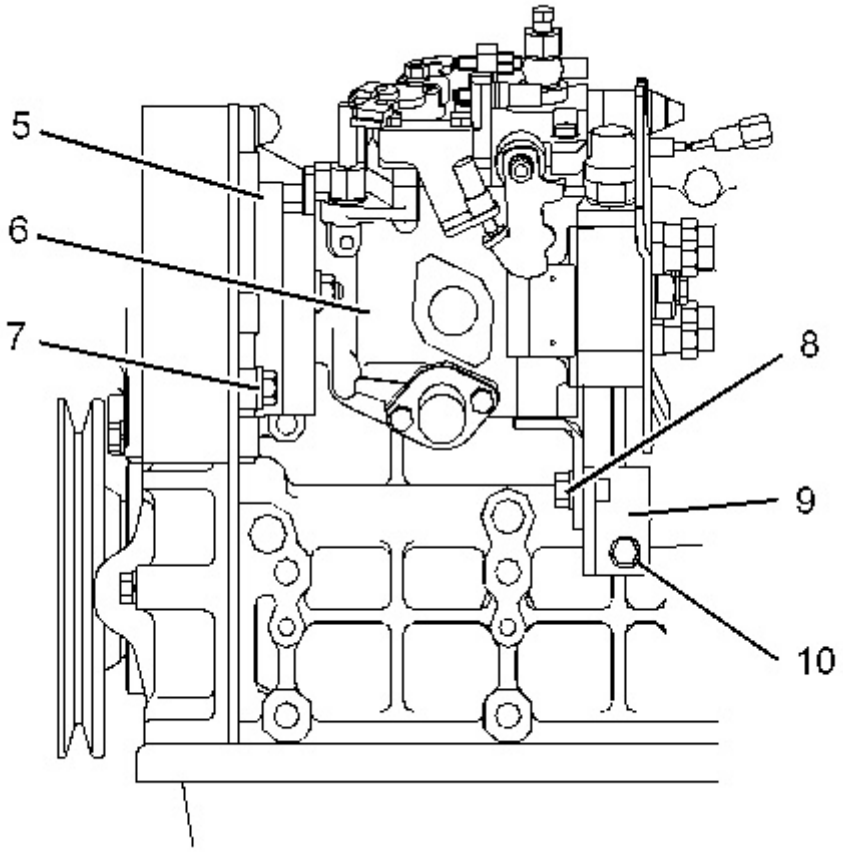


Illustration 3 g01375471

Typical example

6. Loosen bolt (7) .
7. Remove fasteners (8), bolt (10) and bracket (9) .
8. Support fuel injection pump (6) and remove bolt (7) .
9. Remove the assembly of housing (5) and fuel injection pump (6) .

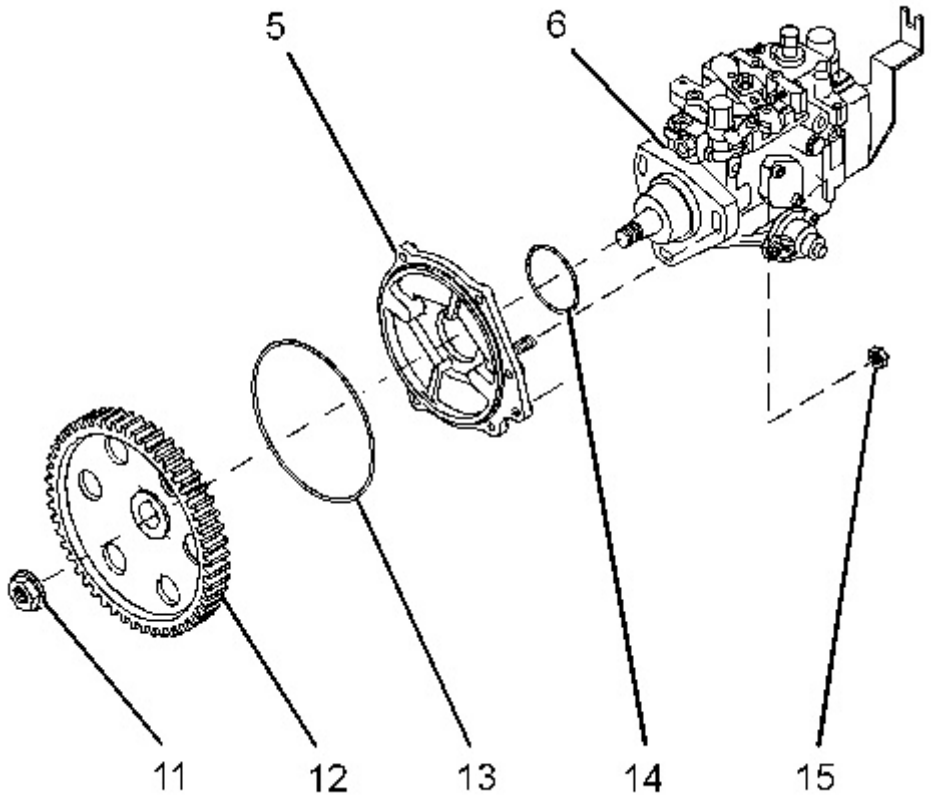


Illustration 4 g01335808

Typical example

10. Remove O-ring seal (13) from housing (5) .
11. Loosen nut (11) .

    Note: Do not remove the nut at this time.
12. Use Tooling (A) to loosen gear (12). Remove nut (11) and gear (12) .

13. If the original fuel injection pump will be installed, mark the flange of fuel injection pump (6) and housing (5). Remove nuts (15) .

    Note: Refer to Systems Operation, Testing and Adjusting, "Fuel Injection Timing - Check" for the correct method of setting the fuel injection pump timing after installation.

14. Remove housing (5) from fuel injection pump (6). Remove O-ring seal (14) from housing (5).

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Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02719941

Fuel Injection Pump - Install

SMCS - 1251-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

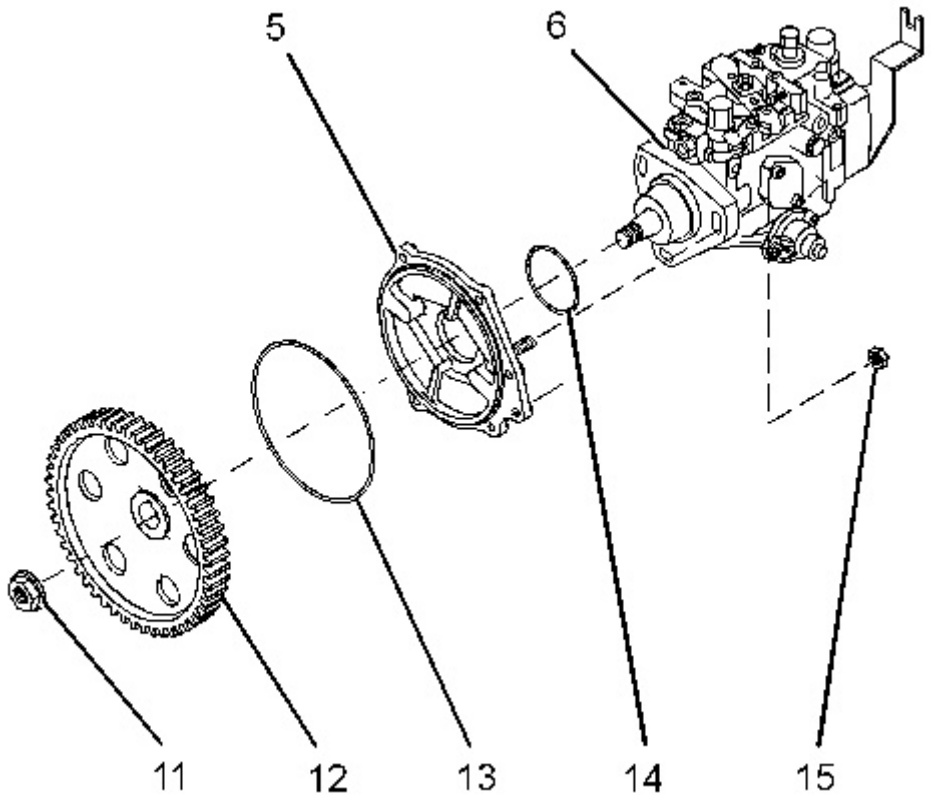


Illustration 1 g01335808

Typical example

2. Ensure that the mating surfaces of housing (5) and fuel injection pump (6) are clean and free from damage.
3. Install a new O-ring seal (14) to housing (5) .
4. Position housing (5) on fuel injection pump (6). If the original fuel injection pump is installed, ensure that the appropriate marks on the flange of the fuel injection pump and the housing are aligned. Install nuts (15) finger tight.
5. Tighten nuts (15) to a torque of 18 N·m (13 lb ft).
6. Install a new O-ring seal (13) to housing (5). Install gear (12) to fuel injection pump (6). Install nut (11) finger tight.

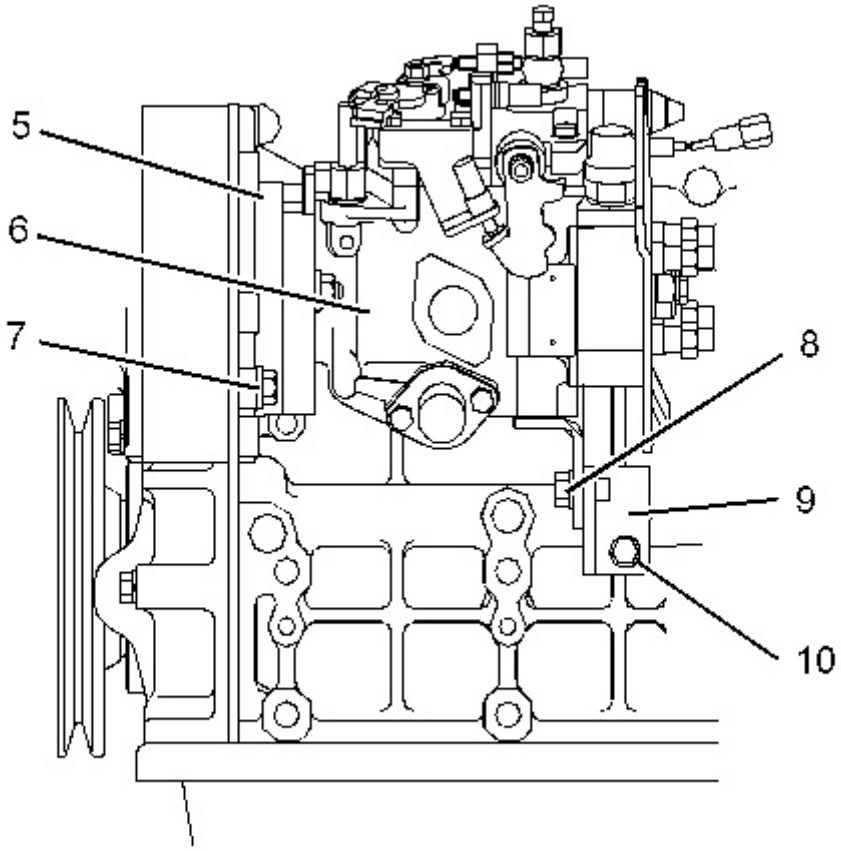


Illustration 2 g01375471

Typical example

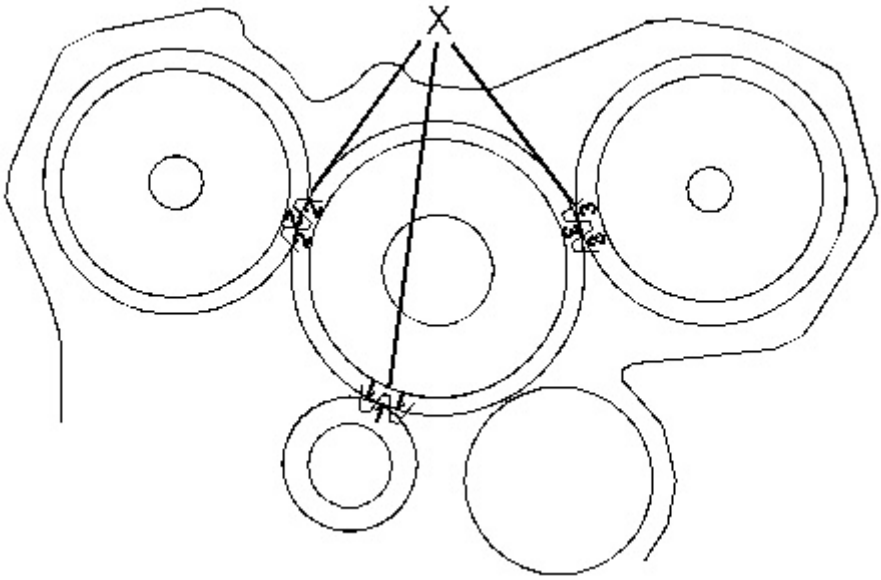


Illustration 3 g01375914

Timing marks on the gears

7. Install the assembly of housing (5) and fuel injection pump (6) to the engine. Ensure that Timing marks (X) on the teeth of the gears are in the correct position. Install bolt (7) finger tight.

8. Position bracket (9) on fuel injection pump (6). Install fasteners (8) and bolt (10) finger tight.

9. Tighten nut (11) to a torque of 90 N·m (66 lb ft). Refer to Illustration 1.

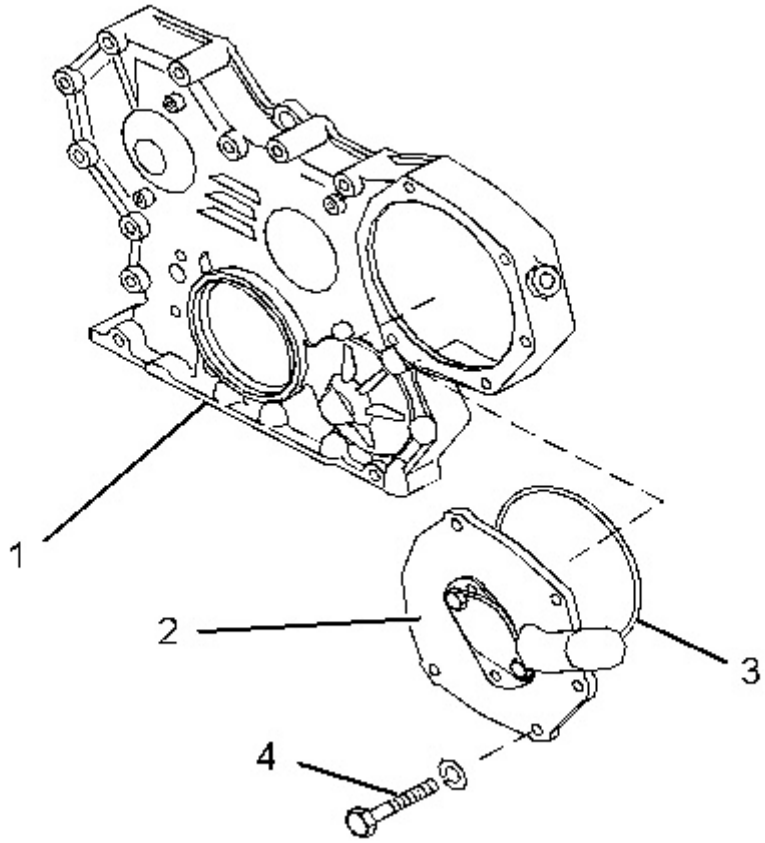


Illustration 4 g01335768

Typical example

10. Install a new O-ring seal (3) to plate (2) .

11. Position plate (2) on front housing (1). Install bolts (4). Tighten the bolts to a torque of 18 N·m (13 lb ft).

12. Tighten bolt (7) to a torque of 18 N·m (13 lb ft). Tighten bolt (10) to a torque of 18 N·m (13 lb ft). Tighten fasteners (8) to a torque of 35 N·m (26 lb ft). Refer to Illustration 2.

13. Adjust the fuel injection pump timing. Refer to Systems Operation, Testing and Adjusting, "Fuel Injection Timing - Check".

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638546

Fuel Injection Pump - Install - Fuel Injection Pumps With a Water Heated Cold Start Device

SMCS - 1251-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

1. Ensure that number one piston is at the top center position on the compression stroke. Refer to Systems Operation, Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

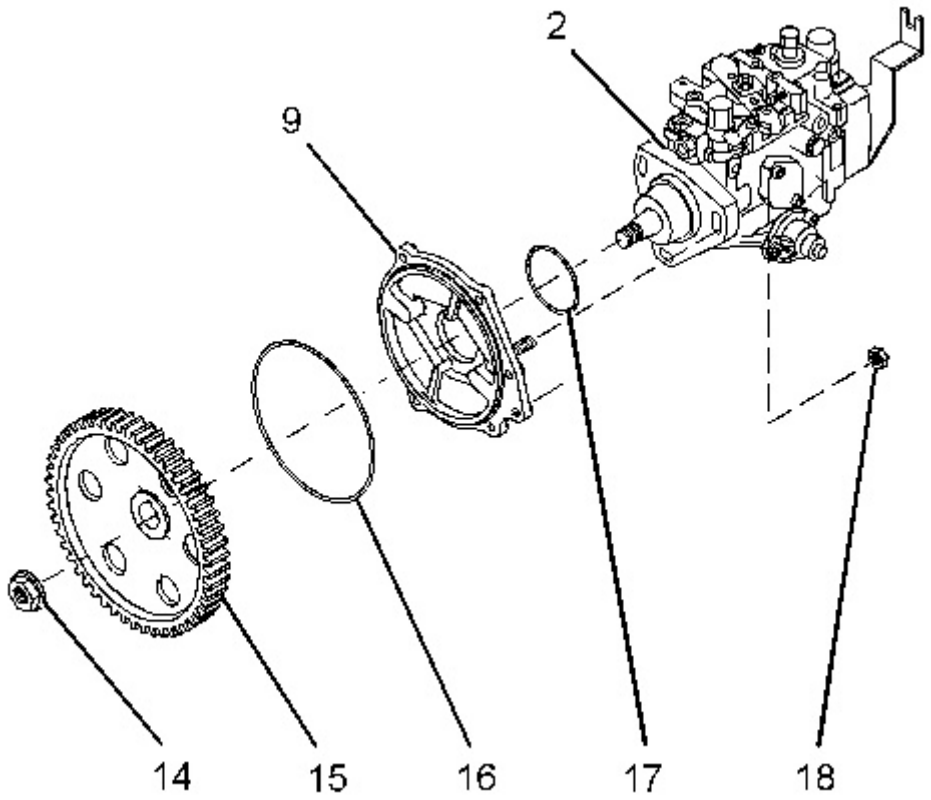


Illustration 1 g01375949

Typical example

2. Ensure that the mating surfaces of housing (9) and fuel injection pump (2) are clean and free from damage.
3. Install a new O-ring seal (17) to housing (9) .
4. Position housing (9) on fuel injection pump (2). If the original fuel injection pump is installed, ensure that the appropriate marks on the flange of the fuel injection pump and the housing are aligned. Install nuts (18) finger tight.
5. Tighten nuts (18) to a torque of 18 N·m (13 lb ft).
6. Install a new O-ring seal (16) to housing (9). Install gear (15) to fuel injection pump (2). Install nut (14) finger tight.

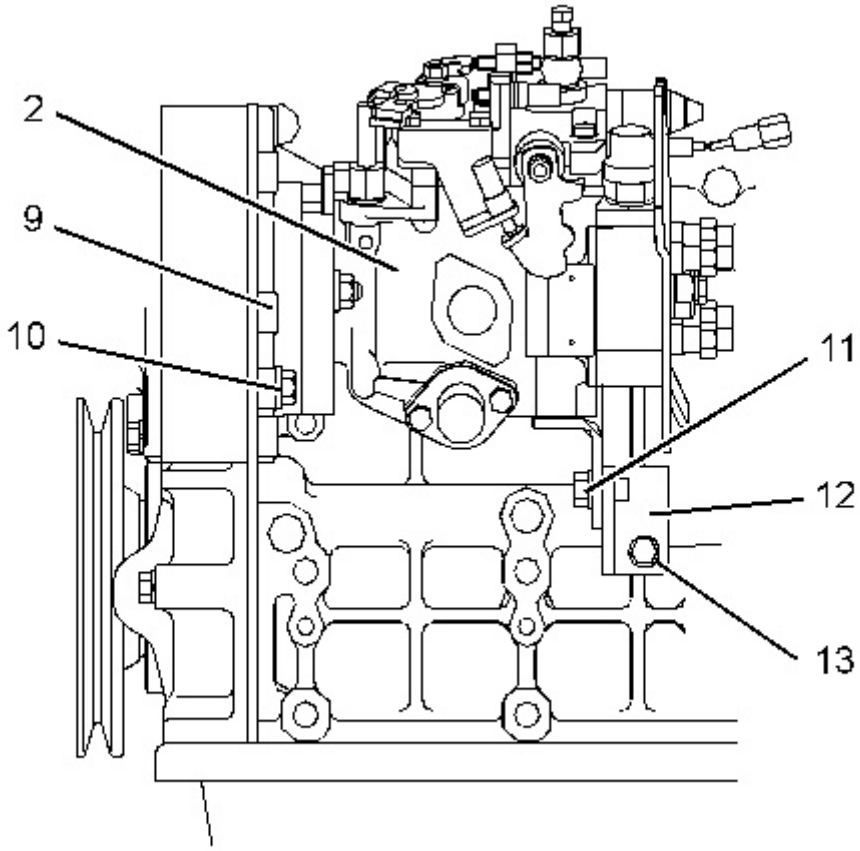


Illustration 2 g01375476

Typical example

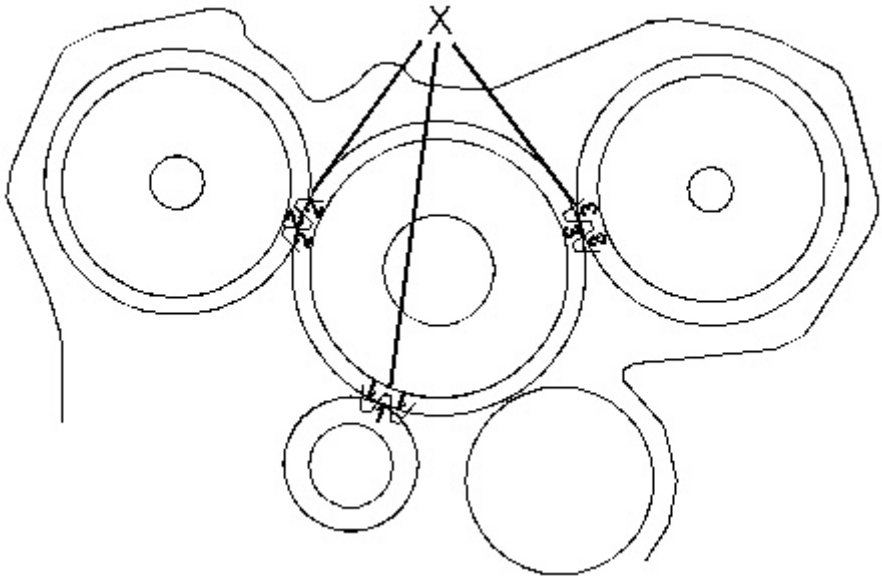


Illustration 3 g01375914

Timing marks on the gears

7. Install the assembly of housing (9) and fuel injection pump (2) to the engine. Ensure that Timing marks (X) on the teeth of the gears are in the correct position. Install bolt (10) finger tight.

8. Position bracket (12) on fuel injection pump (2). Install fasteners (11) and bolt (13) finger tight.

9. Tighten nut (14) to a torque of 90 N·m (66 lb ft). Refer to Illustration 1.

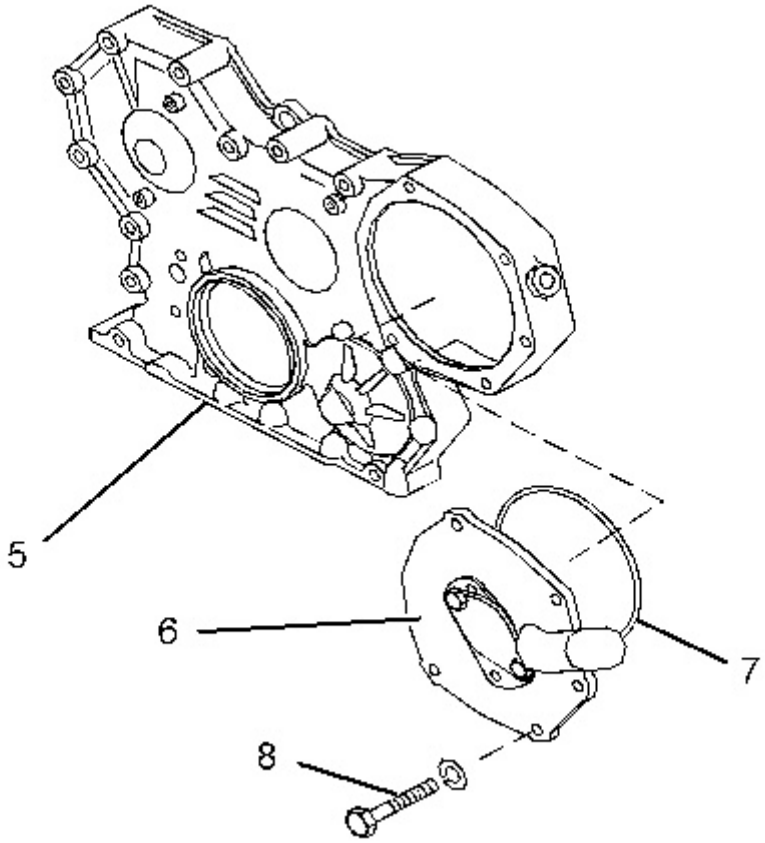


Illustration 4 g01366190

Typical example

10. Install a new O-ring seal (7) to plate (6) .

11. Position plate (6) on front housing (5). Install bolts (8). Tighten the bolts to a torque of 18 N·m (13 lb ft).

12. Tighten bolt (10) to a torque of 18 N·m (13 lb ft). Tighten bolt (13) to a torque of 18 N·m (13 lb ft). Tighten fasteners (11) to a torque of 35 N·m (26 lb ft). Refer to Illustration 2.

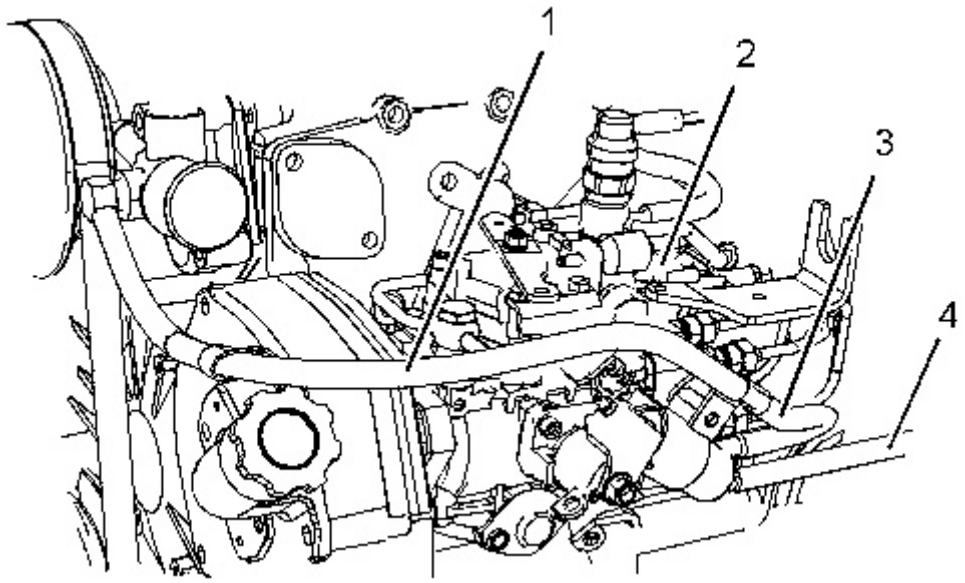


Illustration 5 g01366198

Typical example

13. Install hose (3) to fuel injection pump (2). Tighten the hose clamps securely.
14. Connect hoses (1) and (4) to fuel injection pump (2). Tighten the hose clamps securely.
15. Fill the cooling system with coolant. Refer to Operation and Maintenance Manual, "Cooling System Coolant - Change" for the correct procedure.
16. Adjust the fuel injection pump timing. Refer to Systems Operation, Testing and Adjusting, "Fuel Injection Timing - Check".

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638605

Fuel Injector - Remove and Install - Naturally Aspirated Engines

SMCS - 1290-010

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

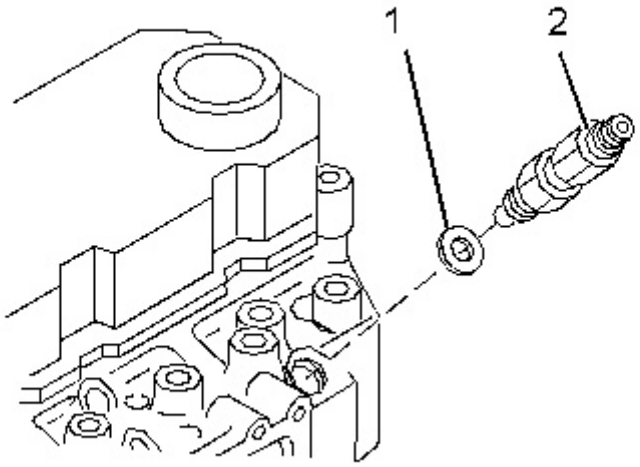


Illustration 1 g01325773

Typical example

1. Use a deep socket to remove fuel injectors (2) from the cylinder head.
2. Remove seat washers (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the bore for the fuel injector in the cylinder head. Ensure that no debris enters the cylinder. Clean the threads on the body of the fuel injector.

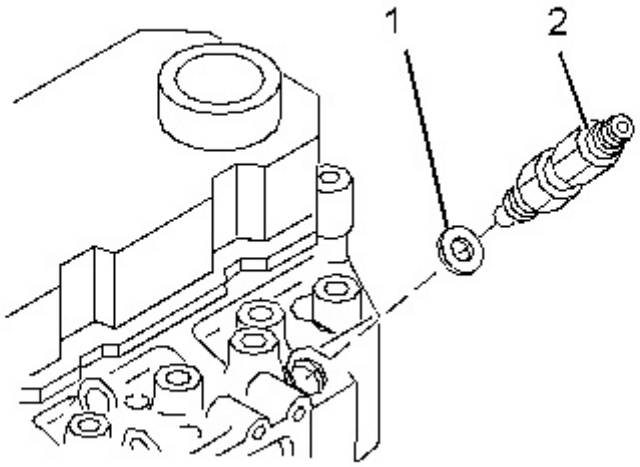


Illustration 2 g01325773

Typical example

2. Install new seat washers (1) into the bore for the fuel injector in the cylinder head.
3. Install fuel injectors (2) into the cylinder head. Use a deep socket to tighten fuel injectors (2) to a torque of 59 N·m (44 lb ft).

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638630

Fuel Injector - Remove and Install - Turbocharged Engines

SMCS - 1290-010

Removal Procedure

Start By:

A. Remove the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

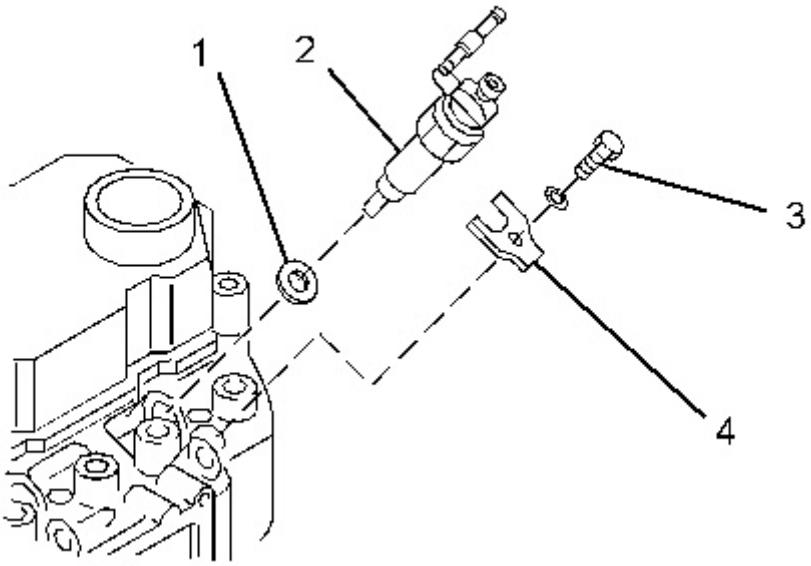


Illustration 1 g01325781

1. Remove bolts (3) and clamps (4) from fuel injectors (2) .
2. Remove fuel injectors (2) from the cylinder head.
3. Remove seat washers (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean the bores for the fuel injectors in the cylinder head. Ensure that no debris enters the cylinders. Clean the fuel injectors.

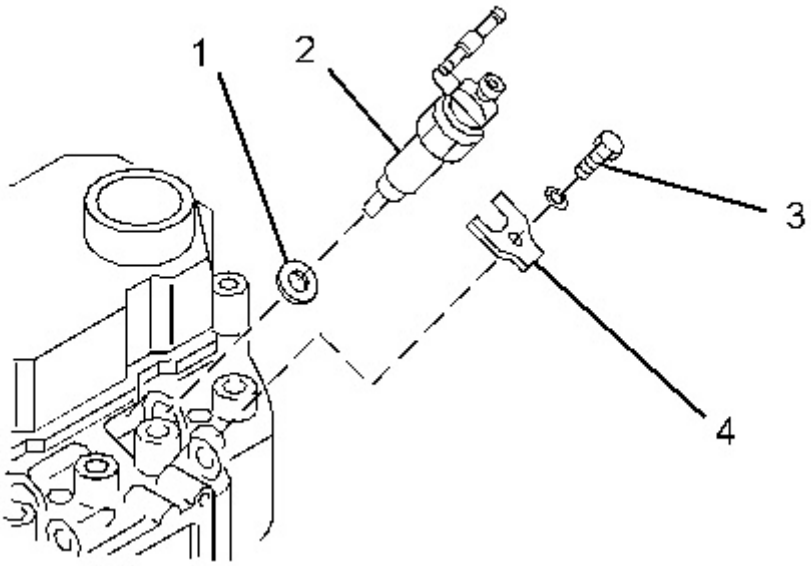


Illustration 2 g01325781

Typical example

2. Install new seat washers (1) to the bores for the fuel injectors in the cylinder head.
3. Install fuel injectors (2) into the cylinder head.
4. Position clamps (4) onto fuel injectors (2) and install bolts (3). Tighten bolts (3) to a torque of 22 N·m (16 lb ft).

End By: Install the fuel injection lines. Refer to Disassembly and Assembly, "Fuel Injection Lines - Remove and Install".

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1261-010; 1263-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

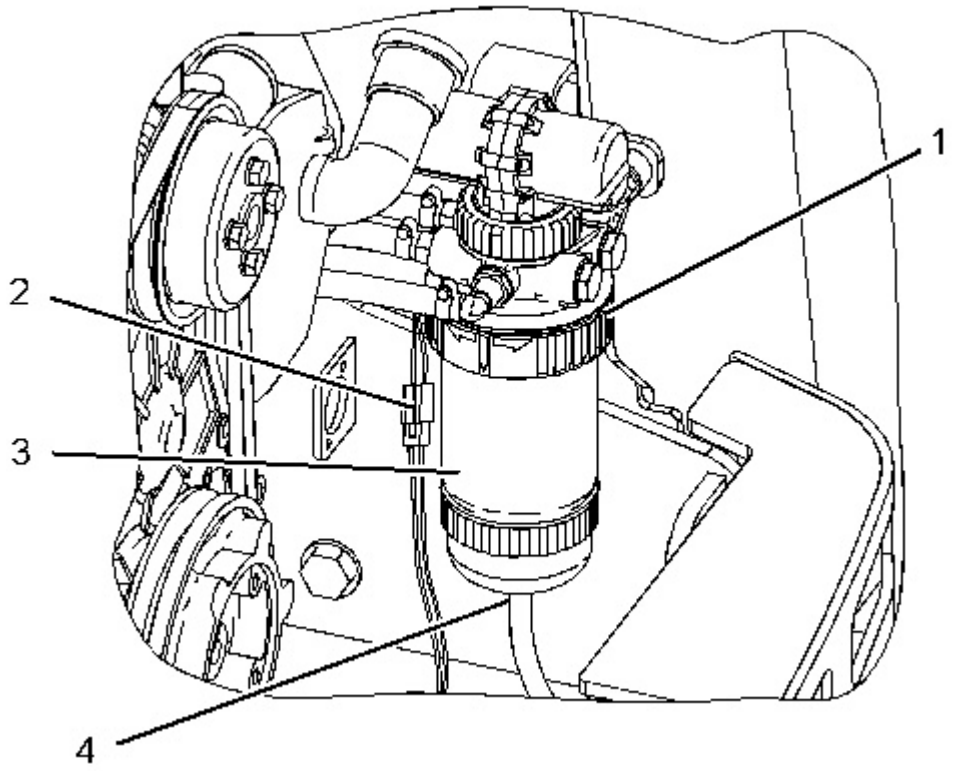


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

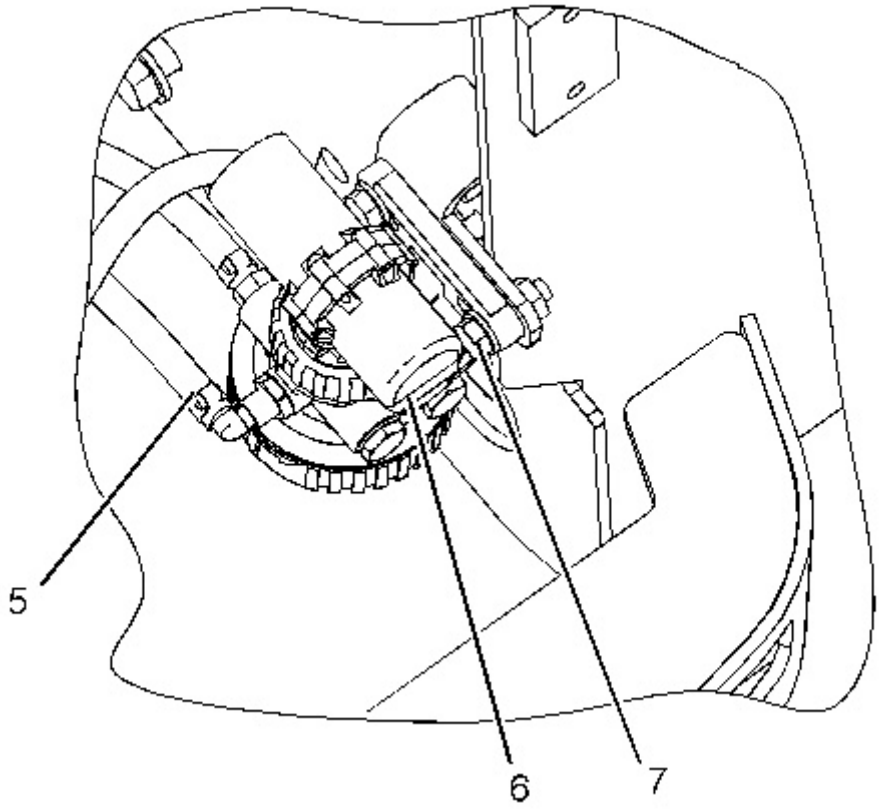


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

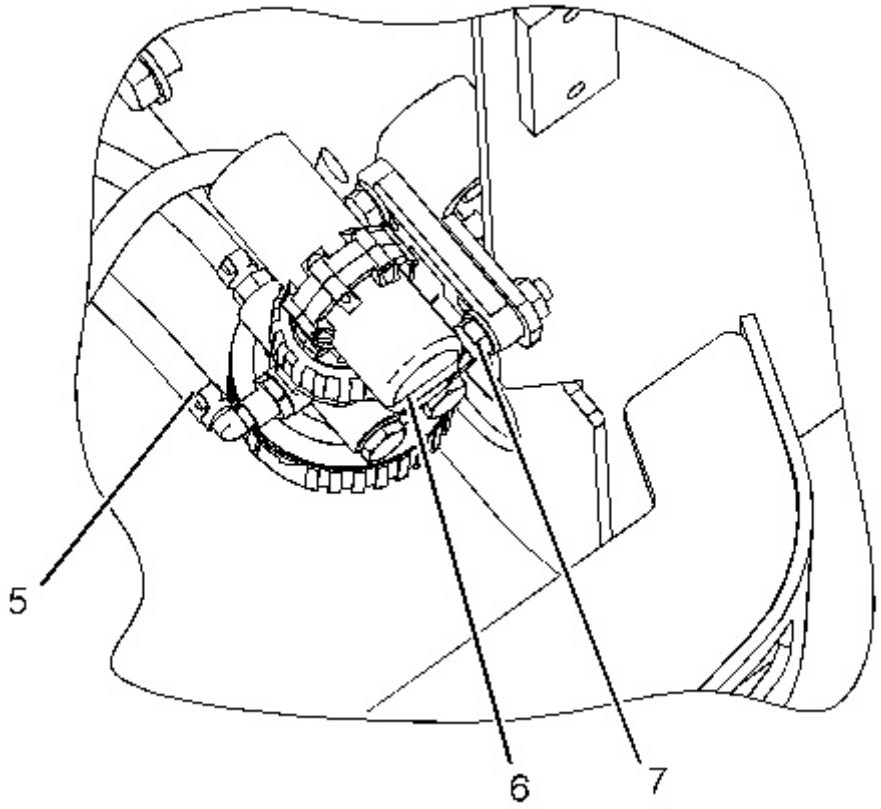


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

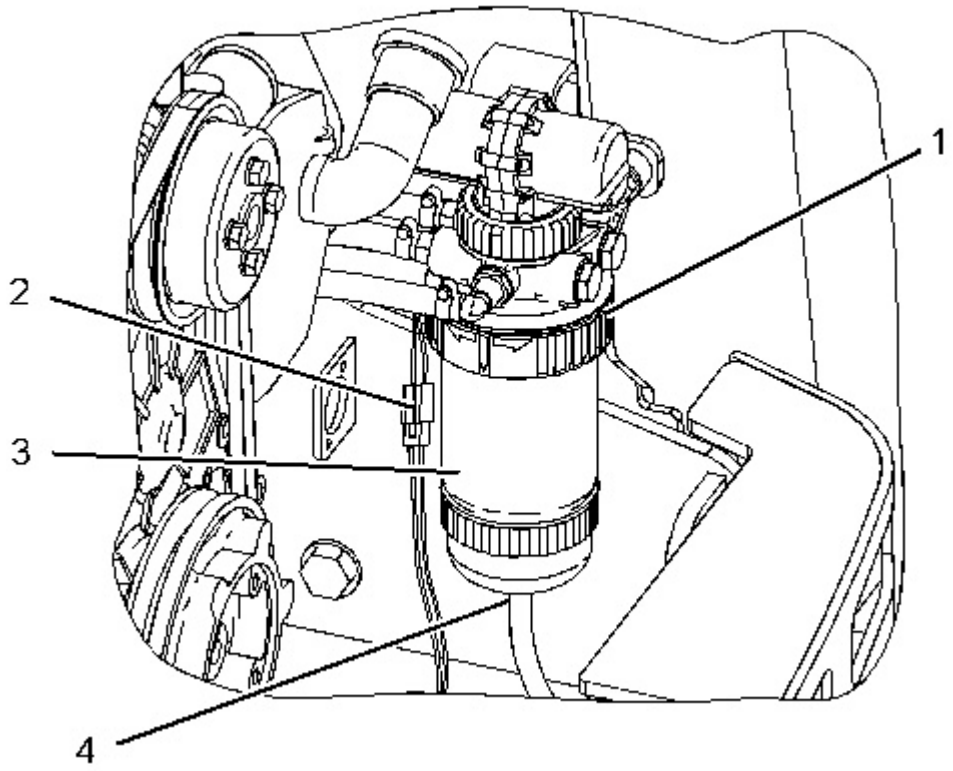


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1260-010; 1263-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

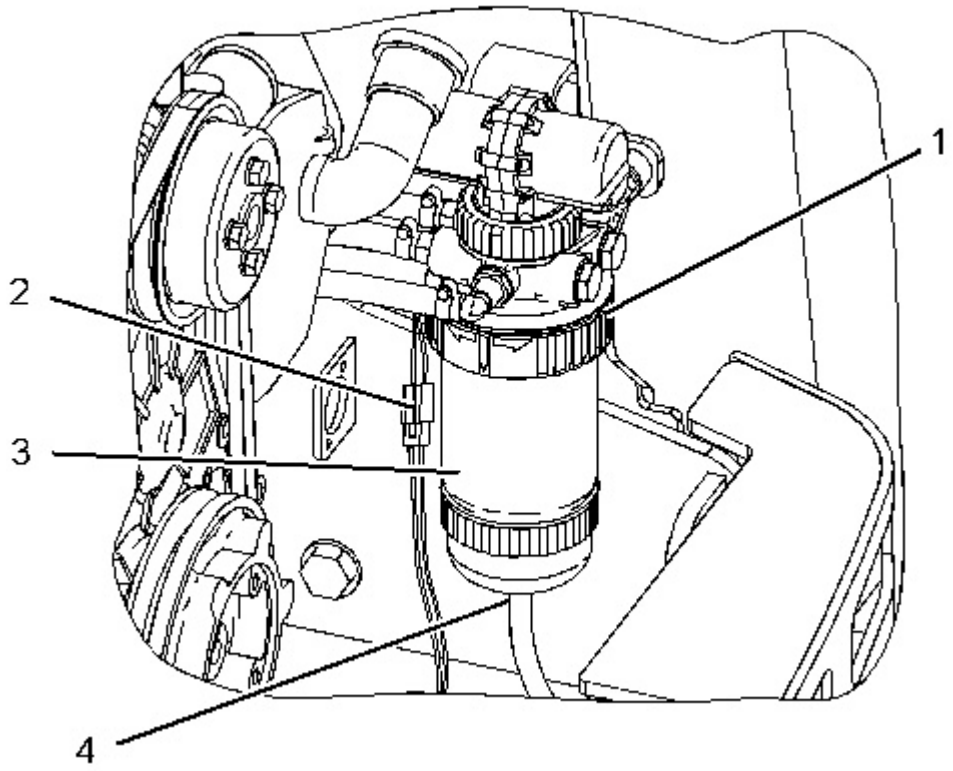


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

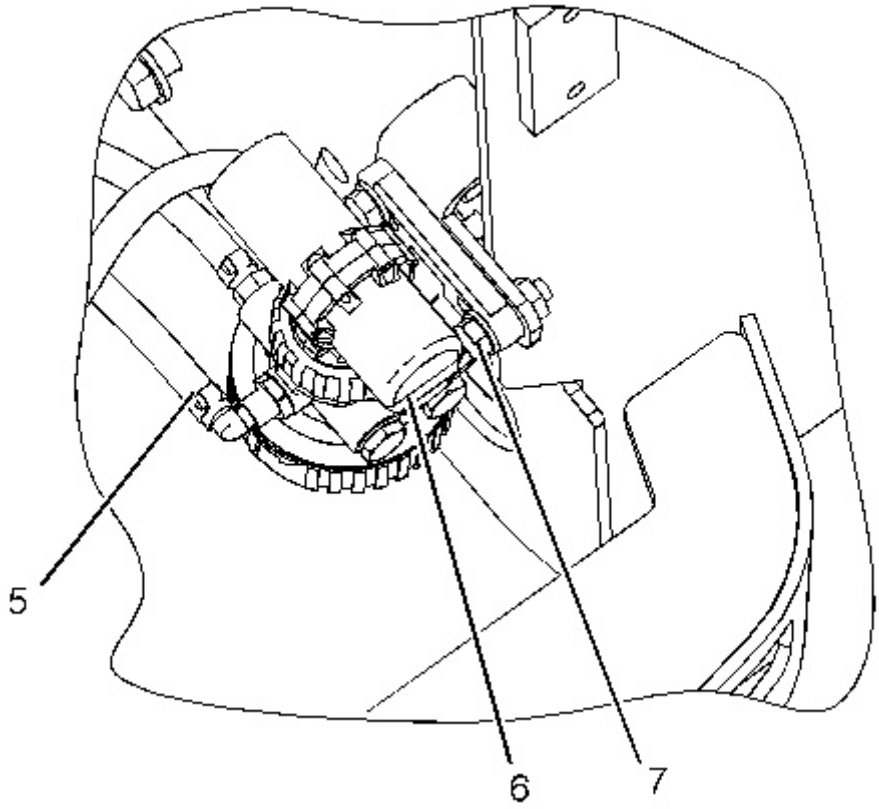


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

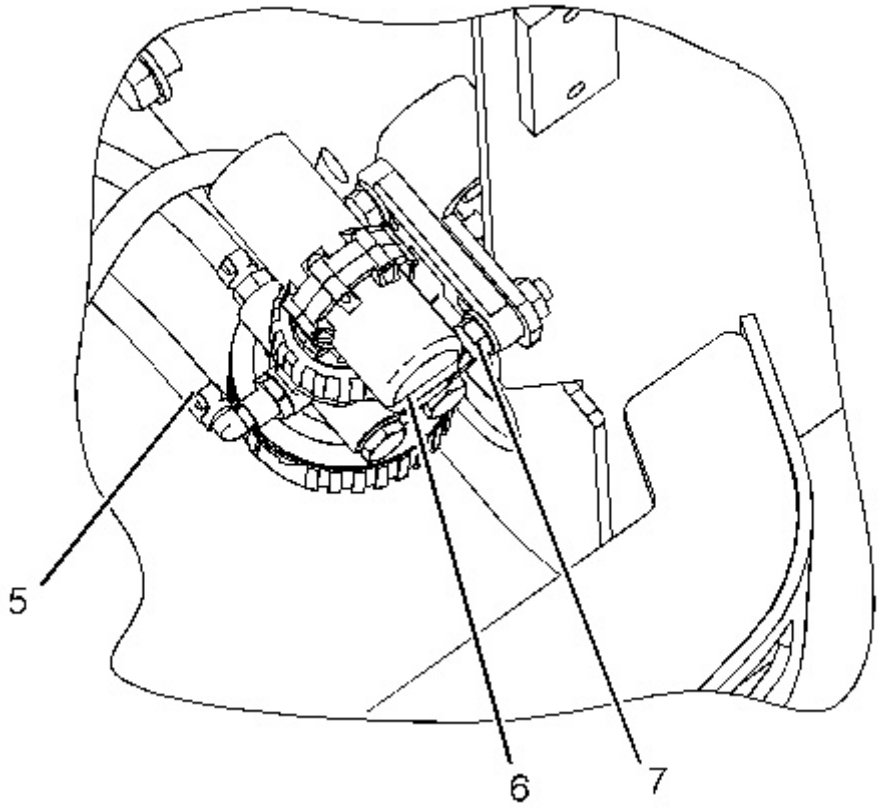


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

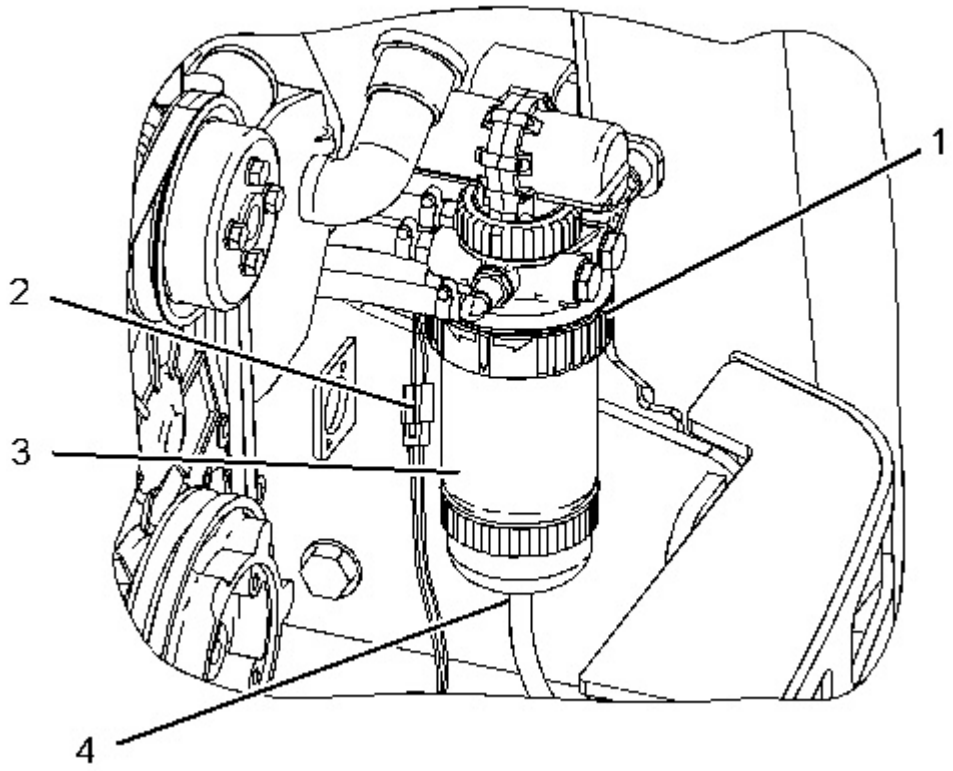


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02638539

Fuel Priming Pump and Fuel Filter Base - Remove and Install

SMCS - 1258-010; 1260-010; 1261-010-SE; 1262-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: Put identification marks on all hose assemblies and on all tube assemblies for installation purposes. Plug all hose assemblies and tube assemblies. This helps prevent fluid loss, and this helps to keep contaminants from entering the system.

1. Turn the fuel supply to the OFF position.
2. Turn the battery disconnect switch to the OFF position.

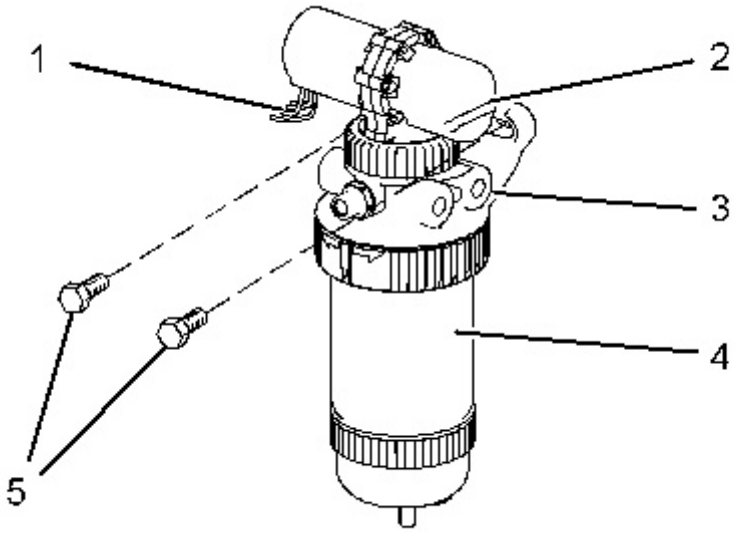


Illustration 1 g01324908

Typical example

3. Drain fuel filter (4). Refer to Operation and Maintenance Manual, "Fuel System Primary Filter/Water Seperator - Drain".
4. Disconnect harness assembly (1) from fuel priming pump (2) .
5. Disconnect the tube assemblies (not shown) from fuel filter base (3) .
6. Remove bolts (5) and remove fuel filter base (3) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that the assembly of the fuel priming pump and the fuel filter base is clean and free from damage. If necessary, replace any components that are damaged.

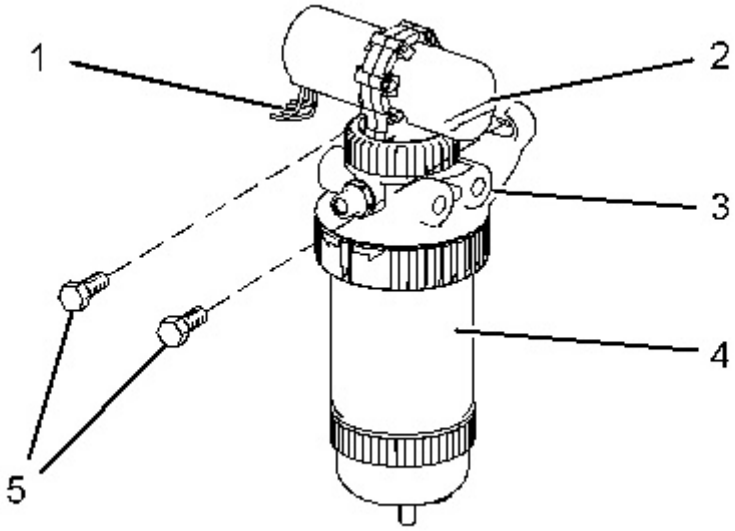


Illustration 2 g01324908

Typical example

2. Position fuel filter base (3) on the mounting bracket. Install bolts (5) to the fuel filter base. Tighten the bolts to a torque of 35 N·m (26 lb ft).
3. Connect the tube assemblies for the fuel inlet and the fuel outlet (not shown) to fuel filter base (3) .
4. If necessary, install a new fuel filter (4) to fuel filter base (3). Refer to Operation and Maintenance Manual, "Fuel System Primary Filter/Water Seperator - Drain".
5. Connect harness assembly (1) to fuel priming pump (2) .
6. Turn the fuel supply to the ON position.
7. Turn the battery disconnect switch to the ON position.
8. Remove the air from the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime".

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02697359

Fuel Transfer Pump

SMCS - 1256

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

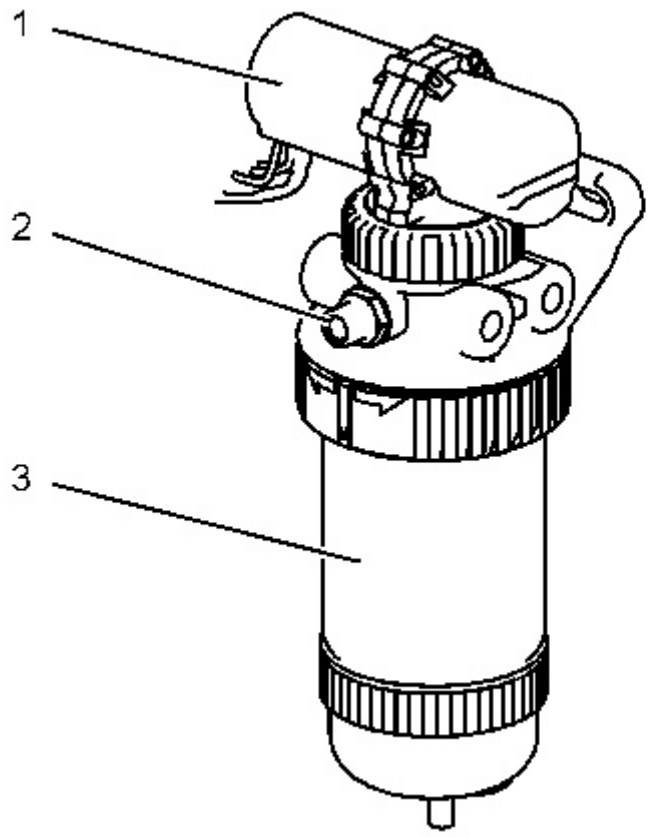


Illustration 1 g01353240

Typical example

(1) Fuel transfer pump

(2) Torque for one fitting ... 6 to 8 N·m (53 to 71 lb in)

(3) Fuel filter/water separator

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02697359

Fuel Transfer Pump

SMCS - 1256

S/N - -

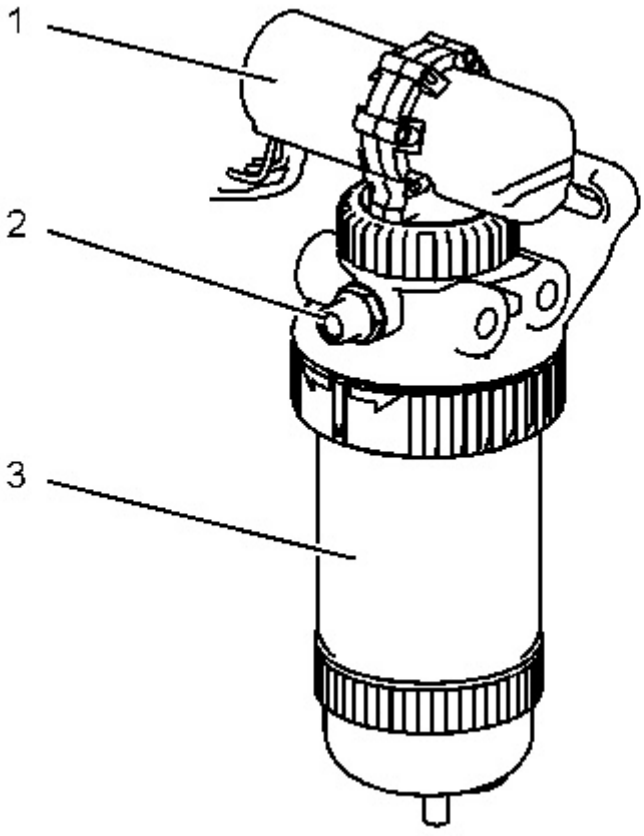


Illustration 1 g01353240

Typical example

(1) Fuel transfer pump

(2) Torque for one fitting ... 6 to 8 N·m (53 to 71 lb in)

(3) Fuel filter/water separator

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1260-010; 1263-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

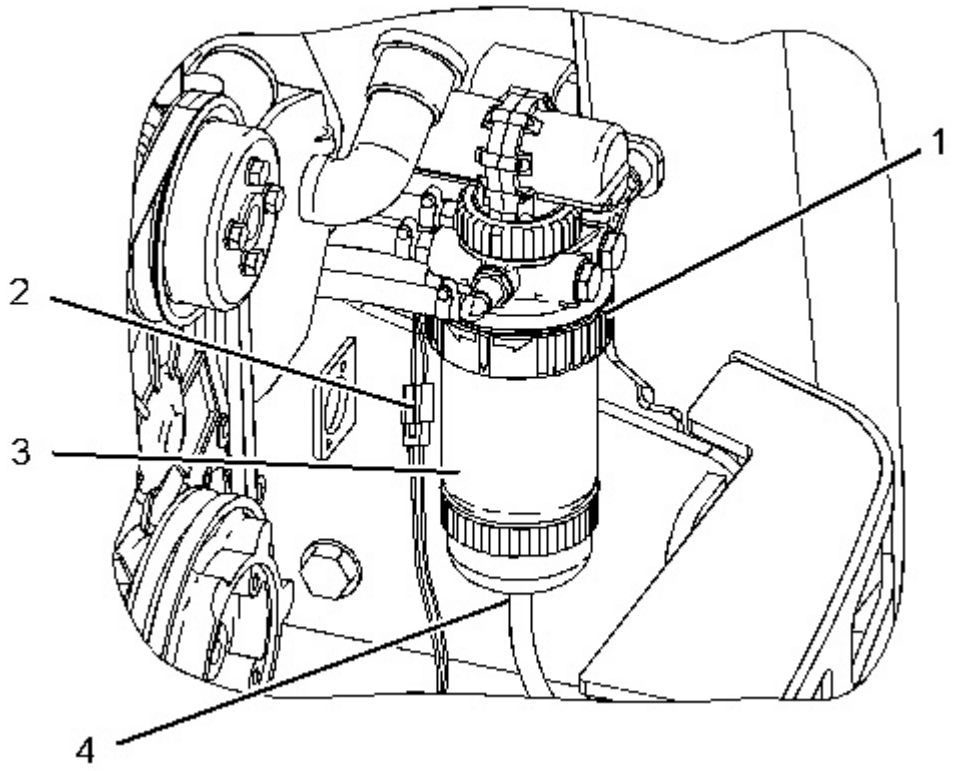


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

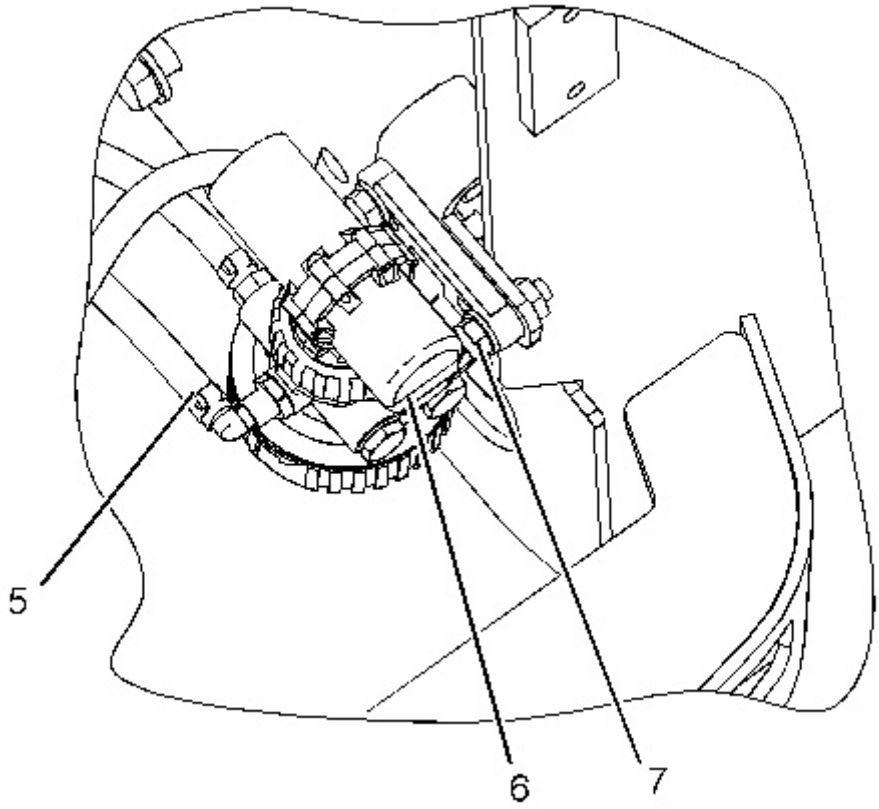


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

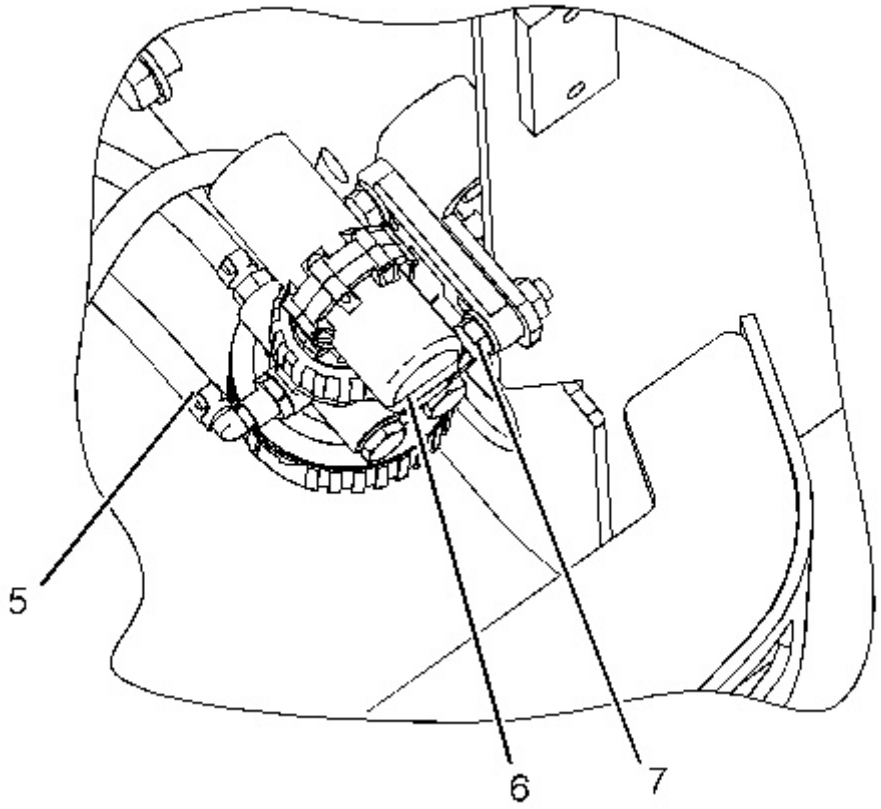


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

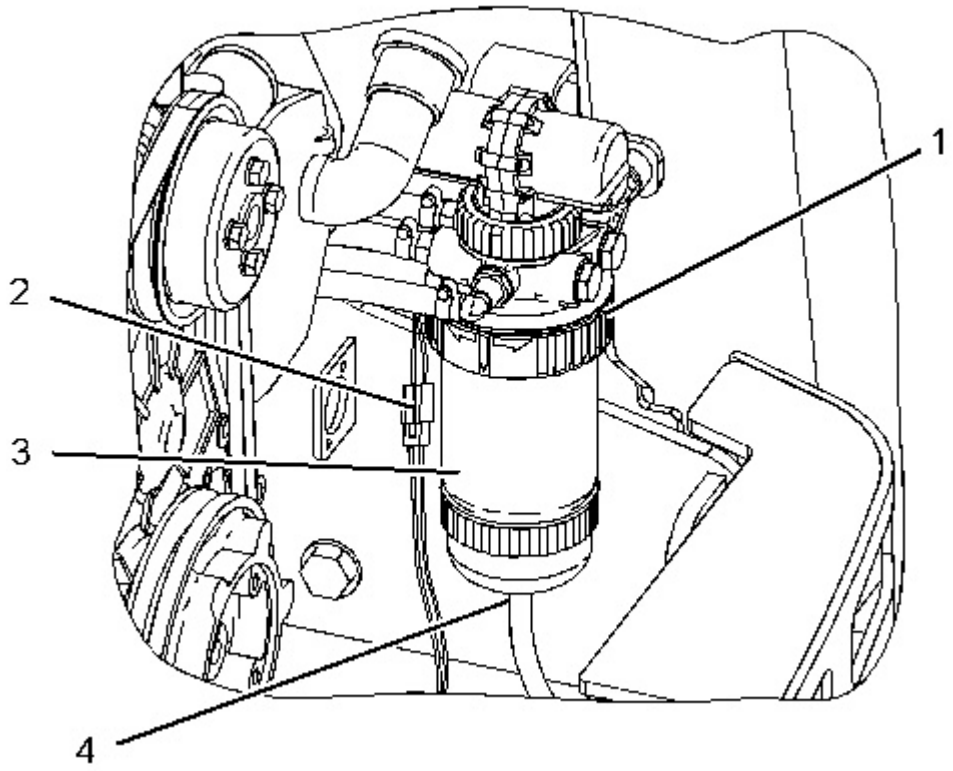


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02954431

General Information

SMCS - 5050

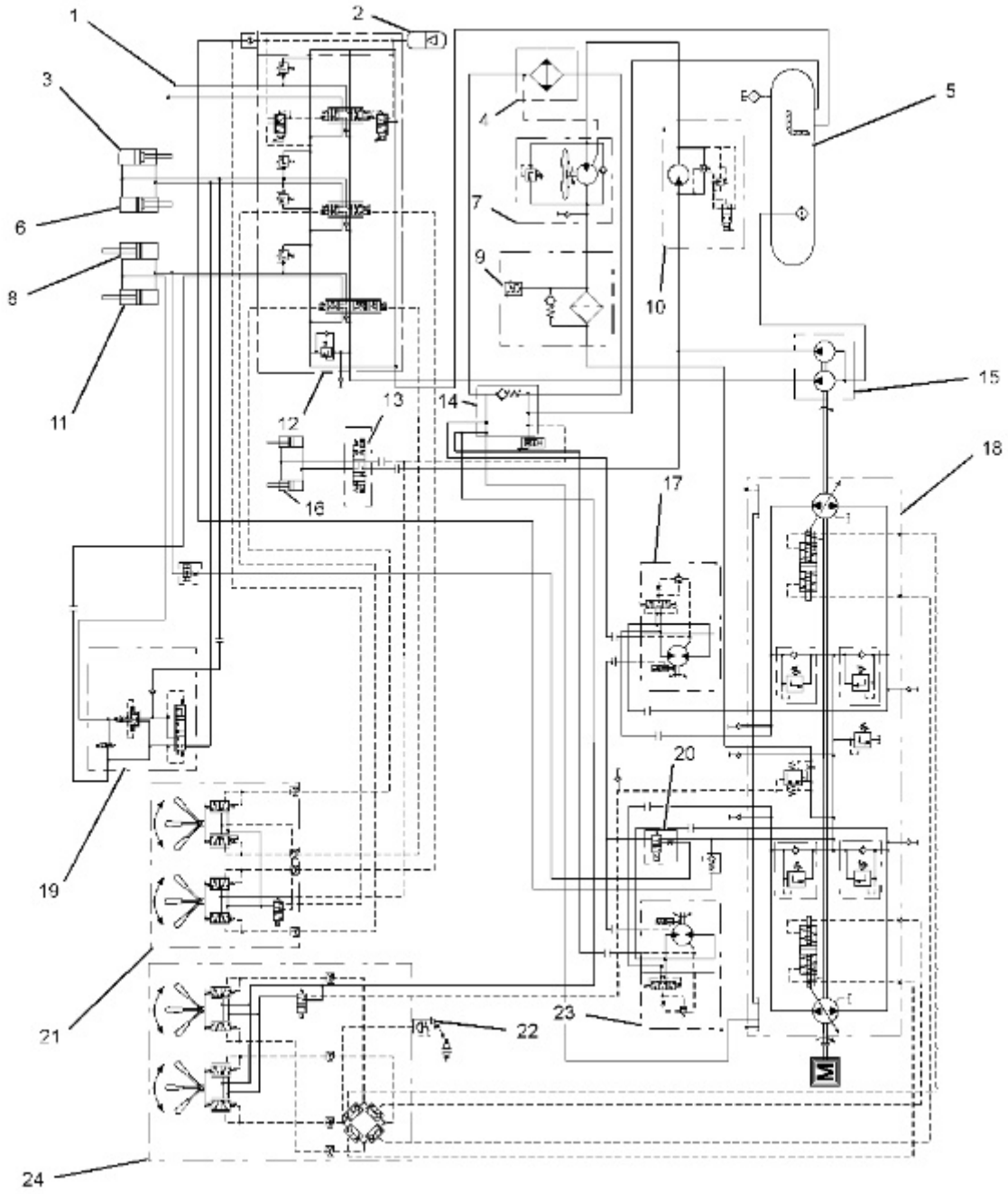


Illustration 1 g01455066

Hydraulic Schematic Single Speed

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Tilt Cylinder Group (Right side)

(4) Hydraulic oil cooler

(5) Hydraulic Tank Group

(6) Tilt Cylinder Group (Left side)

(7) Gear Motor (fan drive)

(8) Lift Cylinder (Right side)

(9) Hydraulic oil filter

(10) Gear Motor (air conditioner)

(11) Lift Cylinder (Left side)

(12) Control Valve (work tool)

(13) Solenoid Valve and Mounting Group (quick coupler)

(14) Return Manifold Group

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(16) Coupler Cylinder Group

(17) Piston Motor Group (hydrostatic right side)

(18) Piston Pump (hydrostatic system)

(19) Diverter Valve (automatic level control valve RAISE)

(20) Solenoid Valve and Mounting Group

(21) Pilot Valve (work tool)

(22) Pressure Switch (optional backward travel alarm)

(23) Piston Motor Group (hydrostatic left side)

(24) Pilot Valve (hydrostatic system)

The Skid Steer Loaders hydraulic system consists of a hydrostatic drive system, a work tool hydraulic system and a pilot hydraulic system. The hydrostatic drive system and the work tool hydraulic system are controlled by the pilot system.

The three systems use one common Hydraulic Tank Group (5) . The Gear Pump (charge oil, implement, air conditioner and fan drive) (15) is attached to the front end of the Piston Pump (hydrostatic system) (18) . The Piston Pump (hydrostatic system) and the Gear Pump (charge oil, implement, air conditioner and fan drive) are splined to the engine. The piston pump provides flow for the hydrostatic drive system. The gear pump is a two-section pump. One section of the gear pump provides flow for the work tool system. The other section of the gear pump provides charge oil for the hydrostatic system, oil for the optional Gear Motor (air conditioner) (10) , oil for the optional Solenoid Valve and Mounting Group (quick coupler) (13) , and oil for the pilot system. The oil flows from the gear pump to the optional Gear Motor (air conditioner). The oil then flows to the Gear Motor (fan drive) (7) . The oil then flows through the hydraulic oil filter (9) . After the oil flows through the hydraulic oil filter, the oil flows to the Piston Pump (hydrostatic system). The oil flow that flows to the work tool system is not filtered by the oil filter.

The gear pump supplies oil to the Pilot Valve (hydrostatic system) (24) and the Pilot Valve (work tool) (21) . The pilot operated hydraulic controls are used to route pilot oil to Piston Pump (hydrostatic system) (18) and pilot oil to Control Valve (work tool) (12) . The pilot oil moves the swashplates in the piston pump in order to control Piston Motor Group (hydrostatic system) for the right side (17) and Piston Motor Group (hydrostatic system) for the left side (23) . The pilot oil shifts the spools in the Control Valve (work tool) in order to operate the work tool.

Oil returns to Return Manifold Group (14) from the following components: the Pilot Valve (hydrostatic system) and Pilot Valve (work tool), the Piston Pump (hydrostatic system), the Piston Motor Group (hydrostatic left side) and Piston Motor Group (hydrostatic right side) and the optional Solenoid Valve and Mounting Group (quick coupler). The oil can flow to the hydraulic oil cooler from the return manifold. Oil that is returning from the Control Valve (work tool) (12) flows directly to the tank.

Hydraulic Supply System

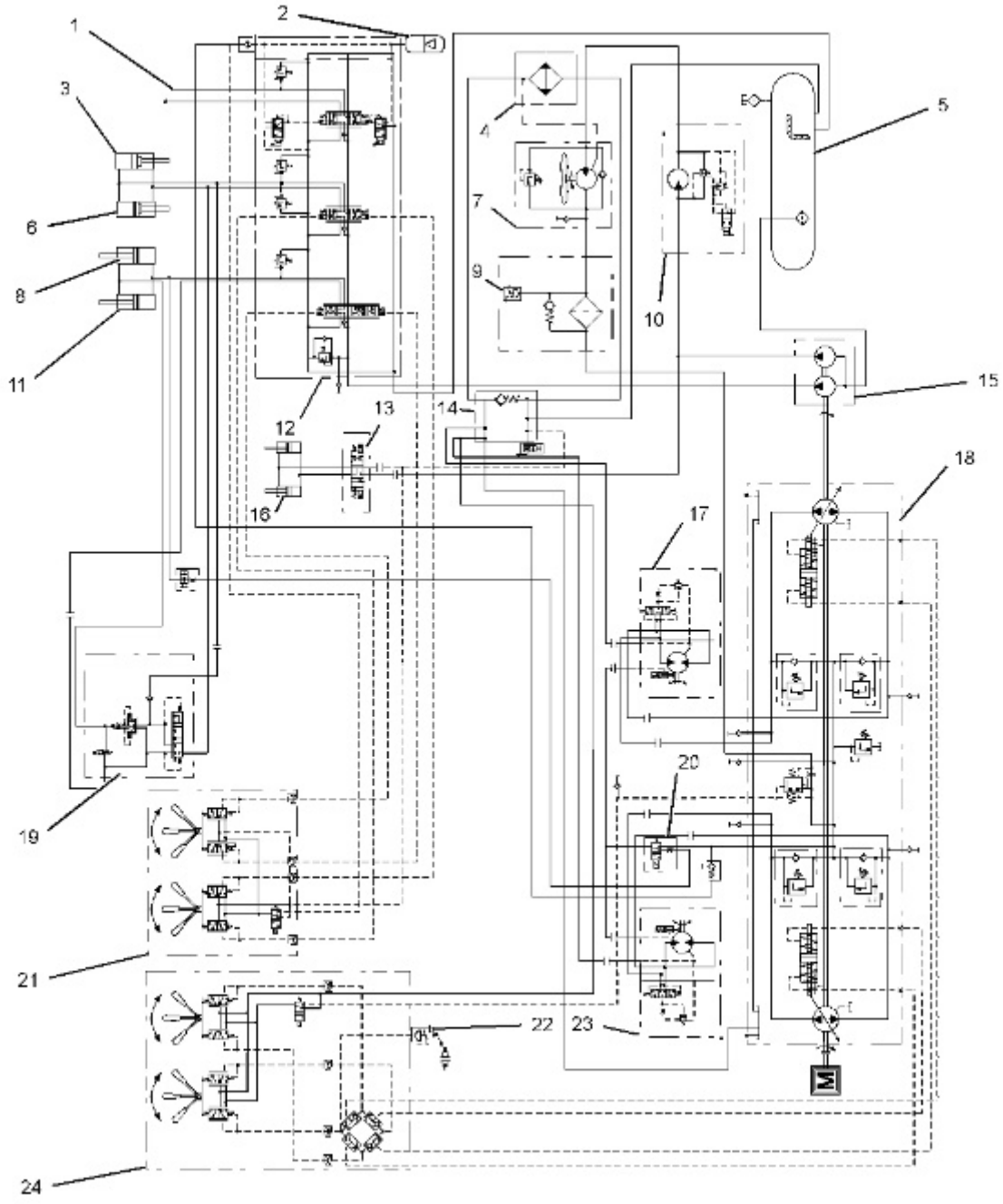


Illustration 2 g01455068

Hydraulic Schematic Single Speed

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Tilt Cylinder Group (Right side)

(4) Hydraulic oil cooler

(5) Hydraulic Tank Group

(6) Tilt Cylinder Group (Left side)

(7) Gear Motor (fan drive)

(8) Lift Cylinder (Right side)

(9) Hydraulic oil filter

(10) Gear Motor (air conditioner)

(11) Lift Cylinder (Left side)

(12) Control Valve (work tool)

(13) Solenoid Valve and Mounting Group (quick coupler)

(14) Return Manifold Group

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(16) Coupler Cylinder Group

(17) Piston Motor Group (hydrostatic right side)

(18) Piston Pump (hydrostatic system)

(19) Diverter Valve (automatic level control valve RAISE)

(20) Solenoid Valve and Mounting Group

(21) Pilot Valve (work tool)

(22) Pressure Switch (optional backward travel alarm)

(23) Piston Motor Group (hydrostatic left side)

(24) Pilot Valve (hydrostatic system)

The hydraulic oil tank (5) stores the hydraulic oil for the machine. The hydraulic tank supplies oil to the hydrostatic system, the work tool hydraulic system, and the pilot hydraulic system.

A strainer is located inside the oil tank on the end of the supply line. The tank is not pressurized. A hose connects the tank to a breather.

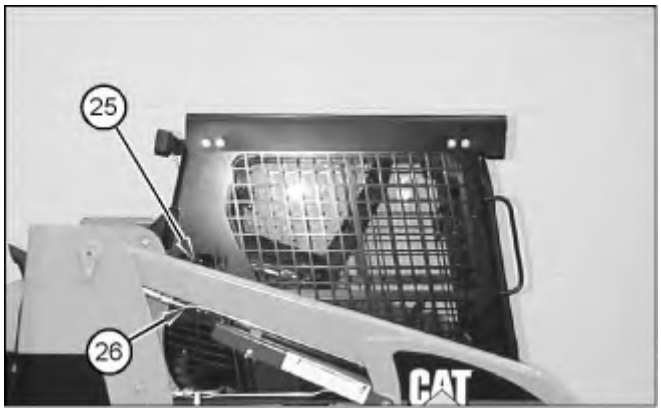


Illustration 3 g01031877

(25) Hydraulic tank filler cap

(26) Hydraulic tank sight gauge

The sight gauge (26) is located on the right side of the machine below the filler cap (25) . Maintain the oil level approximately in the middle of the sight gauge. Refer to the Operation and Maintenance Manual, SEBU7731, "Hydraulic System Oil Level - Check" for more information.

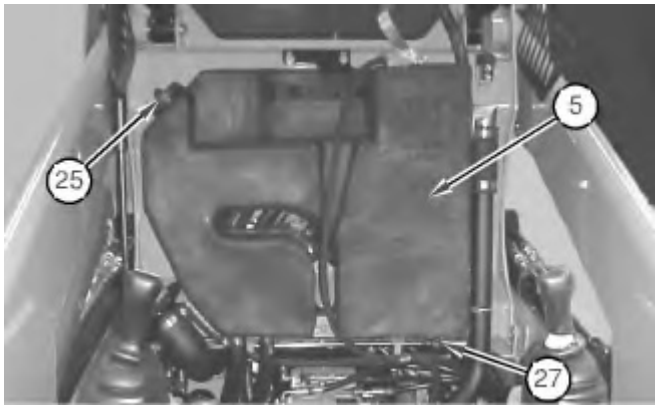


Illustration 4 g01031879

(5) Hydraulic tank

(25) Filler cap

(27) Oil temperature sender

An oil temperature sender (27) is located on the bottom of the hydraulic tank (5) . When the hydraulic oil temperature exceeds 102° ± 3°C (216° ± 5°F), the sender will activate the indicator light that is located on the left control panel. When the hydraulic oil temperature cools to a temperature of approximately 90 °C (194 °F), the sender will deactivate the indicator light.

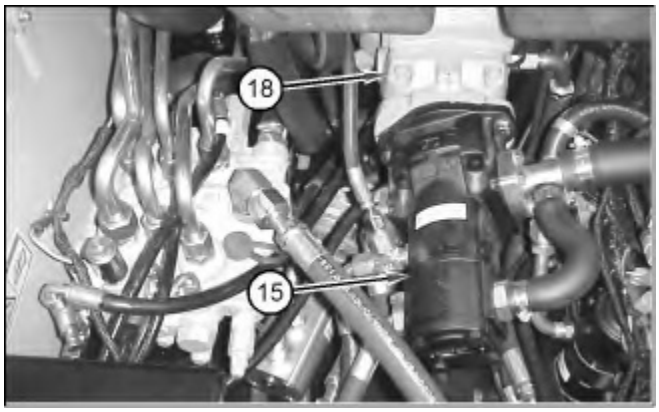


Illustration 5 g01031880

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(18) Piston Pump (hydrostatic system)

Hydraulic oil from hydraulic tank (5) flows into gear pump (15) . The gear pump is driven by a common drive shaft that runs through the piston pump (hydrostatic system) (18) . The gear pump supplies oil to the hydraulic system and to the hydrostatic system.

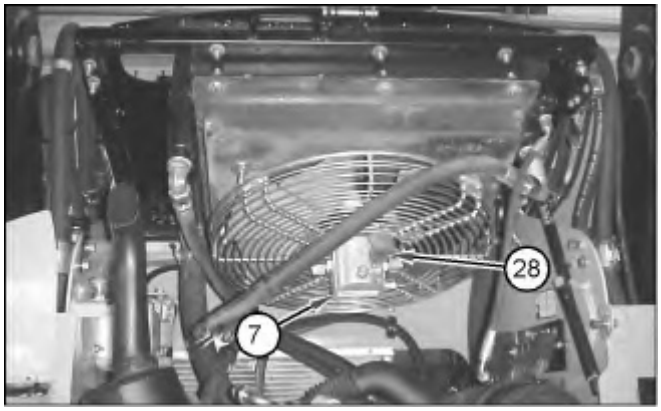


Illustration 6 g01031908

(7) Gear Motor (fan drive)

(28) Test port and fill port

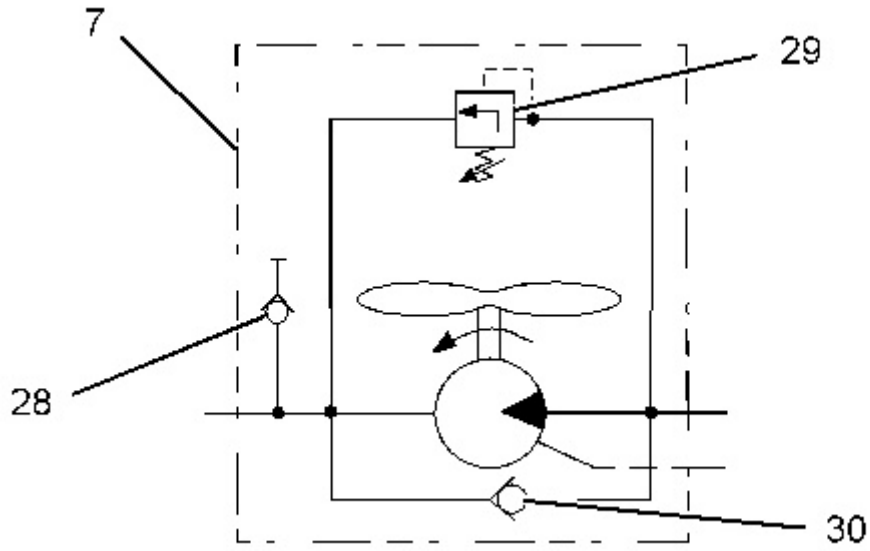


Illustration 7 g01455072

(7) Gear Motor (fan drive)

(28) Test port and fill port

(29) Relief valve

(30) Check valve

Hydraulic oil for the Gear Motor (fan drive) (7) is supplied by the gear pump. Hydraulic oil from the hydraulic oil tank flows to the front section of the gear pump. The oil flows from the gear pump to the gear motor. The flow of oil through the gear motor turns the fan that cools the hydraulic oil that passes through the oil cooler. The fan also cools the coolant that flows through the radiator.

The fan motor will rotate in direct relation to the amount of hydraulic oil flow until the hydraulic oil pressure reaches the setting for the relief valve (29) . The relief valve allows the excess oil to bypass the gear motor.

The check valve (30) allows the gear motor to spin freely after the engine is turned off.

The test port and fill port (28) is used to test for contaminants in the hydraulic oil. For more information on the oil sample port, refer to Hydraulic System Testing and Adjusting, RENR4867, "Hydraulic Oil Contamination Test". The port is also used to pump oil into the piston pump. For more information on the fill port, refer to Hydraulic System Testing and Adjusting, RENR4867, "Filling and Flushing the Hydrostatic System Test".

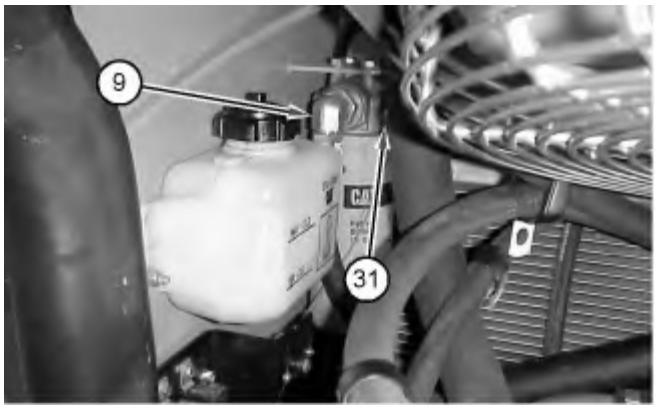


Illustration 8 g01031882

(9) Hydraulic oil filter

(31) Differential pressure indicator

Hydraulic oil then flows out of the gear motor and into the hydraulic oil filter (9) . The hydraulic oil filter is located at the rear of the left side of the engine compartment.

Hydraulic oil flows out of the Gear Motor (fan drive) and into the hydraulic oil filter (9) . The oil filter is a five micron filter. From the oil filter, the hydraulic oil flows to the Piston Pump (hydrostatic system).

The hydraulic oil filter serves the purpose of removing any particles that could damage the piston pump. The hydraulic oil then flows into the front section of the piston pump.

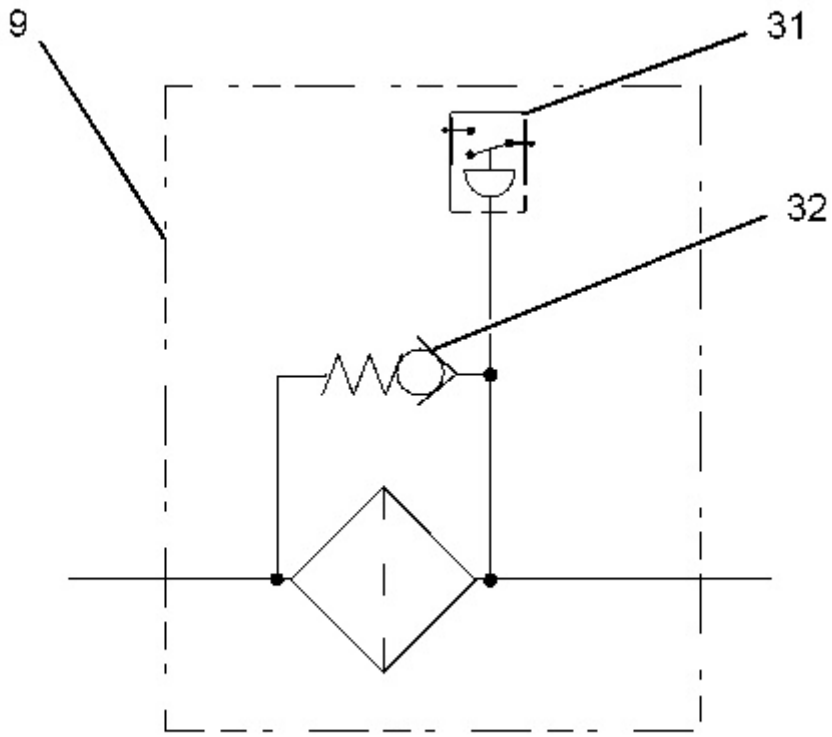


Illustration 9 g01455075

(9) Hydraulic oil filter

(31) Differential pressure indicator

(32) Filter bypass valve

The differential pressure indicator (31) will close when the differential pressure becomes high enough. When the differential pressure indicator closes, an electrical signal causes the light on the right control panel to illuminate. When the differential pressure raises further, the oil filter bypass valve (32) will open. For more information about the alert indicators, refer to the Operation and Maintenance Manual, "Alert Indicators".

Interlock System

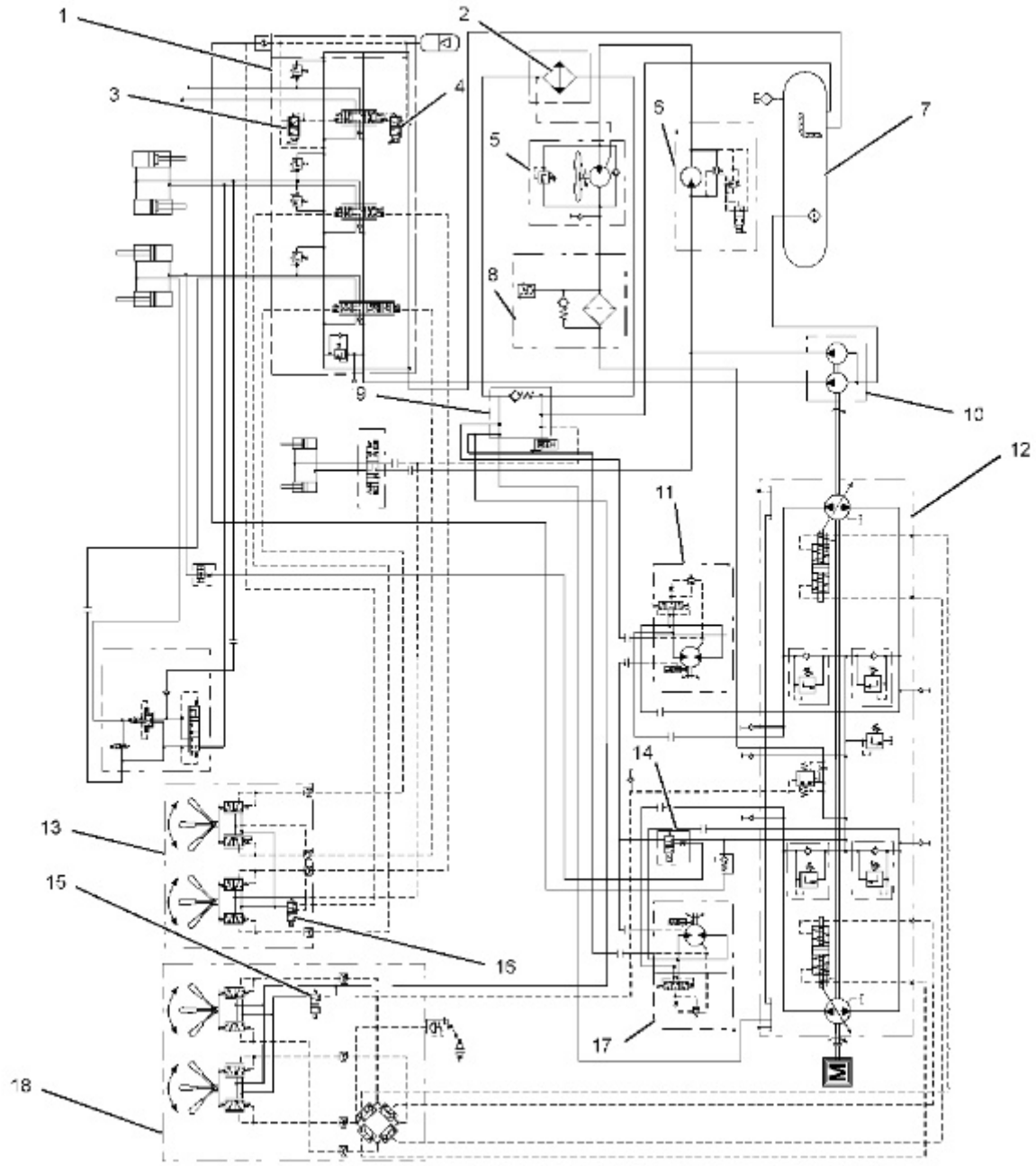


Illustration 10 g01455077

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Hydraulic oil cooler

(3) Solenoid Valve Group

(4) Solenoid Valve Group

(5) Gear Motor (fan drive)

(6) Gear Motor (air conditioner)

(7) Hydraulic Tank Group

(8) Hydraulic oil filter

(9) Return Manifold

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Piston Motor Group (hydrostatic right side)

(12) Piston Pump (hydrostatic system)

(13) Pilot Valve (work tool)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Solenoid Valve Group (hydrostatic system)

(16) Solenoid Valve Group (work tool)

(17) Piston Motor Group (hydrostatic left side)

(18) Pilot Valve (hydrostatic system)

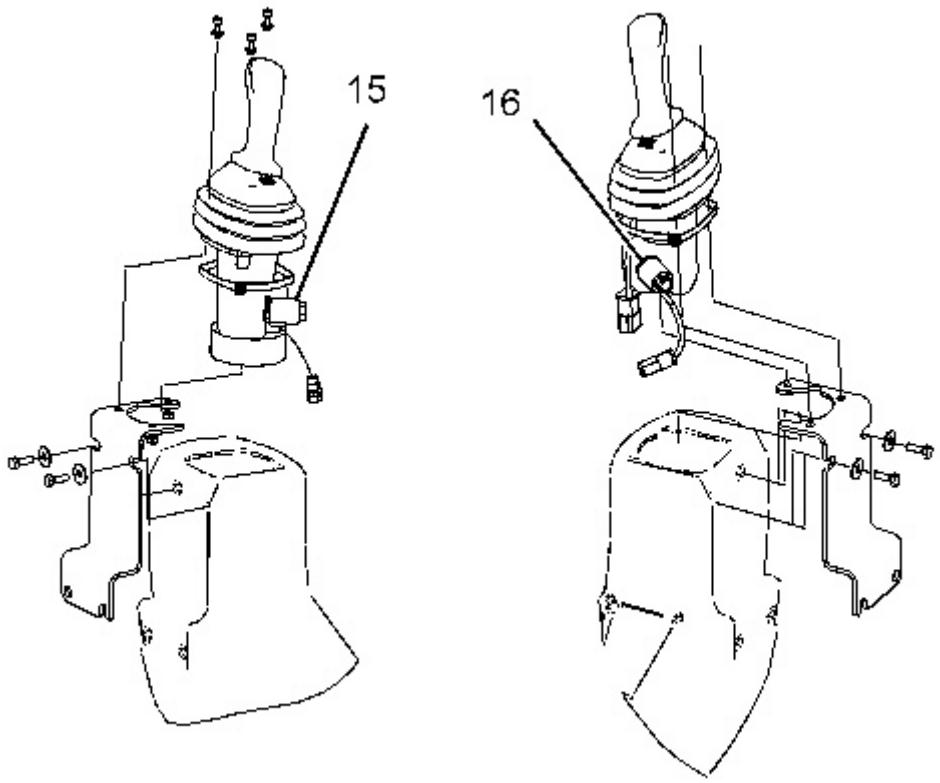


Illustration 11 g01455080

(15) Solenoid Valve Group (hydrostatic system)

(16) Solenoid Valve Group (work tool)

There are five solenoid valves for the interlock system on the Skid Steer Loader. The interlock system includes the following solenoids: the Solenoid Valve Group (hydrostatic system) (15) , the Solenoid Valve Group (work tool) (16) , two Solenoid Valve Groups (3) and (4) and Solenoid Valve and Mounting Group (parking brake) (14) . The Solenoid Valve Group (hydrostatic system), the Solenoid Valve Group (work tool), and the Solenoid Valve and Mounting Group (parking brake) are energized under the following conditions:

- The seat must be occupied.
- The arm bar must be in the DOWN position.
- The parking brake switch must be disengaged.

The Solenoid Valve Group (hydrostatic system) (15) is located on the Pilot Valve (hydrostatic system) (18) . The solenoid valve allows the flow of hydraulic signal oil to the pilot operated hydraulic control. When the solenoid is de-energized, no hydraulic signal oil flows to the hydraulic control.

The Solenoid Valve and Mounting Group (parking brake) (14) is located under the cab on the left side of the machine. The solenoid valve allows the flow of pilot hydraulic oil to the brakes. The parking brakes are located on piston motors (11) and (17) .

When the solenoid is de-energized, the flow of pilot hydraulic oil is blocked. Hydraulic oil from the parking brake actuators drains through the solenoid valve to the hydraulic tank. This allows the force of the actuator spring to engage the brakes. When the solenoid is energized, pilot hydraulic oil flows into the parking brakes. The oil pressure overcomes the force of the spring in order to disengage the parking brakes.

The Solenoid Valve Group (work tool) (16) is located on the Pilot Valve (work tool) (13) . The solenoid valve allows the flow of pilot hydraulic oil to the pilot operated hydraulic control. When the solenoid is de-energized no flow of pilot hydraulic oil reaches the hydraulic control.

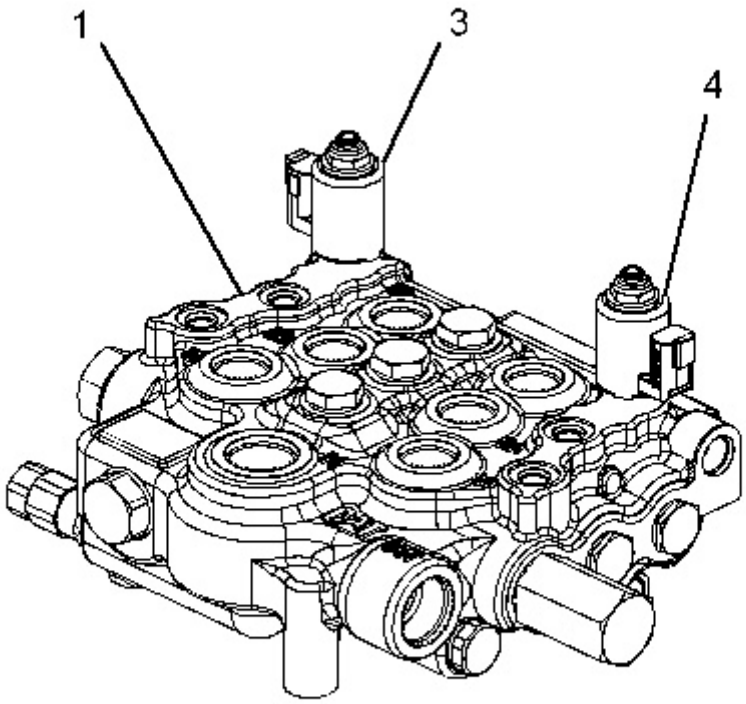


Illustration 12 g01455085

(1) Control Valve (work tool)

(3) Solenoid Valve Group

(4) Solenoid Valve Group

The Solenoid Valve Group (3) and (4) are located on the Control Valve (work tool) (1) . The solenoid valves are electronically activated. The valves enable the flow of pilot hydraulic oil to the auxiliary spool in the control valve.

The Gear Pump (charge oil, implement, air conditioner and fan drive) (10) supplies the hydraulic oil flow for the pilot system and the brake system. After the oil flows through the speed sensing valve, the signal oil to the Pilot Valve (hydrostatic system) (18) should be proportional to the engine rpm.

Return Manifold System

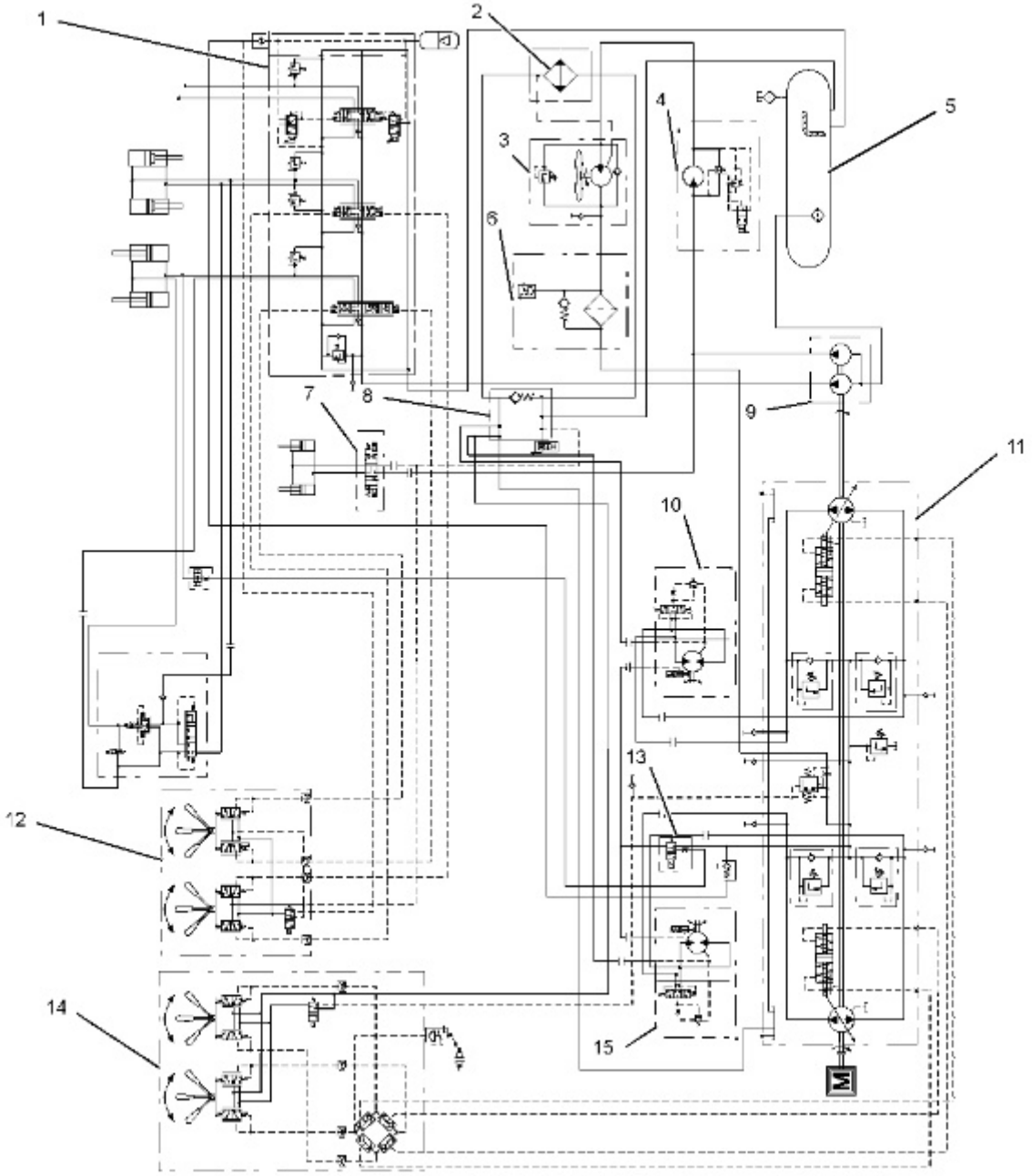


Illustration 13 g01455088

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Hydraulic oil cooler

(3) Gear Motor (fan drive)

(4) Gear Motor (air conditioner)

(5) Hydraulic Tank Group

(6) Hydraulic oil filter

(7) Solenoid Valve and Mounting Group (quick coupler)

(8) Return Manifold

(9) Gear Pump (charge oil, implement, air conditioner and fan drive)

(10) Piston Motor Group (hydrostatic right side)

(11) Piston Pump (hydrostatic system)

(12) Pilot Valve (work tool)

(13) Solenoid Valve and Mounting Group (parking brake)

(14) Pilot Valve (hydrostatic system)

(15) Piston Motor Group (hydrostatic left side)

Oil flows to the Return Manifold Group (8) from the following components: the Pilot Valve (work tool) (12) , the Pilot Valve (hydrostatic system) (14) , Solenoid Valve and Mounting Group (parking brake) (13) , Solenoid Valve and Mounting Group (quick coupler) (7) , the Piston Pump (hydrostatic system) (10) and the Piston Motor Groups (hydrostatic system) (10) and (15) .

The return manifold provides a common junction for the hydraulic oil prior to returning to the hydraulic tank. The return manifold also routes the oil to the hydraulic oil cooler (2) in order to keep the oil from getting too hot.

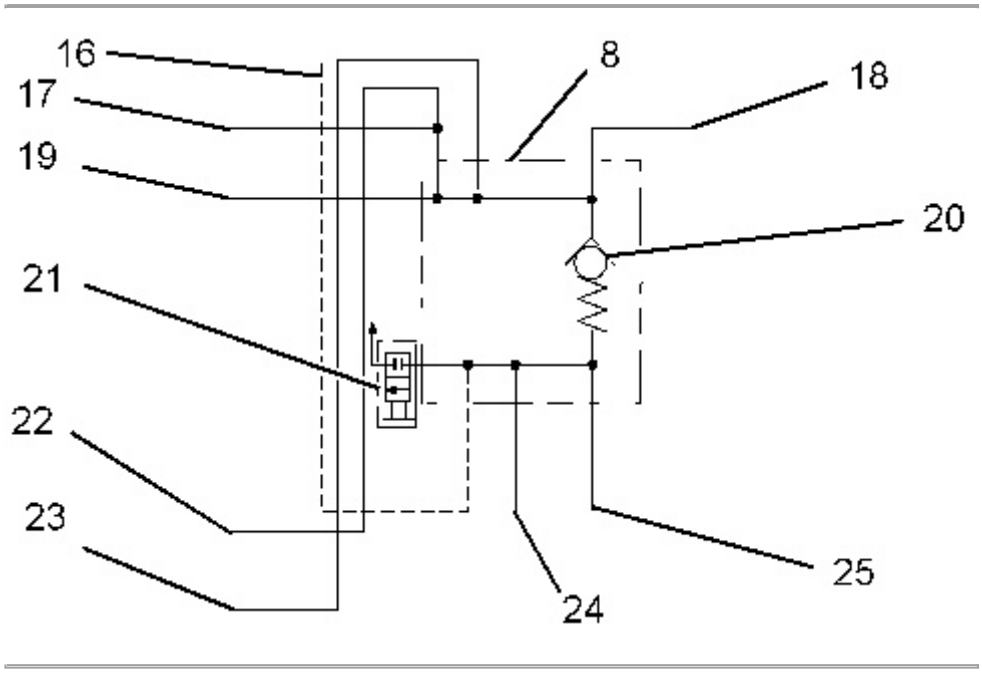


Illustration 14 g01455090

(8) Return Manifold Group

(16) Return oil from the Solenoid Valve and Mounting Group (quick coupler)

(17) Return oil from the Pilot Valve (hydrostatic system)

(18) Return oil to the hydraulic oil cooler

(19) Return oil from the case of the Piston Pump (hydrostatic system)

(20) Bypass check valve of the oil cooler

(21) Hydraulic system drain valve

(22) Return oil from the Piston Motor Group (hydrostatic left side)

(23) Return oil from the Piston Motor Group (hydrostatic right side)

(24) Return oil to the hydraulic tank

(25) Return oil from the hydraulic oil cooler

The hydraulic oil flows to the Gear Motor (fan drive) (3) which causes the cooling fan to rotate. The cooling fan blows air across the oil cooler. The air cools the hydraulic oil. The cooling system is designed to maintain the hydraulic oil temperature at a temperature of approximately 50° ± 10° C (120° ± 20°F). The hydraulic oil then flows through hydraulic oil filter (6) and into the Return Manifold Group (8) .

The bypass check valve of the oil cooler (20) is located in the Return Manifold Group . The bypass check valve prevents hydraulic oil from flowing to the hydraulic oil cooler when the machine is first started, or when the oil temperature is less than the minimum specification for the oil temperature. The bypass check valve opens when the oil pressure inside the cooler exceeds 172 kPa (25 psi). The hydraulic oil flows from the Return Manifold Group and returns to the hydraulic tank (5) .

The hydraulic system drain valve (21) is mounted in the Return Manifold Group . The drain valve is used to drain approximately 90% of the hydraulic oil from the lines, valves and the tank. A hose connects to the valve. The hose allows the oil to be drained into an approved receptacle through an opening in the belly guard.

Hydraulic Quick Coupler

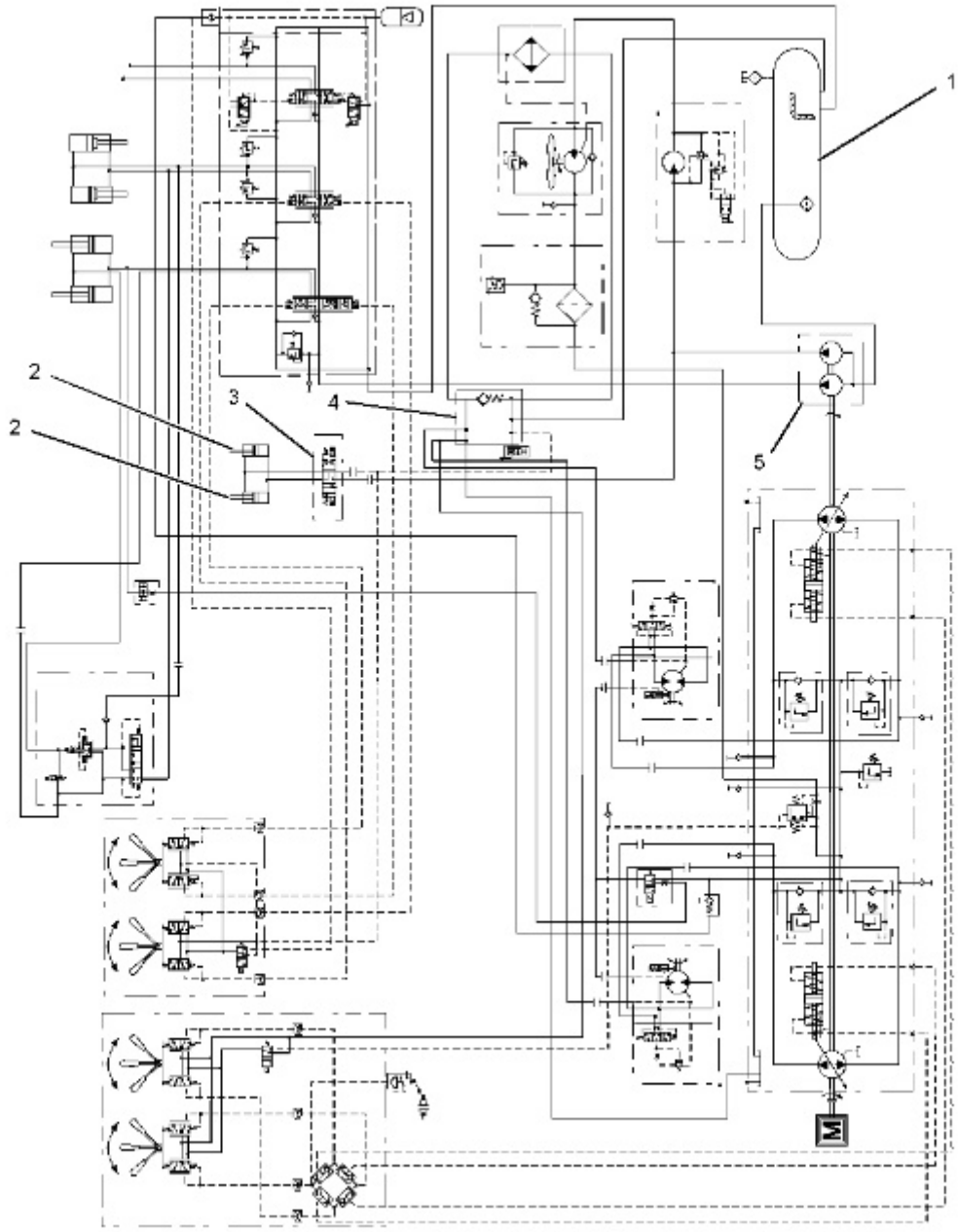


Illustration 15 g01455114

(1) Hydraulic Tank Group

(2) Coupler Cylinder Group

(3) Solenoid Valve and Mounting Group (quick coupler)

(4) Return Manifold Group

(5) Gear Pump (charge oil, implement, air conditioner and fan drive)

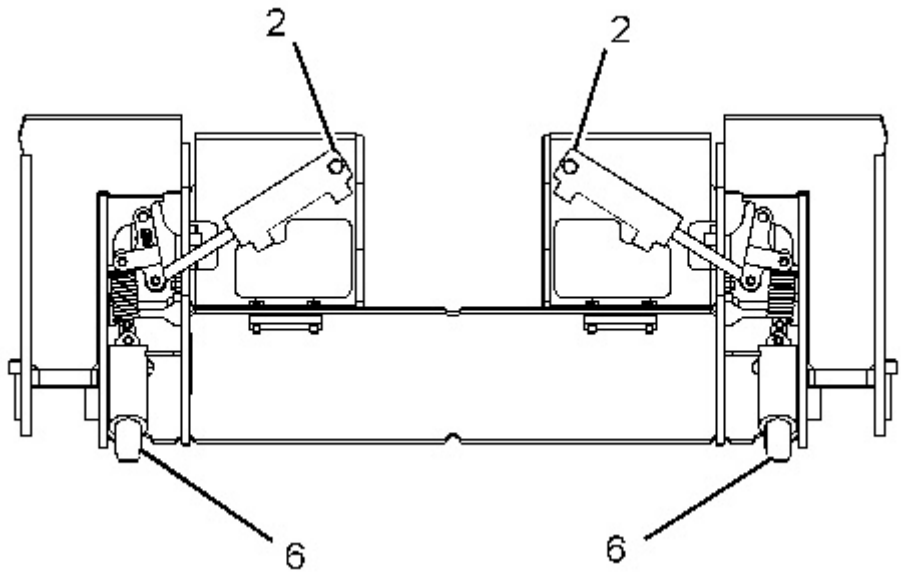


Illustration 16 g01455115

(2) Coupler Cylinder Group

(6) Coupler pins

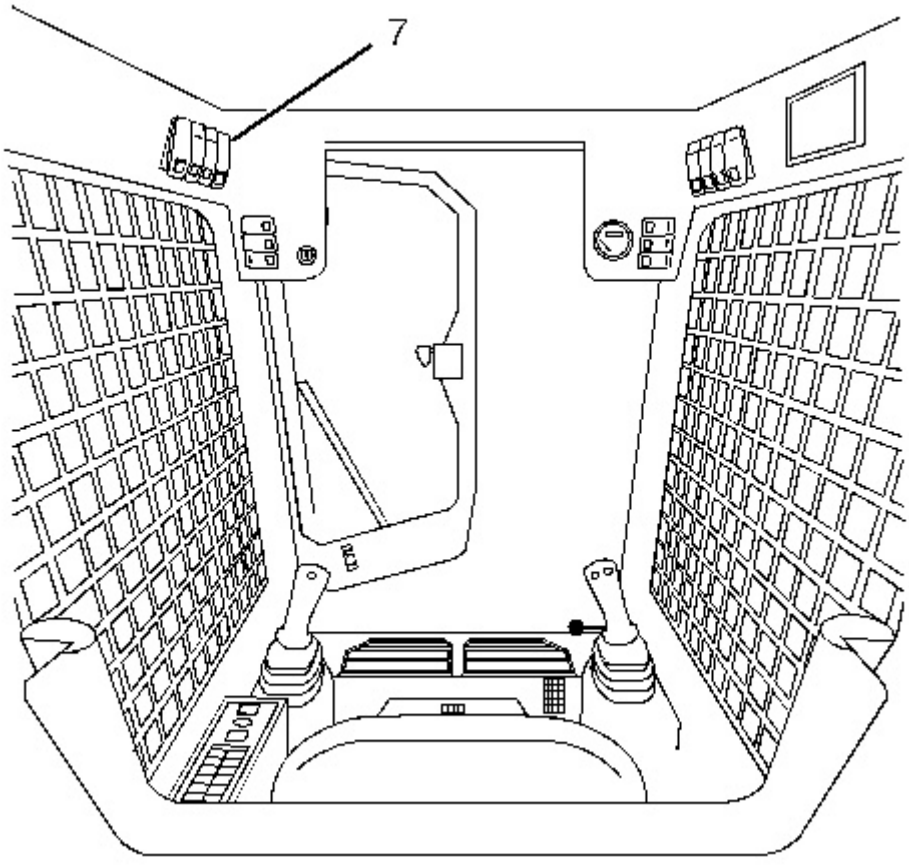


Illustration 17 g01455120

(7) Control switch for the work tool coupler

If the machine is equipped with a hydraulic work tool Quick Coupler Arrangement , the control switch (7) for the work tool coupler will be located on the upper left hand console. Refer to the Operation and Maintenance Manual, SEBU7731, "Machine Operation" for information on the operation of the hydraulic quick coupler.

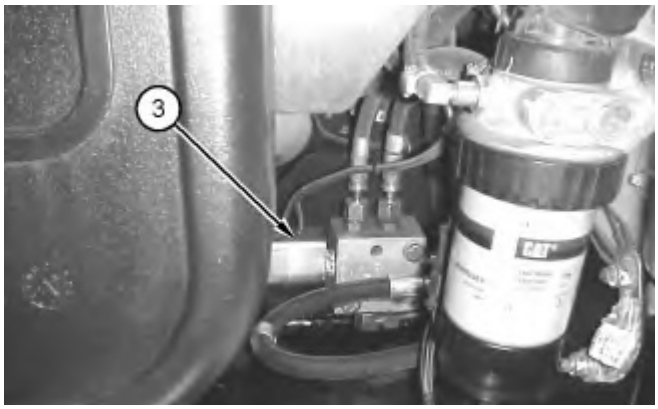


Illustration 18 g01033007

(3) Solenoid Valve and Mounting Group (quick coupler)

The Solenoid Valve and Mounting Group (quick coupler) (3) is located on the right side at the rear of the machine. The control valve may be mounted on the rear bulkhead. The control valve may be mounted onto a bracket. The bracket is attached to the machine near the release lever that is for the engine access door. The mounting location is dependent on the machine configuration and the options.

When the operator presses the top of the control switch and the operator holds the top of the control switch for the work tool coupler, an electrical signal is sent to the solenoid on Solenoid Valve and Mounting Group (quick coupler) (3) . The energized solenoid causes the spool in the control valve to shift upward.

When the spool is shifted in the up position, the oil that is from the front section of the gear pump (5) flows through the valve. The oil then flows into the head ends of the Coupler Cylinder Group (2) . The oil causes the cylinders of the Coupler Cylinder Group (2) to extend. When the cylinders extend, the cylinders cause the coupler pins (6) to move down. The work tool should then be attached to the coupler. Ensure that the work tool is fully engaged to the coupler before the work tool is used. Refer to the Operation and Maintenance Manual, SEBU7731, "Work Tool Coupler Control".

When the operator slides the red button on the control switch downward, and the operator presses the bottom of the control switch for the work tool coupler, an electrical signal is sent to the other solenoid on Solenoid Valve and Mounting Group (quick coupler) (3) . The energized solenoid causes the spool in the control valve to shift downward.

When the spool is shifted in the down position, the oil that is from the front section of the gear pump (5) flows through the valve. The oil then flows into the rod ends of the Coupler Cylinder

Group (2) . The oil causes the cylinders of the Coupler Cylinder Group (2) to retract. When the cylinders retract, the cylinders cause the coupler pins (6) to move up. The work tool should then be detached from the coupler. Ensure that the work tool is fully disengaged from the coupler before the machine is moved. Refer to the Operation and Maintenance Manual, SEBU7731, "Work Tool Coupler Control".

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

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Pilot Hydraulic System

SMCS - 5050-PS

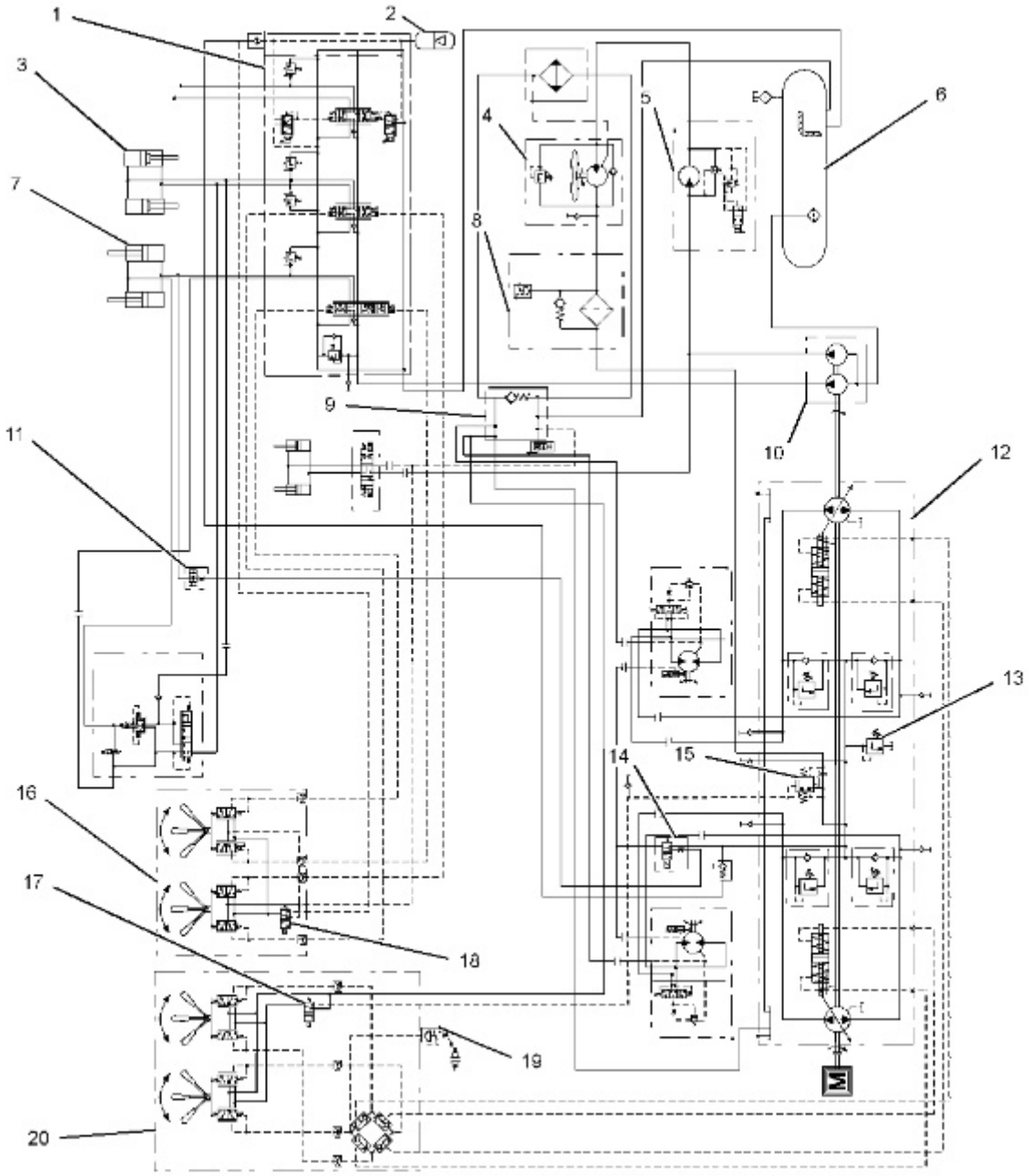


Illustration 1 g01455578

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Accumulator

(3) Tilt Cylinder Group

(4) Gear Motor (fan drive)

(5) Gear Motor (air conditioner)

(6) Hydraulic Tank Group

(7) Lift Cylinder

(8) Hydraulic oil filter

(9) Return Manifold Group

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Ball Valve Group

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(16) Pilot Valve (work tool)

(17) Solenoid Valve Group (hydrostatic system)

(18) Solenoid Valve Group (work tool)

(19) Pressure Switch

(20) Pilot Valve (hydrostatic system)

The pilot hydraulic system is used to move the spools in the Control Valve (work tool) (1) . The pilot hydraulic system is also used to control the operation of the hydrostatic system. The pilot system uses lower pressure oil to control higher pressure oil.

In order for the pilot system to function, the interlocks must be disengaged. The interlock system consists of the following components: the Solenoid Valve Group (hydrostatic system) (17) , the Solenoid Valve Group (work tool) (18) and the Solenoid Valve and Mounting Group (parking brake) (14) . In order for the interlock system to be disengaged, the following conditions must be met:

- The seat must be occupied.
- The armrest must be in the DOWN position.
- The parking brake must be disengaged.

The forward section of the Gear Pump (charge oil, implement, air conditioner and fan drive) (10) provides oil for the pilot oil circuits. The Relief Valve (Charge oil) (13) regulates the pressure of the charge system.

When the interlock system is disengaged, oil flows from the Hydraulic Tank Group (6) to the front section of the Gear Pump (charge oil, implement, air conditioner and fan drive) (10) and then oil flows to the Gear Motor (fan drive) (4) . After the gear motor, oil flows through the hydraulic oil filter (8) . Then, the oil flows to the Piston Pump (hydrostatic system) (12) .

At the Piston Pump (hydrostatic system), the pilot system oil for the hydrostatic system is regulated by the Speed Sensing Valve Group (15) . The pilot system oil that flows to the Pilot Valve (work tool) (16) is regulated by the charge relief valve (16) .

The rest of the charge oil is makeup oil for the hydrostatic system. Any leakage in the hydrostatic system is replaced by the charge oil.

Pilot Valve (hydrostatic system)

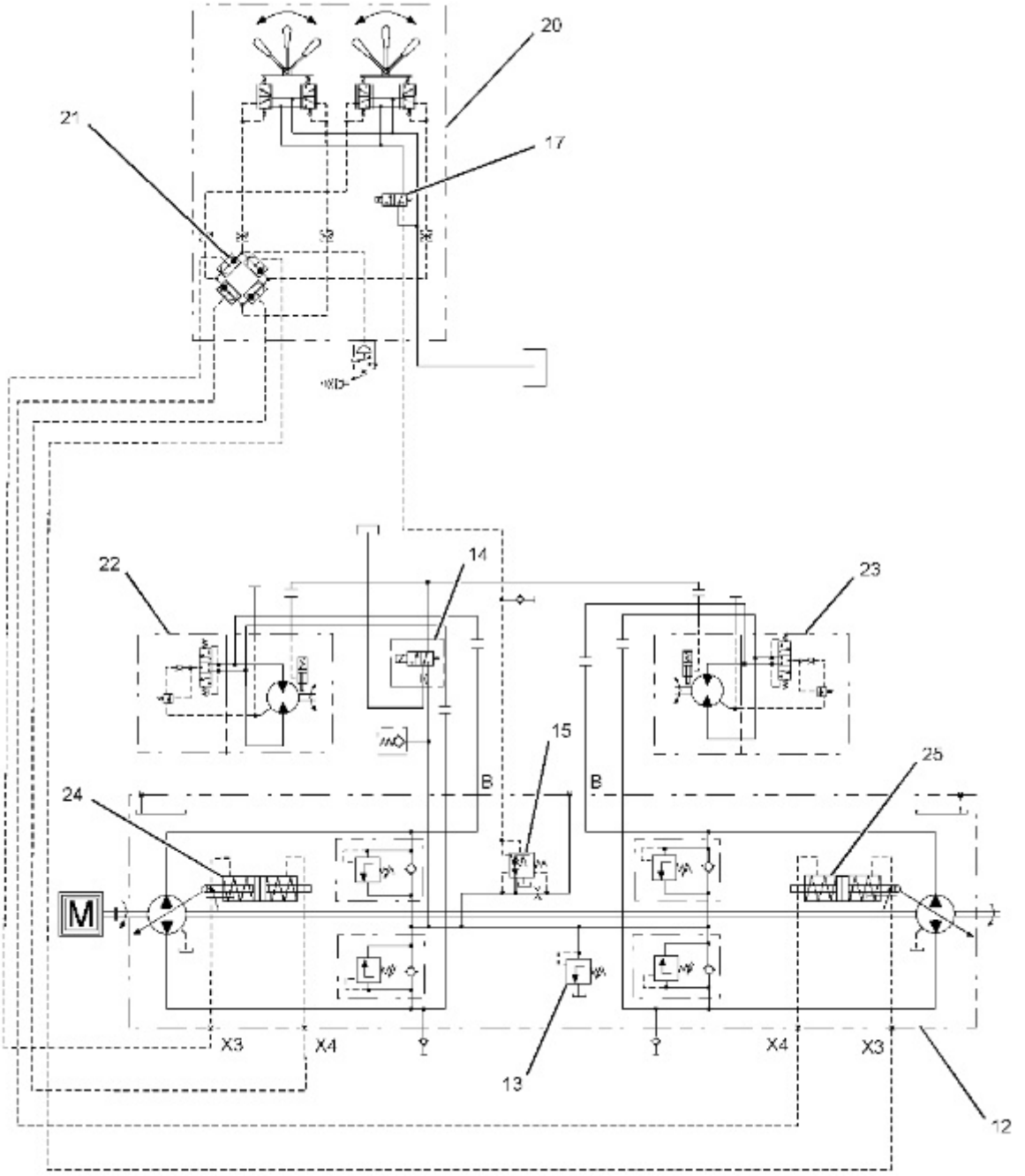


Illustration 2 g01050931

Hydraulic Schematic Single Speed

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(17) Solenoid Valve Group (Hydrostatic System)

(20) Pilot Valve (Hydrostatic System)

(21) Resolver Network

(22) Piston Motor Group (Hydrostatic Left Side)

(23) Piston Motor Group (Hydrostatic Right Side)

(24) Actuator Piston

(25) Actuator Piston

Oil flows from the speed sensing valve group (15) to the pilot valve (hydrostatic system) (20) . The load of the hydrostatic system determines the pressure of the pilot oil that is maintained by speed sensing valve (15) . The rpm of the engine determines the pressure of the pilot oil that is maintained by the Speed Sensing Valve Group .

Table 1

Ports that are Pressurized	**Direction of Machine Travel**
Port "X3" for actuator (24) and Port "X3" for actuator (25)	REVERSE
Port "X4" for actuator (24) and Port "X3" for actuator (25)	LEFT TURN
Port "X3" for actuator (24) and Port "X4" for actuator (25)	RIGHT TURN
Port "X4" for actuator (24) and Port "X4" for actuator (25)	FORWARD

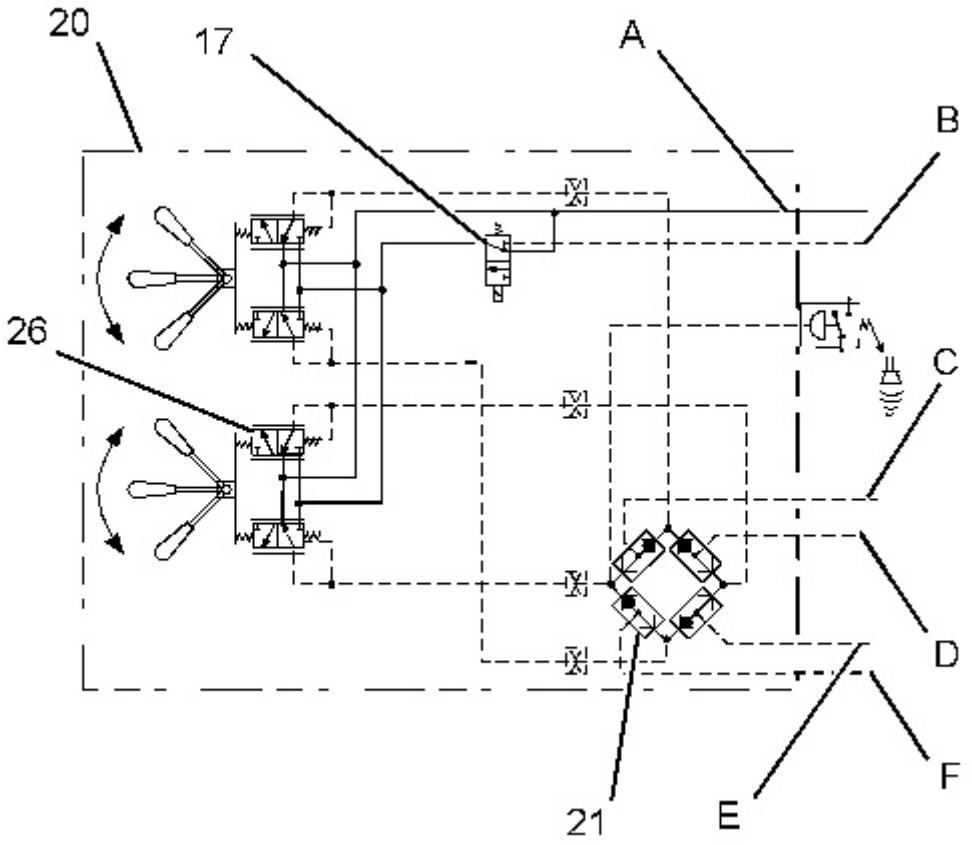


Illustration 3 g01455579

Schematic for the Pilot Valve (hydrostatic system)

(17) Solenoid Valve Group (Hydrostatic System)

(20) Pilot Valve (Hydrostatic System)

(21) Resolver Network

(26) Plunger for the Forward travel

(A) Return to tank port

(B) Pump supply port

(C) Line to "X3" Pilot pressure port (hydrostatic right side) (7)

(D) Line to "X4" Pilot pressure port (hydrostatic left side) (18)

(E) Line to "X4" Pilot pressure port (hydrostatic right side) (8)

(F) Line to "X3" Pilot pressure port (hydrostatic left side) (22)

When the interlock system is disengaged, an electrical signal is sent to the solenoid valve group (17) . The energized solenoid causes the valve spool to shift upward. With the valve spool in the upward position, oil from speed sensing valve (15) that is in line (B) is now able to flow through the solenoid valve (17) . The oil then flows to the plungers for pilot valve (20) .

The pilot oil will be blocked at the plungers if the control lever for the hydrostatic system is in the NEUTRAL position. Because the pilot oil is blocked at the plungers the oil will flow through pilot valve (20) back to the hydraulic tank through line (A) . Centering springs cause the travel control lever to return to the HOLD position whenever the travel control lever is released. Table 1 shows the direction of machine travel when the pilot ports are pressurized by the Pilot Valve (hydrostatic system).

When the travel control lever is moved to the FORWARD travel position, pilot oil flows from speed sensing valve (15) through the energized solenoid valve (17) . The oil then flows to the plungers for the pilot valve (20) . Because the travel control lever is in the FORWARD travel position, the oil now flows through the plunger for the FORWARD travel (26) . The oil then flows into the resolver network (21) .

The oil pressure causes the two resolver balls on the right side of the resolver network to move to the left. When the resolver balls move to the left the balls open a path that allows the pilot oil to flow into the line (D) and the line (E) .

Pilot oil that is in line (D) will flow into port (X4) in order to shift actuator (24) . The pilot oil that flows into port (X4) causes the piston in actuator (24) to shift left. At the same time, pilot oil that is in the line (E) will flow into port (X4) in order to shift actuator (25) . The pilot oil that flows into port (X4) causes the piston in actuator (25) to shift left. The movement of the actuators causes the swashplates to move. This will cause the pump to upstroke. When the pump upstrokes, the flow of oil from port (B) will increase.

Oil from port (B) will flow to piston motor (22) . Oil from port (B) will also flow to piston motor (23) . The flow of oil from the pump will be restricted when the oil reaches the piston motors. The restriction to the flow of oil will cause the pressure of the oil to rise. The rise in the pressure of the oil will cause the piston motors to start to rotate. This will propel the machine in the forward direction.

When the operator releases the travel control lever, the travel control lever returns to the NEUTRAL position. With the travel control lever in the NEUTRAL position, the plunger for the FORWARD travel (26) will move to the left. When the plunger for the FORWARD travel moves to the left the plunger blocks the flow of pilot oil. The plunger for the FORWARD travel (26) will now open a path for the oil in the line (D) and the line (E) to flow back to the hydraulic tank.

Since the pilot oil that is acting against the actuator piston (24) and the actuator piston (25) is now routed back to the hydraulic tank, the centering springs for the actuator pistons will force the actuator pistons back to the NEUTRAL position. When the actuator pistons move to the NEUTRAL position the swashplates move back to the minimum displacement position. When the swashplates move to the minimum displacement position the pumps will be at low pressure standby. Since the flow of oil has stopped to the Piston Motor Groups , the Piston Motor Groups will cease to rotate. The machine will come to a stop.

Refer to the Systems Operation, "Piston Pump (Hydrostatic)" for more information on the piston pump. Refer to the Systems Operation, "Piston Motor (Hydrostatic)" for more information on the piston motor.

Pilot Valve (work tool)

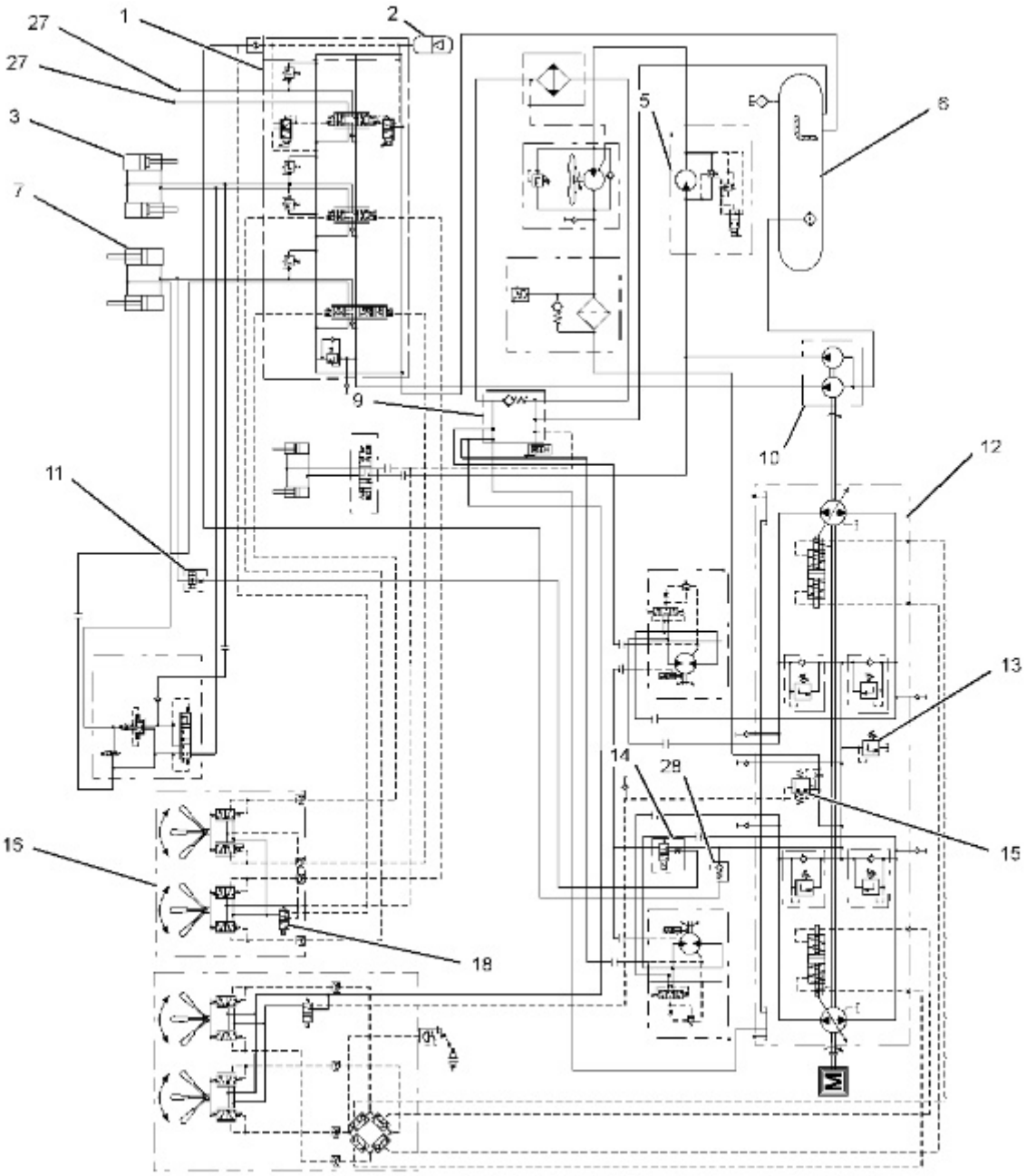


Illustration 4 g01455581

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Accumulator

(3) Tilt Cylinder Group

(5) Gear Motor (air conditioner)

(6) Hydraulic Tank Group

(7) Lift Cylinder

(9) Return Manifold

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Ball Valve Group

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(16) Pilot Valve (work tool)

(18) Solenoid Valve Group (work tool)

(27) Quick disconnects for the auxiliary circuit

(28) Check Valve

The pilot oil for the work tool is supplied by the front section of gear pump (10) . The pilot oil for the work tool is controlled by relief valve (13) . Relief valve (13) is part of piston pump (12) .

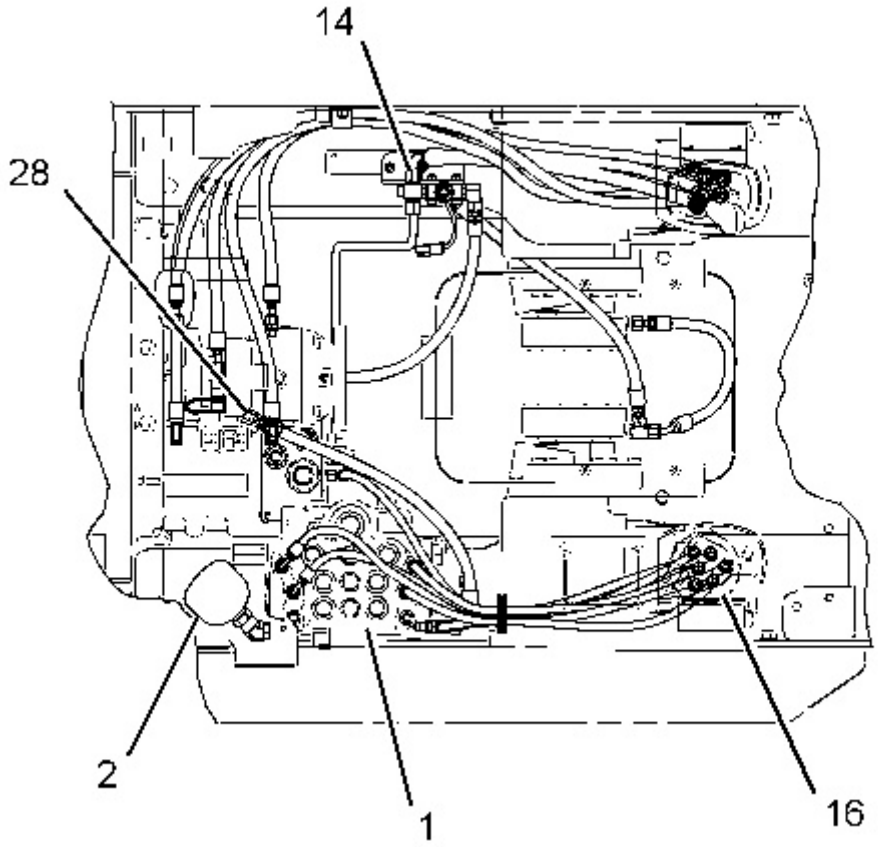


Illustration 5 g01455583

Locations of the Accumulator and Check Valve

(1) Control Valve (work tool)

(2) Accumulator

(14) Solenoid Valve and Mounting Group (parking brake)

(16) Pilot Valve (work tool)

(28) Check Valve

The oil that flows through the check valve (28) is used as pilot oil for the work tool circuits. The check valve is installed in a fitting that is installed to the bottom of piston pump (12) . The pilot oil overcomes the force of the spring in the check valve. The pilot oil then forces the check valve to open. When the check valve opens, the pilot oil flows through the check valve. The oil then flows to the control valve (1) . The oil also flows to the pilot valve (16) .

The pilot oil that flows to control valve (1) is used to activate the auxiliary circuit spool. The flow of the pilot oil is controlled by two solenoid valves. The pilot oil is also used to charge the accumulator (2) . The pilot oil that flows to pilot valve (16) is used to activate the lift spool. The pilot oil is also used to activate the tilt spool.

The interlock system must be disengaged in order for the pilot oil to flow to the work tool circuit. The auxiliary circuit can function with the armrest in the UP position, if the machine is equipped with an interlock override. Refer to the Operation and Maintenance Manual, "Hydraulic Shutoff and Interlock Override" for more information.

When the interlock system is disengaged, an electrical signal is sent to the Solenoid Valve Group (work tool) (15) . The energized solenoid causes the valve spool to shift upward. The pilot oil is able to flow through the valve spool and on to the plungers for pilot valve (16) when the valve spool is in the upward position.

The pilot oil will be blocked at the plungers so long as the control lever for the work tool is in the HOLD position. When the control lever is in the HOLD position, the oil will not flow through pilot valve (16) . Centering springs cause the control lever for the work tool to return to the HOLD position whenever the control lever for the work tool is released from any of the positions except for the FLOAT position. The FLOAT position has a detent that keeps the control lever for the work tool in this position until the operator moves the control lever for the work tool into a different position.

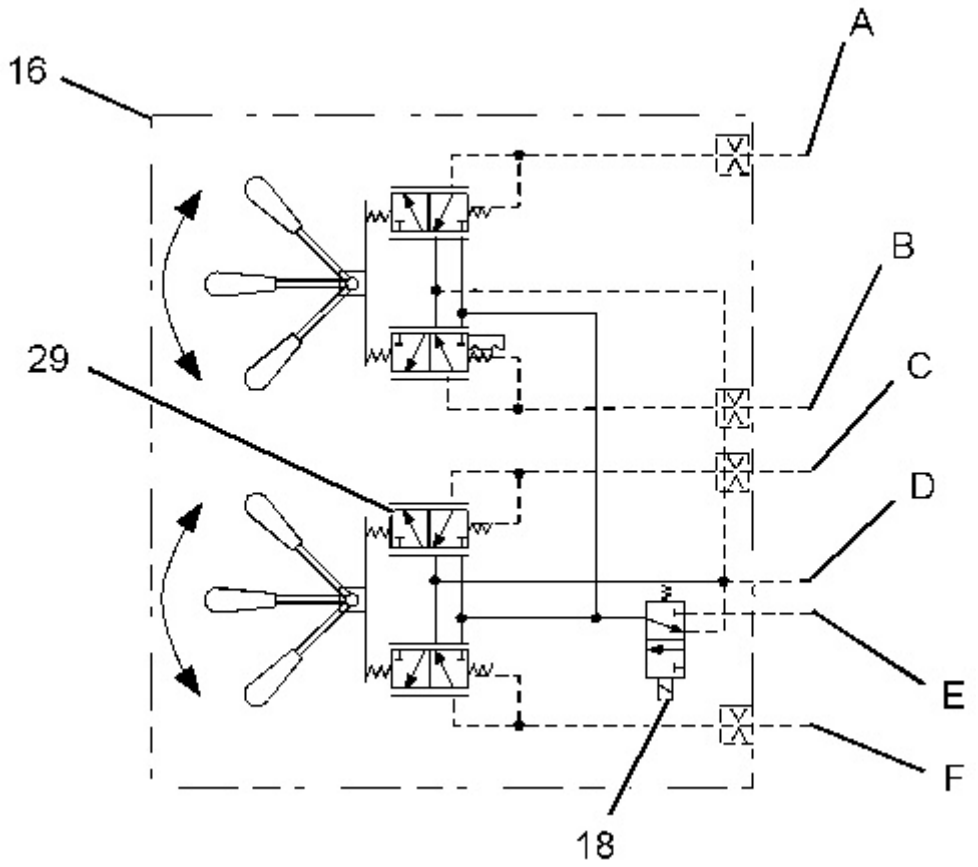


Illustration 6 g01455584

Schematic for the Pilot Valve (work tool)

(16) Pilot Valve (work tool)

(18) Solenoid Valve Group (work tool)

(29) Plunger for work tool TILT BACKWARD

(A) Line to work tool RAISE

(B) Line to work tool LOWER

(C) Line to work tool TILT BACKWARD

(D) Return to tank port

(E) Pump supply port

(F) Line to work tool TILT FORWARD

When the control lever for the work tool is moved to the TILT BACKWARD position, pilot oil flows from the check valve (28) through the energized solenoid valve group (18) . The oil then flows to the plungers for the pilot valve (16) .

Because the control lever for the work tool is in the TILT BACKWARD position, the oil now flows through the plunger for the TILT BACKWARD position (29) . Then, the pilot oil flows to the right side of control valve (1) in order to shift the tilt spool to the TILT BACKWARD

position. The pilot oil overcomes the force of the centering springs for the tilt spool. Then, the pilot oil forces the tilt spool to move to the left.

When the tilt spool moves to the left a path is opened for the implement oil to flow to the tilt cylinders. The implement oil for the work tool is supplied by the rear section of gear pump (10) . The implement oil flows to the tilt spool. Oil flows from the tilt spool to the rod ends of tilt cylinders (3) . The oil pressure causes the tilt cylinders to retract in order to tilt the work tool backward.

When the tilt spool moves to the left a path is also opened for the implement oil to flow from the tilt cylinders back to the hydraulic tank. As the tilt cylinders retract the oil that is in the head end of the tilt cylinders is forced out of the cylinders. The implement oil that is in the head ends of the tilt cylinders flows into the port for the head ends of the tilt cylinders that is in control valve (1) . The oil then returns to the hydraulic tank.

When the operator releases the control lever for the work tool, the control lever for the work tool will move back to the HOLD position. The plunger (29) now moves to the right. This shuts off the flow of pilot oil. Since the flow of pilot oil is blocked to the tilt spool, the centering springs for the tilt spool will move the tilt spool back to the HOLD position. Since the tilt spool is in the HOLD the tilt cylinders will stop retracting.

Refer to the Systems Operation, "Control Valve (Work Tool)" for more information on the control valve.

Accumulator

The accumulator (3) is mounted on the Control Valve (work tool) (2) . The accumulator provides a limited amount of pilot oil after the engine is shut OFF.

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02938262

Work Tool Hydraulic System

SMCS - 5050-WTL

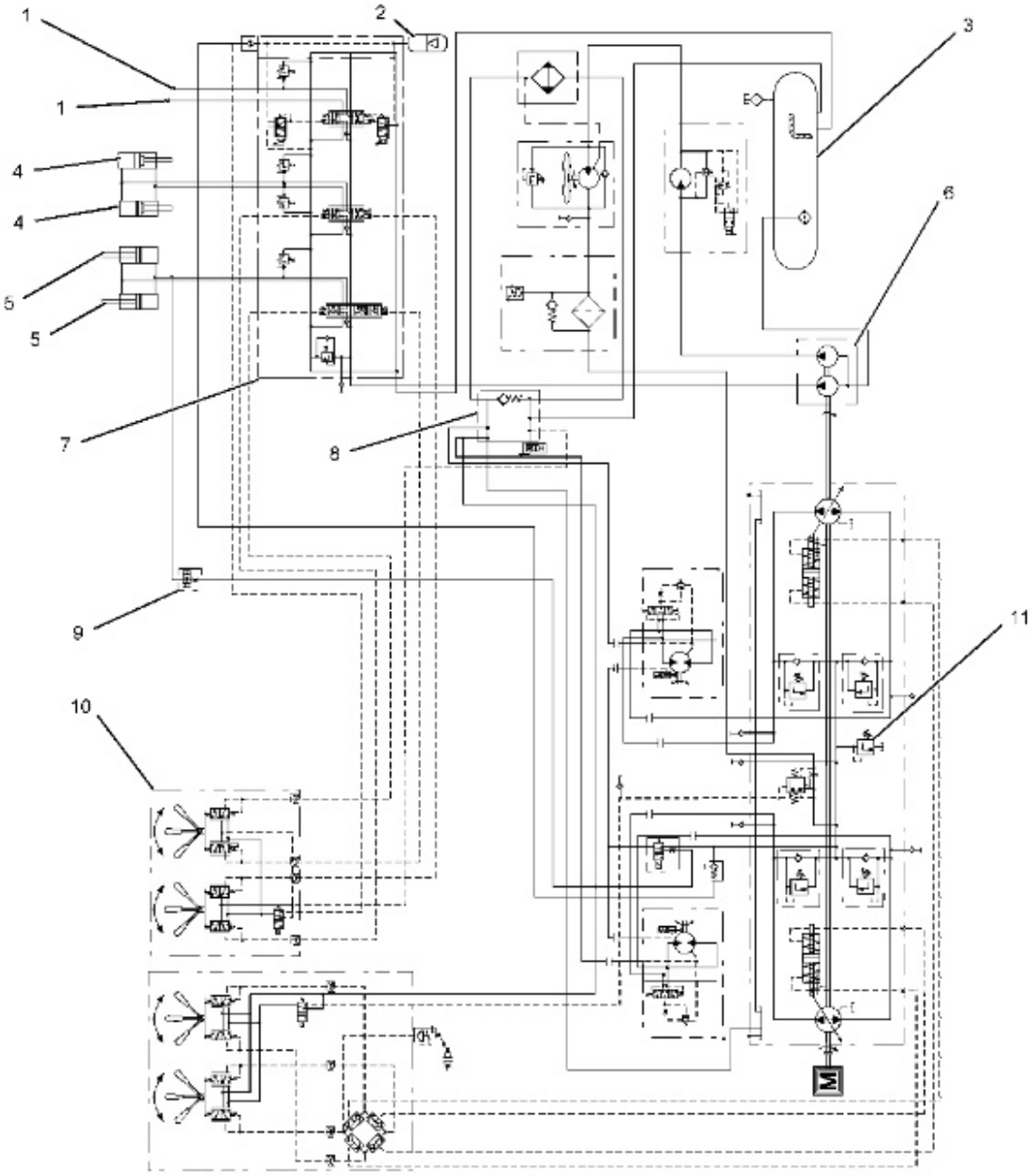


Illustration 1 g01455971

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold Group

(9) Ball Valve

(10) Pilot Valve (work tool)

(11) Relief Valve (charge oil)



Illustration 2 g01045590

(3) Hydraulic Tank Group

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

Gear pump (6) supplies the work tool hydraulic system with oil. Pump (6) is mounted to the front end of the piston pump for the hydrostatic system. Pump (6) is splined to the drive shaft of the piston pump for the hydrostatic system. The piston pump for the hydrostatic system is mounted to the engine. When the engine speed increases, the speed of pump (6) increases. This causes pump (6) to pump more oil to the work tool hydraulic system.

The rear section of gear pump (6) continuously pumps oil through control valve (7). Control valve (7) is an open center control valve. The oil pressure for control valve (7) is regulated by a main relief valve that is installed in control valve (7) .

The pilot oil for the work tool hydraulic system is supplied by the front section of pump (6). Oil flows out of the front section of pump (6) to the motor for the air conditioner. From the motor for the air conditioner, the oil flows to the fan drive motor. The oil flows through the fan drive motor to the oil filter. From the oil filter, the oil flows to the front section of the piston pump for the hydrostatic system. At the piston pump, the hydraulic oil flows passed the speed sensing valve. In order for the oil to flow to pilot valve (10), all three of the interlocks must be disengaged. In order for oil to flow to pilot valve (10), the hydraulic enable solenoid must be energized.

When the electrical requirements are complete, pilot oil will flow through a check valve to the accumulator (2). The pilot oil is used to charge the accumulator (2). The pilot oil will also flow to the pilot valve (10). When pilot valve (10) is activated, oil will be directed to control valve (7) in order to shift a control spool to the desired position. Once a control spool shifts, high pressure oil from pump (6) will flow to the selected work tool. Relief valve (11) maintains the pressure for the pilot oil system. Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

Hydraulic System for the Lift Arms Without the Diverter Valve (If Equipped)

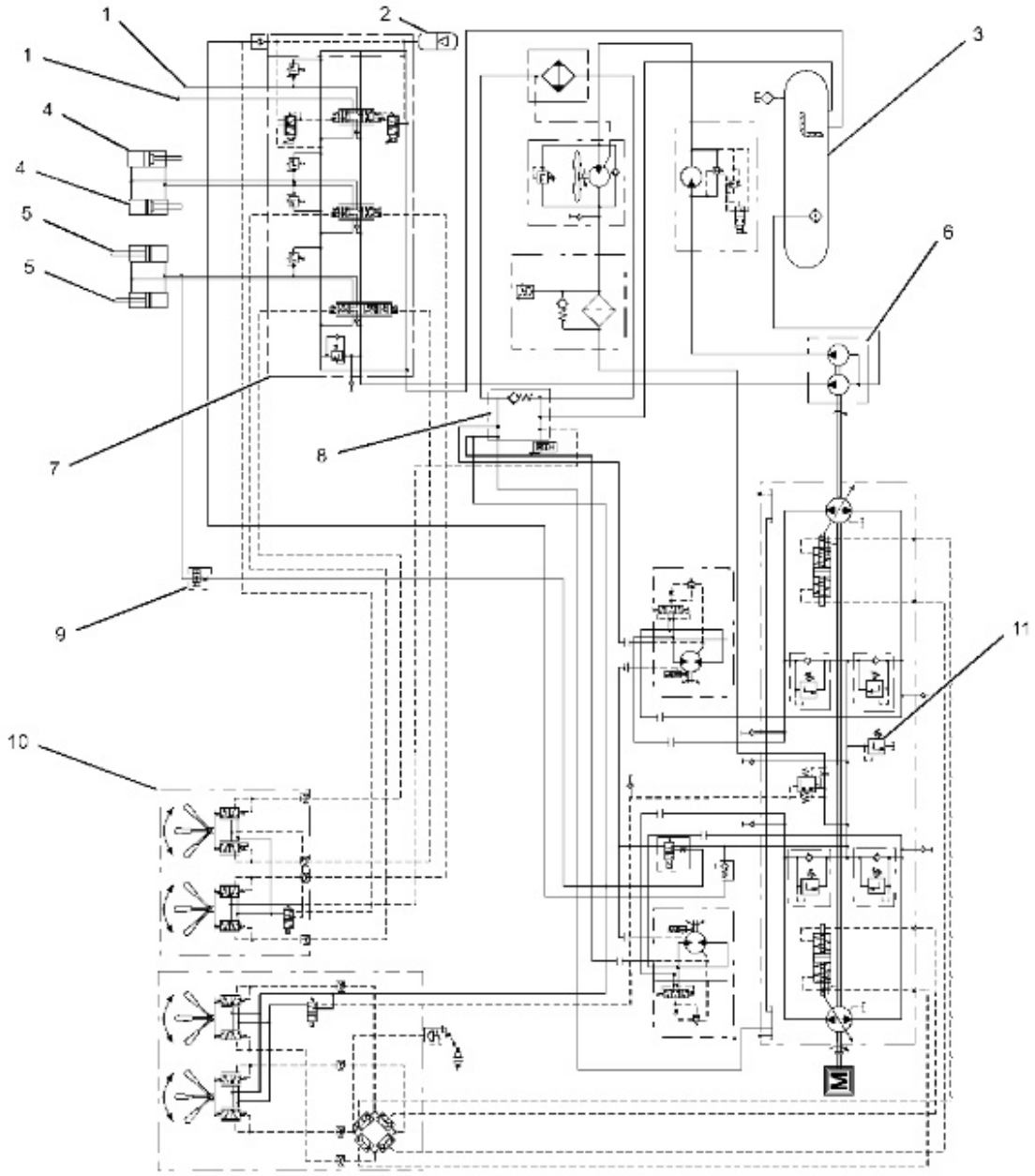


Illustration 3 g01455977

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold

(9) Ball Valve

(10) Pilot Valve (work tool)

(11) Relief Valve (charge oil)

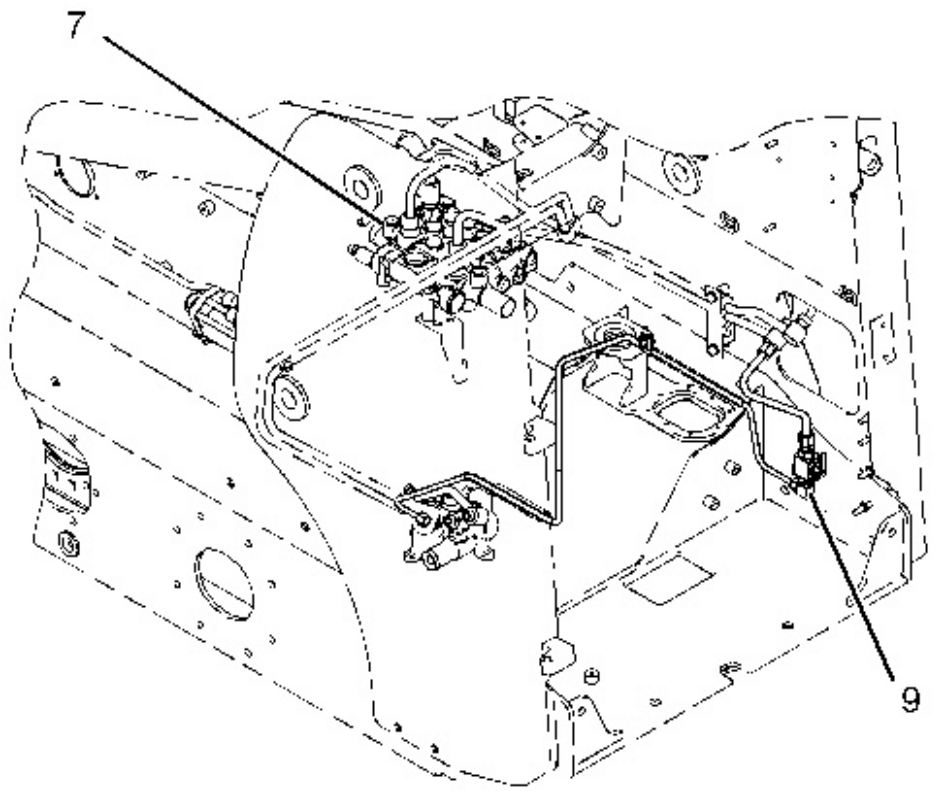


Illustration 4 g01455984

(7) Control Valve (work tool)

(9) Ball Valve

When the control lever for the work tool is moved to the RAISE position, pilot oil flows to the left side of the lift spool that is part of the control valve (7). The pilot oil causes the lift spool to shift to the right.

Hydraulic oil flows from gear pump (6) into control valve (7). The oil then flows past the lift spool and into the line for the head end of the lift cylinders (5) .

As oil forces the rods of the lift cylinders to extend, oil is forced out of the rod end of the cylinders. The oil that flows from the rod ends of the cylinders flows to the lift spool. The oil then flows to the tilt spool that is part of control valve (7) .

When the control lever for the work tool is moved to the LOWER position, pilot oil flows to the right side of the lift spool that is part of control valve (7). The pilot oil causes the lift spool to shift to the left. Hydraulic oil flows from gear pump (6) through the spool and into the line for the rod end of the lift cylinders.

As oil forces the rods to retract, the oil is forced out of the head end of the cylinders. The oil flows to the lift spool. The oil then flows to the tilt spool that is part of control valve (7) .

When the control lever for the work tool is moved to the FLOAT position, pilot oil flows to the right side of the lift spool that is part of control valve (7). The pilot oil causes the lift spool to shift fully to the left. With the spool in this position, the spool opens the rod ends of both of the lift cylinders and the head ends of both of the lift cylinders to the hydraulic tank (3). The weight of the work tool will cause the work tool to lower to the ground. The work tool will then follow the contour of the ground. Supply oil from the gear pump will continue to flow into control valve (7). The tilt spool may be operated when the lift spool is in the FLOAT position.

In the event of engine failure, the ball valve (9) is used in order to manually lower the lift arms. Ball valve (9) allows oil to drain out of the head end of the lift cylinders. The hydraulic oil flow is directed to manifold (8) .

Hydraulic System for the Lift Arms with the Diverter Valve (If Equipped)

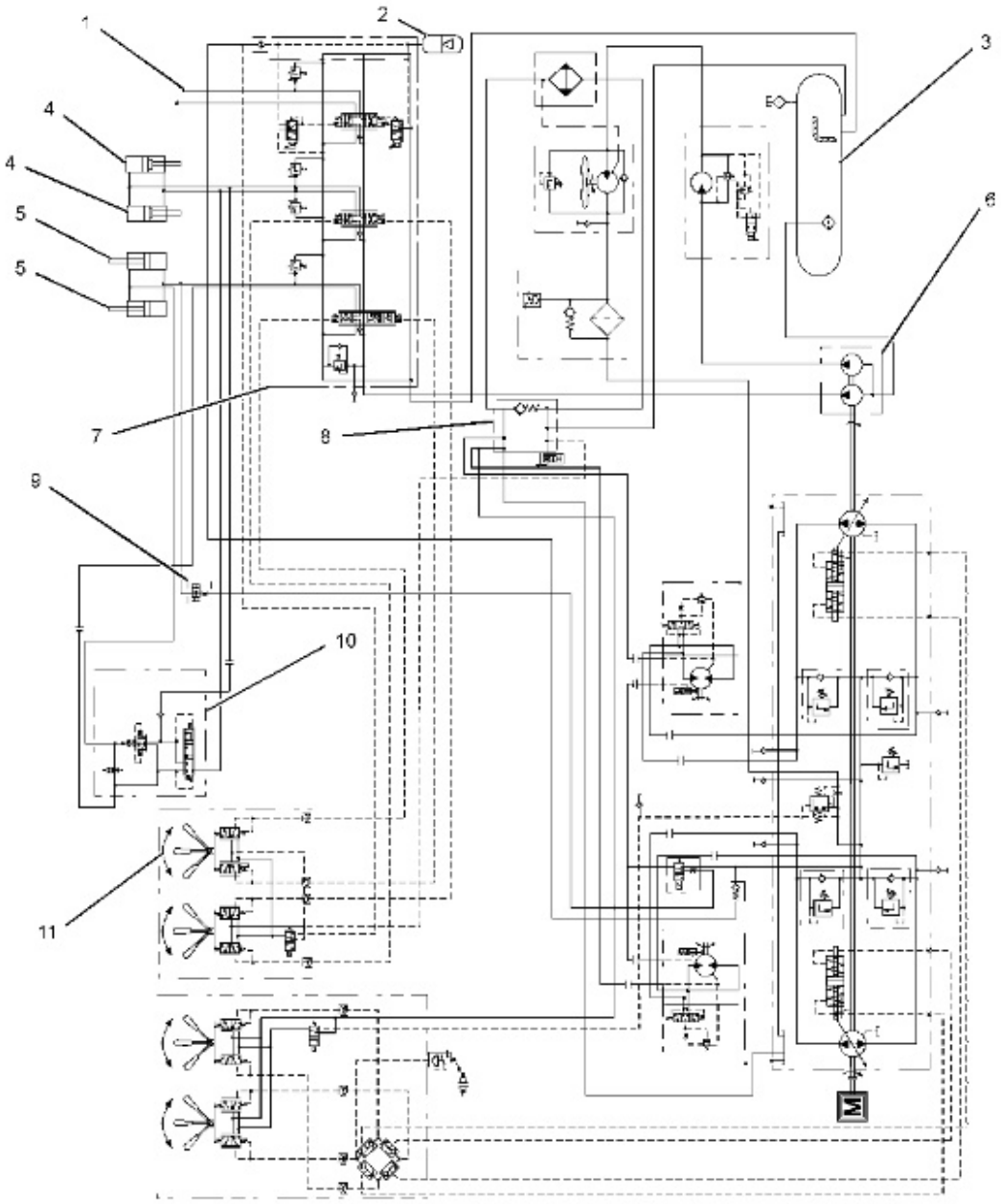


Illustration 5 g01455990

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold

(9) Ball Valve

(10) Diverter Valve

(11) Pilot Valve (work tool)

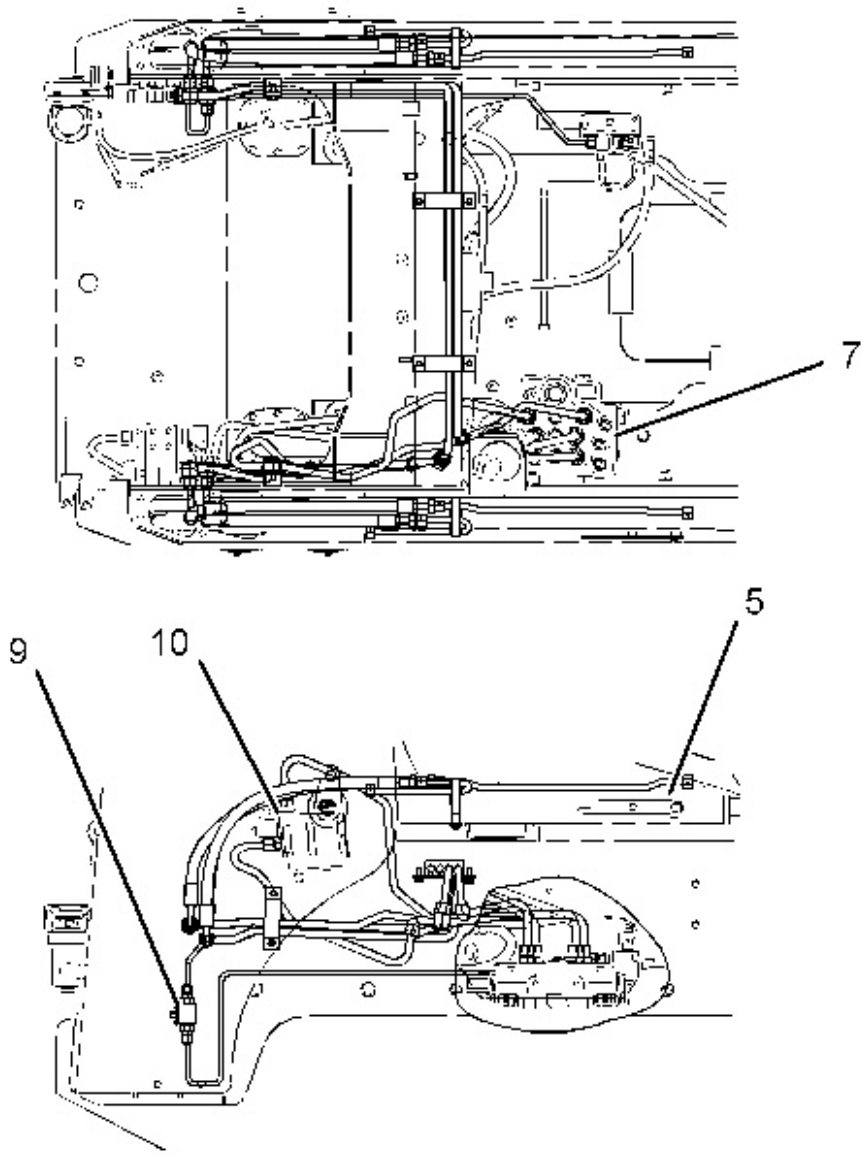


Illustration 6 g01455996

(5) Lift Cylinders

(7) Control Valve (work tool)

(9) Ball Valve

(10) Diverter Valve

When the pilot valve (11) is moved to the RAISE position, the lift spool in control valve (7) is shifted to the RAISE position by pilot oil. Hydraulic oil flows from the gear pump (6) through the lift spool and into the line for the head end of the lift cylinders (4). The oil from the rod end of the lift cylinders

flows to the diverter valve (10). The pressure from the rod end of the lift cylinders is balanced with the pressure from the head end of the tilt cylinders. This causes the work tool to remain level while the lift arms are raised. From the diverter valve, the oil flows to the lift spool. The oil then flows to the tilt spool.

The diverter valve only affects the RAISE function. The LOWER function is not affected by the diverter valve.

In the LOWER position, oil flows from the spool to the diverter valve. From the diverter valve, the oil flows to the rod end of the cylinders. The oil pushes on the piston. The cylinders retract. Oil from the head end of the cylinders flows to the lift spool. Then, the oil flows to the tilt spool.

For information on the operation of the diverter valve, refer to the Systems Operation, "Diverter Valve".

The ball valve (9) is used for manual lowering of the lift arms. The ball valve allows oil to drain out of the head end of the lift cylinders. The hydraulic oil flow is directed to the return manifold (8). The ball valve should be used to lower the lift arms when the engine fails.

Tilt and Auxiliary Hydraulic System

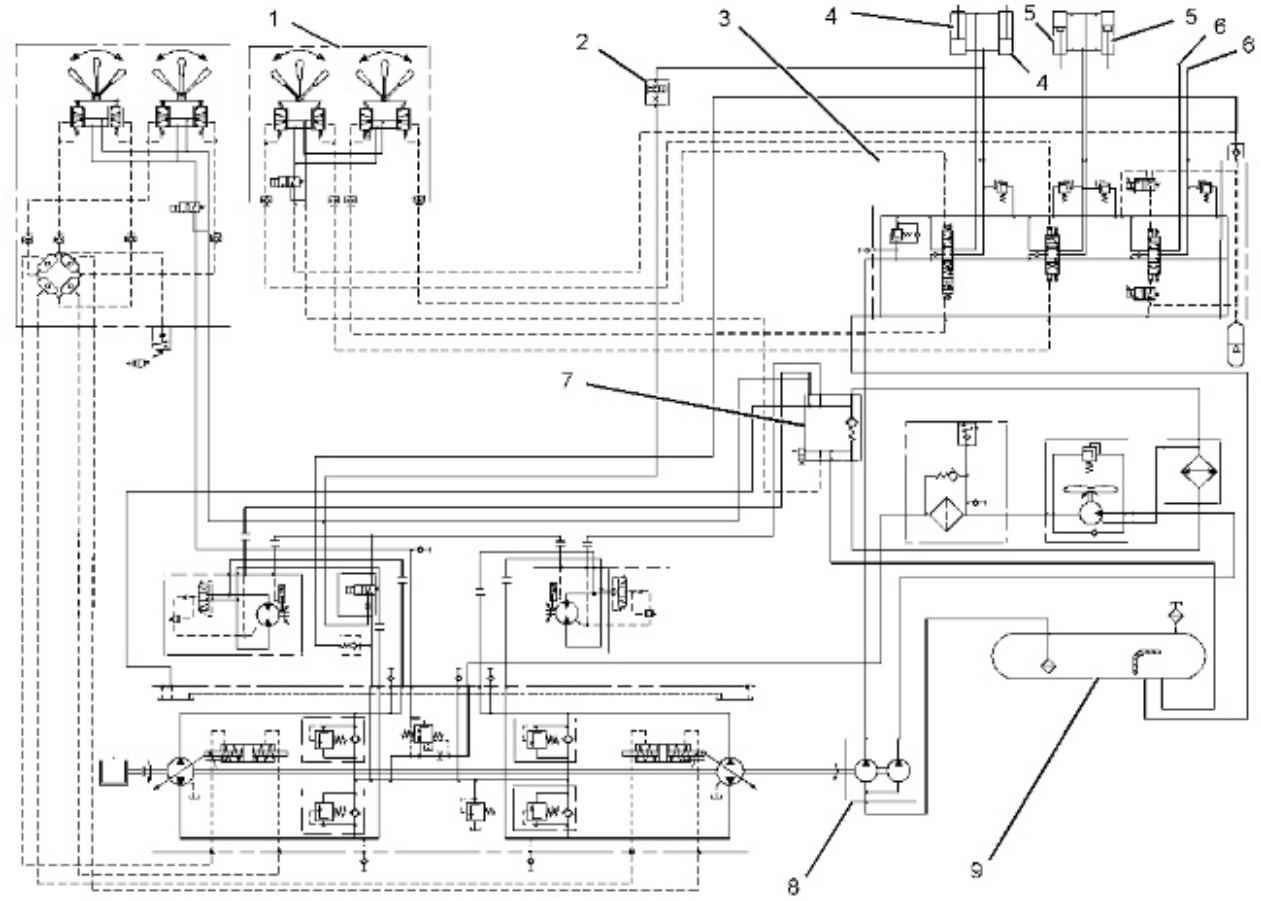


Illustration 7 g01456005

(1) Pilot valve (work tool)

(2) Ball valve (manual work tool lowering)

(3) Control valve (work tool)

(4) Lift cylinders

(5) Tilt cylinders

(6) Auxiliary couplings

(7) Return manifold

(8) Gear pump

(9) Hydraulic tank

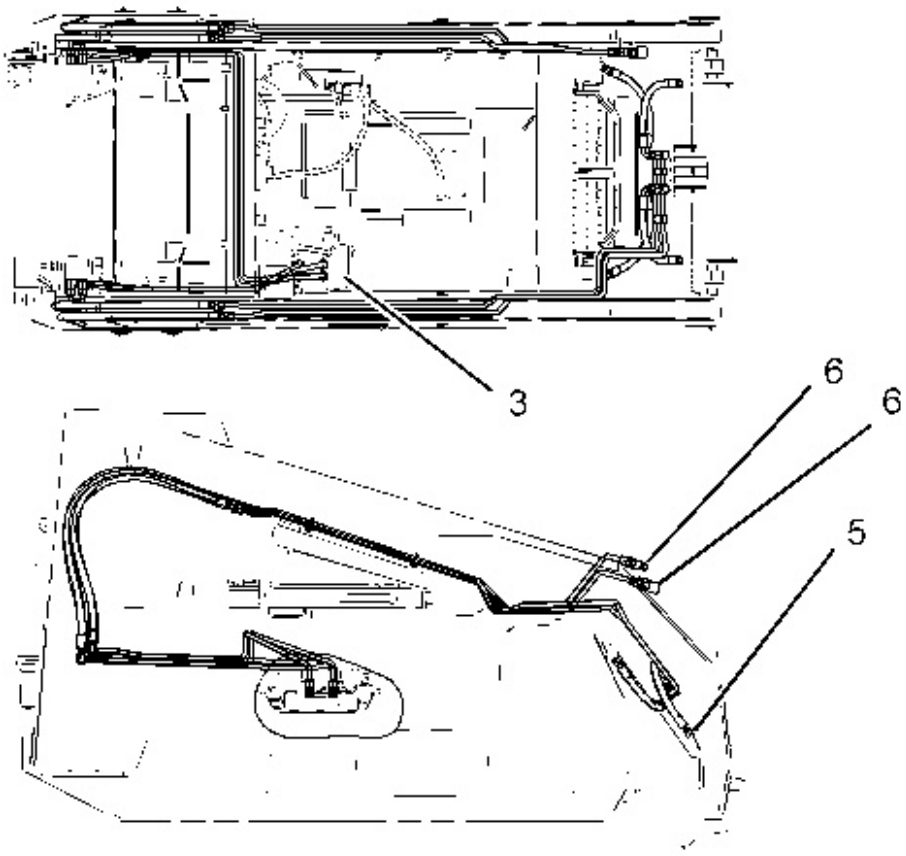


Illustration 8 g01456020

(3) Control valve (work tool)

(5) Tilt cylinders

(6) Auxiliary couplings

The hydraulic oil is directed to the tilt spool in the control valve (3) by the pilot valve (1). The end of the spool that receives the pilot oil depends on the position of the pilot valve (1) .

As the spool is shifted, hydraulic oil flows through the tilt spool and into both of the tilt cylinders.

If the machine is equipped with a diverter valve, the tilt cylinders will also be connected to the diverter valve. The diverter valve acts as a load leveler. The diverter valve is used only when the lift cylinders are being raised.

Pilot oil is directed to the auxiliary circuit spool that is located in the control valve (3) by the auxiliary circuit switch. The auxiliary circuit switch is located on the pilot valve (1) .

The pilot oil for the auxiliary circuit does not flow through the pilot valve (1). When the auxiliary circuit switch is pressed, one of the modulating valves in the control valve (3) will shift. This causes the auxiliary circuit spool to shift. Oil can then flow from the gear pump (8) to auxiliary couplings (6) .

For more information on the operation of the tilt and auxiliary hydraulic system, refer to the Systems Operation, "Control Valve (Work Tool)".

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02090259

Control Valve (Work Tool)

SMCS - 5051

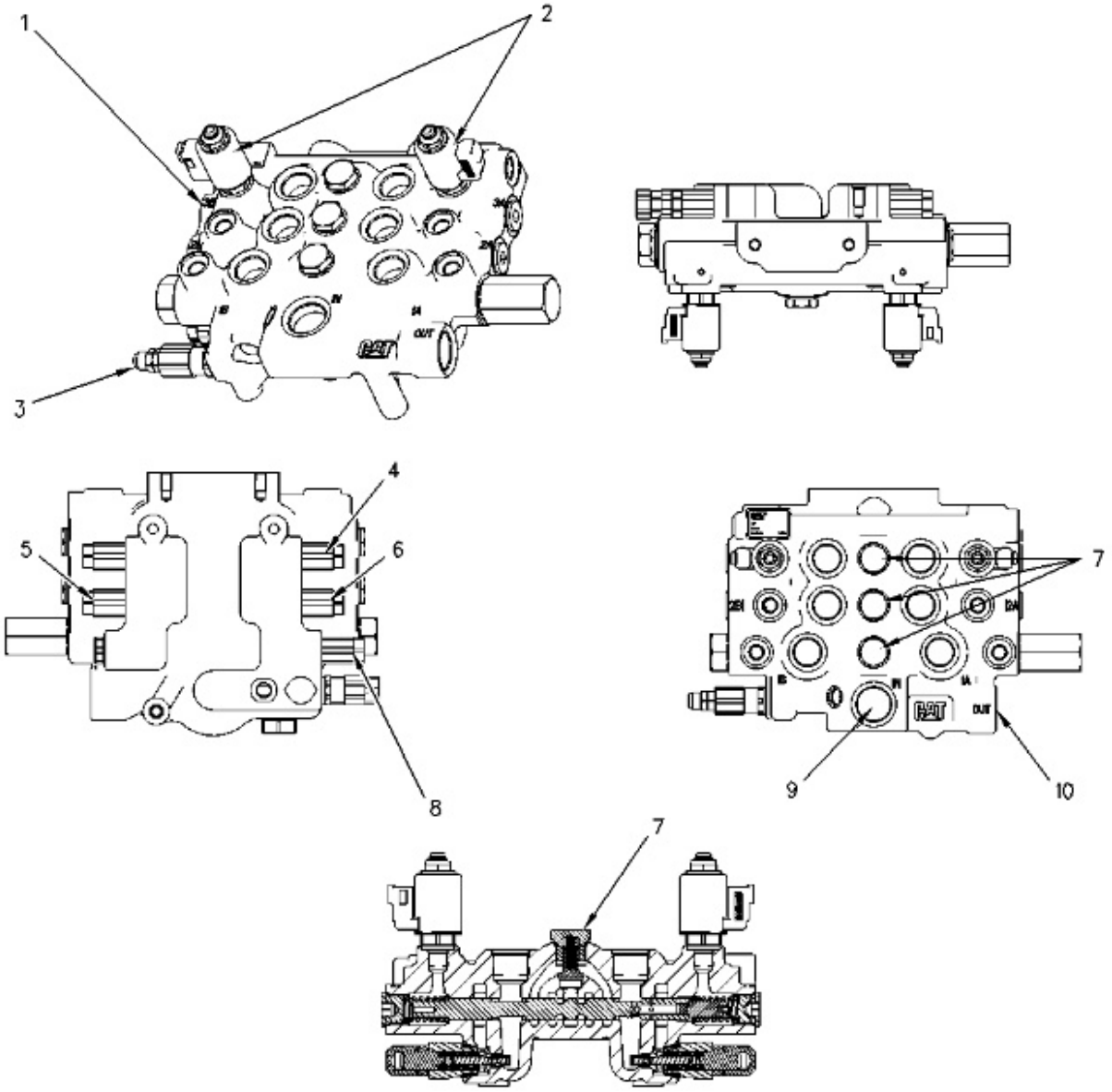


Illustration 1 g00884433

(1) Control valve (work tool)

(2) Modulating valve (auxiliary)

(3) Main relief valve

(4) Auxiliary relief valve

(5) Relief valve for the rod end of the tilt cylinder

(6) Relief valve for the head end of the tilt cylinder

(7) Check valves

(8) Lift cylinder relief valve

(9) Inlet

(10) Outlet

The control valve (work tool) (1) is open center. If the pilot operated hydraulic control (work tool) is not moved, oil flows into the inlet (9), past each of the spools and out of the outlet (10) to the tank.

Lift Control Section

HOLD Position

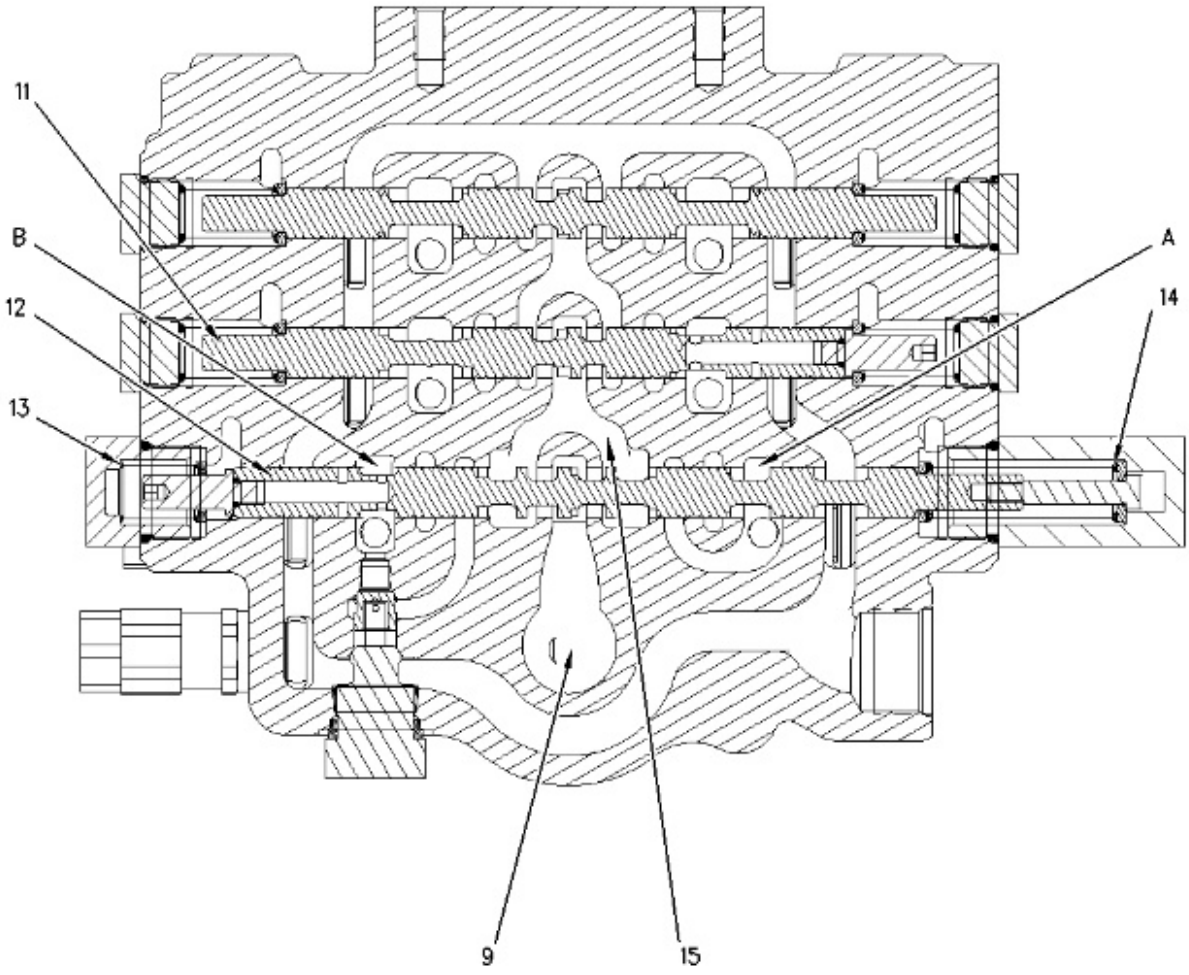


Illustration 2 g00763045

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(13) Spring

(14) Spring

(15) Central passage

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The spring (14) keeps the spool centered because the pilot oil is not flowing to the spool. No movement in the lift cylinders occurs.

RAISE Position

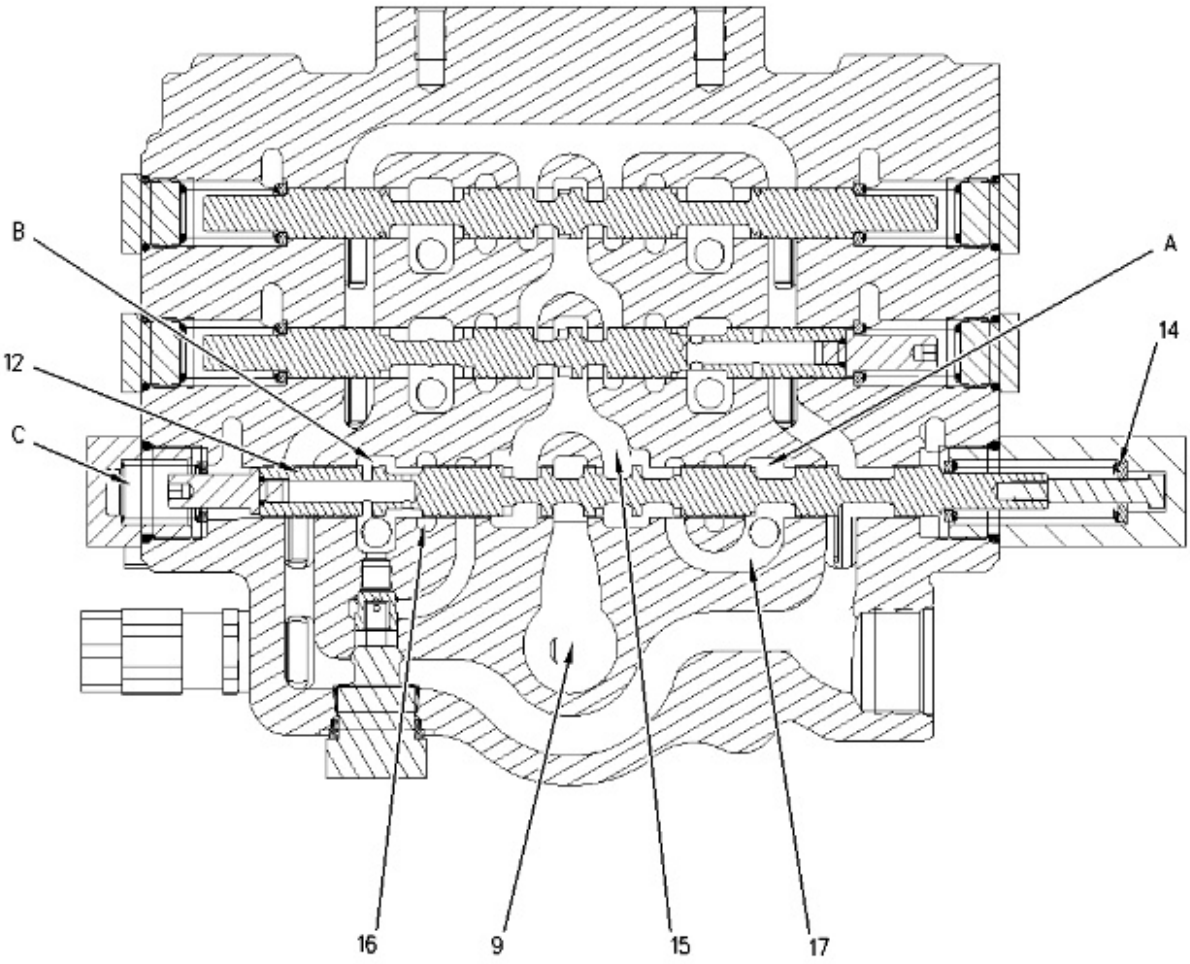


Illustration 3 g00763572

(9) Inlet

(12) Lift control spool

(14) Spring

(15) Central passage

(16) Passage

(17) Passage

(A) Port

(B) Port

(C) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the RAISE position, pilot oil (C) flows from the hydraulic control to the lift control spool. The pilot oil forces the spool (12) to move to the right against the force of the spring (14) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (16) and around the spool to port (B). From port (B), oil flows to the head ends of the lift cylinders in order to raise the lift arms.

Oil that is returning from the rod ends of lift cylinders flows into port (A) and through the passage (17) into the central passage (15) .

When the pilot operated hydraulic control (work tool) is released from the RAISE position pilot oil (C) stops flowing and the spring (14) shifts the spool back to the HOLD position.

LOWER Position

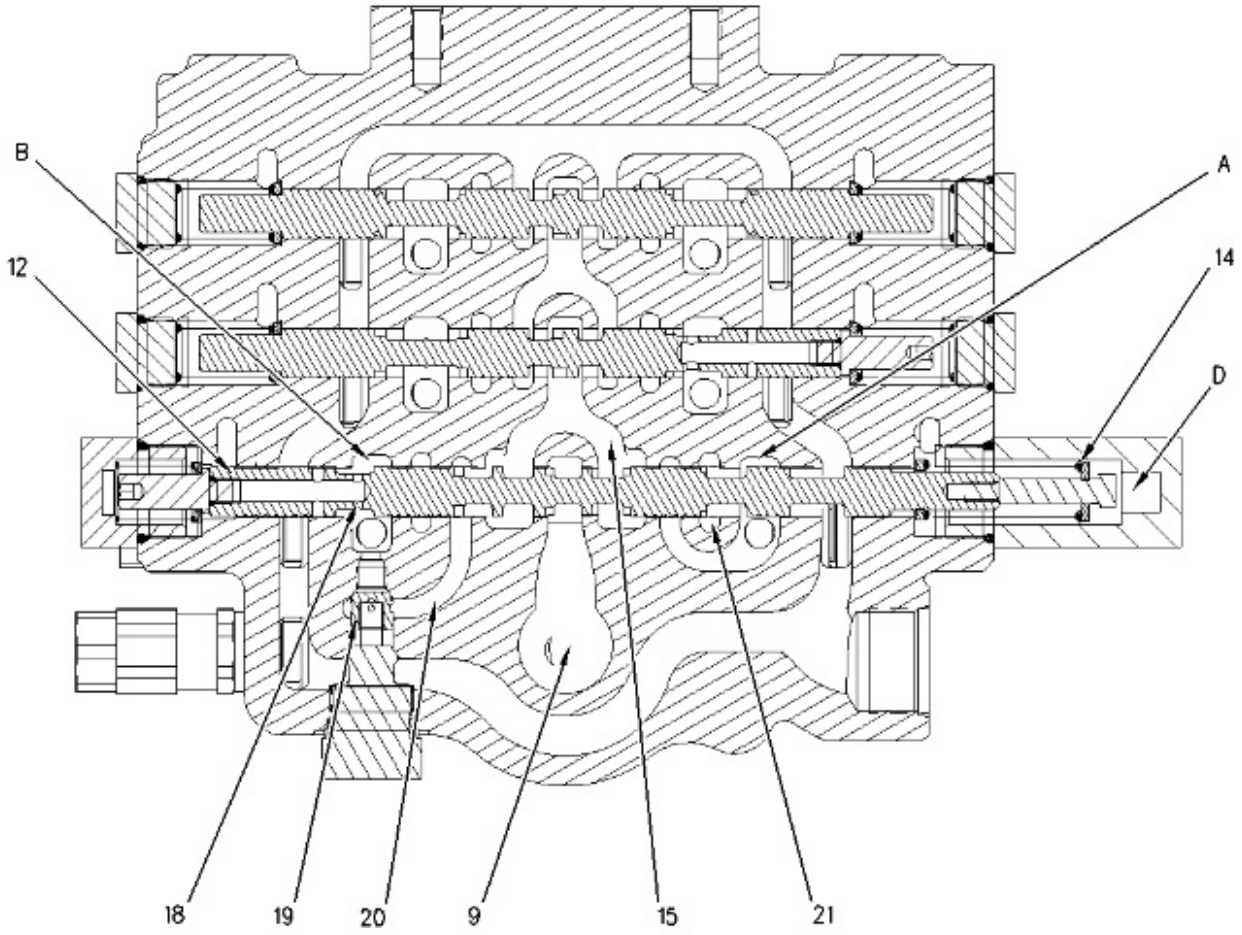


Illustration 4 g00763574

(9) Inlet

(12) Lift control spool

(14) Spring

(15) Central passage

(18) Orifice

(19) Poppet valve

(20) Passage

(21) Passage

(A) Port

(B) Port

(D) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the LOWER position, pilot oil (D) flows from the hydraulic control to the lift control spool (12). The pilot oil forces the spool to move to the left against the force of the spring (14) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (21) and around the spool to port (A). From port (A), oil flows to the rod ends of the lift cylinders in order to lower the lift arms.

Oil that is returning from the head ends of lift cylinders flows into port (B). The oil then flows through the orifice (18). Then, the oil builds pressure in order to open the poppet valve (19). The oil flows through the passage (20) into the central passage (15) .

When the pilot operated hydraulic control (work tool) is released from the LOWER position pilot oil (D) stops flowing and the spring (14) shifts the spool back to the HOLD position.

FLOAT Position

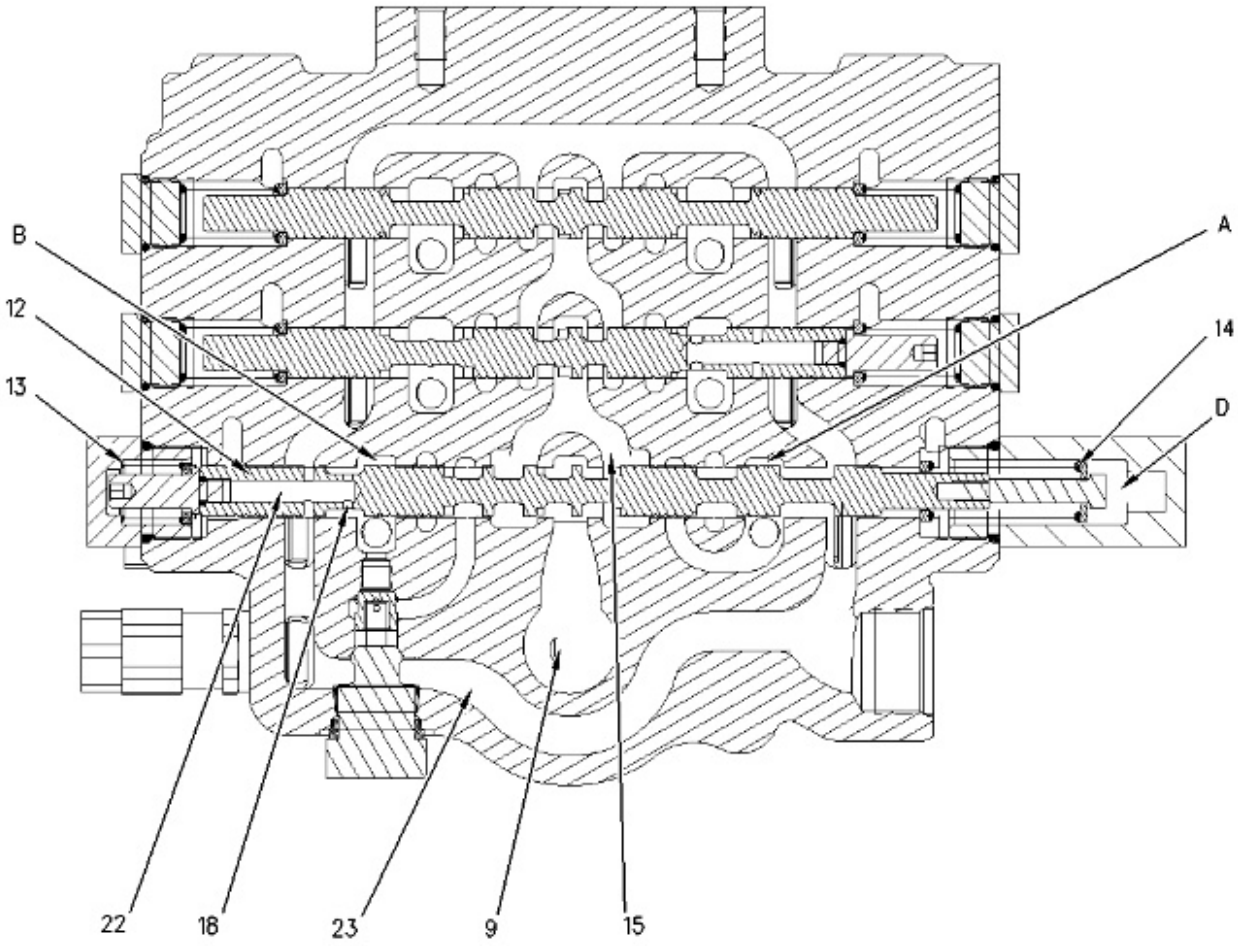


Illustration 5 g00763581

(9) Inlet

(12) Lift control spool

(13) Spring

(14) Spring

(15) Central passage

(18) Orifice

(22) Internal passage

(23) Return passage

(A) Port

(B) Port

(D) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the FLOAT position, pilot oil (D) flows from the hydraulic control to the lift control spool (12). The pilot oil forces the spool to move to the left against the force of the springs (13) and (14) .

Oil continues to flow from the inlet (9) through the central passage (15). Oil that is in the rod ends of the lift cylinders can flow to the tank through port (A). Oil that is in the head ends of the lift cylinders can flow through port (B) and through the orifice (18). The oil can then flow through the internal passage (22) to the tank passage (23). The work tool will lower to the ground and the work tool will follow along the contour of the ground.

The pilot operated hydraulic control (work tool) will remain in the FLOAT position until the operator moves the hydraulic control. The hydraulic control will then return to the HOLD position.

Tilt Control Section

HOLD Position

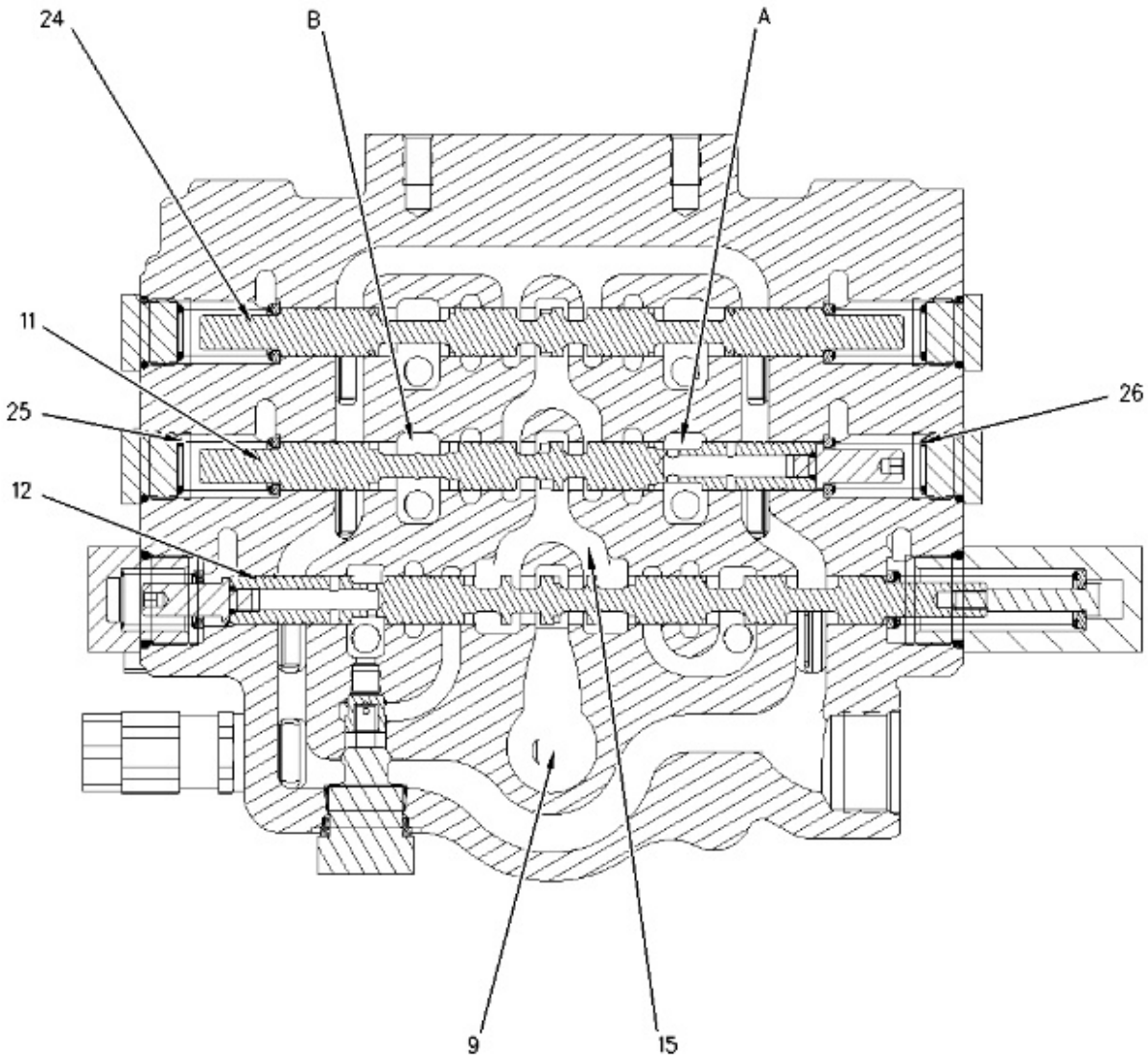


Illustration 6 g00770078

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(15) Central passage

(24) Auxiliary circuit spool

(25) Spring

(26) Spring

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15). From the tilt control spool, the oil flows to the auxiliary circuit spool (24) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The springs (25) and (26) keep the spool centered because the pilot oil is not flowing to the spool. No movement in the tilt cylinders occurs.

TILT FORWARD Position

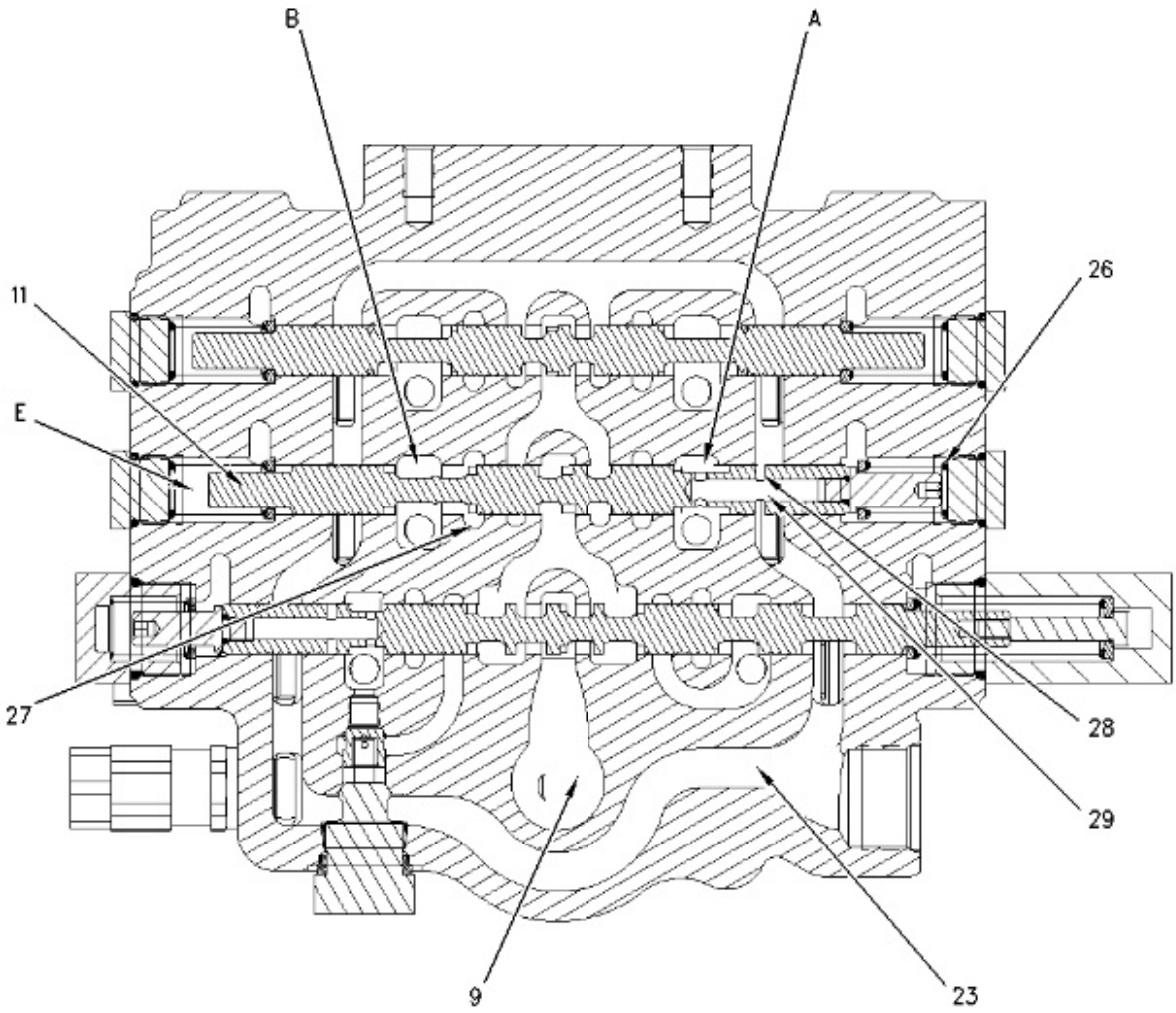


Illustration 7 g00763583

(9) Inlet

(11) Tilt control spool

(23) Tank passage

(26) Spring

(27) Passage

(28) Orifice

(29) Internal passage

(A) Port

(B) Port

(E) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the TILT FORWARD position, pilot oil (E) flows from the hydraulic control to the tilt control spool (11). The pilot oil forces the spool to move to the right against the force of the spring (26) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the tilt circuit and flows through the passage (27) and around the spool to port (B). From port (B), oil flows to the head ends of the tilt cylinders in order to tilt the work tool forward.

Oil that is returning from the rod ends of tilt cylinders flows into port (A) and through the orifice (28). Then, the oil flows through the internal passage (29) into the tank passage (23) .

When the hydraulic control is released from the TILT FORWARD position, pilot oil (E) stops flowing and the spring (26) shifts the spool back to the HOLD position.

TILT BACK Position

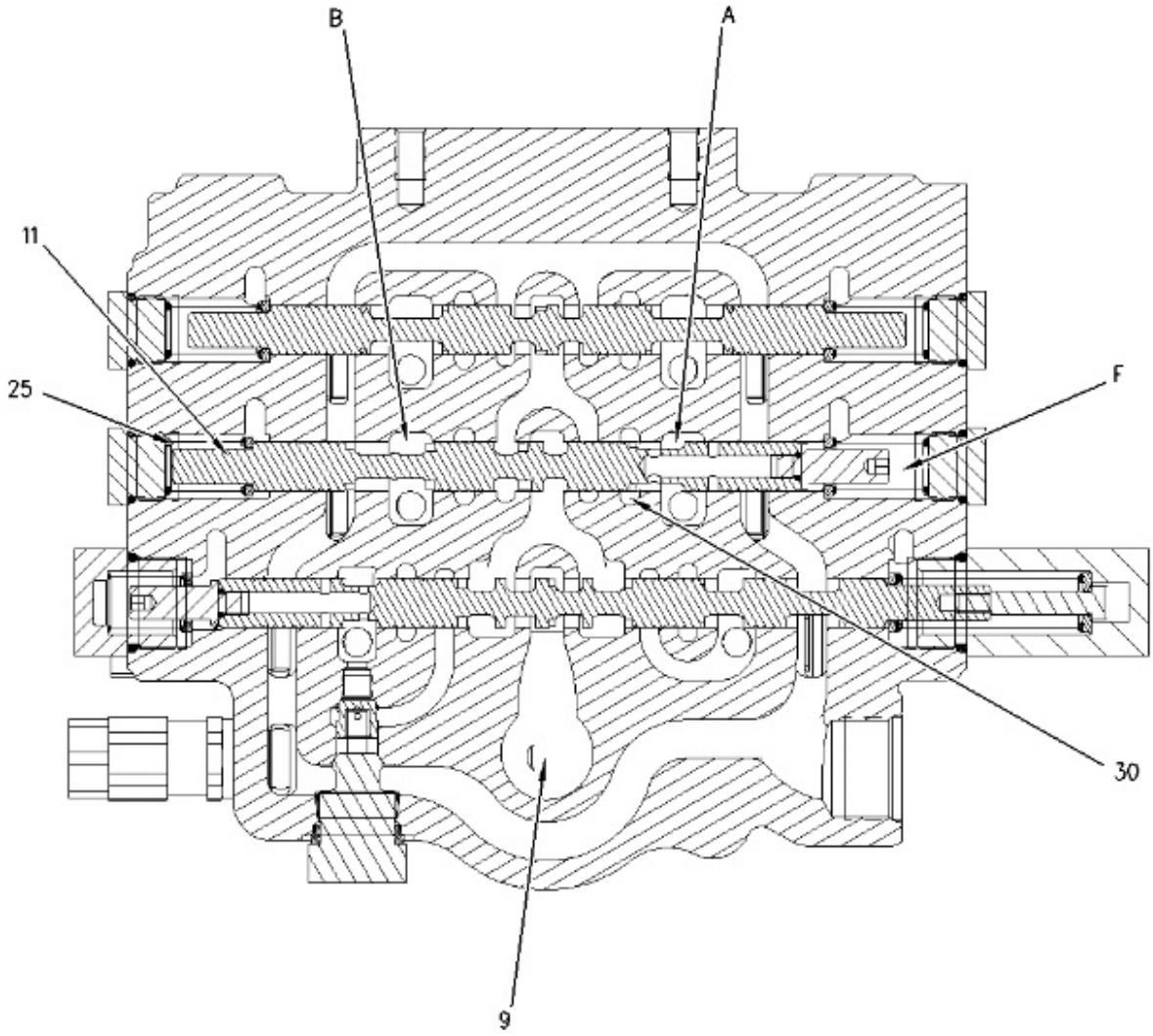


Illustration 8 g00763586

(9) Inlet

(11) Tilt control spool

(25) Spring

(30) Passage

(A) Port

(B) Port

(F) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the TILT BACK position pilot oil (F) flows from the hydraulic control to the tilt control spool (11). The pilot oil forces the spool to move to the left against the force of the spring (25) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (30) and around the spool to port (A). From port (A), oil flows to the rod ends of the tilt cylinders. This causes the work tool to tilt back.

Oil that is returning from the head ends of tilt cylinders flows into port (B) and around the spool to the tank passage (23) .

When the hydraulic control is released from the TILT BACK position pilot oil (F) stops flowing and the spring (25) shifts the spool back to the HOLD position.

Auxiliary Control Section

HOLD Position

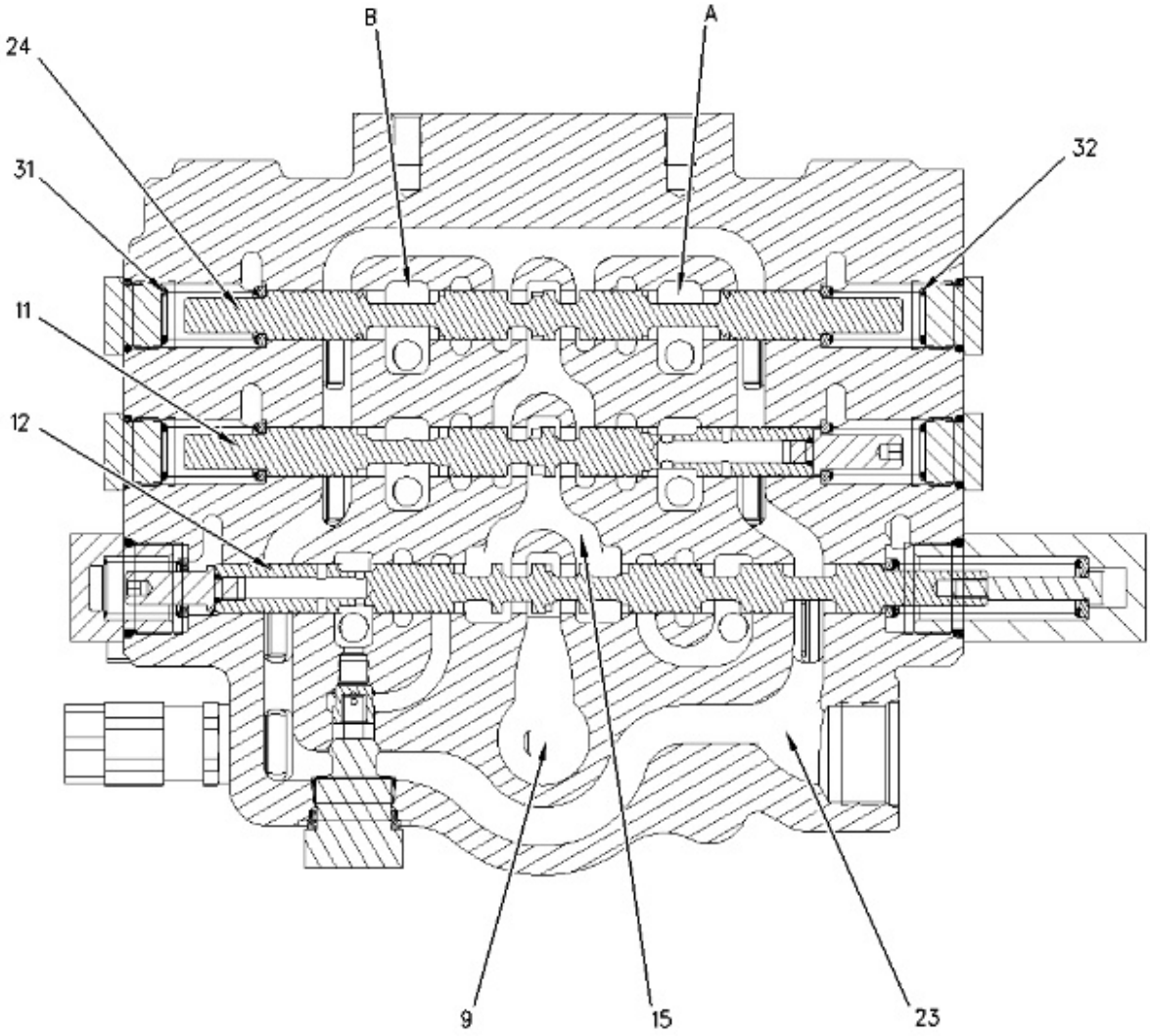


Illustration 9 g00770080

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(15) Central passage

(23) Tank passage

(24) Auxiliary circuit spool

(31) Spring

(32) Spring

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position and the auxiliary circuit switch is not activated, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15). From the tilt control spool, the oil flows to the auxiliary circuit spool (24). Then, the oil flows to the tank passage (23) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The springs (31) and (32) keep the spool centered because the pilot oil is not flowing to the spool. No oil flows in the auxiliary circuit.

POSITION ONE

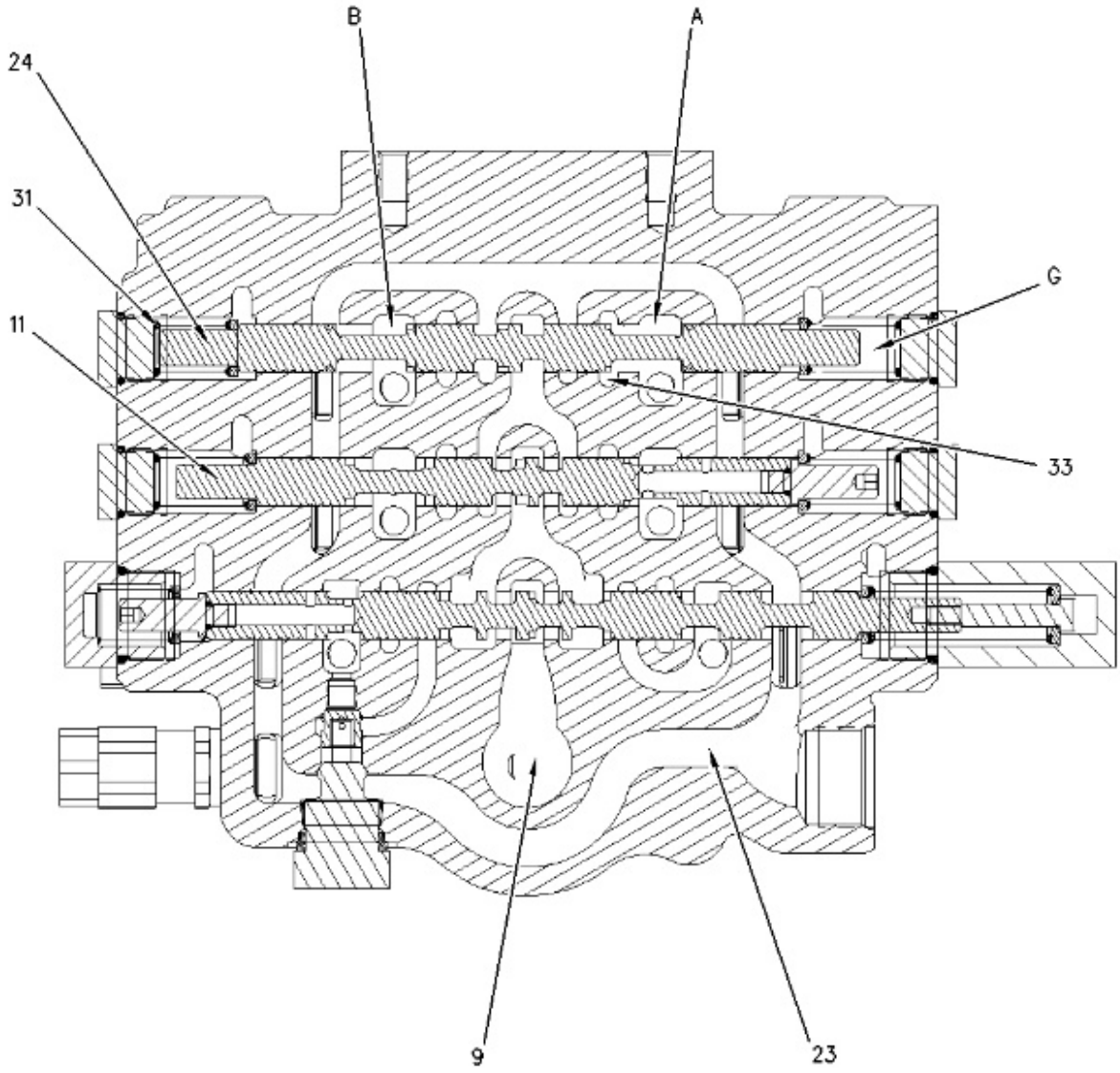


Illustration 10 g00763588

(9) Inlet

(11) Tilt control spool

(23) Tank passage

(24) Auxiliary circuit spool

(31) Spring

(33) Passage

(A) Port

(B) Port

(G) Pilot oil from the modulating valve (auxiliary)

When the left side of the auxiliary switch is pressed, pilot oil (G) flows from the modulating valve (auxiliary) to the auxiliary spool (24). The pilot oil forces the spool to move to the left against the force of the spring (31) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the auxiliary circuit and flows through the passage (33) and around the spool to port (A). From port (A), oil flows to the lower auxiliary connection.

Oil that is returning from the upper auxiliary connection flows into port (B) and around the spool to the tank passage (23) .

When the switch is released, pilot oil (G) stops flowing and the spring (31) shifts the spool back to the HOLD position.

POSITION TWO

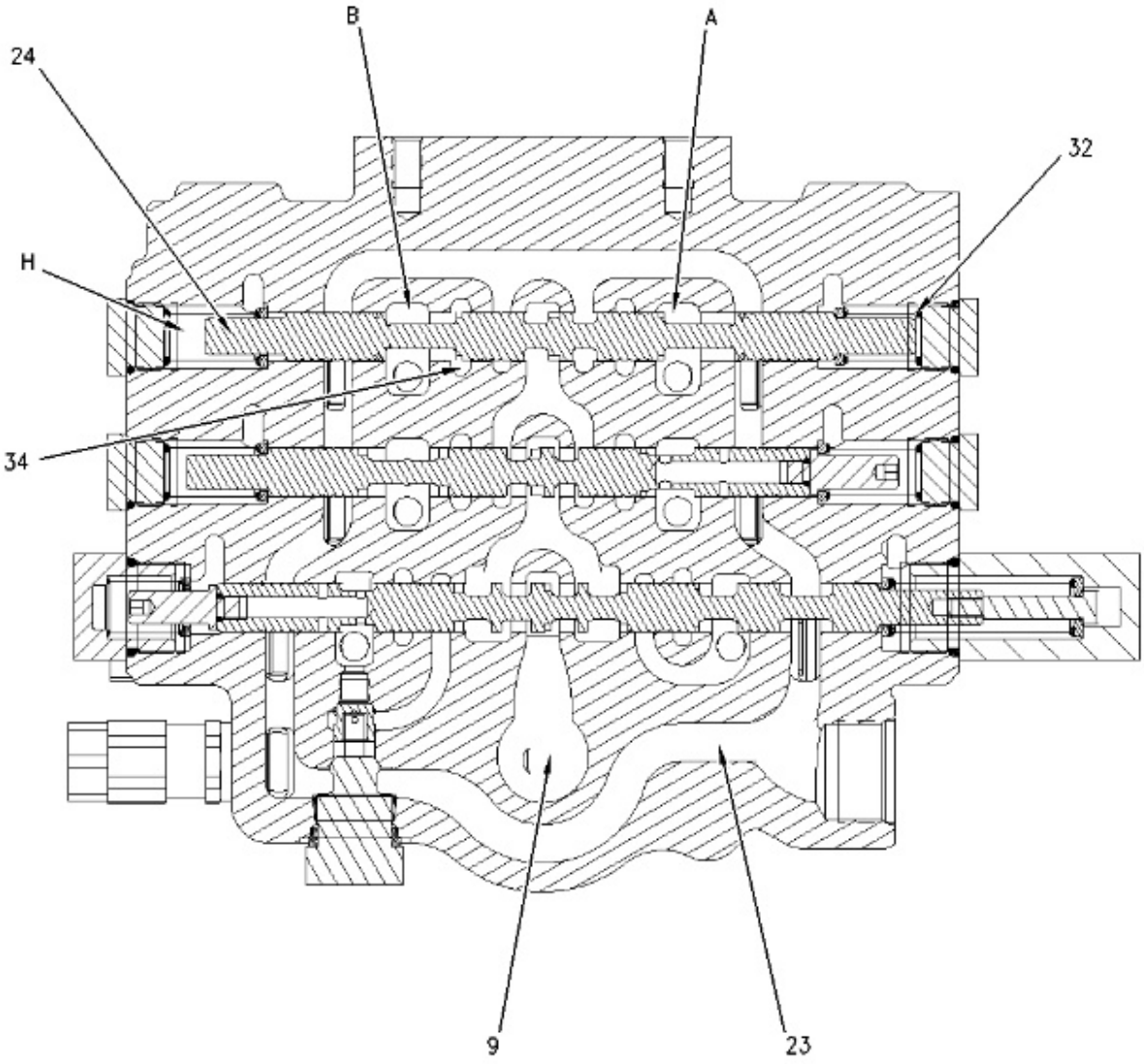


Illustration 11 g00763594

(9) Inlet

(23) Tank passage

(24) Auxiliary circuit spool

(32) Spring

(34) Passage

(A) Port

(B) Port

(H) Pilot oil from the modulating valve (auxiliary)

When the right side of the auxiliary switch is pressed, pilot oil (H) flows from the modulating valve (auxiliary) to the auxiliary spool (24). The pilot oil forces the spool to move to the right against the force of the spring (32) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the auxiliary circuit and flows through the passage (34) and around the spool to port (B). From port (B), oil flows to the upper auxiliary circuit connection.

Oil that is returning from the lower auxiliary connection flows into port (A) and around the spool to the tank passage (23) .

When the switch is released, pilot oil (H) stops flowing and the spring (32) shifts the spool back to the HOLD position.

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Control Manifold and Solenoid (Work Tool Positioner)

SMCS - 5264; 5479

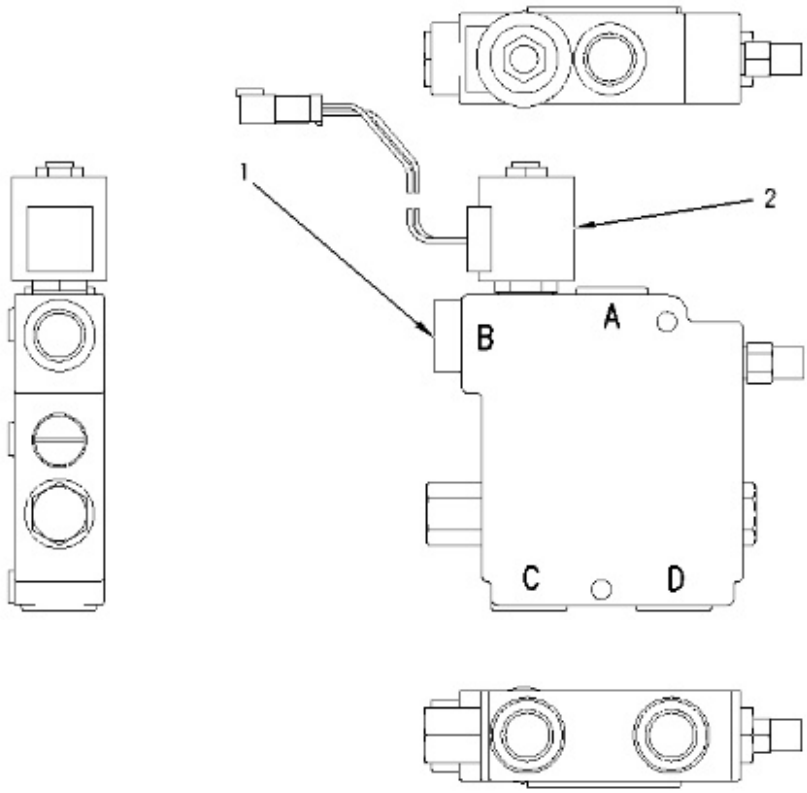


Illustration 1 g00550914

(1) Control Manifold. (2) Solenoid valve.

The control manifold (1) maintains the selected angle of the work tool as the lift arms are raised. The control manifold only functions during the RAISE function. During the LOWER function, the control manifold does not affect the operation of the machine.

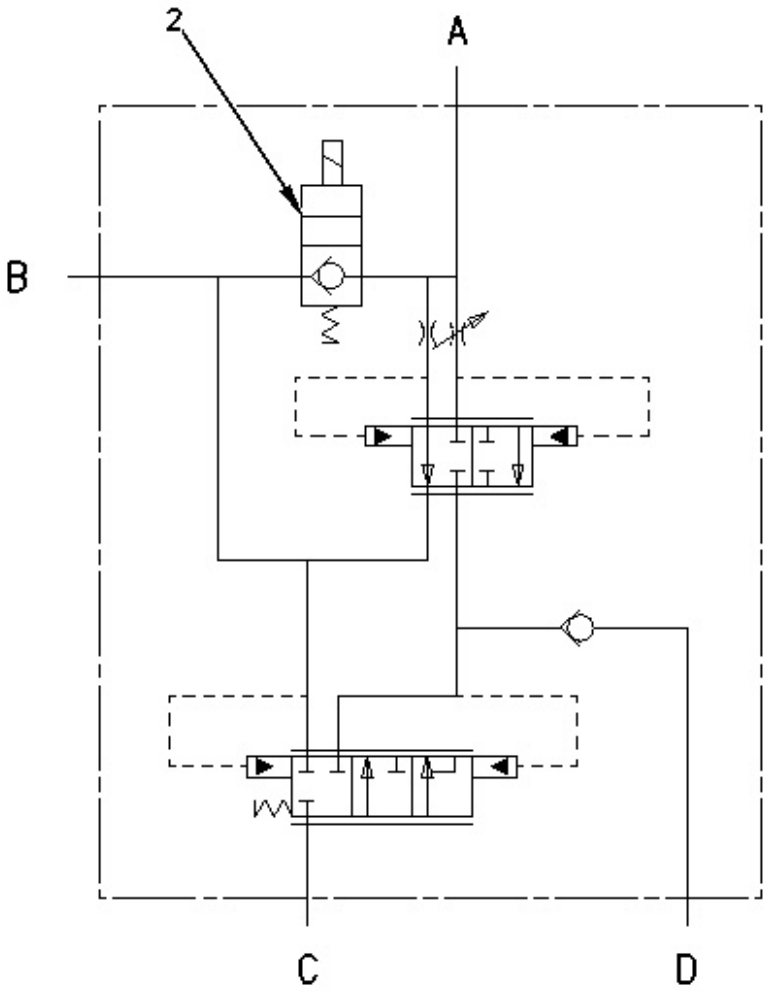


Illustration 2 g00551233

(2) Solenoid valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

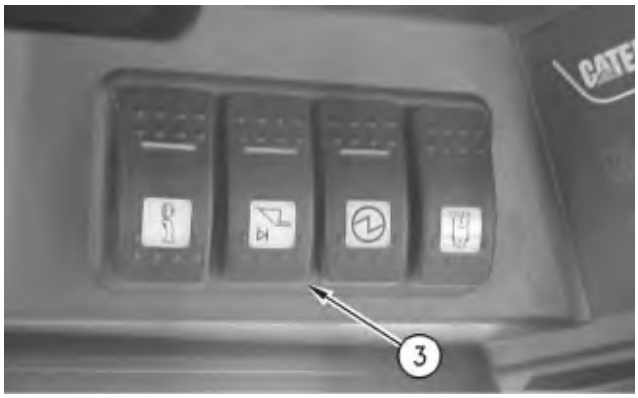


Illustration 3 g00666165

(3) The automatic leveling switch

The solenoid valve (2) enables the control manifold. The solenoid valve is controlled by the switch (3). The switch (3) is located in the second position from the left side of the instrument panel. The instrument panel is located to the left and above the ignition switch.

When you start the engine, solenoid (2) is energized. The control manifold is not activated. Oil flows through port (A) to solenoid (2). The oil flows through the top section of solenoid (2) and through port (B). Then, the oil flows to the lift spool.

Press the bottom of the switch in order to activate the self-leveling function of the control manifold. When you press the bottom of the switch, solenoid (2) is de-energized. Oil flows through port (A) to the divider spool and to the unloading spool. Press the bottom of the switch again in order to deactivate the self-leveling function of control manifold. Solenoid (2) is energized.

Self-Leveling Operation (Raising the Work Tool)

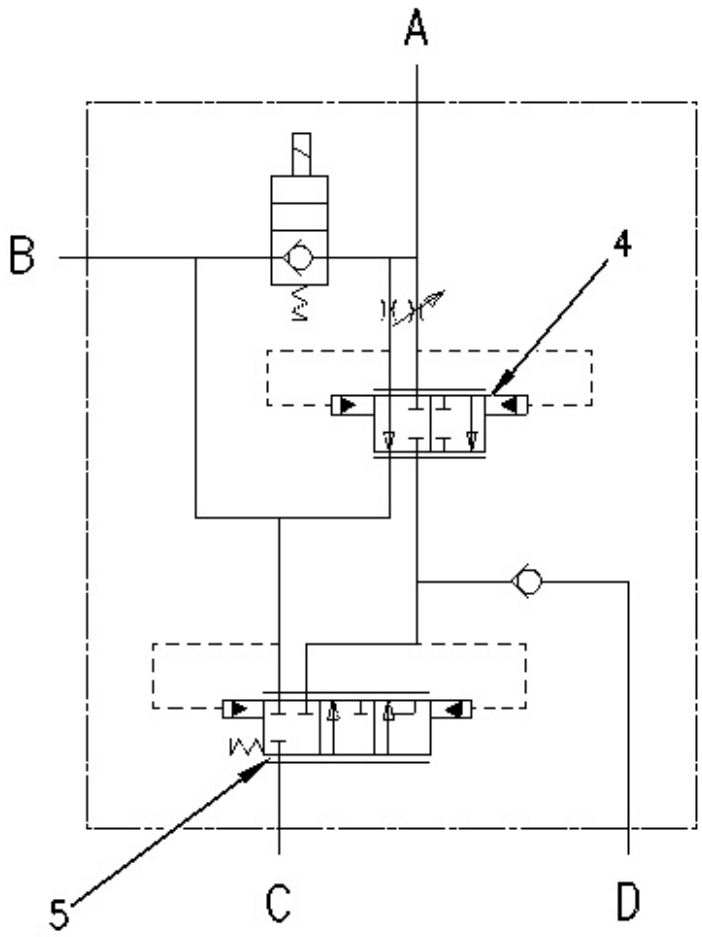


Illustration 4 g00551505

(4) Flow divider valve. (5) Unloading spool.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

The control manifold is activated. Solenoid (2) is de-energized. When the tilt control valve is in the HOLD position and the lift control valve is in the RAISE position, oil from the lift control valve enters the head end of the lift cylinders. As the lift cylinders extend, oil from the rod end of the lift cylinder enters port (A) .

The oil enters the flow divider valve (4). The hydraulic oil divides into two loops. One loop flows through the fixed orifice. The second loop flows through the adjustable orifice. The flow divider valve (4) balances the pressure between the head end of the tilt cylinder and the rod end of the lift

cylinder. When the pressure between the head end of the tilt cylinder and rod end of the lift cylinder are kept in balance, the load will stay level.

The oil that flows through the fixed orifice flows out of port (B) and back to the tank. The variable orifice adjusts to the flow of oil from the rod end of the lift cylinders. The oil flows through the divider spool. Then, the oil flows to the unloading spool. The ports for the unloading spool are blocked. The oil will flow through the check valve and out port (D). From port (D), oil flows to the head end of the tilt cylinders and to the tilt control valve.

The internal ports are blocked in the tilt control valve. Because the internal ports are blocked in the tilt control valve, the oil flows to the head end of the tilt cylinder. As the tilt cylinders extend, the oil from the rod end of the tilt cylinders flows into port (C) .

The resistance to movement in the tilt cylinders causes pressure in the oil line from port (D). The check valve blocks oil. The resistance to movement in the tilt cylinders causes pressure. The pressure is great enough to open the unloading spool (5). The oil flows through the unloading spool and out port (B) back to the tank.

Hydraulic oil flows through the unloading spool (5). The oil flow reduces the pressure through port (C). The centering spring for the unloading spool shifts the unloading spool.

When the fixed orifice loop pressure increases, the pilot oil shifts the flow divider (4). The oil will flow through the flow divider and out port (B) .

Lowering the Work Tool

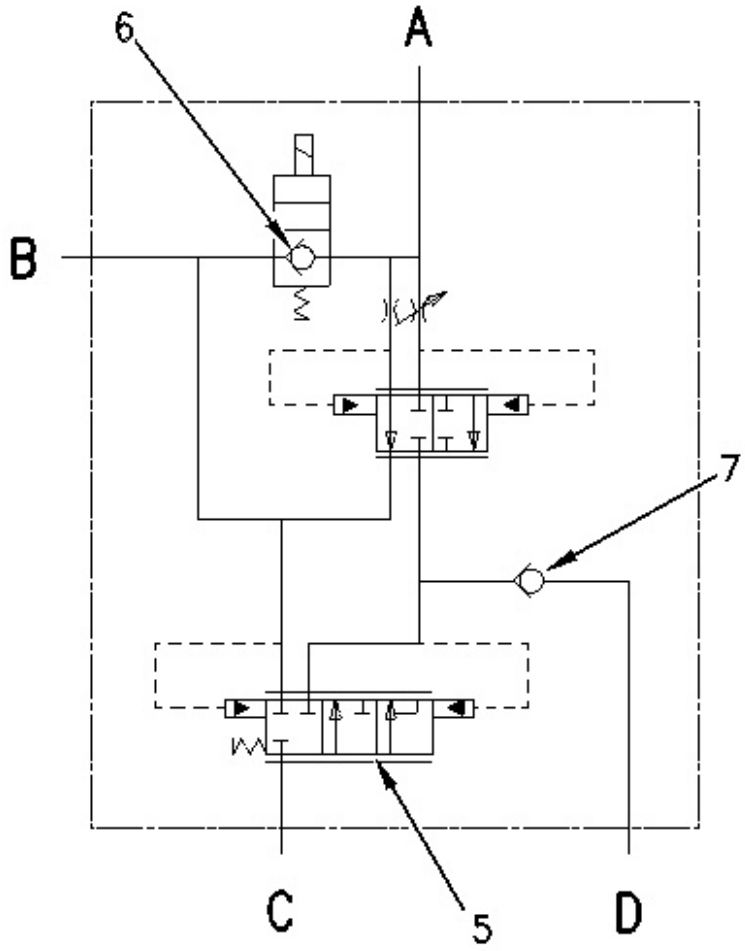


Illustration 5 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the tilt control valve is in the HOLD position and the lift control valve is in the LOWER position oil enters the control manifold through port (B). The oil opens check valve (6). The oil flows through port (A) to the rod end of the lift cylinders.

Oil flows from the head end of the lift cylinders and branches. Part of the oil flows to the ball valve. The oil flow is blocked. The oil flows to the lift control valve. Then, the oil flows through the valve to the tank.

Tilting the Work Tool Forward

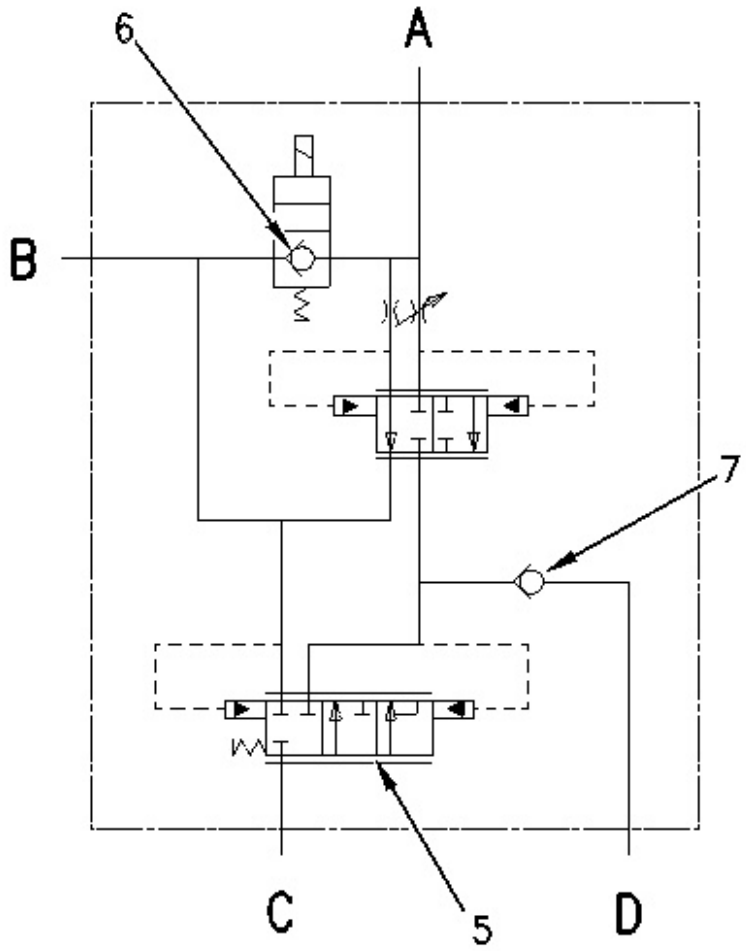


Illustration 6 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the lift control valve is in the HOLD position and the tilt control valve is in the TILT FORWARD position, oil flows from the pump toward the head end of the tilt cylinders and branches. The oil flows into the control manifold through port (D), but the flow is blocked by the check valve (7). Then, the oil flows to the head end of the tilt cylinders.

Hydraulic oil from the rod end of the cylinders flows toward the tilt control valve and branches. Oil enters the control manifold through port (C), but the flow is blocked by the unloading spool (5). The

control manifold is used during lifting operations only. Then, the oil flows to the tilt control valve and to the tank.

Tilting the Work Tool Backward

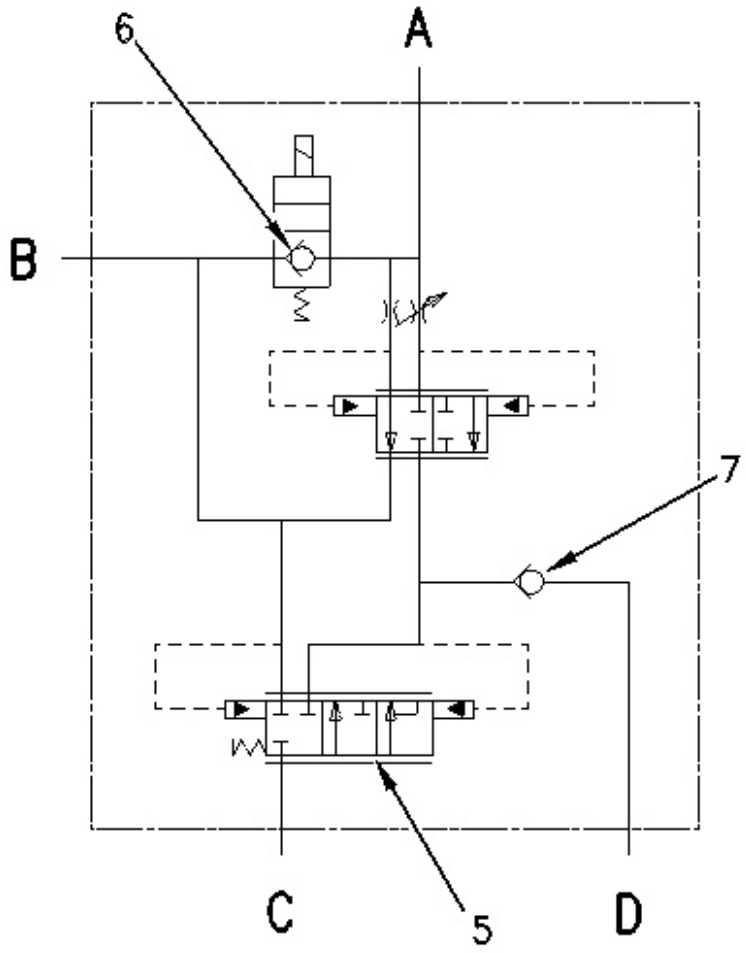


Illustration 7 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the lift control valve is in the HOLD position and the tilt control valve is in the TILT BACK position oil flows into the rod end of the tilt cylinder from the tilt control valve. Oil also flows into the control manifold through port (C), but the flow is blocked by the unloading spool (5). Oil flows from the head end of the tilt cylinder to the tilt control valve and back to the tank. Oil from the head end of the tilt cylinder also flows to the control manifold through port (D), but the flow is blocked by the check valve (7) .

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02957909

General Information

SMCS - 5050

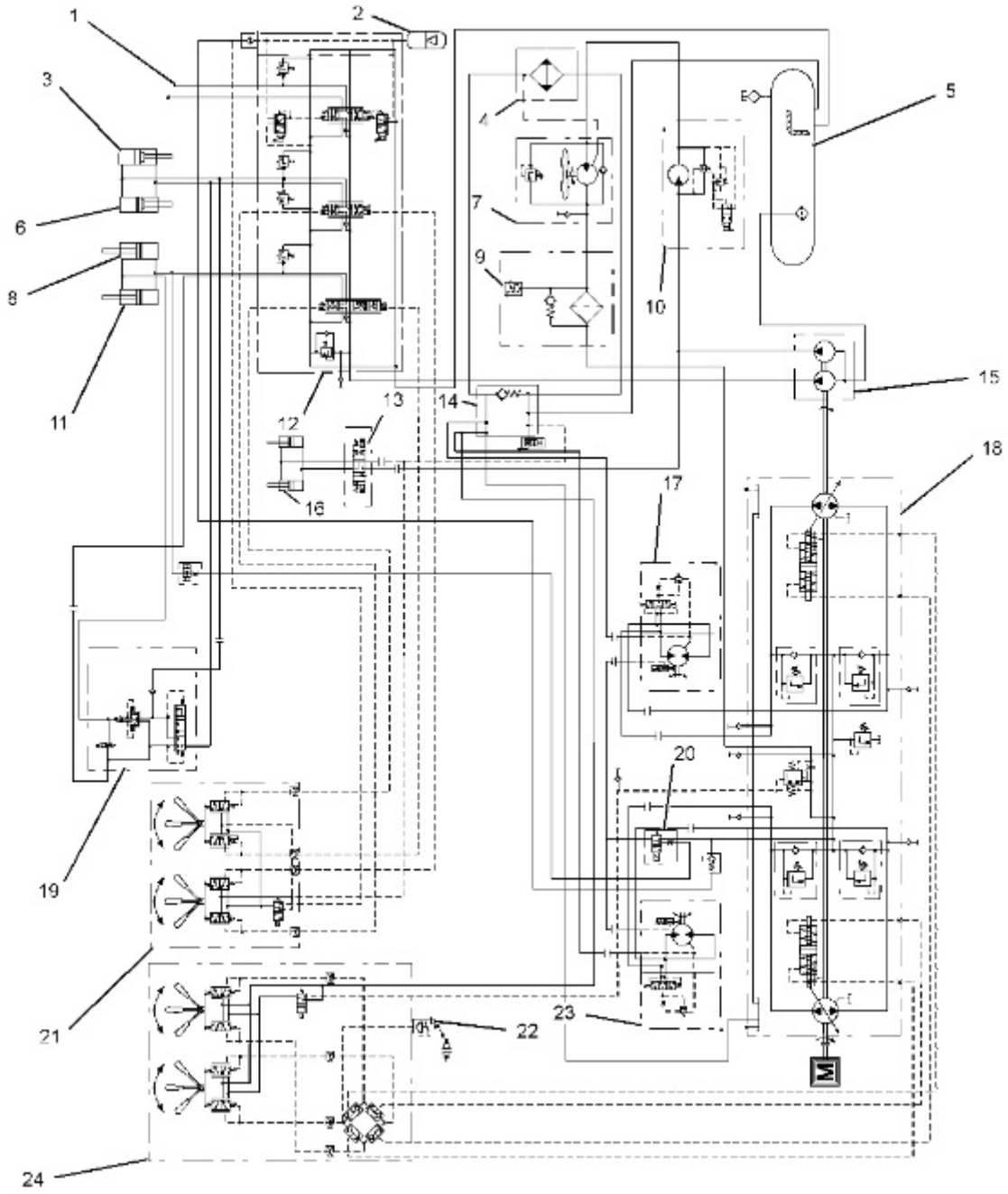


Illustration 1 g01455066

Hydraulic Schematic Single Speed

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Tilt Cylinder Group (Right side)

(4) Hydraulic oil cooler

(5) Hydraulic Tank Group

(6) Tilt Cylinder Group (Left side)

(7) Gear Motor (fan drive)

(8) Lift Cylinder (Right side)

(9) Hydraulic oil filter

(10) Gear Motor (air conditioner)

(11) Lift Cylinder (Left side)

(12) Control Valve (work tool)

(13) Solenoid Valve and Mounting Group (quick coupler)

(14) Return Manifold Group

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(16) Coupler Cylinder Group

(17) Piston Motor Group (hydrostatic right side)

(18) Piston Pump (hydrostatic system)

(19) Diverter Valve (automatic level control valve RAISE)

(20) Solenoid Valve and Mounting Group

(21) Pilot Valve (work tool)

(22) Pressure Switch (optional backward travel alarm)

(23) Piston Motor Group (hydrostatic left side)

(24) Pilot Valve (hydrostatic system)

The Skid Steer Loaders hydraulic system consists of a hydrostatic drive system, a work tool hydraulic system and a pilot hydraulic system. The hydrostatic drive system and the work tool hydraulic system are controlled by the pilot system.

The three systems use one common Hydraulic Tank Group (5). The Gear Pump (charge oil, implement, air conditioner and fan drive) (15) is attached to the front end of the Piston Pump (hydrostatic system) (18). The Piston Pump (hydrostatic system) and the Gear Pump (charge oil, implement, air conditioner and fan drive) are splined to the engine. The piston pump provides flow for the hydrostatic drive system. The gear pump is a two-section pump. One section of the gear pump provides flow for the work tool system. The other section of the gear pump provides charge oil for the hydrostatic system, oil for the optional Gear Motor (air conditioner) (10), oil for the optional Solenoid Valve and Mounting Group (quick coupler) (13), and oil for the pilot system. The oil flows from the gear pump to the optional Gear Motor (air conditioner). The oil then flows to the Gear Motor (fan drive) (7). The oil then flows through the hydraulic oil filter (9). After the oil flows through the hydraulic oil filter, the oil flows to the Piston Pump (hydrostatic system). The oil flow that flows to the work tool system is not filtered by the oil filter.

The gear pump supplies oil to the Pilot Valve (hydrostatic system) (24) and the Pilot Valve (work tool) (21). The pilot operated hydraulic controls are used to route pilot oil to Piston Pump (hydrostatic system) (18) and pilot oil to Control Valve (work tool) (12). The pilot oil moves the swashplates in the piston pump in order to control Piston Motor Group (hydrostatic system) for the right side (17) and Piston Motor Group (hydrostatic system) for the left side (23). The pilot oil shifts the spools in the Control Valve (work tool) in order to operate the work tool.

Oil returns to Return Manifold Group (14) from the following components: the Pilot Valve (hydrostatic system) and Pilot Valve (work tool), the Piston Pump (hydrostatic system), the Piston Motor Group (hydrostatic left side) and Piston Motor Group (hydrostatic right side) and the optional Solenoid Valve and Mounting Group (quick coupler). The oil can flow to the hydraulic oil cooler from the return manifold. Oil that is returning from the Control Valve (work tool) (12) flows directly to the tank.

Hydraulic Supply System

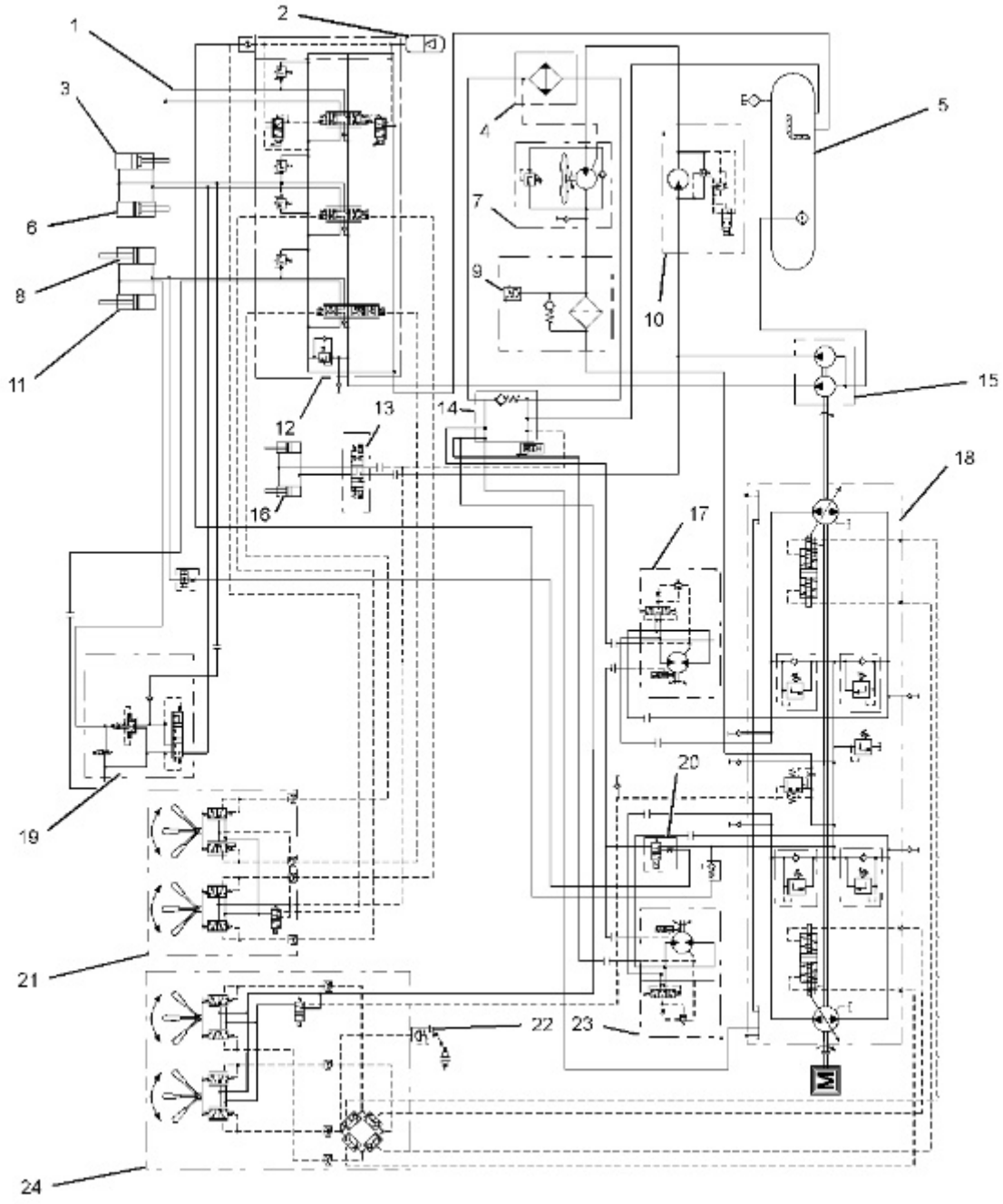


Illustration 2 g01455068

Hydraulic Schematic Single Speed

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Tilt Cylinder Group (Right side)

(4) Hydraulic oil cooler

(5) Hydraulic Tank Group

(6) Tilt Cylinder Group (Left side)

(7) Gear Motor (fan drive)

(8) Lift Cylinder (Right side)

(9) Hydraulic oil filter

(10) Gear Motor (air conditioner)

(11) Lift Cylinder (Left side)

(12) Control Valve (work tool)

(13) Solenoid Valve and Mounting Group (quick coupler)

(14) Return Manifold Group

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(16) Coupler Cylinder Group

(17) Piston Motor Group (hydrostatic right side)

(18) Piston Pump (hydrostatic system)

(19) Diverter Valve (automatic level control valve RAISE)

(20) Solenoid Valve and Mounting Group

(21) Pilot Valve (work tool)

(22) Pressure Switch (optional backward travel alarm)

(23) Piston Motor Group (hydrostatic left side)

(24) Pilot Valve (hydrostatic system)

The hydraulic oil tank (5) stores the hydraulic oil for the machine. The hydraulic tank supplies oil to the hydrostatic system, the work tool hydraulic system, and the pilot hydraulic system.

A strainer is located inside the oil tank on the end of the supply line. The tank is not pressurized. A hose connects the tank to a breather.

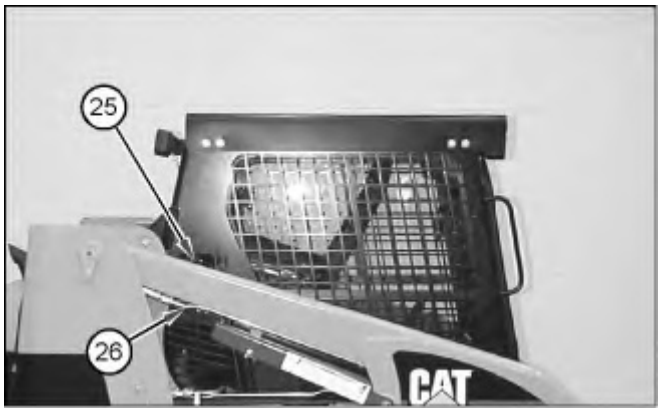


Illustration 3 g01031877

(25) Hydraulic tank filler cap

(26) Hydraulic tank sight gauge

The sight gauge (26) is located on the right side of the machine below the filler cap (25). Maintain the oil level approximately in the middle of the sight gauge. Refer to the Operation and Maintenance Manual, SEBU7731, "Hydraulic System Oil Level - Check" for more information.

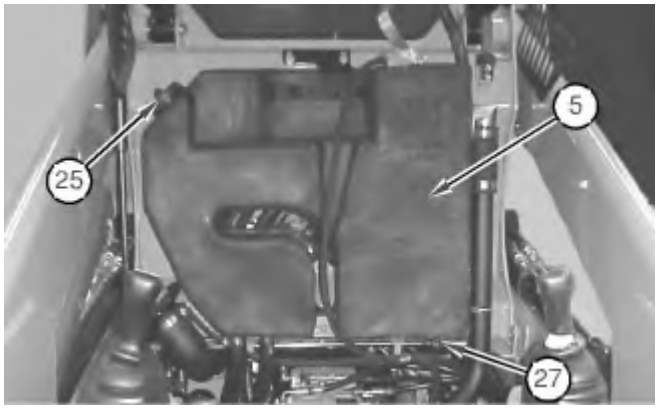


Illustration 4 g01031879

(5) Hydraulic tank

(25) Filler cap

(27) Oil temperature sender

An oil temperature sender (27) is located on the bottom of the hydraulic tank (5). When the hydraulic oil temperature exceeds 102° ± 3°C (216° ± 5°F), the sender will activate the indicator light that is located on the left control panel. When the hydraulic oil temperature cools to a temperature of approximately 90 °C (194 °F), the sender will deactivate the indicator light.

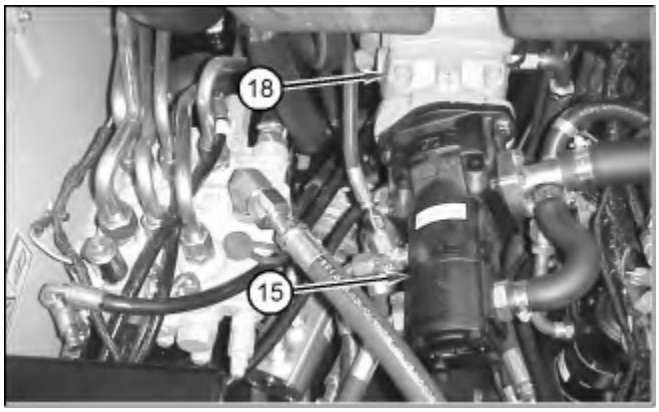


Illustration 5 g01031880

(15) Gear Pump (charge oil, implement, air conditioner and fan drive)

(18) Piston Pump (hydrostatic system)

Hydraulic oil from hydraulic tank (5) flows into gear pump (15). The gear pump is driven by a common drive shaft that runs through the piston pump (hydrostatic system) (18). The gear pump supplies oil to the hydraulic system and to the hydrostatic system.

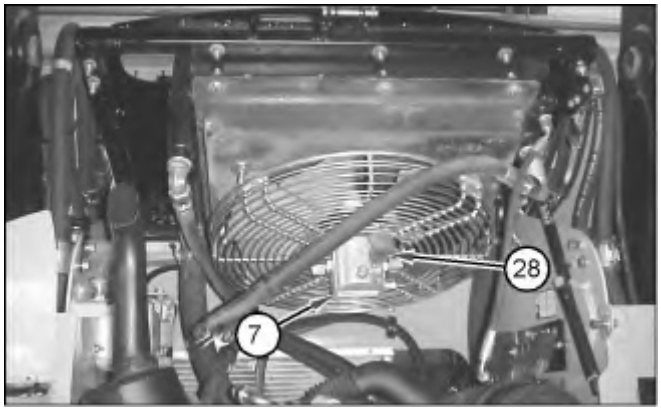


Illustration 6 g01031908

(7) Gear Motor (fan drive)

(28) Test port and fill port

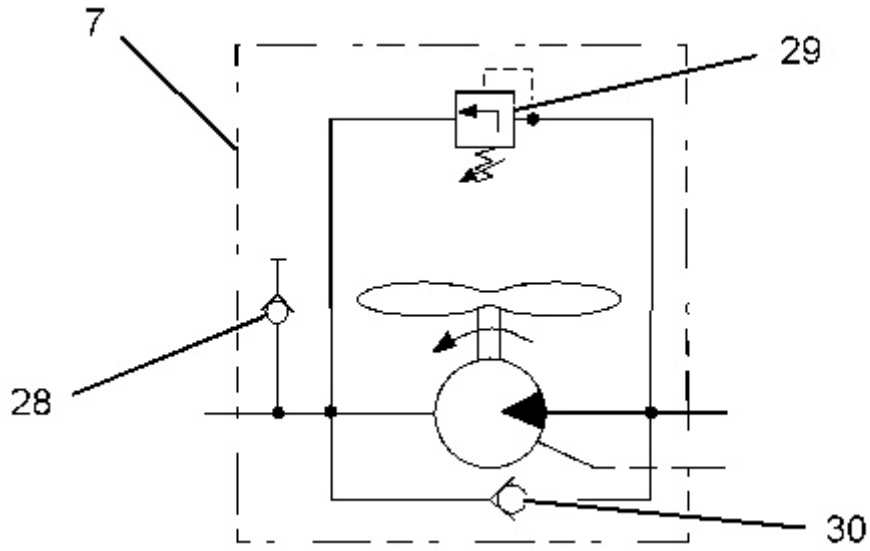


Illustration 7 g01455072

(7) Gear Motor (fan drive)

(28) Test port and fill port

(29) Relief valve

(30) Check valve

Hydraulic oil for the Gear Motor (fan drive) (7) is supplied by the gear pump. Hydraulic oil from the hydraulic oil tank flows to the front section of the gear pump. The oil flows from the gear pump to the gear motor. The flow of oil through the gear motor turns the fan that cools the hydraulic oil that passes through the oil cooler. The fan also cools the coolant that flows through the radiator.

The fan motor will rotate in direct relation to the amount of hydraulic oil flow until the hydraulic oil pressure reaches the setting for the relief valve (29). The relief valve allows the excess oil to bypass the gear motor.

The check valve (30) allows the gear motor to spin freely after the engine is turned off.

The test port and fill port (28) is used to test for contaminants in the hydraulic oil. For more information on the oil sample port, refer to Hydraulic System Testing and Adjusting, RENR4867, "Hydraulic Oil Contamination Test". The port is also used to pump oil into the piston pump. For more information on the fill port, refer to Hydraulic System Testing and Adjusting, RENR4867, "Filling and Flushing the Hydrostatic System Test".

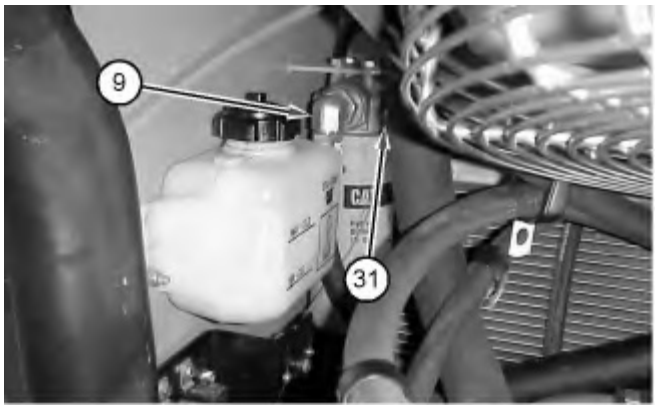


Illustration 8 g01031882

(9) Hydraulic oil filter

(31) Differential pressure indicator

Hydraulic oil then flows out of the gear motor and into the hydraulic oil filter (9). The hydraulic oil filter is located at the rear of the left side of the engine compartment.

Hydraulic oil flows out of the Gear Motor (fan drive) and into the hydraulic oil filter (9). The oil filter is a five micron filter. From the oil filter, the hydraulic oil flows to the Piston Pump (hydrostatic system).

The hydraulic oil filter serves the purpose of removing any particles that could damage the piston pump. The hydraulic oil then flows into the front section of the piston pump.

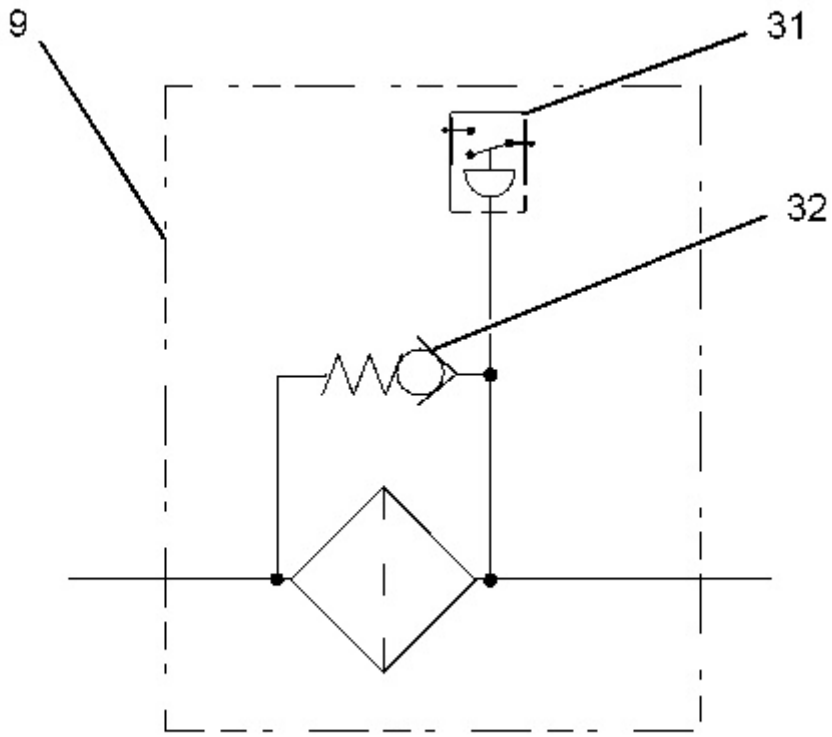


Illustration 9 g01455075

(9) Hydraulic oil filter

(31) Differential pressure indicator

(32) Filter bypass valve

The differential pressure indicator (31) will close when the differential pressure becomes high enough. When the differential pressure indicator closes, an electrical signal causes the light on the right control panel to illuminate. When the differential pressure raises further, the oil filter bypass valve (32) will open. For more information about the alert indicators, refer to the Operation and Maintenance Manual, "Alert Indicators".

Interlock System

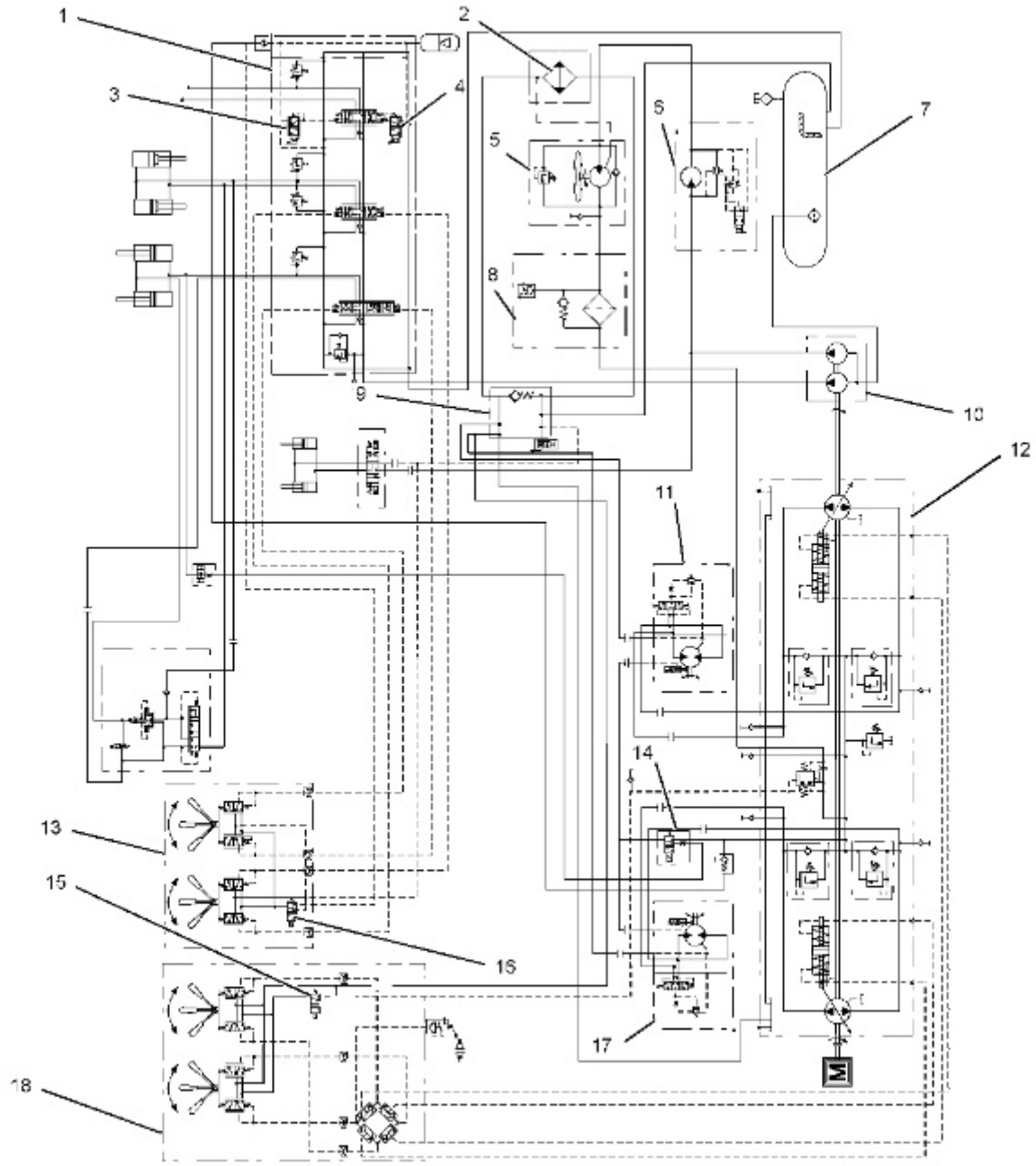


Illustration 10 g01455077

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Hydraulic oil cooler

(3) Solenoid Valve Group

(4) Solenoid Valve Group

(5) Gear Motor (fan drive)

(6) Gear Motor (air conditioner)

(7) Hydraulic Tank Group

(8) Hydraulic oil filter

(9) Return Manifold

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Piston Motor Group (hydrostatic right side)

(12) Piston Pump (hydrostatic system)

(13) Pilot Valve (work tool)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Solenoid Valve Group (hydrostatic system)

(16) Solenoid Valve Group (work tool)

(17) Piston Motor Group (hydrostatic left side)

(18) Pilot Valve (hydrostatic system)

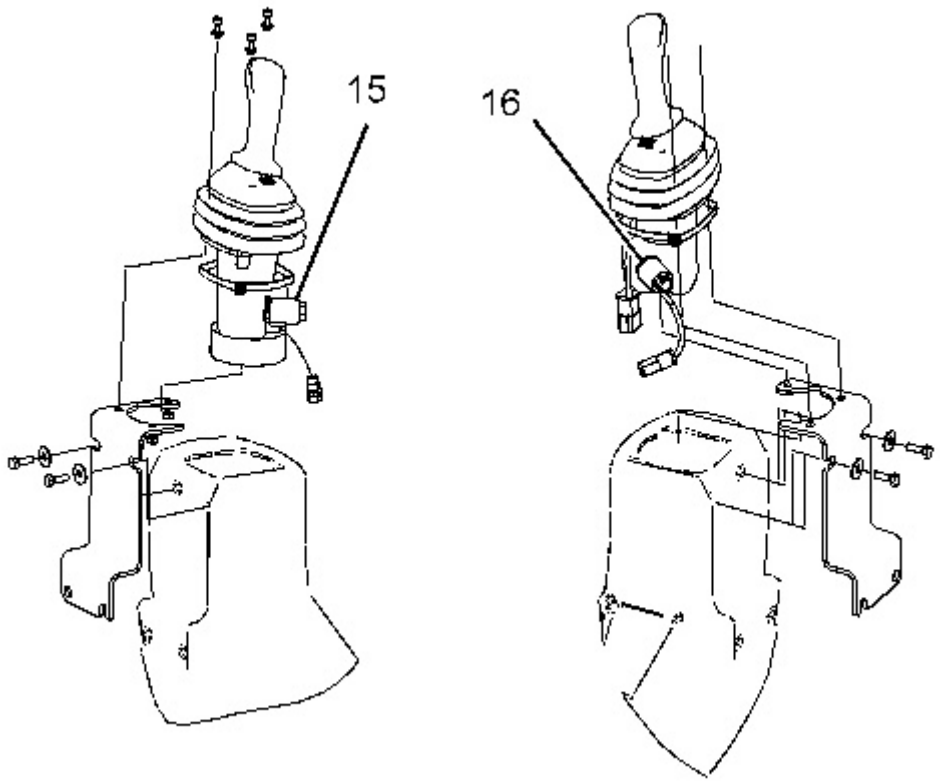


Illustration 11 g01455080

(15) Solenoid Valve Group (hydrostatic system)

(16) Solenoid Valve Group (work tool)

There are five solenoid valves for the interlock system on the Skid Steer Loader. The interlock system includes the following solenoids: the Solenoid Valve Group (hydrostatic system) (15), the Solenoid Valve Group (work tool) (16), two Solenoid Valve Groups (3) and (4) and Solenoid Valve and Mounting Group (parking brake) (14). The Solenoid Valve Group (hydrostatic system), the Solenoid Valve Group (work tool), and the Solenoid Valve and Mounting Group (parking brake) are energized under the following conditions:

- The seat must be occupied.
- The arm bar must be in the DOWN position.
- The parking brake switch must be disengaged.

The Solenoid Valve Group (hydrostatic system) (15) is located on the Pilot Valve (hydrostatic system) (18). The solenoid valve allows the flow of hydraulic signal oil to the pilot operated hydraulic control. When the solenoid is de-energized, no hydraulic signal oil flows to the hydraulic control.

The Solenoid Valve and Mounting Group (parking brake) (14) is located under the cab on the left side of the machine. The solenoid valve allows the flow of pilot hydraulic oil to the brakes. The parking brakes are located on piston motors (11) and (17) .

When the solenoid is de-energized, the flow of pilot hydraulic oil is blocked. Hydraulic oil from the parking brake actuators drains through the solenoid valve to the hydraulic tank. This allows the force of the actuator spring to engage the brakes. When the solenoid is energized, pilot hydraulic oil flows into the parking brakes. The oil pressure overcomes the force of the spring in order to disengage the parking brakes.

The Solenoid Valve Group (work tool) (16) is located on the Pilot Valve (work tool) (13). The solenoid valve allows the flow of pilot hydraulic oil to the pilot operated hydraulic control. When the solenoid is de-energized no flow of pilot hydraulic oil reaches the hydraulic control.

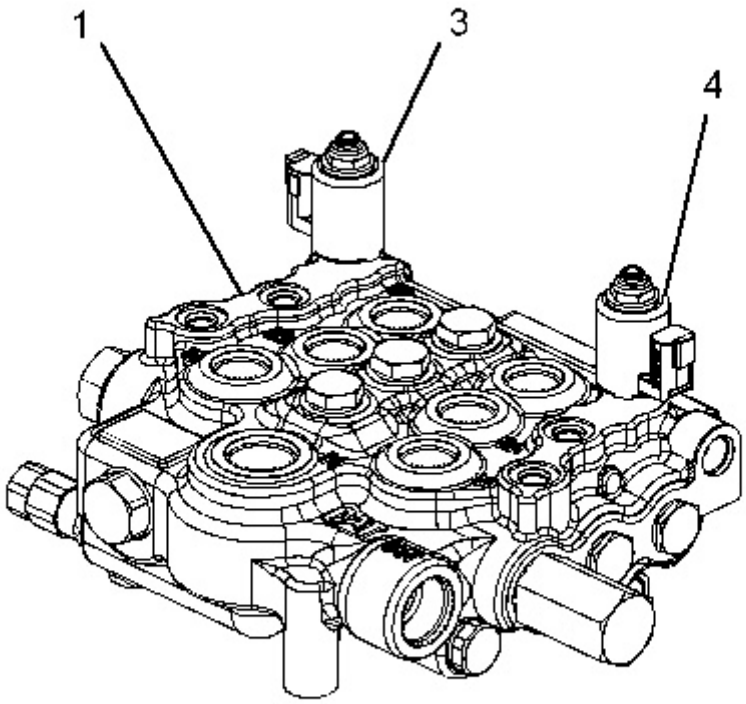


Illustration 12 g01455085

(1) Control Valve (work tool)

(3) Solenoid Valve Group

(4) Solenoid Valve Group

The Solenoid Valve Group (3) and (4) are located on the Control Valve (work tool) (1). The solenoid valves are electronically activated. The valves enable the flow of pilot hydraulic oil to the auxiliary spool in the control valve.

The Gear Pump (charge oil, implement, air conditioner and fan drive) (10) supplies the hydraulic oil flow for the pilot system and the brake system. After the oil flows through the speed sensing valve, the signal oil to the Pilot Valve (hydrostatic system) (18) should be proportional to the engine rpm.

Return Manifold System

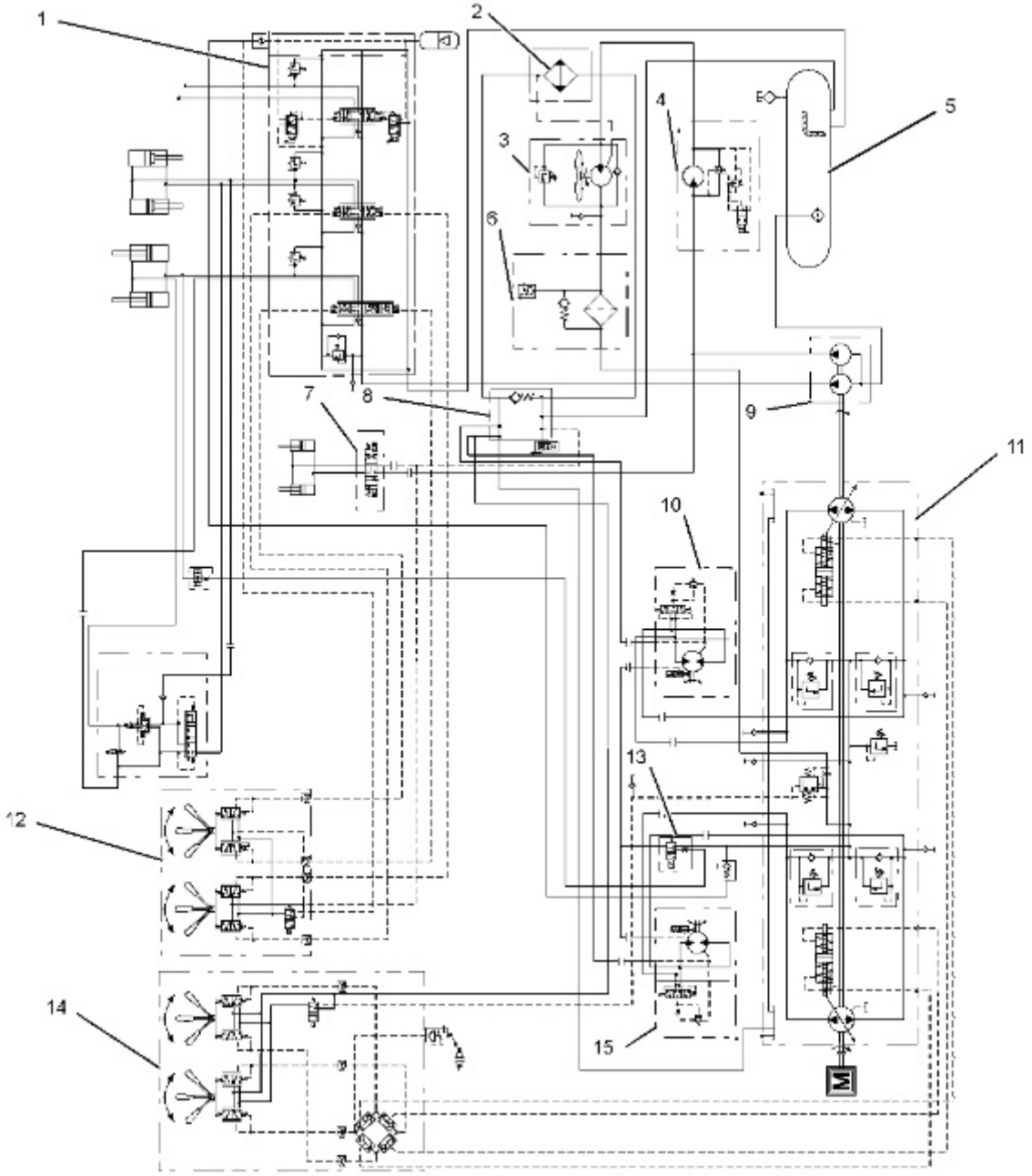


Illustration 13 g01455088

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Hydraulic oil cooler

(3) Gear Motor (fan drive)

(4) Gear Motor (air conditioner)

(5) Hydraulic Tank Group

(6) Hydraulic oil filter

(7) Solenoid Valve and Mounting Group (quick coupler)

(8) Return Manifold

(9) Gear Pump (charge oil, implement, air conditioner and fan drive)

(10) Piston Motor Group (hydrostatic right side)

(11) Piston Pump (hydrostatic system)

(12) Pilot Valve (work tool)

(13) Solenoid Valve and Mounting Group (parking brake)

(14) Pilot Valve (hydrostatic system)

(15) Piston Motor Group (hydrostatic left side)

Oil flows to the Return Manifold Group (8) from the following components: the Pilot Valve (work tool) (12), the Pilot Valve (hydrostatic system) (14), Solenoid Valve and Mounting Group (parking brake) (13), Solenoid Valve and Mounting Group (quick coupler) (7), the Piston Pump (hydrostatic system) (10) and the Piston Motor Groups (hydrostatic system) (10) and (15) .

The return manifold provides a common junction for the hydraulic oil prior to returning to the hydraulic tank. The return manifold also routes the oil to the hydraulic oil cooler (2) in order to keep the oil from getting too hot.

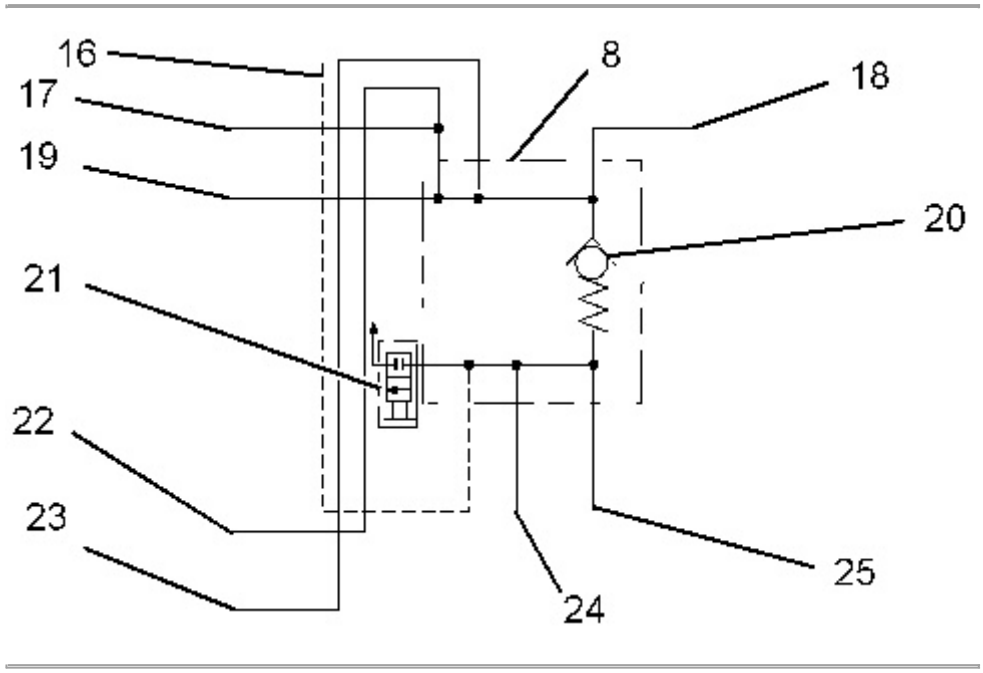


Illustration 14 g01455090

(8) Return Manifold Group

(16) Return oil from the Solenoid Valve and Mounting Group (quick coupler)

(17) Return oil from the Pilot Valve (hydrostatic system)

(18) Return oil to the hydraulic oil cooler

(19) Return oil from the case of the Piston Pump (hydrostatic system)

(20) Bypass check valve of the oil cooler

(21) Hydraulic system drain valve

(22) Return oil from the Piston Motor Group (hydrostatic left side)

(23) Return oil from the Piston Motor Group (hydrostatic right side)

(24) Return oil to the hydraulic tank

(25) Return oil from the hydraulic oil cooler

The hydraulic oil flows to the Gear Motor (fan drive) (3) which causes the cooling fan to rotate. The cooling fan blows air across the oil cooler. The air cools the hydraulic oil. The cooling system is designed to maintain the hydraulic oil temperature at a temperature of approximately 50° ± 10° C (120° ± 20°F). The hydraulic oil then flows through hydraulic oil filter (6) and into the Return Manifold Group (8) .

The bypass check valve of the oil cooler (20) is located in the Return Manifold Group. The bypass check valve prevents hydraulic oil from flowing to the hydraulic oil cooler when the machine is first started, or when the oil temperature is less than the minimum specification for the oil temperature. The bypass check valve opens when the oil pressure inside the cooler exceeds 172 kPa (25 psi). The hydraulic oil flows from the Return Manifold Group and returns to the hydraulic tank (5) .

The hydraulic system drain valve (21) is mounted in the Return Manifold Group. The drain valve is used to drain approximately 90% of the hydraulic oil from the lines, valves and the tank. A hose connects to the valve. The hose allows the oil to be drained into an approved receptacle through an opening in the belly guard.

Hydraulic Quick Coupler

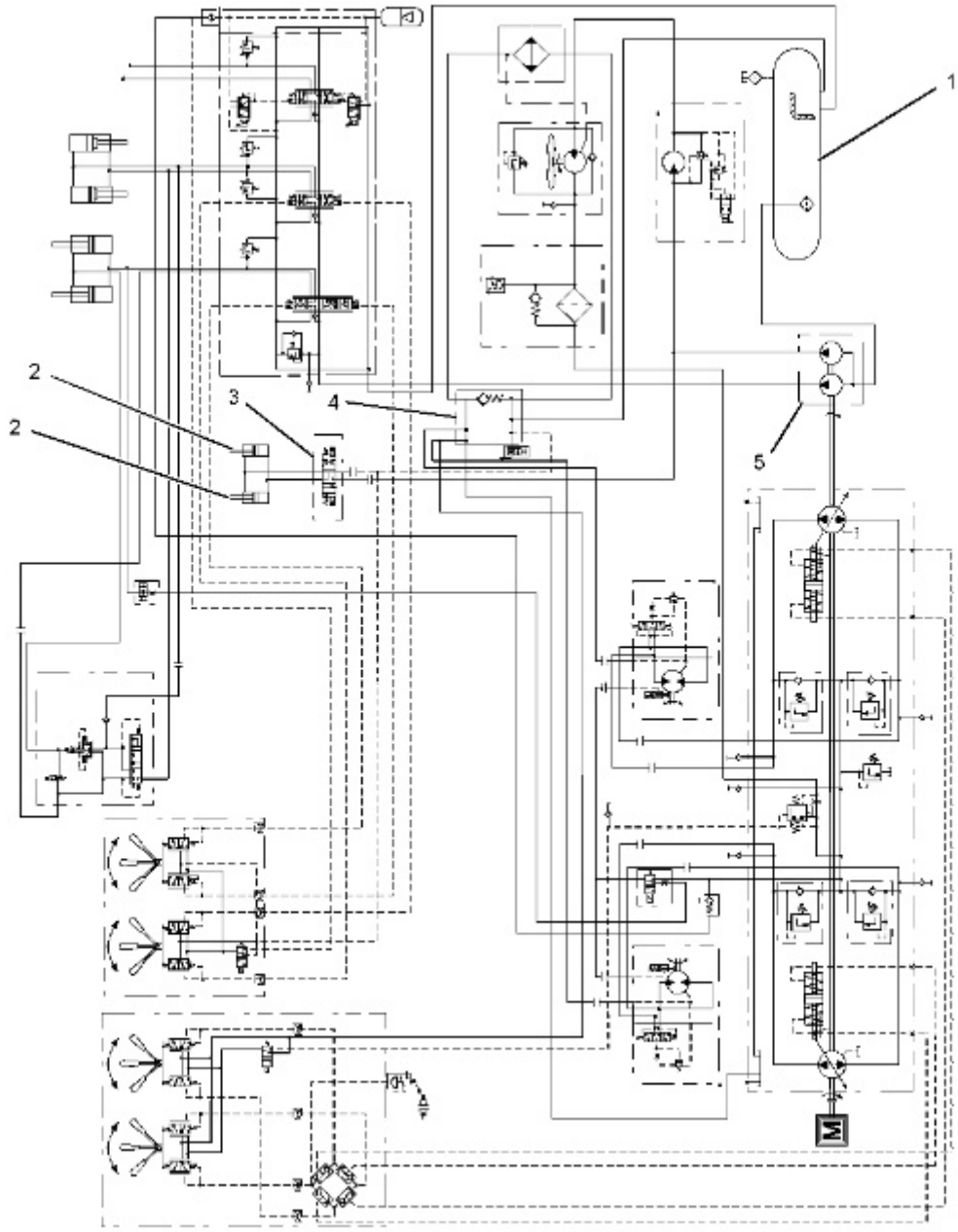


Illustration 15 g01455114

(1) Hydraulic Tank Group

(2) Coupler Cylinder Group

(3) Solenoid Valve and Mounting Group (quick coupler)

(4) Return Manifold Group

(5) Gear Pump (charge oil, implement, air conditioner and fan drive)

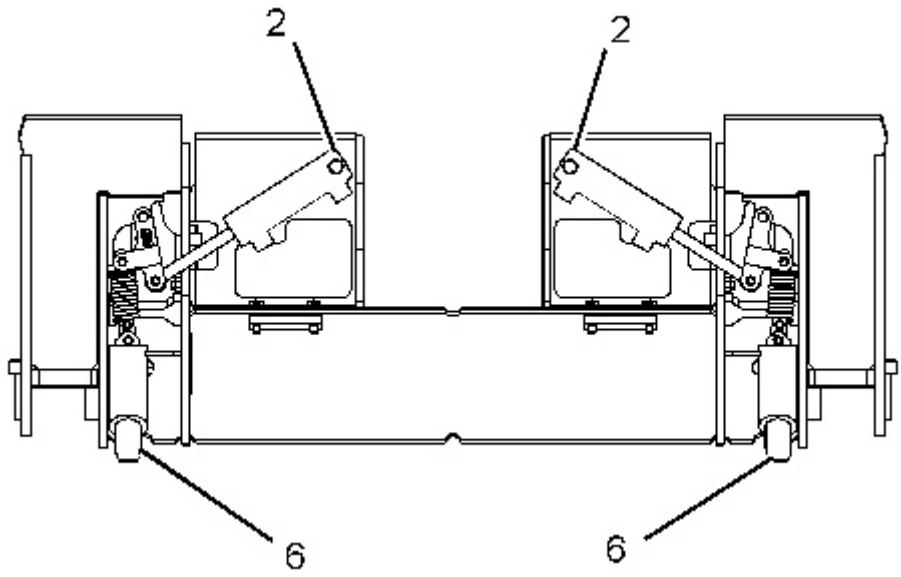


Illustration 16 g01455115

(2) Coupler Cylinder Group

(6) Coupler pins

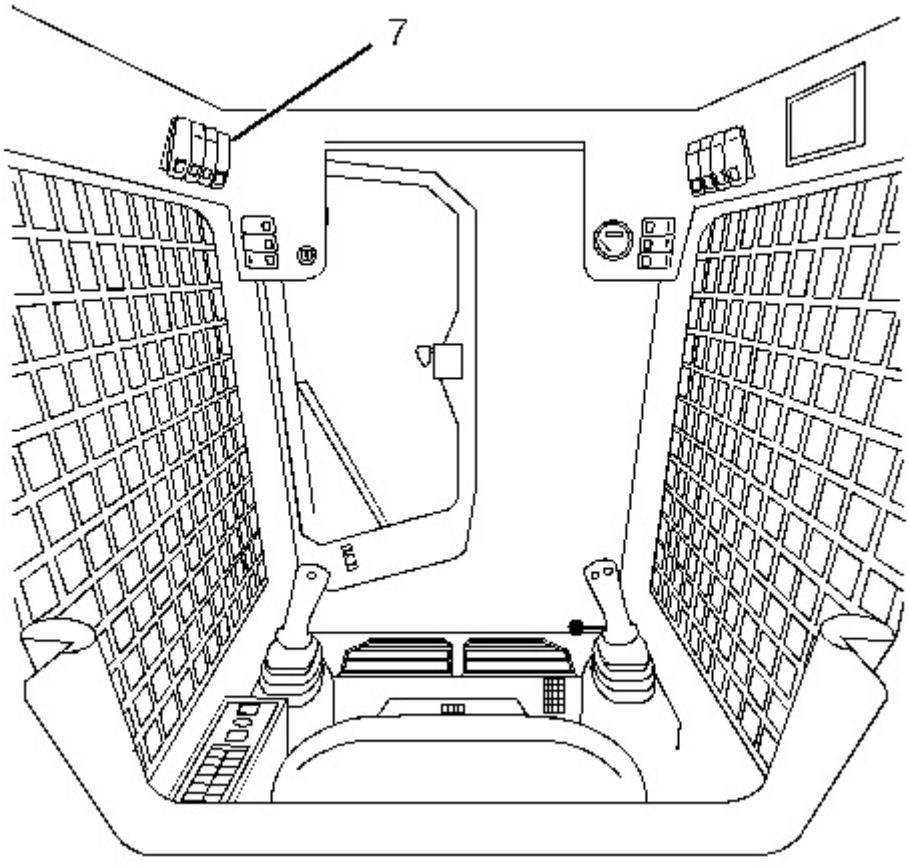


Illustration 17 g01455120

(7) Control switch for the work tool coupler

If the machine is equipped with a hydraulic work tool Quick Coupler Arrangement, the control switch (7) for the work tool coupler will be located on the upper left hand console. Refer to the Operation and Maintenance Manual, SEBU7731, "Machine Operation" for information on the operation of the hydraulic quick coupler.

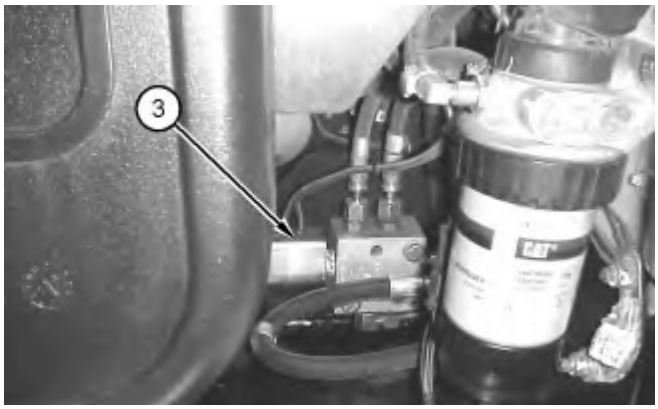


Illustration 18 g01033007

(3) Solenoid Valve and Mounting Group (quick coupler)

The Solenoid Valve and Mounting Group (quick coupler) (3) is located on the right side at the rear of the machine. The control valve may be mounted on the rear bulkhead. The control valve may be mounted onto a bracket. The bracket is attached to the machine near the release lever that is for the engine access door. The mounting location is dependent on the machine configuration and the options.

When the operator presses the top of the control switch and the operator holds the top of the control switch for the work tool coupler, an electrical signal is sent to the solenoid on Solenoid Valve and Mounting Group (quick coupler) (3). The energized solenoid causes the spool in the control valve to shift upward.

When the spool is shifted in the up position, the oil that is from the front section of the gear pump (5) flows through the valve. The oil then flows into the head ends of the Coupler Cylinder Group (2). The oil causes the cylinders of the Coupler Cylinder Group (2) to extend. When the cylinders extend, the cylinders cause the coupler pins (6) to move down. The work tool should then be attached to the coupler. Ensure that the work tool is fully engaged to the coupler before the work tool is used. Refer to the Operation and Maintenance Manual, SEBU7731, "Work Tool Coupler Control".

When the operator slides the red button on the control switch downward, and the operator presses the bottom of the control switch for the work tool coupler, an electrical signal is sent to the other solenoid on Solenoid Valve and Mounting Group (quick coupler) (3). The energized solenoid causes the spool in the control valve to shift downward.

When the spool is shifted in the down position, the oil that is from the front section of the gear pump (5) flows through the valve. The oil then flows into the rod ends of the Coupler Cylinder

Group (2). The oil causes the cylinders of the Coupler Cylinder Group (2) to retract. When the cylinders retract, the cylinders cause the coupler pins (6) to move up. The work tool should then be detached from the coupler. Ensure that the work tool is fully disengaged from the coupler before the machine is moved. Refer to the Operation and Maintenance Manual, "Work Tool Coupler Control".

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

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Pilot Hydraulic System

SMCS - 5050-PS

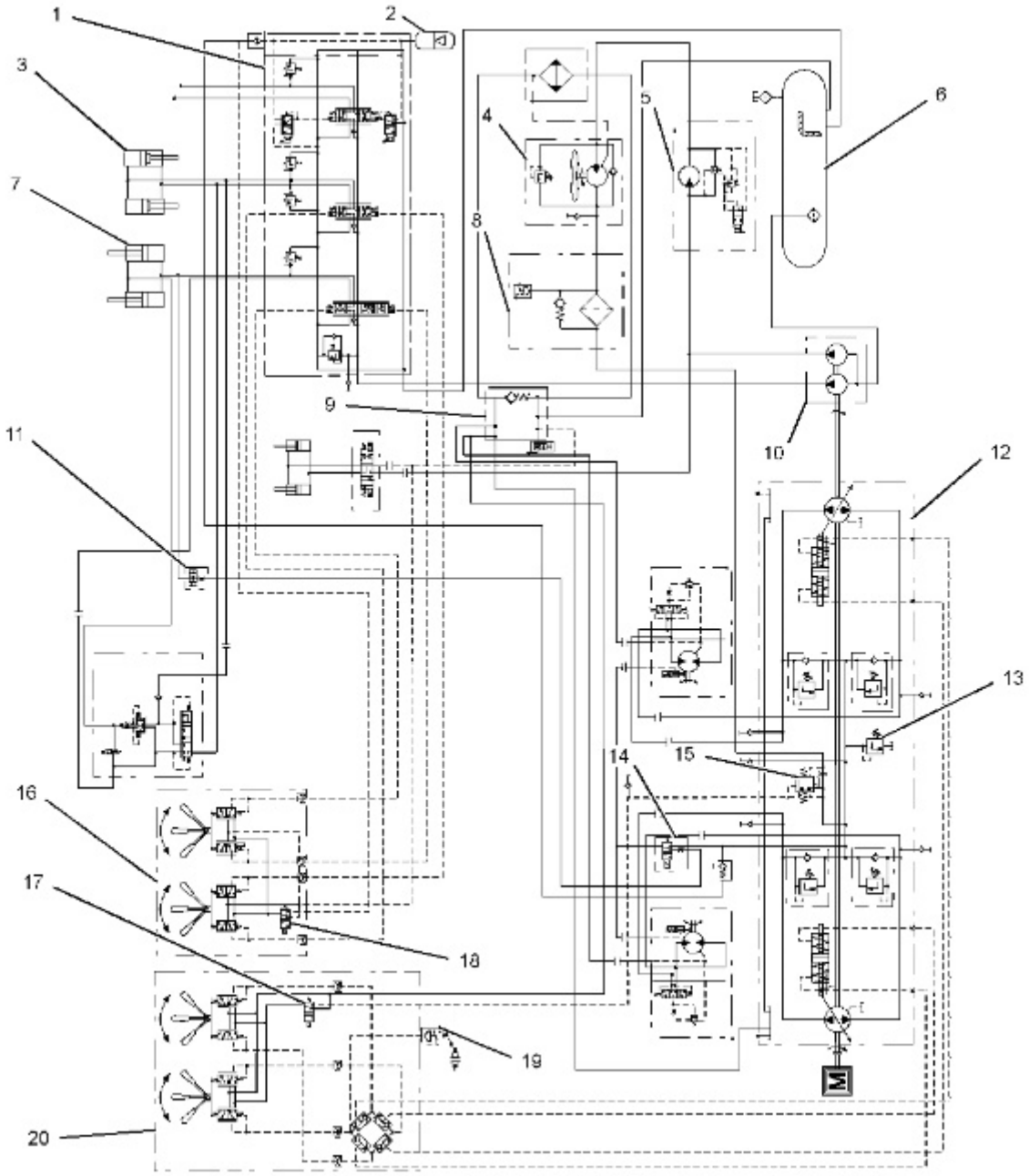


Illustration 1 g01455578

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Accumulator

(3) Tilt Cylinder Group

(4) Gear Motor (fan drive)

(5) Gear Motor (air conditioner)

(6) Hydraulic Tank Group

(7) Lift Cylinder

(8) Hydraulic oil filter

(9) Return Manifold Group

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Ball Valve Group

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(16) Pilot Valve (work tool)

(17) Solenoid Valve Group (hydrostatic system)

(18) Solenoid Valve Group (work tool)

(19) Pressure Switch

(20) Pilot Valve (hydrostatic system)

The pilot hydraulic system is used to move the spools in the Control Valve (work tool) (1) . The pilot hydraulic system is also used to control the operation of the hydrostatic system. The pilot system uses lower pressure oil to control higher pressure oil.

In order for the pilot system to function, the interlocks must be disengaged. The interlock system consists of the following components: the Solenoid Valve Group (hydrostatic system) (17) , the Solenoid Valve Group (work tool) (18) and the Solenoid Valve and Mounting Group (parking brake) (14) . In order for the interlock system to be disengaged, the following conditions must be met:

- The seat must be occupied.
- The armrest must be in the DOWN position.
- The parking brake must be disengaged.

The forward section of the Gear Pump (charge oil, implement, air conditioner and fan drive) (10) provides oil for the pilot oil circuits. The Relief Valve (Charge oil) (13) regulates the pressure of the charge system.

When the interlock system is disengaged, oil flows from the Hydraulic Tank Group (6) to the front section of the Gear Pump (charge oil, implement, air conditioner and fan drive) (10) and then oil flows to the Gear Motor (fan drive) (4) . After the gear motor, oil flows through the hydraulic oil filter (8) . Then, the oil flows to the Piston Pump (hydrostatic system) (12) .

At the Piston Pump (hydrostatic system), the pilot system oil for the hydrostatic system is regulated by the Speed Sensing Valve Group (15) . The pilot system oil that flows to the Pilot Valve (work tool) (16) is regulated by the charge relief valve (16) .

The rest of the charge oil is makeup oil for the hydrostatic system. Any leakage in the hydrostatic system is replaced by the charge oil.

Pilot Valve (hydrostatic system)

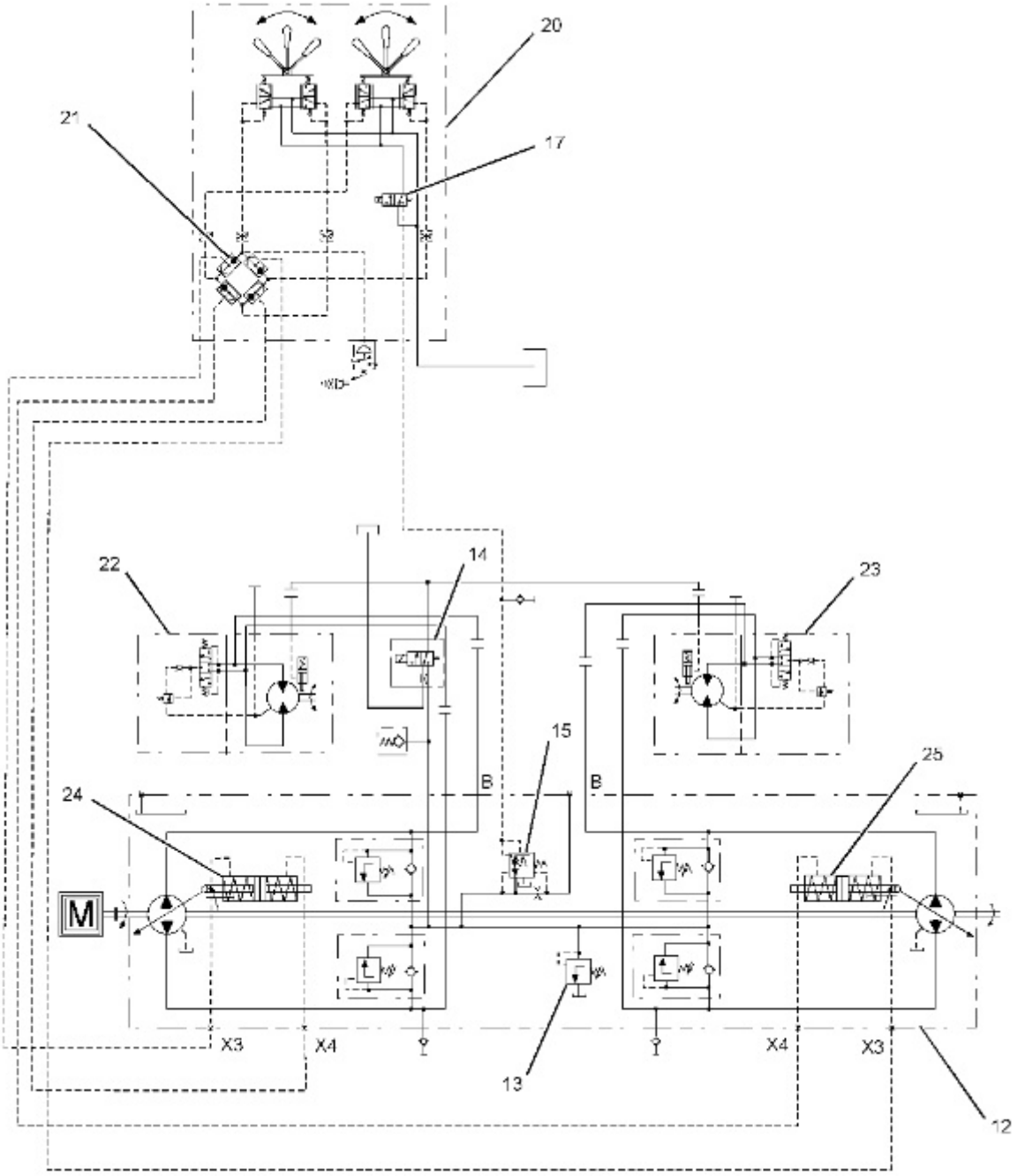


Illustration 2 g01050931

Hydraulic Schematic Single Speed

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(17) Solenoid Valve Group (Hydrostatic System)

(20) Pilot Valve (Hydrostatic System)

(21) Resolver Network

(22) Piston Motor Group (Hydrostatic Left Side)

(23) Piston Motor Group (Hydrostatic Right Side)

(24) Actuator Piston

(25) Actuator Piston

Oil flows from the speed sensing valve group (15) to the pilot valve (hydrostatic system) (20) . The load of the hydrostatic system determines the pressure of the pilot oil that is maintained by speed sensing valve (15) . The rpm of the engine determines the pressure of the pilot oil that is maintained by the Speed Sensing Valve Group .

Table 1

Ports that are Pressurized	**Direction of Machine Travel**
Port "X3" for actuator (24) and Port "X3" for actuator (25)	REVERSE
Port "X4" for actuator (24) and Port "X3" for actuator (25)	LEFT TURN
Port "X3" for actuator (24) and Port "X4" for actuator (25)	RIGHT TURN
Port "X4" for actuator (24) and Port "X4" for actuator (25)	FORWARD

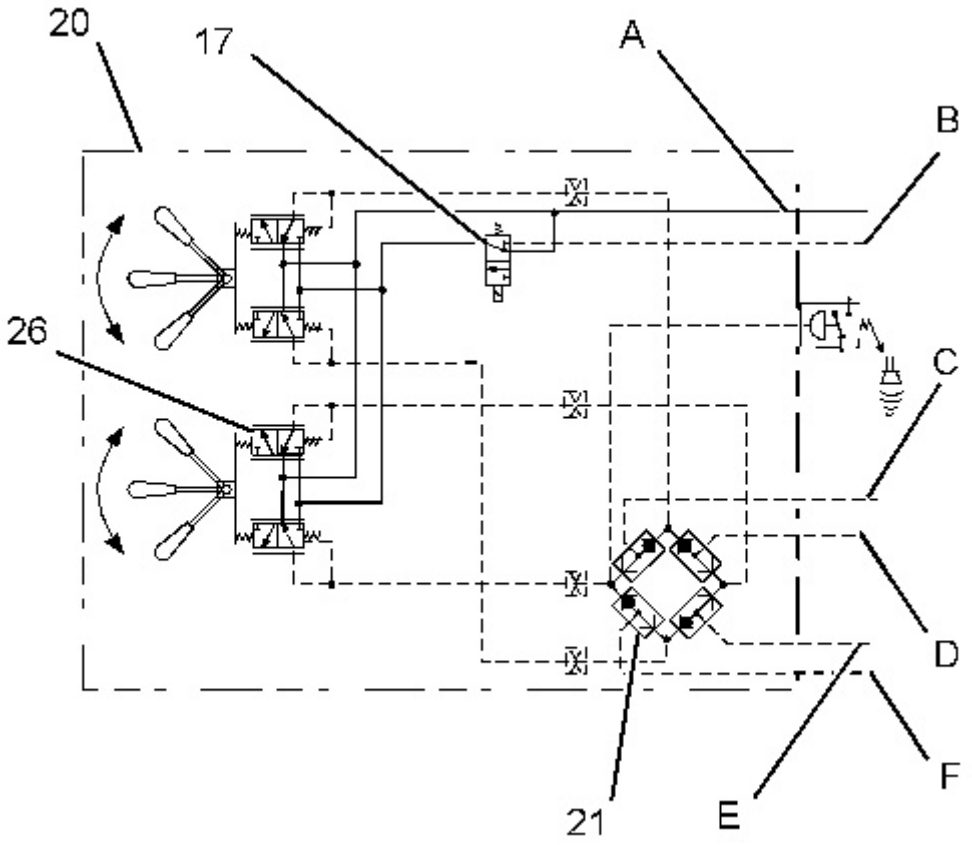


Illustration 3 g01455579

Schematic for the Pilot Valve (hydrostatic system)

(17) Solenoid Valve Group (Hydrostatic System)

(20) Pilot Valve (Hydrostatic System)

(21) Resolver Network

(26) Plunger for the Forward travel

(A) Return to tank port

(B) Pump supply port

(C) Line to "X3" Pilot pressure port (hydrostatic right side) (7)

(D) Line to "X4" Pilot pressure port (hydrostatic left side) (18)

(E) Line to "X4" Pilot pressure port (hydrostatic right side) (8)

(F) Line to "X3" Pilot pressure port (hydrostatic left side) (22)

When the interlock system is disengaged, an electrical signal is sent to the solenoid valve group (17) . The energized solenoid causes the valve spool to shift upward. With the valve spool in the upward position, oil from speed sensing valve (15) that is in line (B) is now able to flow through the solenoid valve (17) . The oil then flows to the plungers for pilot valve (20) .

The pilot oil will be blocked at the plungers if the control lever for the hydrostatic system is in the NEUTRAL position. Because the pilot oil is blocked at the plungers the oil will flow through pilot valve (20) back to the hydraulic tank through line (A) . Centering springs cause the travel control lever to return to the HOLD position whenever the travel control lever is released. Table 1 shows the direction of machine travel when the pilot ports are pressurized by the Pilot Valve (hydrostatic system).

When the travel control lever is moved to the FORWARD travel position, pilot oil flows from speed sensing valve (15) through the energized solenoid valve (17) . The oil then flows to the plungers for the pilot valve (20) . Because the travel control lever is in the FORWARD travel position, the oil now flows through the plunger for the FORWARD travel (26) . The oil then flows into the resolver network (21) .

The oil pressure causes the two resolver balls on the right side of the resolver network to move to the left. When the resolver balls move to the left the balls open a path that allows the pilot oil to flow into the line (D) and the line (E) .

Pilot oil that is in line (D) will flow into port (X4) in order to shift actuator (24) . The pilot oil that flows into port (X4) causes the piston in actuator (24) to shift left. At the same time, pilot oil that is in the line (E) will flow into port (X4) in order to shift actuator (25) . The pilot oil that flows into port (X4) causes the piston in actuator (25) to shift left. The movement of the actuators causes the swashplates to move. This will cause the pump to upstroke. When the pump upstrokes, the flow of oil from port (B) will increase.

Oil from port (B) will flow to piston motor (22) . Oil from port (B) will also flow to piston motor (23) . The flow of oil from the pump will be restricted when the oil reaches the piston motors. The restriction to the flow of oil will cause the pressure of the oil to rise. The rise in the pressure of the oil will cause the piston motors to start to rotate. This will propel the machine in the forward direction.

When the operator releases the travel control lever, the travel control lever returns to the NEUTRAL position. With the travel control lever in the NEUTRAL position, the plunger for the FORWARD travel (26) will move to the left. When the plunger for the FORWARD travel moves to the left the plunger blocks the flow of pilot oil. The plunger for the FORWARD travel (26) will now open a path for the oil in the line (D) and the line (E) to flow back to the hydraulic tank.

Since the pilot oil that is acting against the actuator piston (24) and the actuator piston (25) is now routed back to the hydraulic tank, the centering springs for the actuator pistons will force the actuator pistons back to the NEUTRAL position. When the actuator pistons move to the NEUTRAL position the swashplates move back to the minimum displacement position. When the swashplates move to the minimum displacement position the pumps will be at low pressure standby. Since the flow of oil has stopped to the Piston Motor Groups , the Piston Motor Groups will cease to rotate. The machine will come to a stop.

Refer to the Systems Operation, "Piston Pump (Hydrostatic)" for more information on the piston pump. Refer to the Systems Operation, "Piston Motor (Hydrostatic)" for more information on the piston motor.

Pilot Valve (work tool)

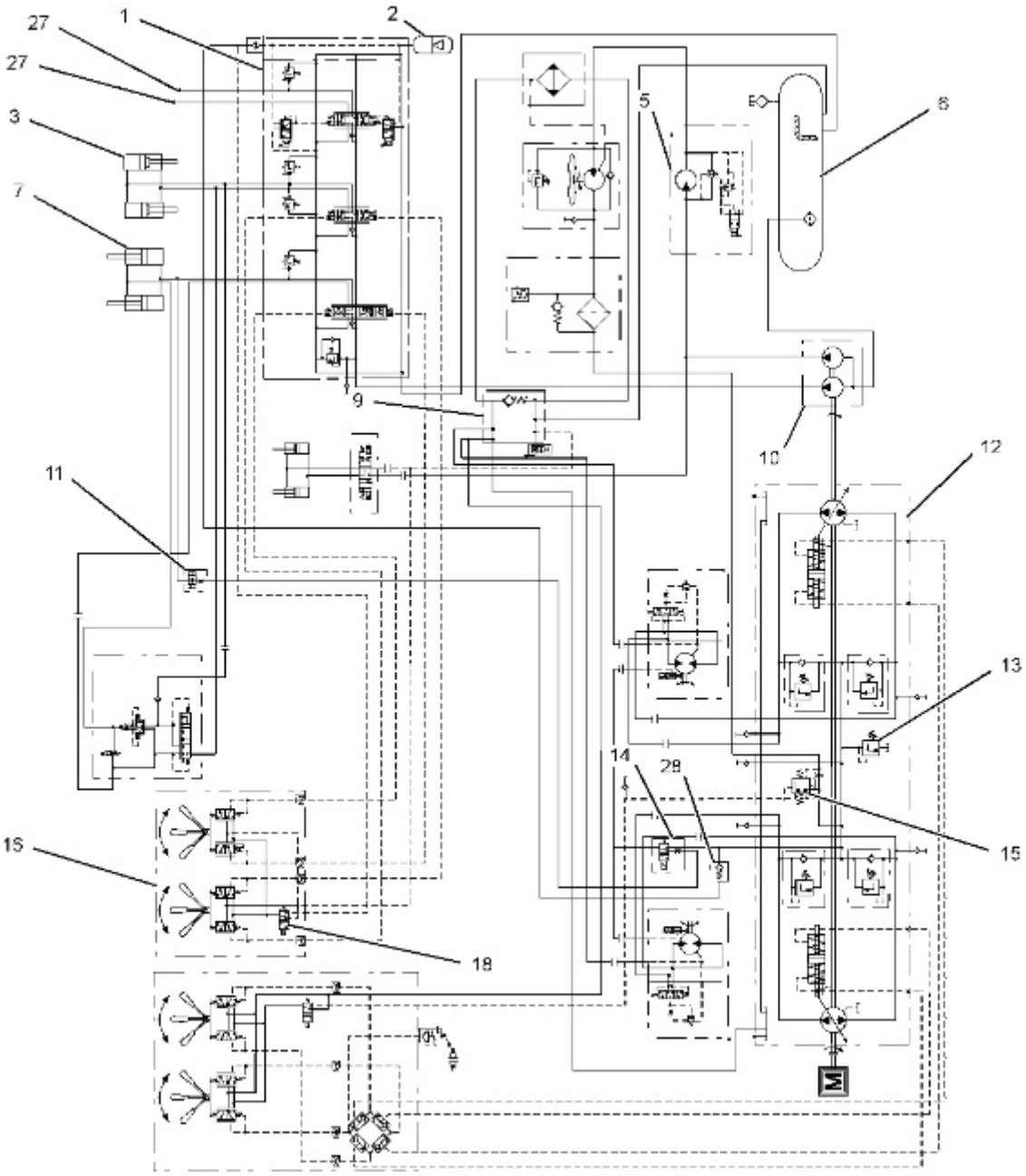


Illustration 4 g01455581

Hydraulic Schematic Single Speed

(1) Control Valve (work tool)

(2) Accumulator

(3) Tilt Cylinder Group

(5) Gear Motor (air conditioner)

(6) Hydraulic Tank Group

(7) Lift Cylinder

(9) Return Manifold

(10) Gear Pump (charge oil, implement, air conditioner and fan drive)

(11) Ball Valve Group

(12) Piston Pump (hydrostatic system)

(13) Relief Valve (Charge oil)

(14) Solenoid Valve and Mounting Group (parking brake)

(15) Speed Sensing Valve Group

(16) Pilot Valve (work tool)

(18) Solenoid Valve Group (work tool)

(27) Quick disconnects for the auxiliary circuit

(28) Check Valve

The pilot oil for the work tool is supplied by the front section of gear pump (10) . The pilot oil for the work tool is controlled by relief valve (13) . Relief valve (13) is part of piston pump (12) .

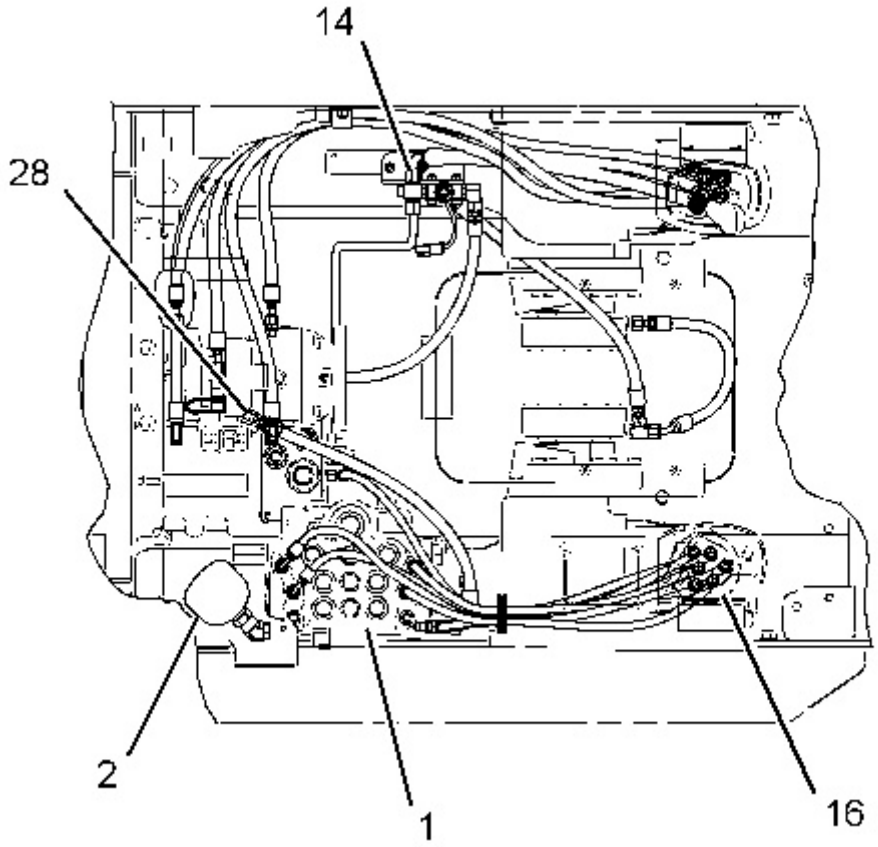


Illustration 5 g01455583

Locations of the Accumulator and Check Valve

(1) Control Valve (work tool)

(2) Accumulator

(14) Solenoid Valve and Mounting Group (parking brake)

(16) Pilot Valve (work tool)

(28) Check Valve

The oil that flows through the check valve (28) is used as pilot oil for the work tool circuits. The check valve is installed in a fitting that is installed to the bottom of piston pump (12) . The pilot oil overcomes the force of the spring in the check valve. The pilot oil then forces the check valve to open. When the check valve opens, the pilot oil flows through the check valve. The oil then flows to the control valve (1) . The oil also flows to the pilot valve (16) .

The pilot oil that flows to control valve (1) is used to activate the auxiliary circuit spool. The flow of the pilot oil is controlled by two solenoid valves. The pilot oil is also used to charge the accumulator (2) . The pilot oil that flows to pilot valve (16) is used to activate the lift spool. The pilot oil is also used to activate the tilt spool.

The interlock system must be disengaged in order for the pilot oil to flow to the work tool circuit. The auxiliary circuit can function with the armrest in the UP position, if the machine is equipped with an interlock override. Refer to the Operation and Maintenance Manual, "Hydraulic Shutoff and Interlock Override" for more information.

When the interlock system is disengaged, an electrical signal is sent to the Solenoid Valve Group (work tool) (15) . The energized solenoid causes the valve spool to shift upward. The pilot oil is able to flow through the valve spool and on to the plungers for pilot valve (16) when the valve spool is in the upward position.

The pilot oil will be blocked at the plungers so long as the control lever for the work tool is in the HOLD position. When the control lever is in the HOLD position, the oil will not flow through pilot valve (16) . Centering springs cause the control lever for the work tool to return to the HOLD position whenever the control lever for the work tool is released from any of the positions except for the FLOAT position. The FLOAT position has a detent that keeps the control lever for the work tool in this position until the operator moves the control lever for the work tool into a different position.

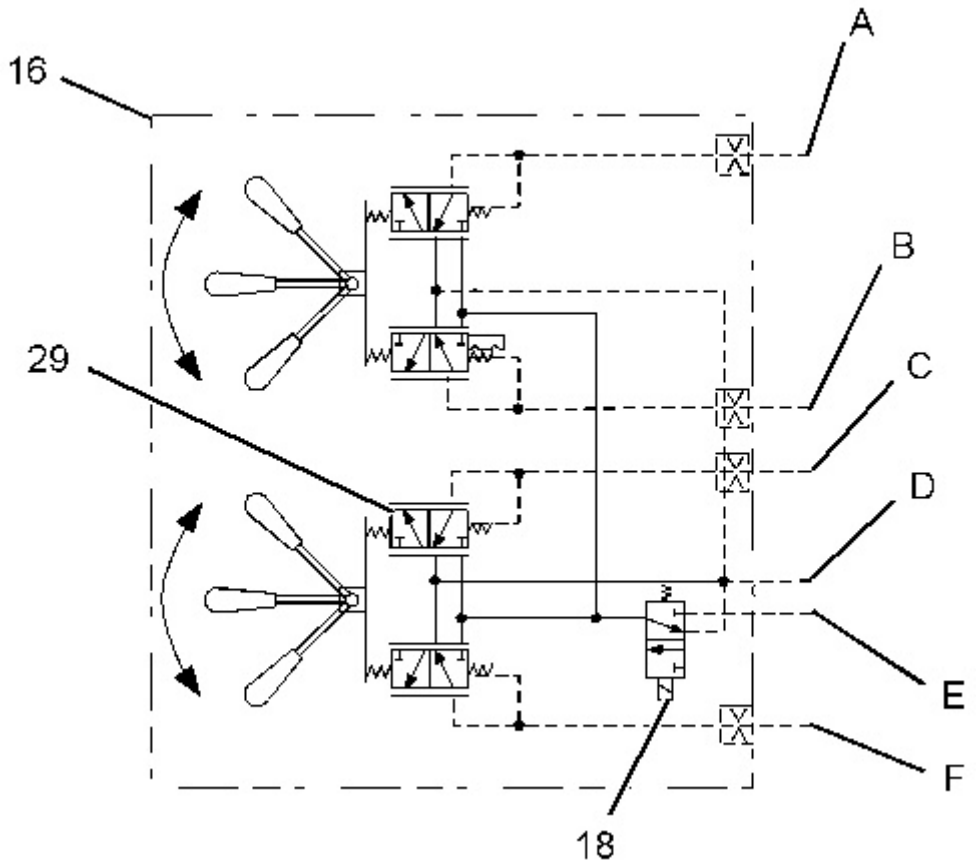


Illustration 6 g01455584

Schematic for the Pilot Valve (work tool)

(16) Pilot Valve (work tool)

(18) Solenoid Valve Group (work tool)

(29) Plunger for work tool TILT BACKWARD

(A) Line to work tool RAISE

(B) Line to work tool LOWER

(C) Line to work tool TILT BACKWARD

(D) Return to tank port

(E) Pump supply port

(F) Line to work tool TILT FORWARD

When the control lever for the work tool is moved to the TILT BACKWARD position, pilot oil flows from the check valve (28) through the energized solenoid valve group (18) . The oil then flows to the plungers for the pilot valve (16) .

Because the control lever for the work tool is in the TILT BACKWARD position, the oil now flows through the plunger for the TILT BACKWARD position (29) . Then, the pilot oil flows to the right side of control valve (1) in order to shift the tilt spool to the TILT BACKWARD

position. The pilot oil overcomes the force of the centering springs for the tilt spool. Then, the pilot oil forces the tilt spool to move to the left.

When the tilt spool moves to the left a path is opened for the implement oil to flow to the tilt cylinders. The implement oil for the work tool is supplied by the rear section of gear pump (10) . The implement oil flows to the tilt spool. Oil flows from the tilt spool to the rod ends of tilt cylinders (3) . The oil pressure causes the tilt cylinders to retract in order to tilt the work tool backward.

When the tilt spool moves to the left a path is also opened for the implement oil to flow from the tilt cylinders back to the hydraulic tank. As the tilt cylinders retract the oil that is in the head end of the tilt cylinders is forced out of the cylinders. The implement oil that is in the head ends of the tilt cylinders flows into the port for the head ends of the tilt cylinders that is in control valve (1) . The oil then returns to the hydraulic tank.

When the operator releases the control lever for the work tool, the control lever for the work tool will move back to the HOLD position. The plunger (29) now moves to the right. This shuts off the flow of pilot oil. Since the flow of pilot oil is blocked to the tilt spool, the centering springs for the tilt spool will move the tilt spool back to the HOLD position. Since the tilt spool is in the HOLD the tilt cylinders will stop retracting.

Refer to the Systems Operation, "Control Valve (Work Tool)" for more information on the control valve.

Accumulator

The accumulator (3) is mounted on the Control Valve (work tool) (2) . The accumulator provides a limited amount of pilot oil after the engine is shut OFF.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02093443

Pilot Valve (Joystick)

SMCS - 5059; 5705

There are two pilot valves on the machine. The two pilot valves get hydraulic oil from separate circuits. Hydraulic oil for both circuits comes from the gear pump.

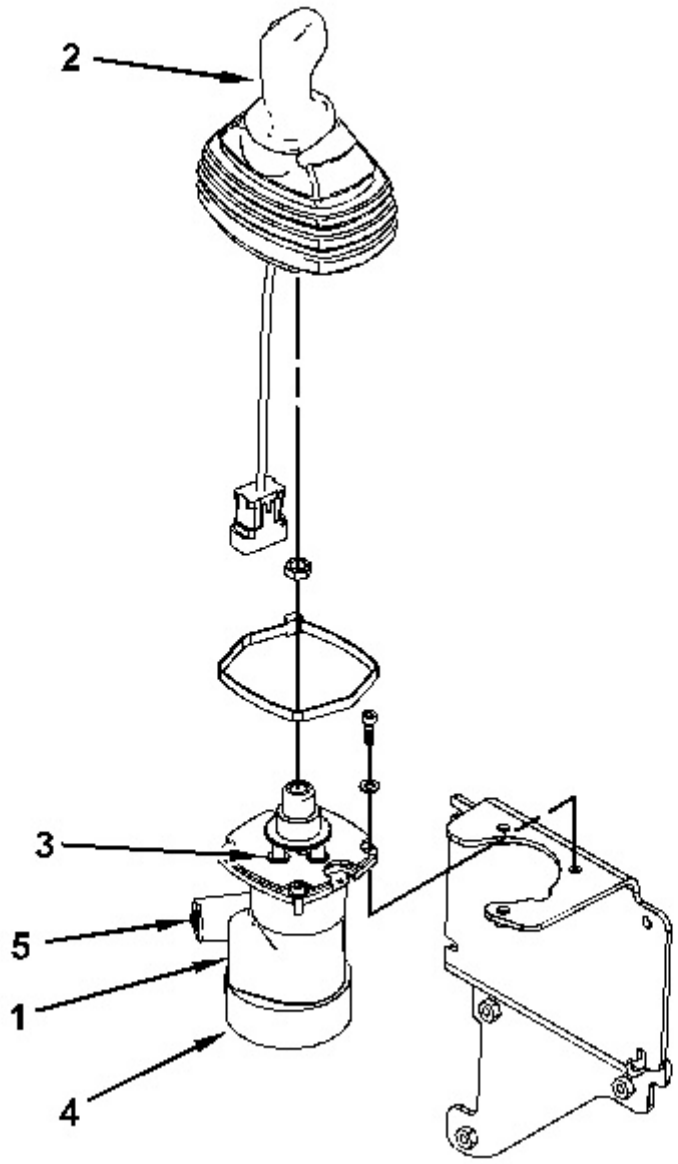


Illustration 1 g01056035

(1) Pilot valve

(2) Control lever

(3) Plungers

(4) Resolver block

(5) Solenoid valve (hydrostatic)

The first pilot valve (1) controls the motion of the machine. The control lever (2) is moved to a desired position. The plungers (3) for the pilot valve are moved by the control lever. The plungers direct the oil flow to the resolver block (4). The resolver block directs the hydraulic oil to the actuator pistons for the piston pump (hydrostatic). The solenoid valve (hydrostatic) (5) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

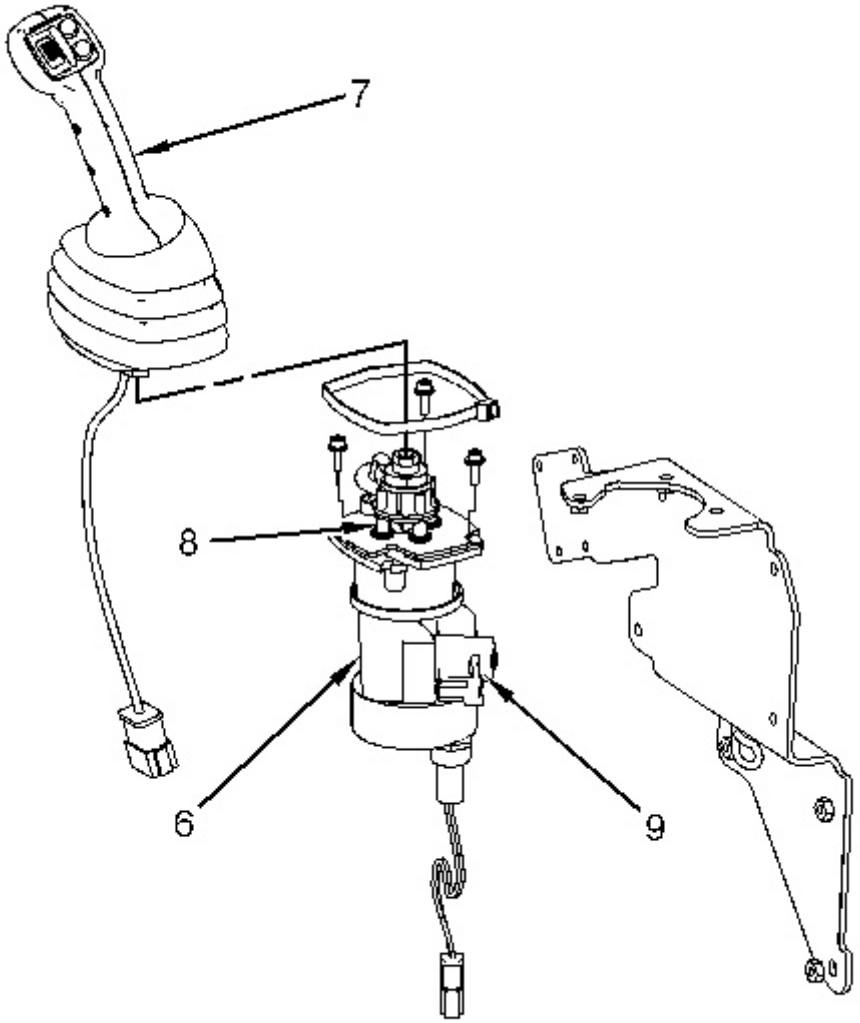


Illustration 2 g01056040

(6) Pilot valve

(7) Control lever

(8) Plungers

(9) Solenoid valve (work tool)

The second pilot valve (6) controls the motion of the work tool. The control lever (7) is moved to a desired position. The plungers (8) for the pilot valve direct the pilot hydraulic oil to the respective spool in the control valve (work tool). The work tool reacts accordingly. The solenoid valve (work tool) (9) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

The control levers on both pilot valves are spring centered. When the levers are released from any position except for the FLOAT position, the levers will return to the NEUTRAL position. The FLOAT position has a detent that keeps the pilot valve for the work tool in the FLOAT position until you move the lever. Then, the pilot valve will return to the NEUTRAL position.

Refer to the Operation and Maintenance Manual, "Operator Controls - Joystick Controls" for more information on the pilot operated hydraulic controls.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
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i02938262

Work Tool Hydraulic System

SMCS - 5050-WTL

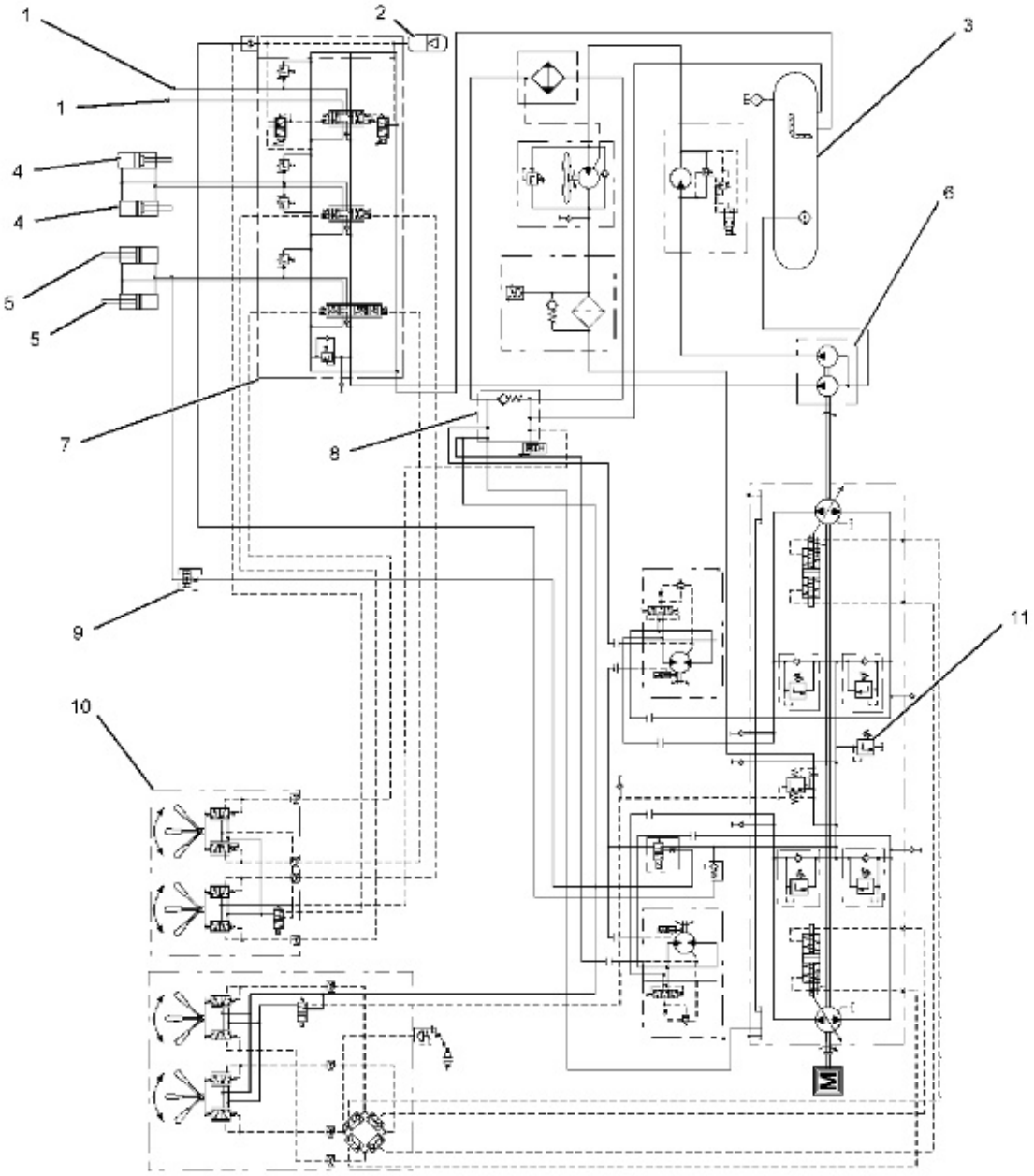


Illustration 1 g01455971

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold Group

(9) Ball Valve

(10) Pilot Valve (work tool)

(11) Relief Valve (charge oil)



Illustration 2 g01045590

(3) Hydraulic Tank Group

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

Gear pump (6) supplies the work tool hydraulic system with oil. Pump (6) is mounted to the front end of the piston pump for the hydrostatic system. Pump (6) is splined to the drive shaft of the piston pump for the hydrostatic system. The piston pump for the hydrostatic system is mounted to the engine. When the engine speed increases, the speed of pump (6) increases. This causes pump (6) to pump more oil to the work tool hydraulic system.

The rear section of gear pump (6) continuously pumps oil through control valve (7). Control valve (7) is an open center control valve. The oil pressure for control valve (7) is regulated by a main relief valve that is installed in control valve (7) .

The pilot oil for the work tool hydraulic system is supplied by the front section of pump (6). Oil flows out of the front section of pump (6) to the motor for the air conditioner. From the motor for the air conditioner, the oil flows to the fan drive motor. The oil flows through the fan drive motor to the oil filter. From the oil filter, the oil flows to the front section of the piston pump for the hydrostatic system. At the piston pump, the hydraulic oil flows passed the speed sensing valve. In order for the oil to flow to pilot valve (10), all three of the interlocks must be disengaged. In order for oil to flow to pilot valve (10), the hydraulic enable solenoid must be energized.

When the electrical requirements are complete, pilot oil will flow through a check valve to the accumulator (2). The pilot oil is used to charge the accumulator (2). The pilot oil will also flow to the pilot valve (10). When pilot valve (10) is activated, oil will be directed to control valve (7) in order to shift a control spool to the desired position. Once a control spool shifts, high pressure oil from pump (6) will flow to the selected work tool. Relief valve (11) maintains the pressure for the pilot oil system. Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

Hydraulic System for the Lift Arms Without the Diverter Valve (If Equipped)

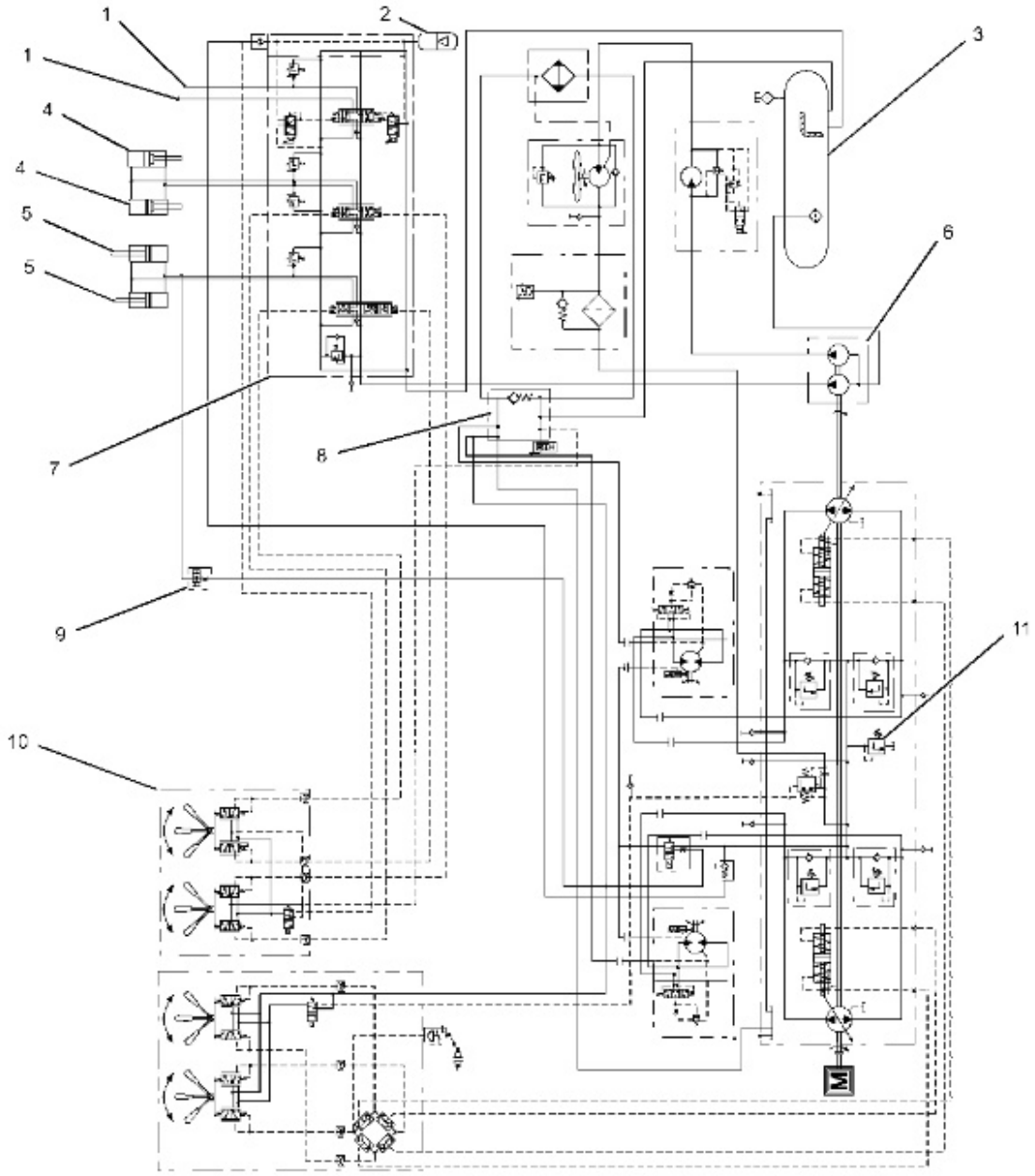


Illustration 3 g01455977

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold

(9) Ball Valve

(10) Pilot Valve (work tool)

(11) Relief Valve (charge oil)

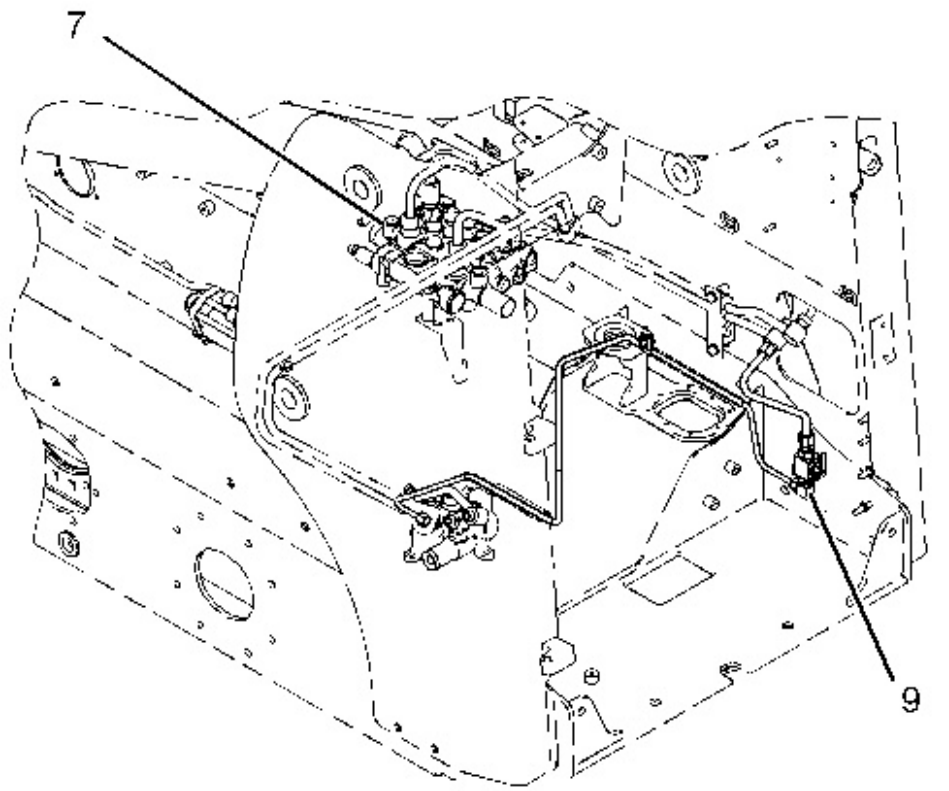


Illustration 4 g01455984

(7) Control Valve (work tool)

(9) Ball Valve

When the control lever for the work tool is moved to the RAISE position, pilot oil flows to the left side of the lift spool that is part of the control valve (7). The pilot oil causes the lift spool to shift to the right.

Hydraulic oil flows from gear pump (6) into control valve (7). The oil then flows past the lift spool and into the line for the head end of the lift cylinders (5) .

As oil forces the rods of the lift cylinders to extend, oil is forced out of the rod end of the cylinders. The oil that flows from the rod ends of the cylinders flows to the lift spool. The oil then flows to the tilt spool that is part of control valve (7) .

When the control lever for the work tool is moved to the LOWER position, pilot oil flows to the right side of the lift spool that is part of control valve (7). The pilot oil causes the lift spool to shift to the left. Hydraulic oil flows from gear pump (6) through the spool and into the line for the rod end of the lift cylinders.

As oil forces the rods to retract, the oil is forced out of the head end of the cylinders. The oil flows to the lift spool. The oil then flows to the tilt spool that is part of control valve (7) .

When the control lever for the work tool is moved to the FLOAT position, pilot oil flows to the right side of the lift spool that is part of control valve (7). The pilot oil causes the lift spool to shift fully to the left. With the spool in this position, the spool opens the rod ends of both of the lift cylinders and the head ends of both of the lift cylinders to the hydraulic tank (3). The weight of the work tool will cause the work tool to lower to the ground. The work tool will then follow the contour of the ground. Supply oil from the gear pump will continue to flow into control valve (7). The tilt spool may be operated when the lift spool is in the FLOAT position.

In the event of engine failure, the ball valve (9) is used in order to manually lower the lift arms. Ball valve (9) allows oil to drain out of the head end of the lift cylinders. The hydraulic oil flow is directed to manifold (8) .

Hydraulic System for the Lift Arms with the Diverter Valve (If Equipped)

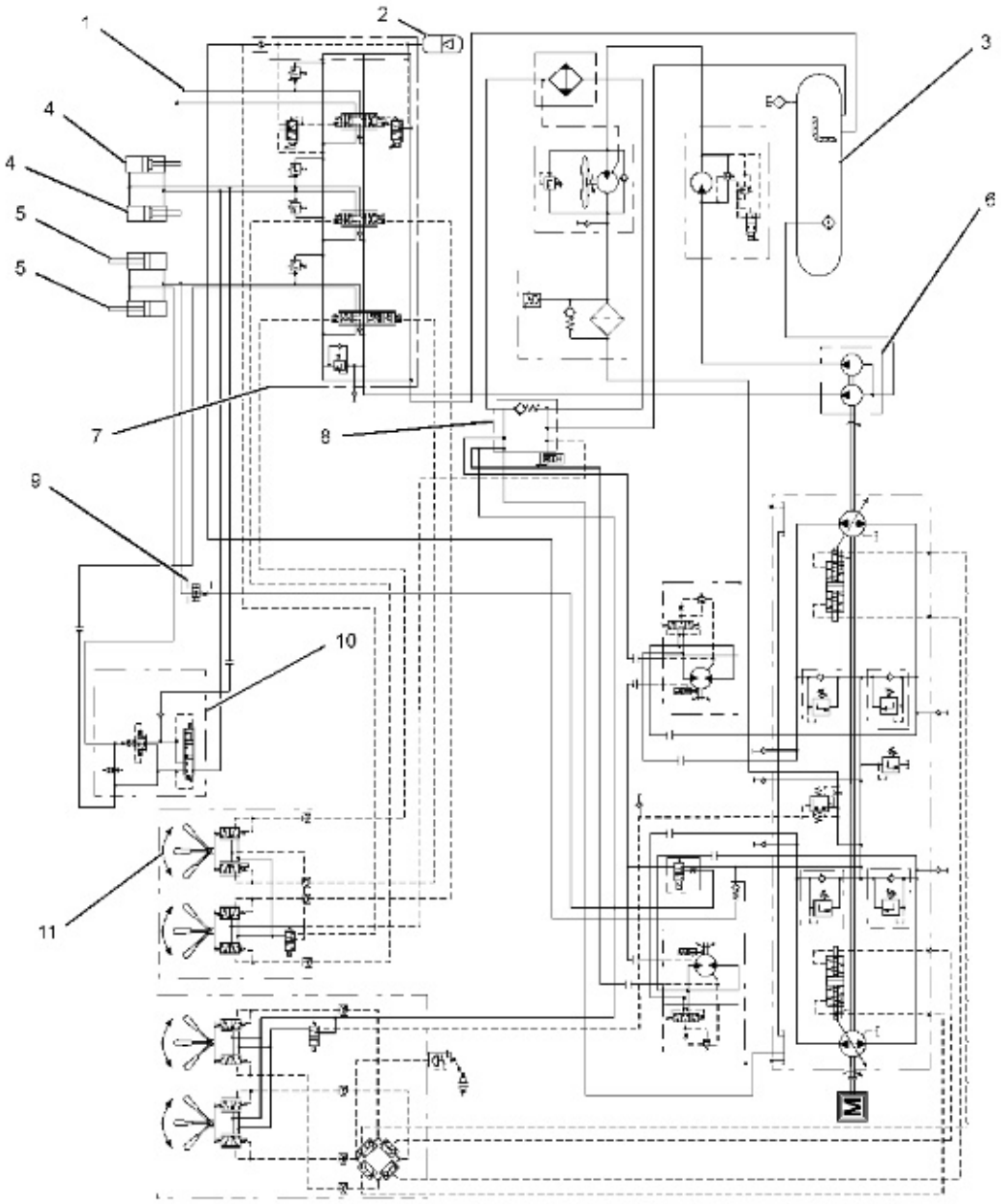


Illustration 5 g01455990

Work Tool Hydraulic System

(1) Quick disconnects for the auxiliary circuit

(2) Accumulator

(3) Hydraulic Tank Group

(4) Tilt Cylinder Group

(5) Lift Cylinders

(6) Gear Pump (charge oil, work tool, air conditioner and fan drive)

(7) Control Valve (work tool)

(8) Return Manifold

(9) Ball Valve

(10) Diverter Valve

(11) Pilot Valve (work tool)

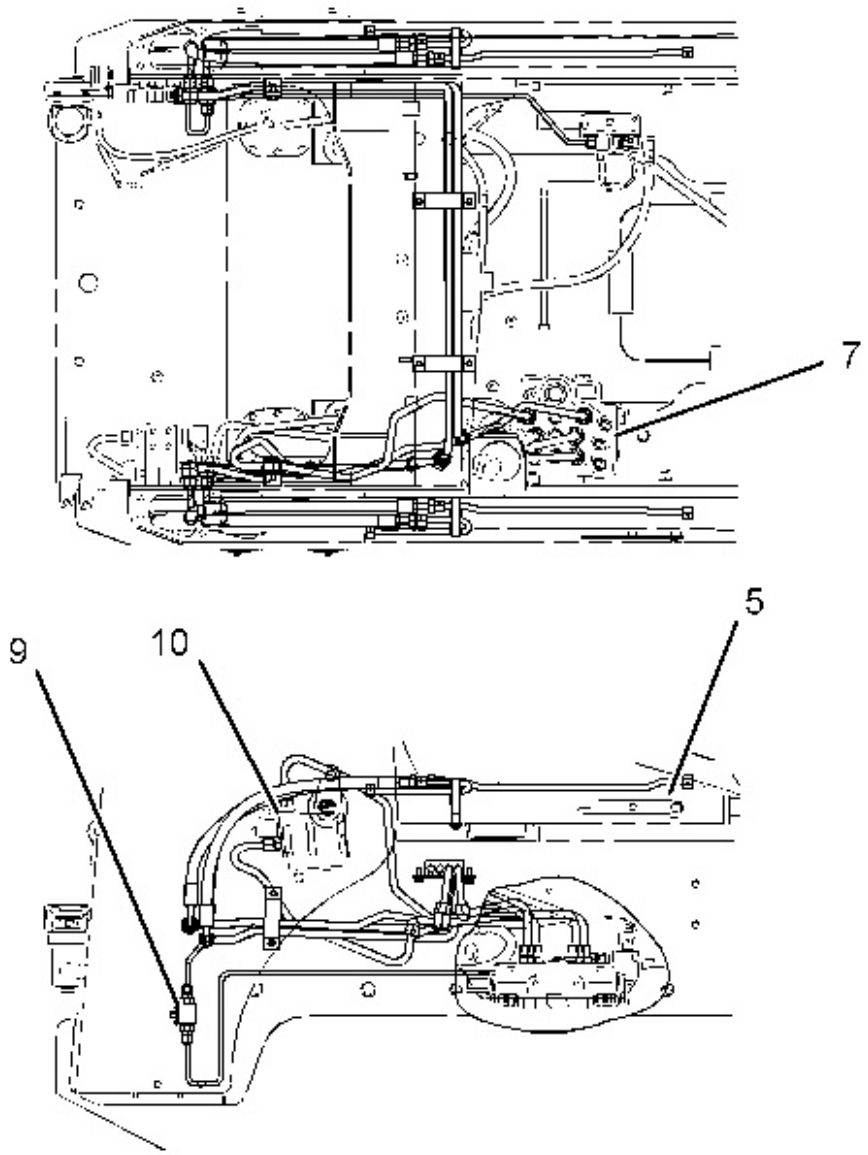


Illustration 6 g01455996

(5) Lift Cylinders

(7) Control Valve (work tool)

(9) Ball Valve

(10) Diverter Valve

When the pilot valve (11) is moved to the RAISE position, the lift spool in control valve (7) is shifted to the RAISE position by pilot oil. Hydraulic oil flows from the gear pump (6) through the lift spool and into the line for the head end of the lift cylinders (4). The oil from the rod end of the lift cylinders

flows to the diverter valve (10). The pressure from the rod end of the lift cylinders is balanced with the pressure from the head end of the tilt cylinders. This causes the work tool to remain level while the lift arms are raised. From the diverter valve, the oil flows to the lift spool. The oil then flows to the tilt spool.

The diverter valve only affects the RAISE function. The LOWER function is not affected by the diverter valve.

In the LOWER position, oil flows from the spool to the diverter valve. From the diverter valve, the oil flows to the rod end of the cylinders. The oil pushes on the piston. The cylinders retract. Oil from the head end of the cylinders flows to the lift spool. Then, the oil flows to the tilt spool.

For information on the operation of the diverter valve, refer to the Systems Operation, "Diverter Valve".

The ball valve (9) is used for manual lowering of the lift arms. The ball valve allows oil to drain out of the head end of the lift cylinders. The hydraulic oil flow is directed to the return manifold (8). The ball valve should be used to lower the lift arms when the engine fails.

Tilt and Auxiliary Hydraulic System

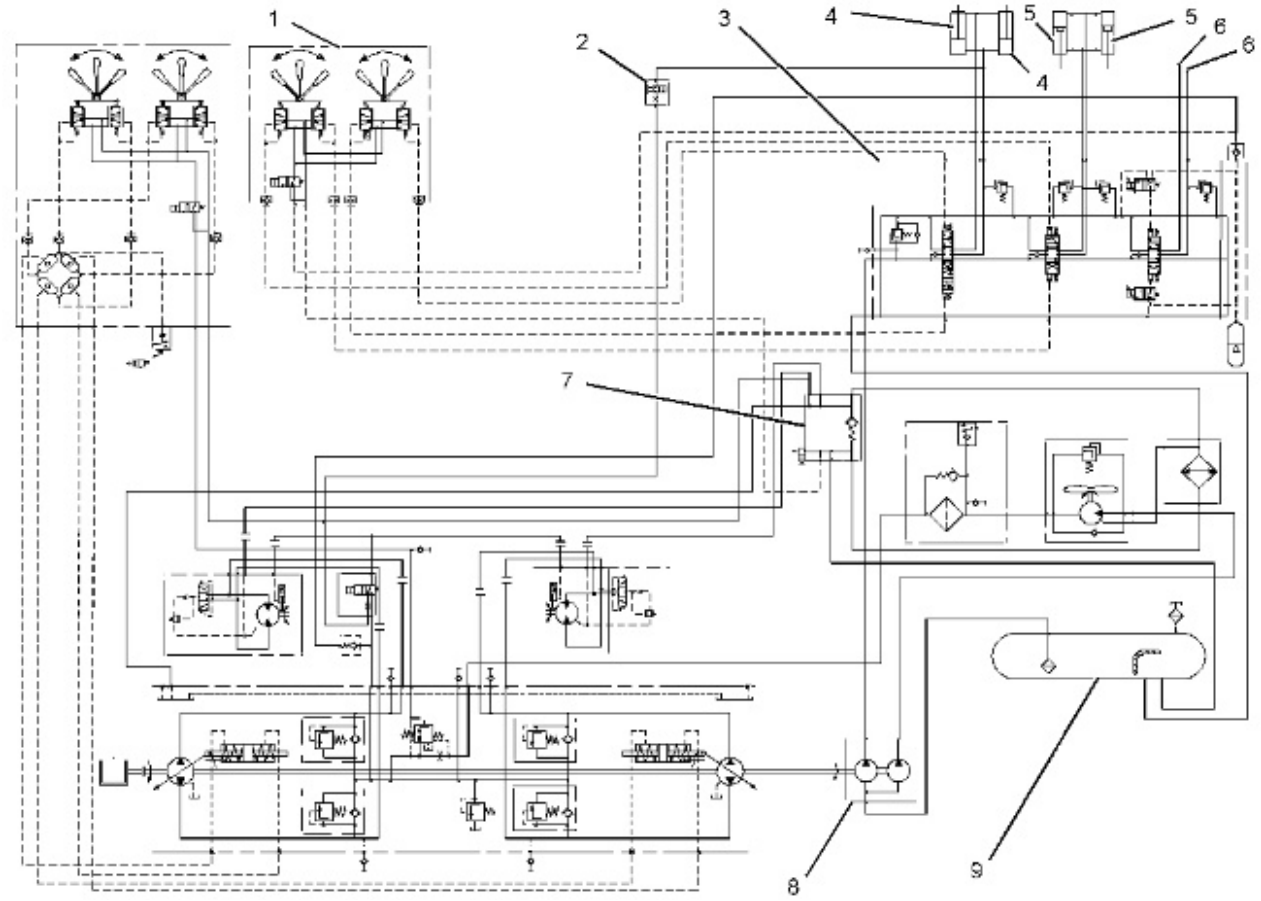


Illustration 7 g01456005

(1) Pilot valve (work tool)

(2) Ball valve (manual work tool lowering)

(3) Control valve (work tool)

(4) Lift cylinders

(5) Tilt cylinders

(6) Auxiliary couplings

(7) Return manifold

(8) Gear pump

(9) Hydraulic tank

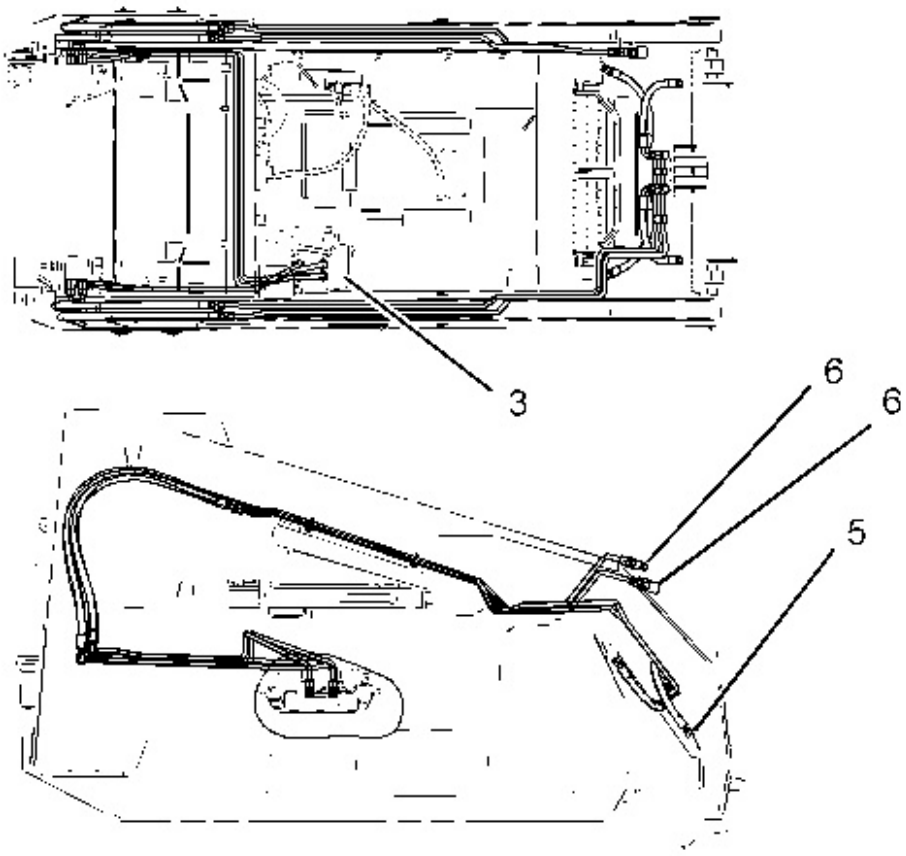


Illustration 8 g01456020

(3) Control valve (work tool)

(5) Tilt cylinders

(6) Auxiliary couplings

The hydraulic oil is directed to the tilt spool in the control valve (3) by the pilot valve (1). The end of the spool that receives the pilot oil depends on the position of the pilot valve (1) .

As the spool is shifted, hydraulic oil flows through the tilt spool and into both of the tilt cylinders.

If the machine is equipped with a diverter valve, the tilt cylinders will also be connected to the diverter valve. The diverter valve acts as a load leveler. The diverter valve is used only when the lift cylinders are being raised.

Pilot oil is directed to the auxiliary circuit spool that is located in the control valve (3) by the auxiliary circuit switch. The auxiliary circuit switch is located on the pilot valve (1) .

The pilot oil for the auxiliary circuit does not flow through the pilot valve (1). When the auxiliary circuit switch is pressed, one of the modulating valves in the control valve (3) will shift. This causes the auxiliary circuit spool to shift. Oil can then flow from the gear pump (8) to auxiliary couplings (6) .

For more information on the operation of the tilt and auxiliary hydraulic system, refer to the Systems Operation, "Control Valve (Work Tool)".

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
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i02090259

Control Valve (Work Tool)

SMCS - 5051

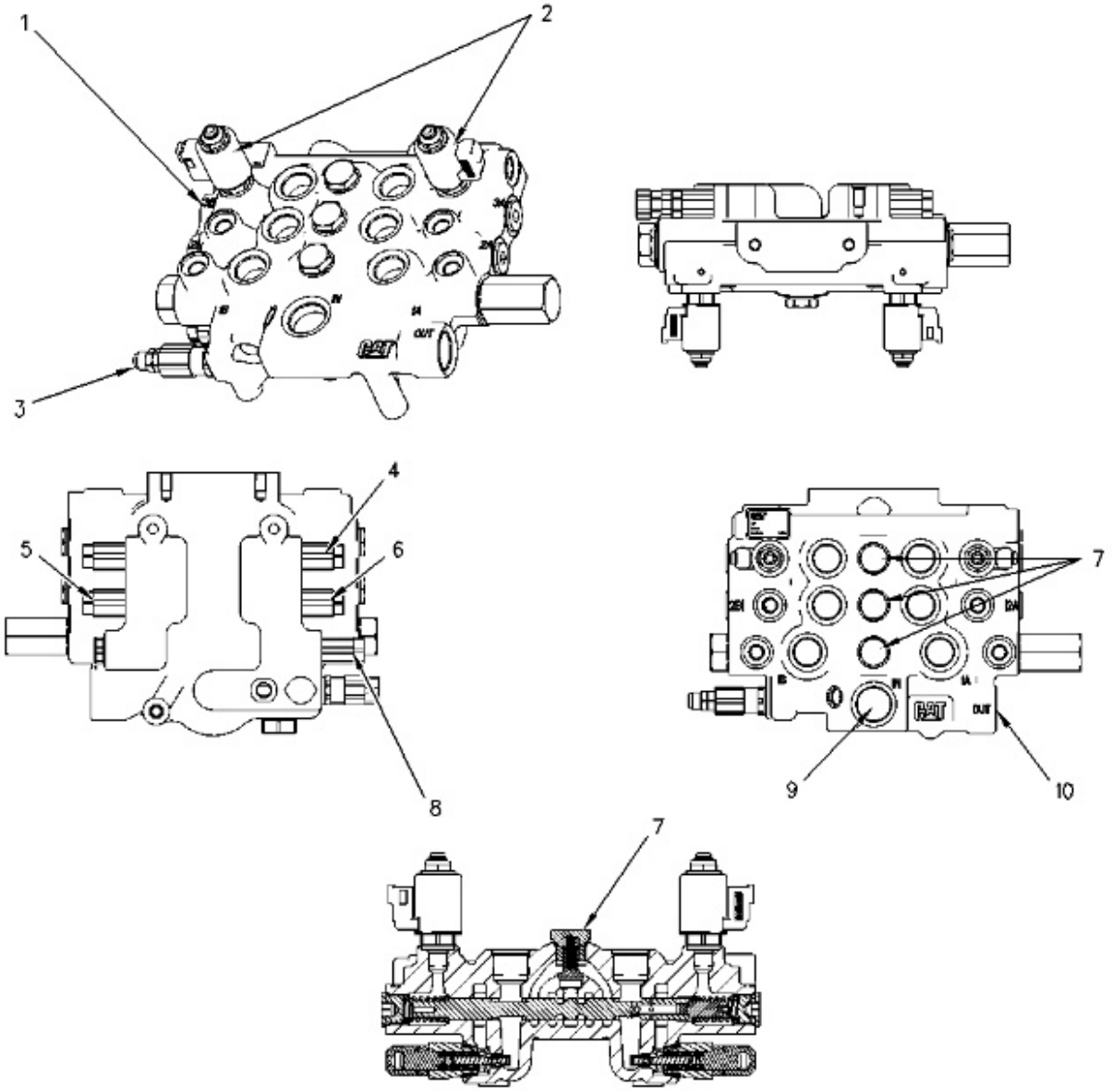


Illustration 1 g00884433

(1) Control valve (work tool)

(2) Modulating valve (auxiliary)

(3) Main relief valve

(4) Auxiliary relief valve

(5) Relief valve for the rod end of the tilt cylinder

(6) Relief valve for the head end of the tilt cylinder

(7) Check valves

(8) Lift cylinder relief valve

(9) Inlet

(10) Outlet

The control valve (work tool) (1) is open center. If the pilot operated hydraulic control (work tool) is not moved, oil flows into the inlet (9), past each of the spools and out of the outlet (10) to the tank.

Lift Control Section

HOLD Position

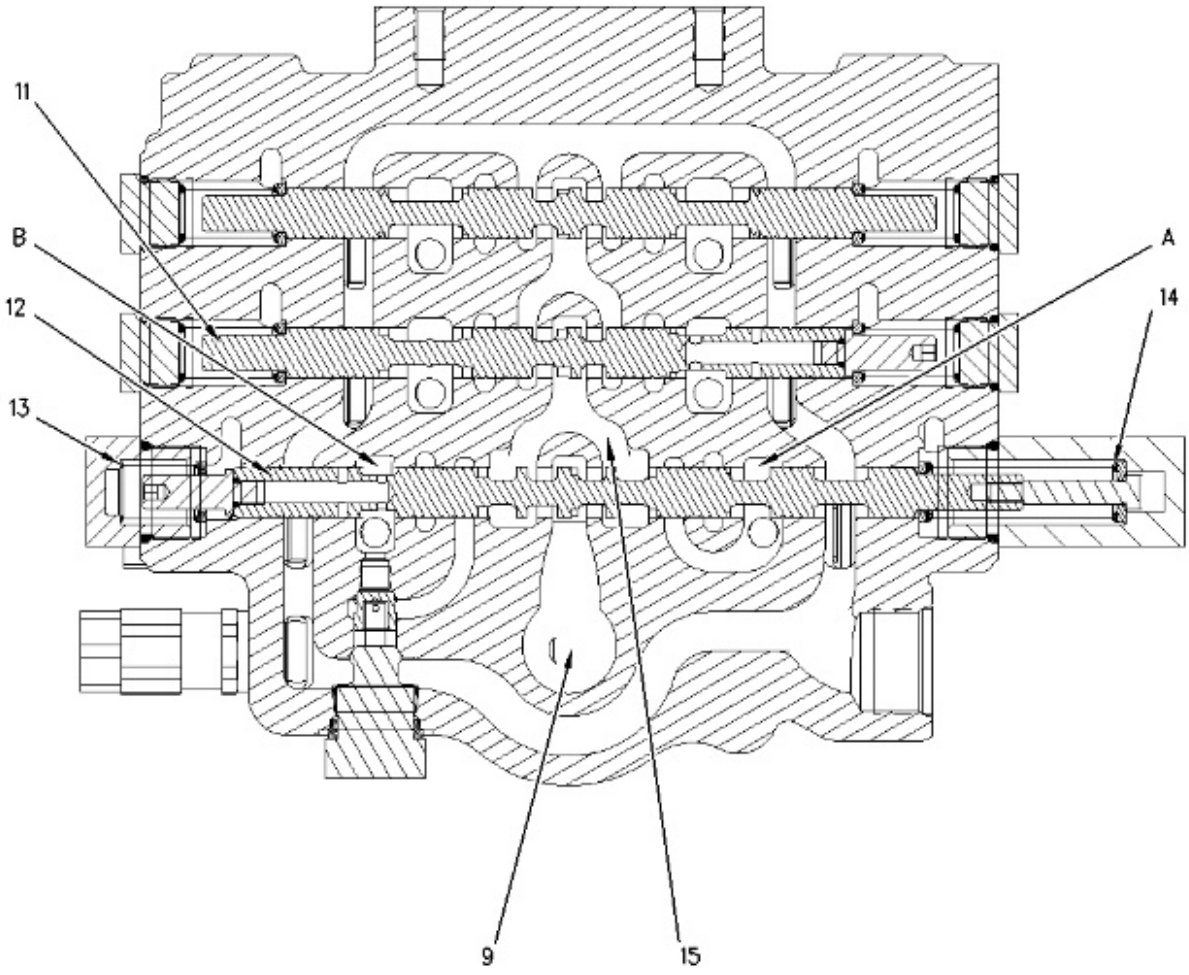


Illustration 2 g00763045

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(13) Spring

(14) Spring

(15) Central passage

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The spring (14) keeps the spool centered because the pilot oil is not flowing to the spool. No movement in the lift cylinders occurs.

RAISE Position

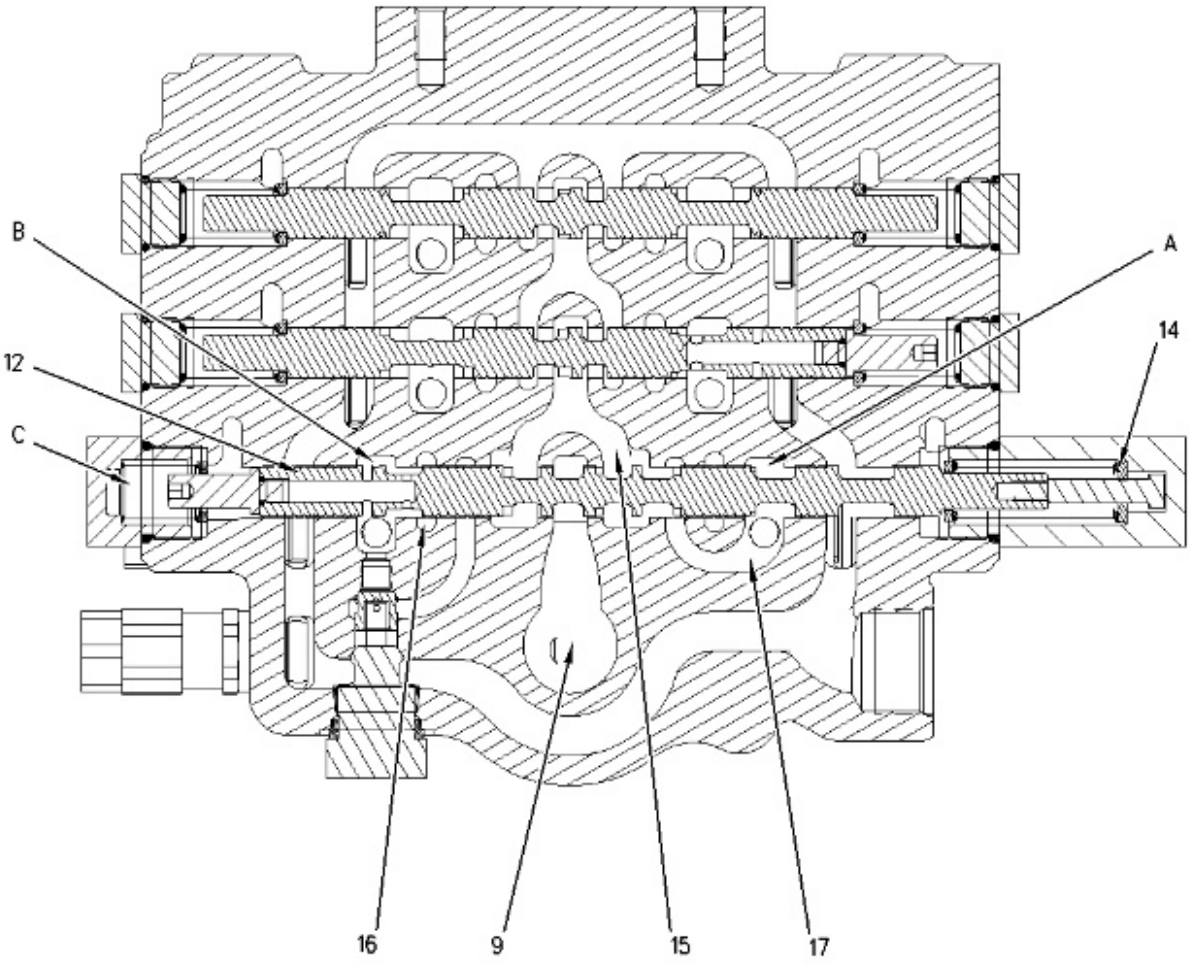


Illustration 3 g00763572

(9) Inlet

(12) Lift control spool

(14) Spring

(15) Central passage

(16) Passage

(17) Passage

(A) Port

(B) Port

(C) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the RAISE position, pilot oil (C) flows from the hydraulic control to the lift control spool. The pilot oil forces the spool (12) to move to the right against the force of the spring (14) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (16) and around the spool to port (B). From port (B), oil flows to the head ends of the lift cylinders in order to raise the lift arms.

Oil that is returning from the rod ends of lift cylinders flows into port (A) and through the passage (17) into the central passage (15) .

When the pilot operated hydraulic control (work tool) is released from the RAISE position pilot oil (C) stops flowing and the spring (14) shifts the spool back to the HOLD position.

LOWER Position

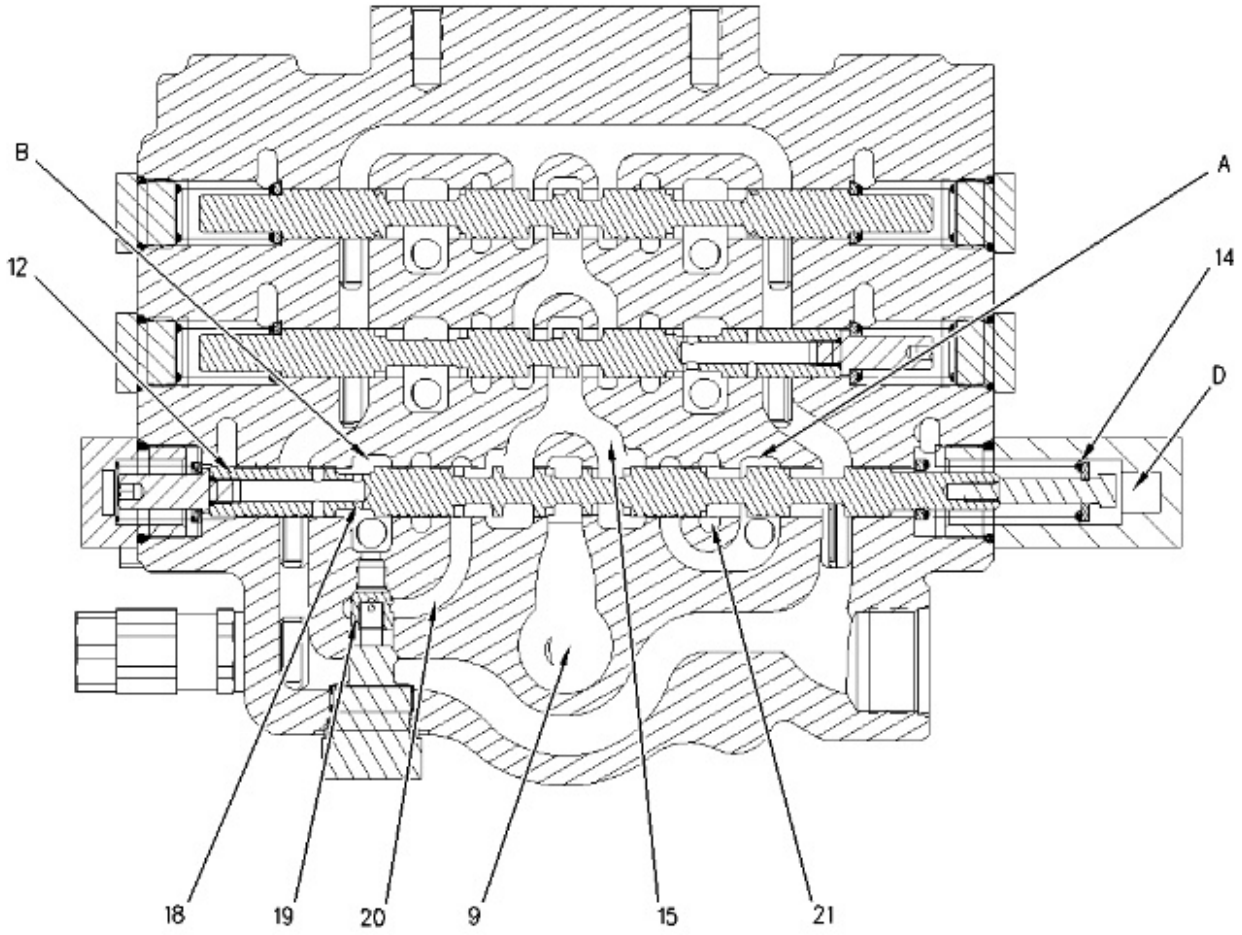


Illustration 4 g00763574

(9) Inlet

(12) Lift control spool

(14) Spring

(15) Central passage

(18) Orifice

(19) Poppet valve

(20) Passage

(21) Passage

(A) Port

(B) Port

(D) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the LOWER position, pilot oil (D) flows from the hydraulic control to the lift control spool (12). The pilot oil forces the spool to move to the left against the force of the spring (14) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (21) and around the spool to port (A). From port (A), oil flows to the rod ends of the lift cylinders in order to lower the lift arms.

Oil that is returning from the head ends of lift cylinders flows into port (B). The oil then flows through the orifice (18). Then, the oil builds pressure in order to open the poppet valve (19). The oil flows through the passage (20) into the central passage (15) .

When the pilot operated hydraulic control (work tool) is released from the LOWER position pilot oil (D) stops flowing and the spring (14) shifts the spool back to the HOLD position.

FLOAT Position

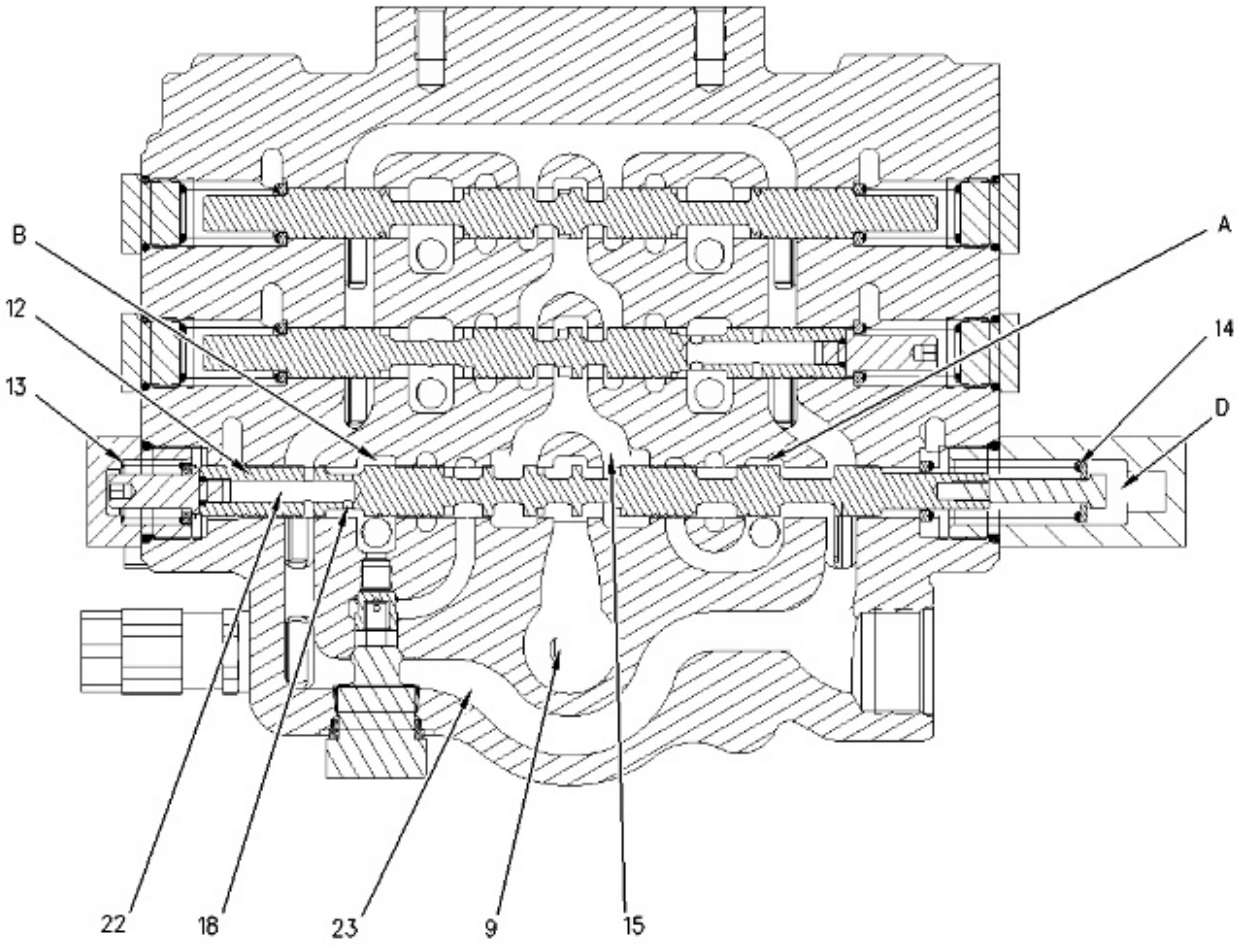


Illustration 5 g00763581

(9) Inlet

(12) Lift control spool

(13) Spring

(14) Spring

(15) Central passage

(18) Orifice

(22) Internal passage

(23) Return passage

(A) Port

(B) Port

(D) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the FLOAT position, pilot oil (D) flows from the hydraulic control to the lift control spool (12). The pilot oil forces the spool to move to the left against the force of the springs (13) and (14) .

Oil continues to flow from the inlet (9) through the central passage (15). Oil that is in the rod ends of the lift cylinders can flow to the tank through port (A). Oil that is in the head ends of the lift cylinders can flow through port (B) and through the orifice (18). The oil can then flow through the internal passage (22) to the tank passage (23). The work tool will lower to the ground and the work tool will follow along the contour of the ground.

The pilot operated hydraulic control (work tool) will remain in the FLOAT position until the operator moves the hydraulic control. The hydraulic control will then return to the HOLD position.

Tilt Control Section

HOLD Position

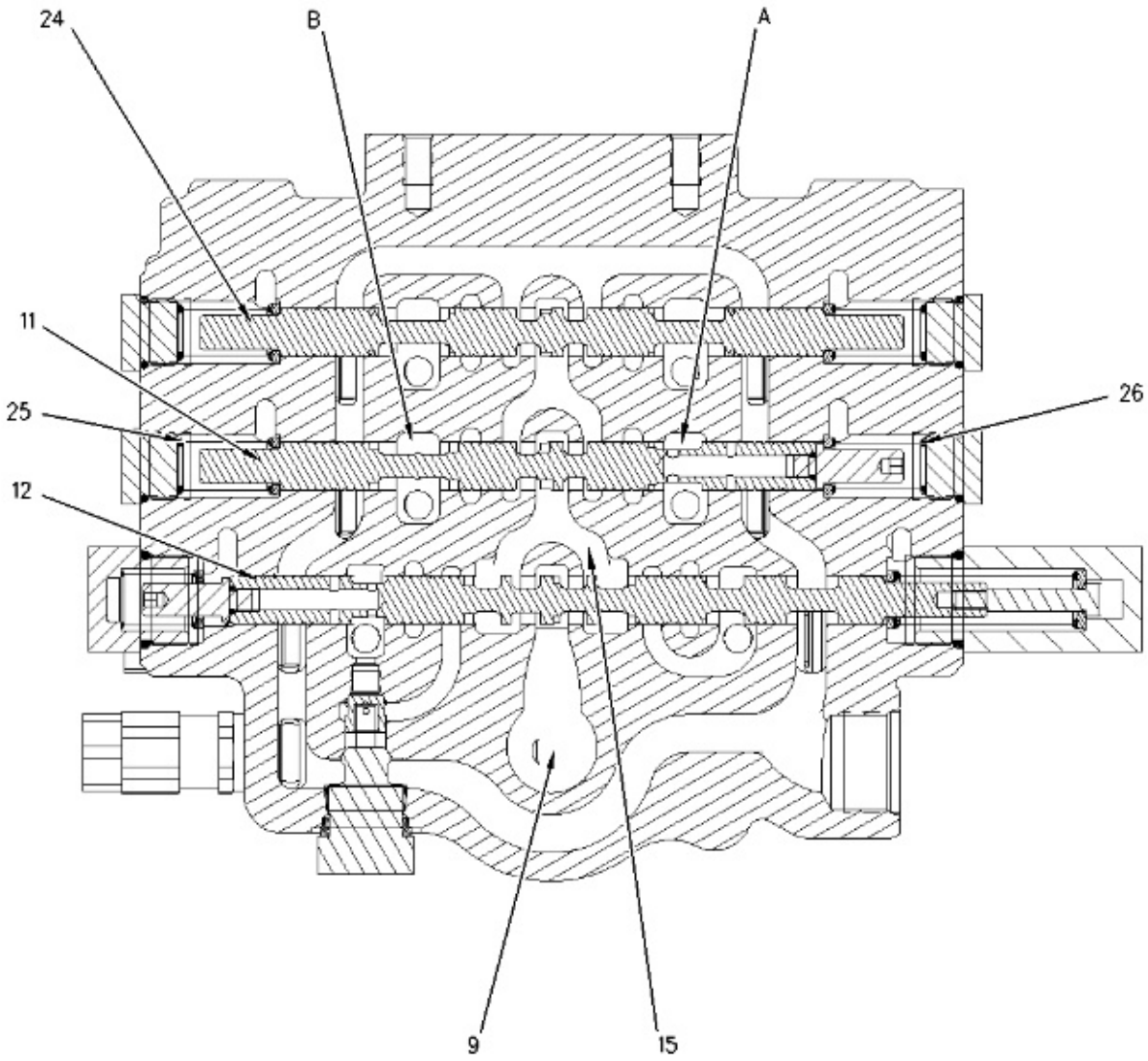


Illustration 6 g00770078

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(15) Central passage

(24) Auxiliary circuit spool

(25) Spring

(26) Spring

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15). From the tilt control spool, the oil flows to the auxiliary circuit spool (24) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The springs (25) and (26) keep the spool centered because the pilot oil is not flowing to the spool. No movement in the tilt cylinders occurs.

TILT FORWARD Position

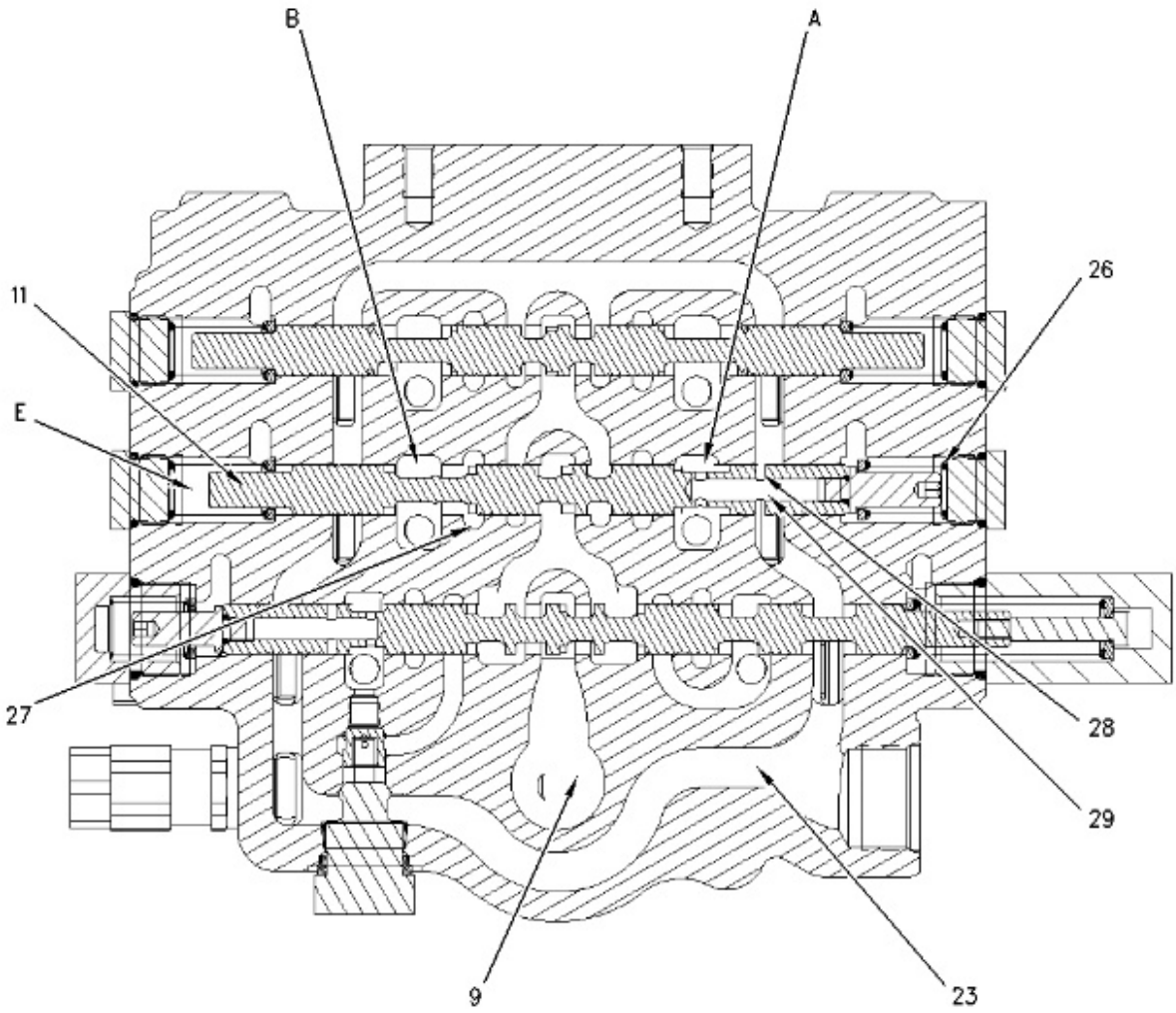


Illustration 7 g00763583

(9) Inlet

(11) Tilt control spool

(23) Tank passage

(26) Spring

(27) Passage

(28) Orifice

(29) Internal passage

(A) Port

(B) Port

(E) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the TILT FORWARD position, pilot oil (E) flows from the hydraulic control to the tilt control spool (11). The pilot oil forces the spool to move to the right against the force of the spring (26) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the tilt circuit and flows through the passage (27) and around the spool to port (B). From port (B), oil flows to the head ends of the tilt cylinders in order to tilt the work tool forward.

Oil that is returning from the rod ends of tilt cylinders flows into port (A) and through the orifice (28). Then, the oil flows through the internal passage (29) into the tank passage (23) .

When the hydraulic control is released from the TILT FORWARD position, pilot oil (E) stops flowing and the spring (26) shifts the spool back to the HOLD position.

TILT BACK Position

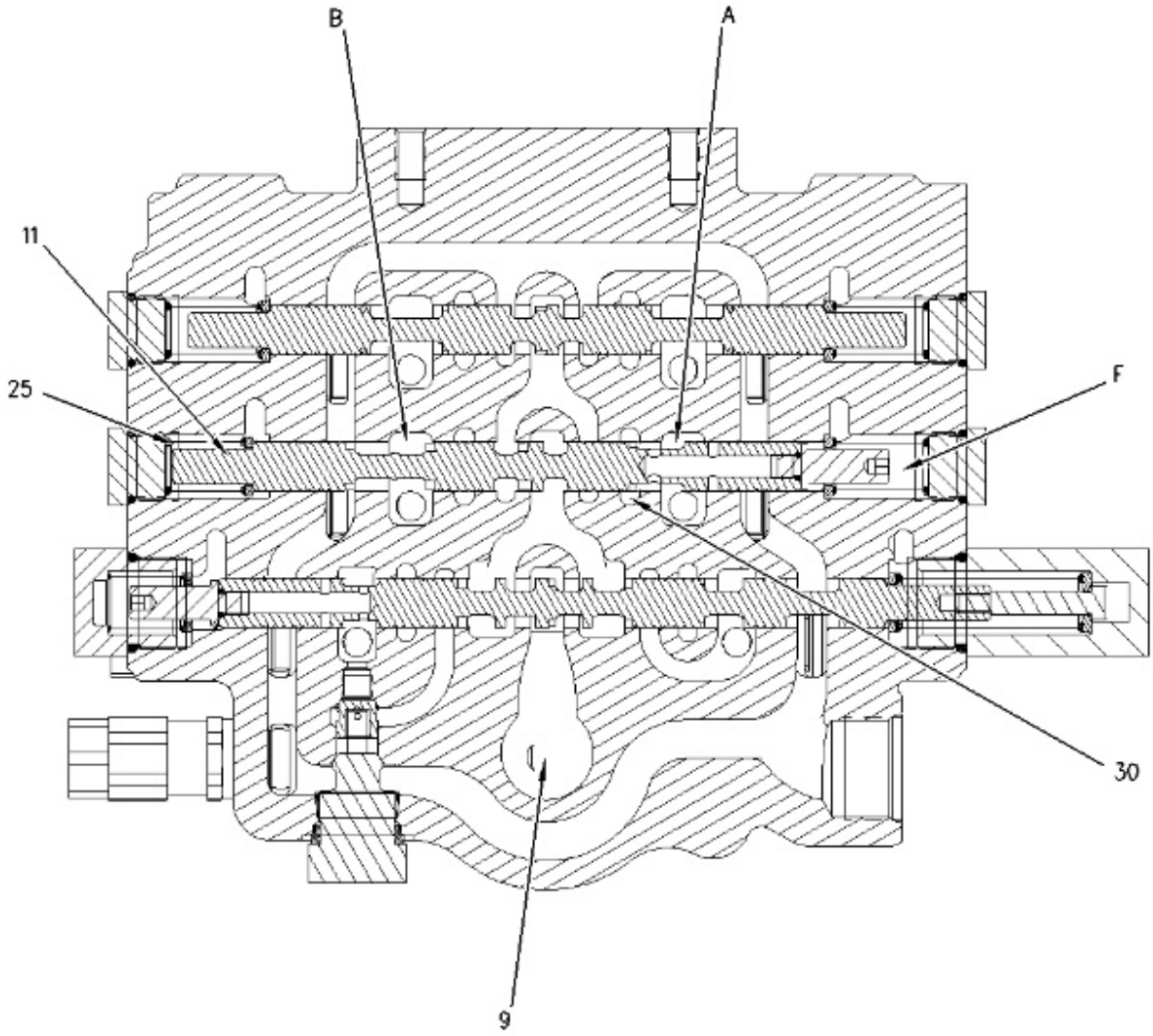


Illustration 8 g00763586

(9) Inlet

(11) Tilt control spool

(25) Spring

(30) Passage

(A) Port

(B) Port

(F) Pilot oil from the pilot operated hydraulic control (work tool)

When the pilot operated hydraulic control (work tool) is moved to the TILT BACK position pilot oil (F) flows from the hydraulic control to the tilt control spool (11). The pilot oil forces the spool to move to the left against the force of the spring (25) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the lift circuit and flows through the passage (30) and around the spool to port (A). From port (A), oil flows to the rod ends of the tilt cylinders. This causes the work tool to tilt back.

Oil that is returning from the head ends of tilt cylinders flows into port (B) and around the spool to the tank passage (23) .

When the hydraulic control is released from the TILT BACK position pilot oil (F) stops flowing and the spring (25) shifts the spool back to the HOLD position.

Auxiliary Control Section

HOLD Position

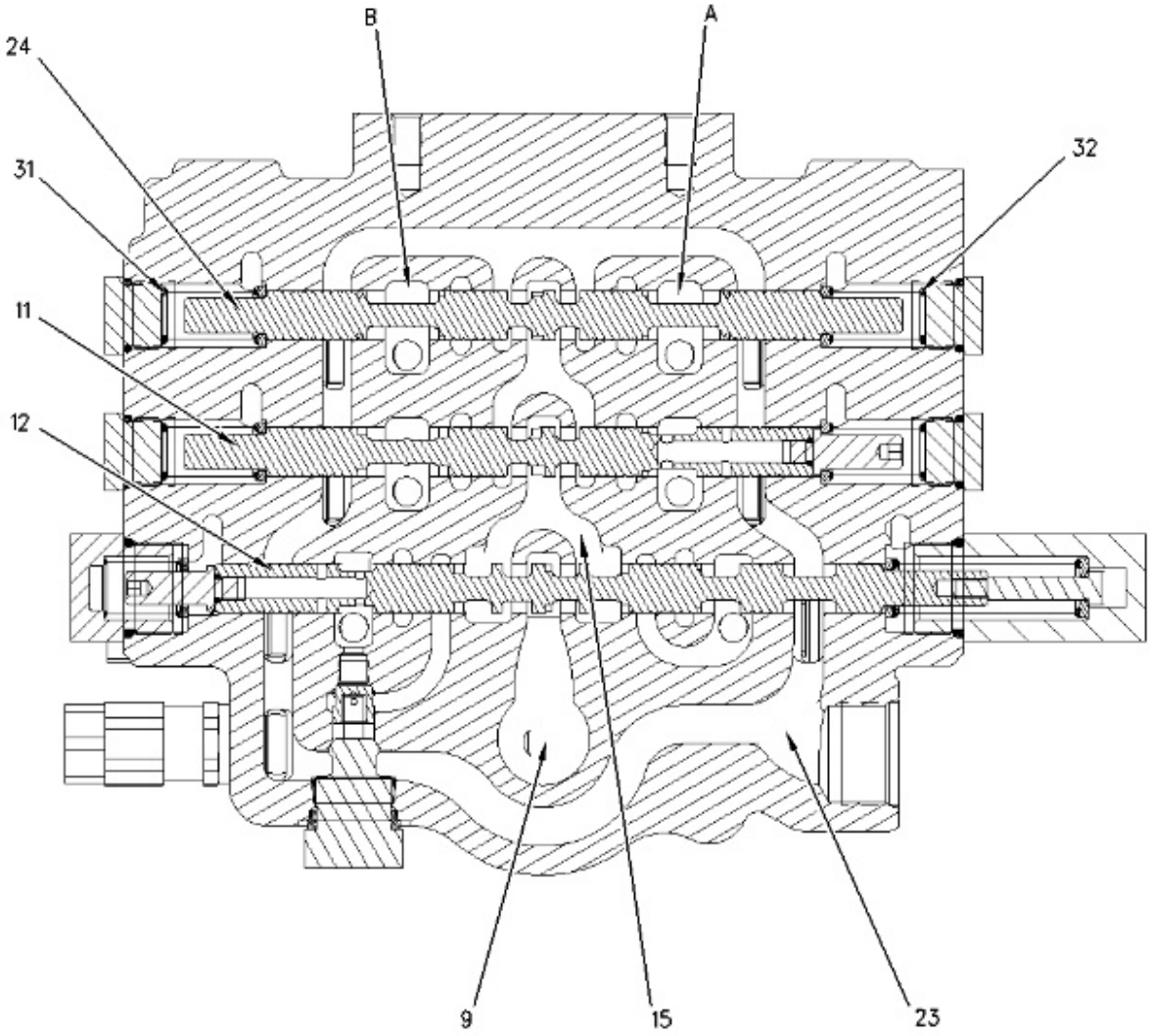


Illustration 9 g00770080

(9) Inlet

(11) Tilt control spool

(12) Lift control spool

(15) Central passage

(23) Tank passage

(24) Auxiliary circuit spool

(31) Spring

(32) Spring

(A) Port

(B) Port

When the pilot operated hydraulic control (work tool) is in the HOLD position and the auxiliary circuit switch is not activated, oil flows from the inlet (9), around the lift control spool (12), and to the tilt control spool (11) through the central passage (15). From the tilt control spool, the oil flows to the auxiliary circuit spool (24). Then, the oil flows to the tank passage (23) .

The spool blocks the oil from entering any of the passages. Oil cannot flow to ports (A) or (B). The springs (31) and (32) keep the spool centered because the pilot oil is not flowing to the spool. No oil flows in the auxiliary circuit.

POSITION ONE

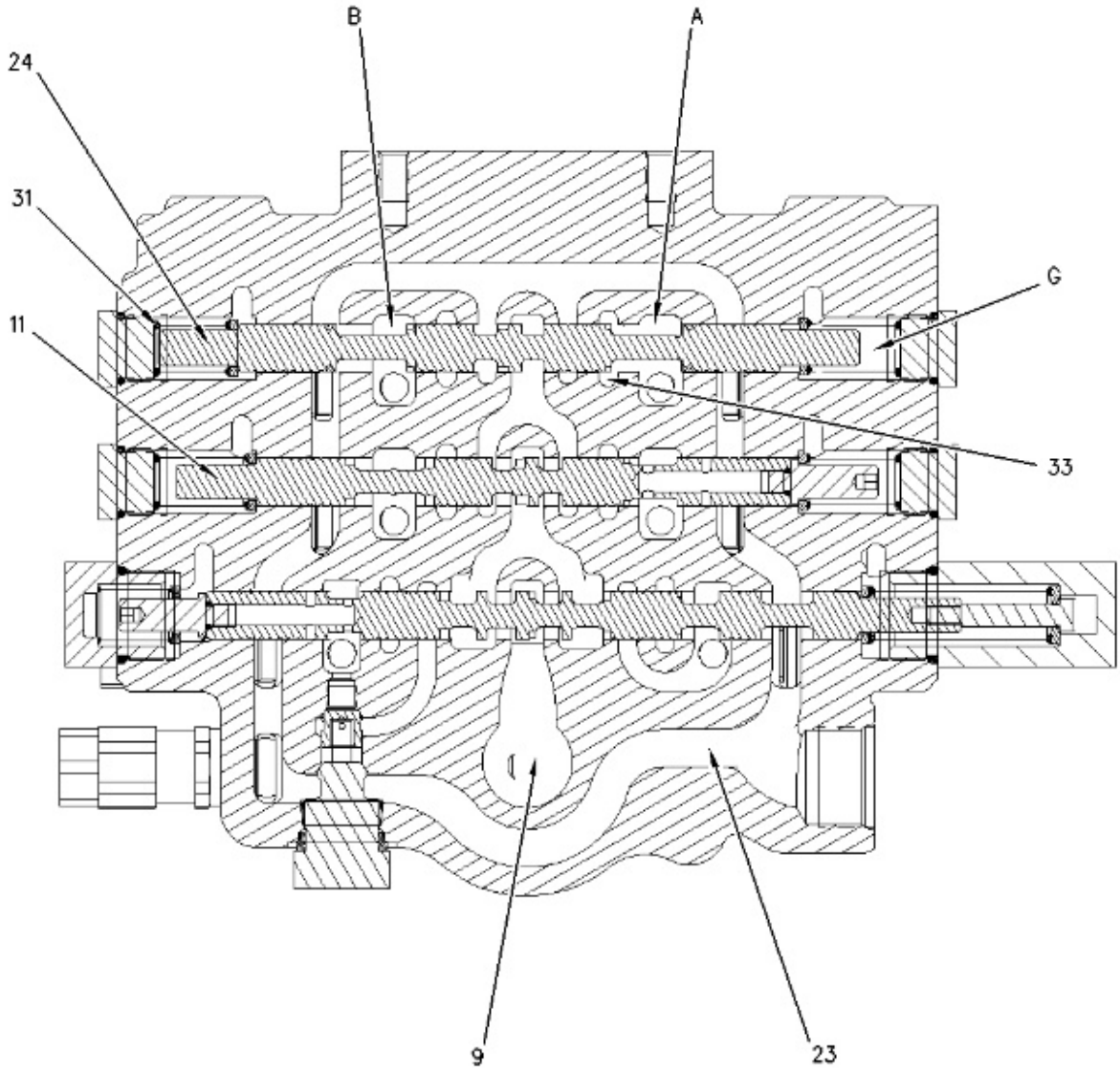


Illustration 10 g00763588

(9) Inlet

(11) Tilt control spool

(23) Tank passage

(24) Auxiliary circuit spool

(31) Spring

(33) Passage

(A) Port

(B) Port

(G) Pilot oil from the modulating valve (auxiliary)

When the left side of the auxiliary switch is pressed, pilot oil (G) flows from the modulating valve (auxiliary) to the auxiliary spool (24). The pilot oil forces the spool to move to the left against the force of the spring (31) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the auxiliary circuit and flows through the passage (33) and around the spool to port (A). From port (A), oil flows to the lower auxiliary connection.

Oil that is returning from the upper auxiliary connection flows into port (B) and around the spool to the tank passage (23) .

When the switch is released, pilot oil (G) stops flowing and the spring (31) shifts the spool back to the HOLD position.

POSITION TWO

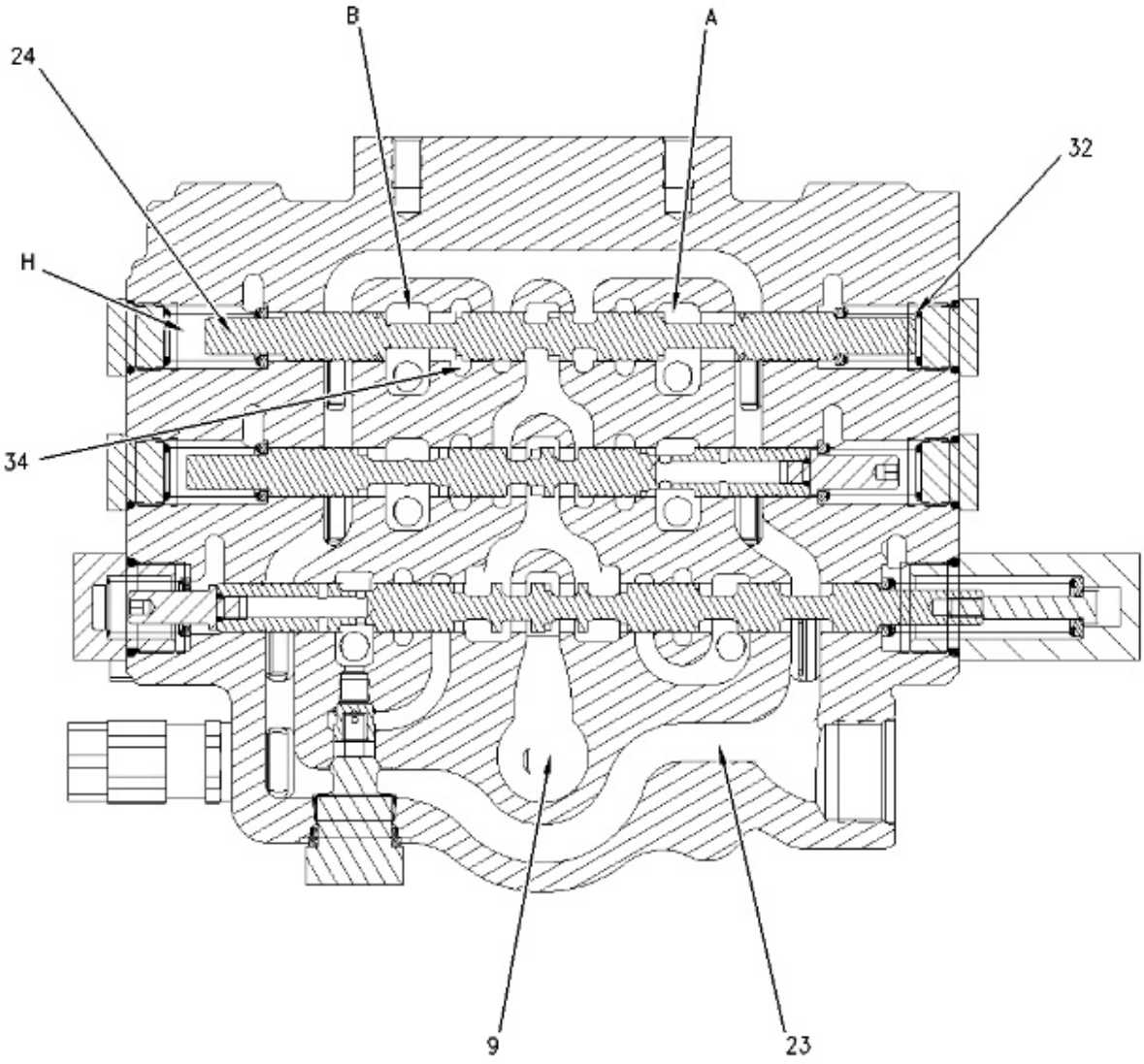


Illustration 11 g00763594

(9) Inlet

(23) Tank passage

(24) Auxiliary circuit spool

(32) Spring

(34) Passage

(A) Port

(B) Port

(H) Pilot oil from the modulating valve (auxiliary)

When the right side of the auxiliary switch is pressed, pilot oil (H) flows from the modulating valve (auxiliary) to the auxiliary spool (24). The pilot oil forces the spool to move to the right against the force of the spring (32) .

Oil is blocked from the inlet (9) by the spool. The oil opens the check valve (7) in Illustration 1 for the auxiliary circuit and flows through the passage (34) and around the spool to port (B). From port (B), oil flows to the upper auxiliary circuit connection.

Oil that is returning from the lower auxiliary connection flows into port (A) and around the spool to the tank passage (23) .

When the switch is released, pilot oil (H) stops flowing and the spring (32) shifts the spool back to the HOLD position.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02932995

Control Manifold and Solenoid (Work Tool Positioner)

SMCS - 5264; 5479

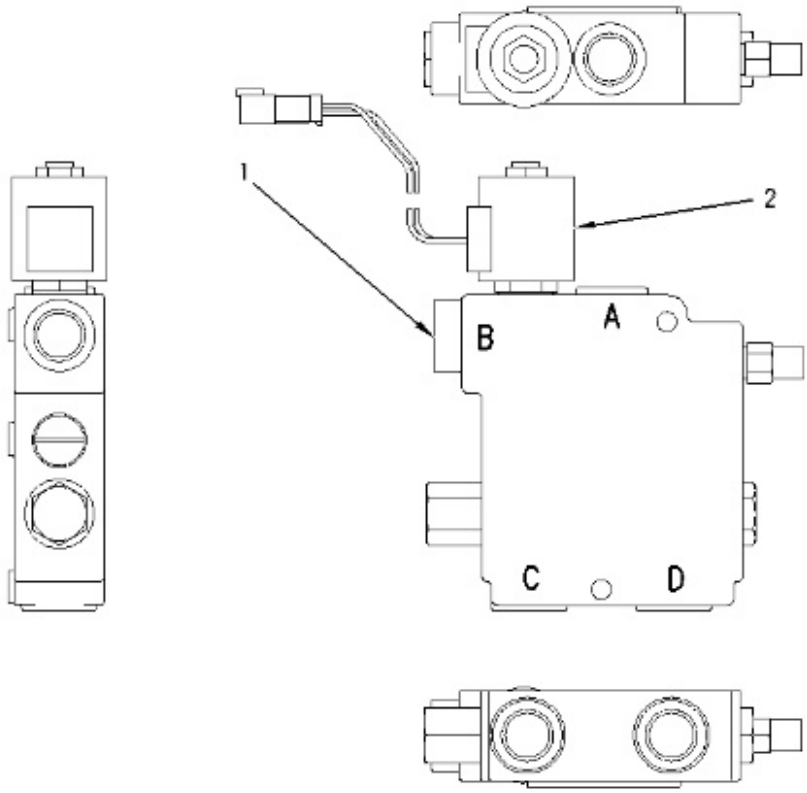


Illustration 1 g00550914

(1) Control Manifold. (2) Solenoid valve.

The control manifold (1) maintains the selected angle of the work tool as the lift arms are raised. The control manifold only functions during the RAISE function. During the LOWER function, the control manifold does not affect the operation of the machine.

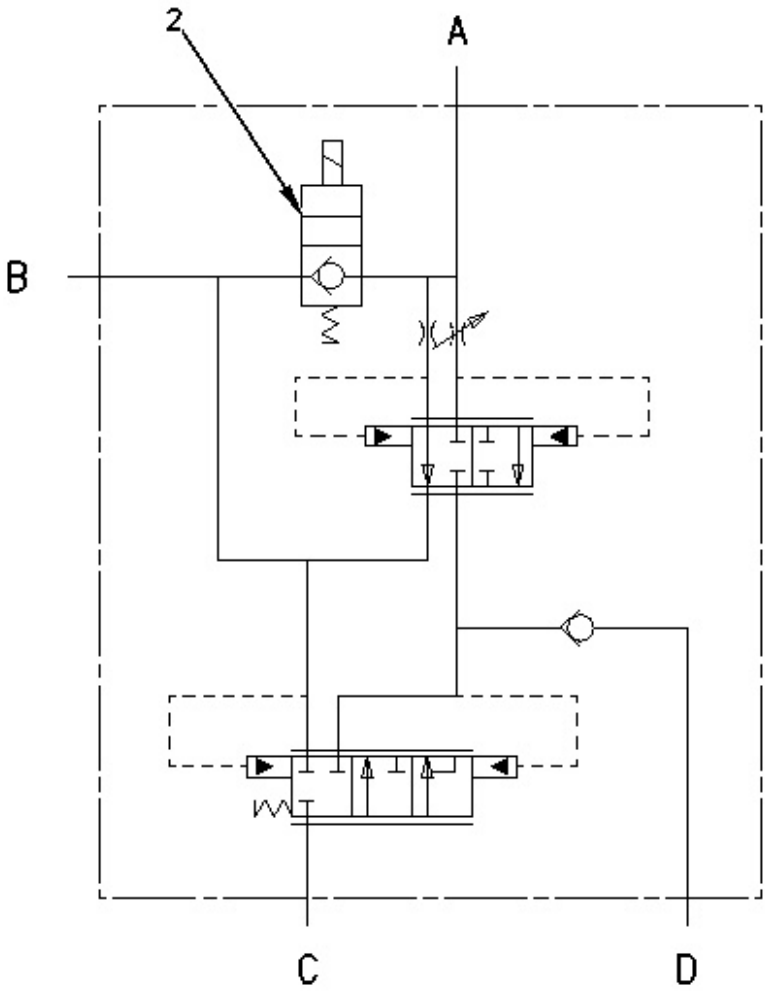


Illustration 2 g00551233

(2) Solenoid valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

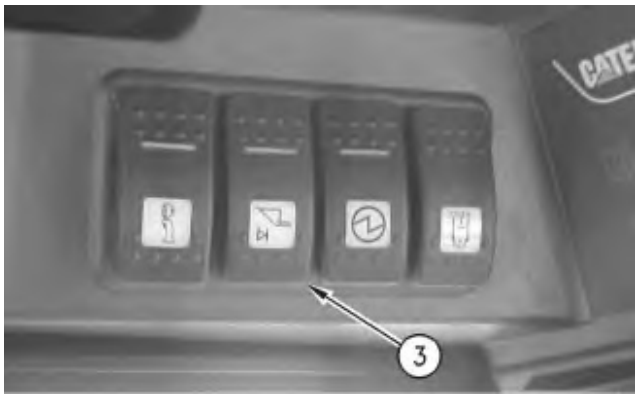


Illustration 3 g00666165

(3) The automatic leveling switch

The solenoid valve (2) enables the control manifold. The solenoid valve is controlled by the switch (3). The switch (3) is located in the second position from the left side of the instrument panel. The instrument panel is located to the left and above the ignition switch.

When you start the engine, solenoid (2) is energized. The control manifold is not activated. Oil flows through port (A) to solenoid (2). The oil flows through the top section of solenoid (2) and through port (B). Then, the oil flows to the lift spool.

Press the bottom of the switch in order to activate the self-leveling function of the control manifold. When you press the bottom of the switch, solenoid (2) is de-energized. Oil flows through port (A) to the divider spool and to the unloading spool. Press the bottom of the switch again in order to deactivate the self-leveling function of control manifold. Solenoid (2) is energized.

Self-Leveling Operation (Raising the Work Tool)

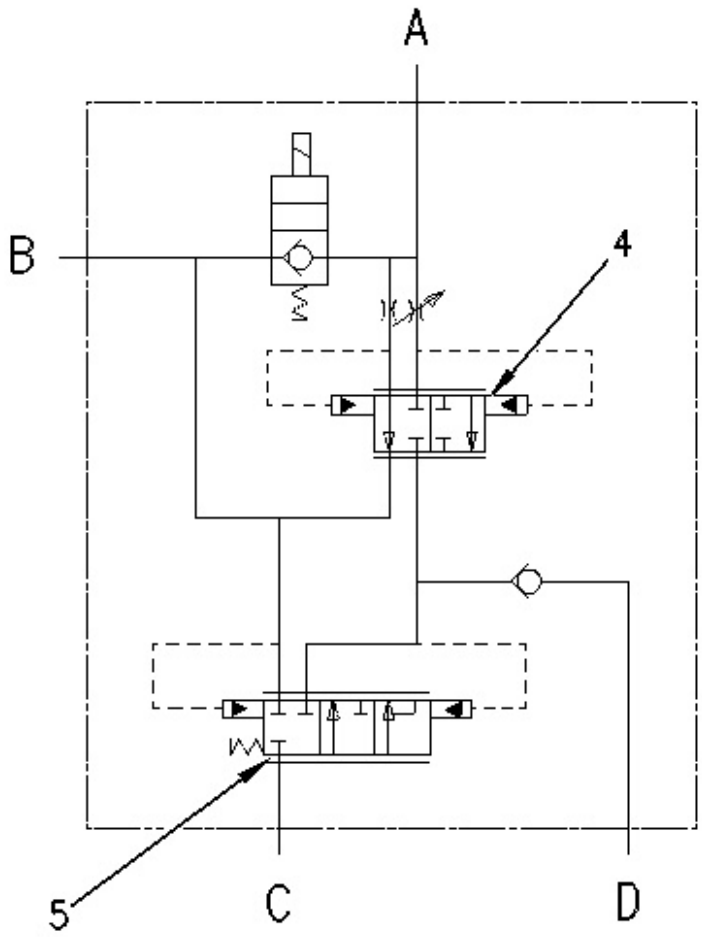


Illustration 4 g00551505

(4) Flow divider valve. (5) Unloading spool.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

The control manifold is activated. Solenoid (2) is de-energized. When the tilt control valve is in the HOLD position and the lift control valve is in the RAISE position, oil from the lift control valve enters the head end of the lift cylinders. As the lift cylinders extend, oil from the rod end of the lift cylinder enters port (A) .

The oil enters the flow divider valve (4). The hydraulic oil divides into two loops. One loop flows through the fixed orifice. The second loop flows through the adjustable orifice. The flow divider valve (4) balances the pressure between the head end of the tilt cylinder and the rod end of the lift

cylinder. When the pressure between the head end of the tilt cylinder and rod end of the lift cylinder are kept in balance, the load will stay level.

The oil that flows through the fixed orifice flows out of port (B) and back to the tank. The variable orifice adjusts to the flow of oil from the rod end of the lift cylinders. The oil flows through the divider spool. Then, the oil flows to the unloading spool. The ports for the unloading spool are blocked. The oil will flow through the check valve and out port (D). From port (D), oil flows to the head end of the tilt cylinders and to the tilt control valve.

The internal ports are blocked in the tilt control valve. Because the internal ports are blocked in the tilt control valve, the oil flows to the head end of the tilt cylinder. As the tilt cylinders extend, the oil from the rod end of the tilt cylinders flows into port (C) .

The resistance to movement in the tilt cylinders causes pressure in the oil line from port (D). The check valve blocks oil. The resistance to movement in the tilt cylinders causes pressure. The pressure is great enough to open the unloading spool (5). The oil flows through the unloading spool and out port (B) back to the tank.

Hydraulic oil flows through the unloading spool (5). The oil flow reduces the pressure through port (C). The centering spring for the unloading spool shifts the unloading spool.

When the fixed orifice loop pressure increases, the pilot oil shifts the flow divider (4). The oil will flow through the flow divider and out port (B) .

Lowering the Work Tool

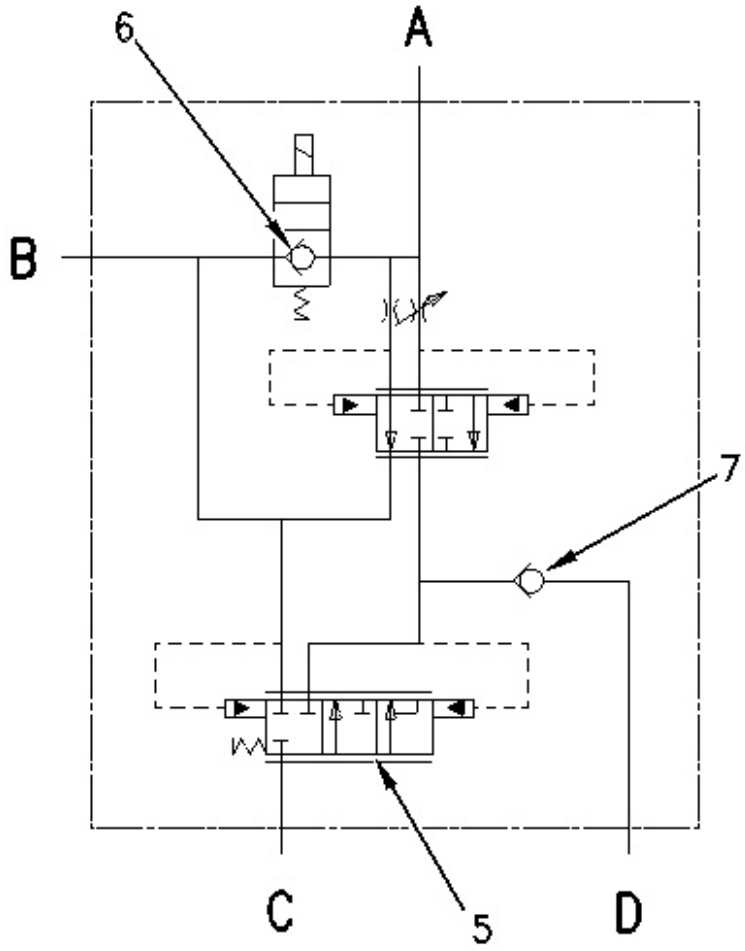


Illustration 5 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the tilt control valve is in the HOLD position and the lift control valve is in the LOWER position oil enters the control manifold through port (B). The oil opens check valve (6). The oil flows through port (A) to the rod end of the lift cylinders.

Oil flows from the head end of the lift cylinders and branches. Part of the oil flows to the ball valve. The oil flow is blocked. The oil flows to the lift control valve. Then, the oil flows through the valve to the tank.

Tilting the Work Tool Forward

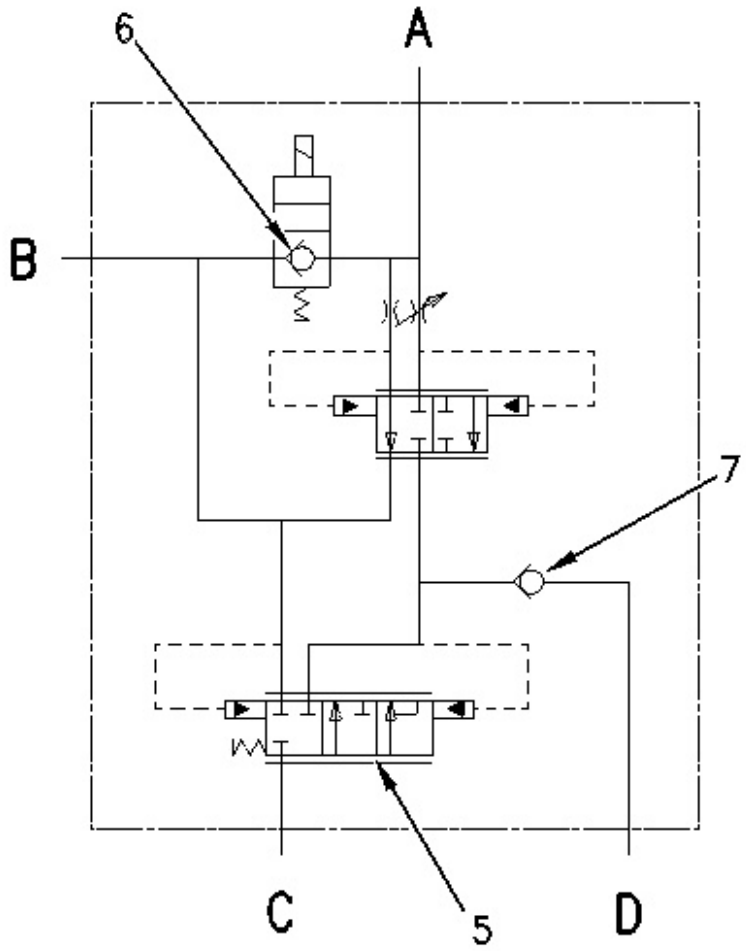


Illustration 6 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the lift control valve is in the HOLD position and the tilt control valve is in the TILT FORWARD position, oil flows from the pump toward the head end of the tilt cylinders and branches. The oil flows into the control manifold through port (D), but the flow is blocked by the check valve (7). Then, the oil flows to the head end of the tilt cylinders.

Hydraulic oil from the rod end of the cylinders flows toward the tilt control valve and branches. Oil enters the control manifold through port (C), but the flow is blocked by the unloading spool (5). The

control manifold is used during lifting operations only. Then, the oil flows to the tilt control valve and to the tank.

Tilting the Work Tool Backward

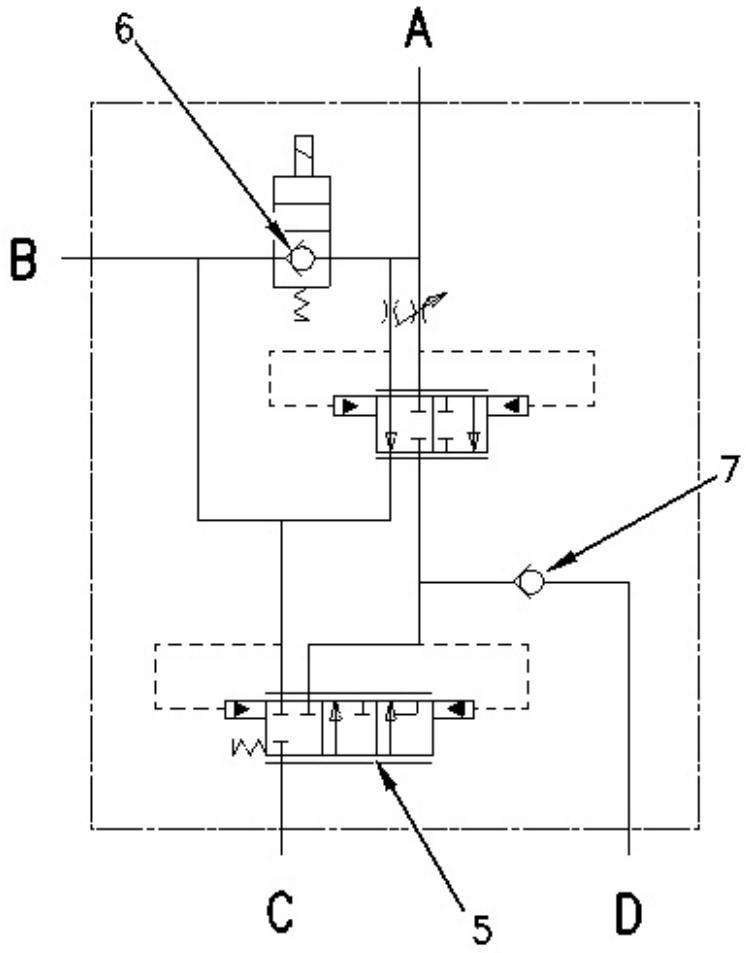


Illustration 7 g00551970

(5) Unloading spool. (6) Check valve. (7) Check valve.

(A) Oil from the rod end of the lift cylinders

(B) Oil for the lift control valve

(C) Oil for the rod end of the tilt cylinders

(D) Oil for the head end of the tilt cylinders

When the lift control valve is in the HOLD position and the tilt control valve is in the TILT BACK position oil flows into the rod end of the tilt cylinder from the tilt control valve. Oil also flows into the control manifold through port (C), but the flow is blocked by the unloading spool (5). Oil flows from the head end of the tilt cylinder to the tilt control valve and back to the tank. Oil from the head end of the tilt cylinder also flows to the control manifold through port (D), but the flow is blocked by the check valve (7) .

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Machine Preparation

SMCS - 4350-035; 5050-035

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic system.

1. Move the machine to a smooth horizontal location. Move the machine away from other machines and personnel. Lower the bucket to the ground. Stop the engine.
2. Permit only one operator on the machine.
3. Block the front tires and the rear tires of the machine.
4. Place a barrier around the machine in order to keep personnel away from rotating machinery.
5. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Visual checks and measurements are the first steps during troubleshooting. Refer to Testing and Adjusting, "Visual Inspection". Next, perform the operational checks. Refer to Testing and Adjusting, "Operational Checks". Finally, perform the required tests and adjustments on the machine.

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Testing and Adjusting
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4867-03 **Publication Date -01/11/2009** **Date Updated -24/11/2009**

i02045270

Visual Inspection

SMCS - 4350-035; 5050-040

Before you perform this procedure, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the system is the first step when you troubleshoot a problem.



Illustration 1 g00696549

1. Check the hydraulic oil level in the sight glass for the hydraulic tank.
2. Look for air bubbles in the oil. Look for water in the oil.

   Note: Air bubbles may be caused by a fitting that is loose or damaged. A loose fitting or a damaged fitting allows air to enter the suction side of the system. This causes the oil to leak.
3. Add oil to the hydraulic system, if necessary. Refer to the Operation and Maintenance Manual for the recommended oil and for the correct procedure.
4. Check all lines, all hoses, and all connections for damage and for leaks. Look for fluid on the ground under the machine.

   Note: If fluid can leak out of a fitting or out of a connection, air can leak into the system.



Illustration 2 g01050319

5. Remove the hydraulic oil filter and inspect the filter for foreign material. A magnet will separate ferrous particles from nonferrous particles.

Next, perform the operational checks and last perform the instrument tests.

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i02721470

Operational Checks

SMCS - 4350-535; 5050-535

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

The following operational checks can be used for the following items:

- find leakage in the system.
- determine whether the pilot operated hydraulic controls are functioning correctly.
- determine whether the pumps and motors are functioning correctly.
- determine whether the whole work tool system is functioning correctly.

In order for the hydraulic system to function properly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set properly will have an impact on other components in the system.

Note: When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Lift Cylinder Speed Test

Note: Perform the lift cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. If the automatic leveling switch is in the ON position, then turn the automatic leveling switch to the OFF position.
5. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
6. Operate the lift cylinder through at least five lift cycles. This will ensure that there is warm oil in the lift cylinders.
7. Tilt the bucket to the full TILT BACK position. Lower the bucket to the full LOWER position.
8. Raise the bucket from the full LOWER position. Record the time from the full LOWER position to the full RAISE position.
9. Lower the bucket from the full RAISE position. Record the time from the full RAISE position to the full LOWER position.
10. Raise the bucket to the full RAISE position. Move the hydraulic control to the FLOAT position. Record the time from the full RAISE position to the full LOWER position.

Table 1

TRAVEL TIME (SPEED) FOR THE LIFT CYLINDERS		
Position of the Hydraulic Control	**236B/ 246B**	**252B/ 262B**
RAISE	2.7 ± 0.5 seconds	4.8 ± 0.5 seconds
LOWER	2.7 ± 0.5 seconds	3.4 ± 0.5 seconds
FLOAT	2.8 ± 0.5 seconds	3.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Tilt Cylinder Speed Test

Note: Perform the tilt cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.

2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinders.
6. Tilt the bucket to the full TILT BACK position. Raise the bucket to the full RAISE position.
7. Tilt the bucket from the full TILT BACK position to the full DUMP position. Record the time from the full TILT BACK position to the full DUMP position.
8. Tilt the bucket from the full DUMP position to the full TILT BACK position. Record the time from the full DUMP position to the full TILT BACK position.
9. Lower the bucket to the ground.

Table 2

TRAVEL TIME (SPEED) FOR THE TILT CYLINDERS	
Position of the Hydraulic Control	**236B/ 246B/ 252B/ 262B**
DUMP	2.1 ± 0.5 seconds
TILT BACK	1.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Hydraulic Quick Coupler (if equipped)

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Press the switch in order to engage the quick coupler. Record the time that is needed to engage the quick coupler. Press the switch in order to disengage the quick coupler. Record the time that is needed to disengage the quick coupler.

Table 3

TRAVEL TIME (SPEED) FOR THE COUPLER CYLINDERS	
Engaging the quick coupler	3.0 seconds maximum
Disengaging the quick coupler	3.0 seconds maximum

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Drift Check (Lift and Tilt Cylinder)

Use this procedure to determine the amount of wear that occurs in the lift cylinders and the tilt cylinders.

Note: Perform the following tests with a general purpose bucket on the machine. If a general purpose bucket is not available, use a load weight of 200 kg (441 lb).

1. Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.
2. Run the engine at HIGH IDLE.
3. Operate the lift cylinders through at least five cycles. This will ensure that there is warm oil in the lift cylinder.
4. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinder.
5. Raise the bucket to the full RAISE position.
6. Tilt the bucket forward until the bucket is parallel with the ground.
7. Reduce the engine speed to LOW IDLE. Stop the engine.
8. Mark the cylinders.
9. Use a stopwatch to count for one minute. Measure the drift of the cylinders.

   Table 4

CYLINDER DRIFT		
Cylinders	**Time**	**Cylinder Drift**
Tilt Cylinders	1 minute	3 mm (0.118 inch)
Lift Cylinders	1 minute	3 mm (0.118 inch)

   Note: If the lift cylinder drift and/or the tilt cylinder drift exceeds the maximum, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

10. Start the engine and lower the bucket to the ground.

Test for Tracking of the Machine (Drift)

This test will determine if each displacement stop is adjusted correctly in each group of rotation. The two displacement stops adjust the maximum stroke of the swashplate in each of the groups of rotation in the forward direction.

Note: If the machine drifts to the same side in both forward and reverse, check the chain tension on both sides of the machine before you proceed with the test.

1. Move the machine to a testing location that is flat, level and 30.5 m (100 ft) long. Allow enough space on each side of the centerline for any machine drift that could exceed 3 m (10 ft).

   .

2. Inflate all four tires to the same air pressure.

3. Start the test outside the test area. The machine must enter the testing location in straight line travel and the machine must be traveling at full speed. The engine must be set to HIGH IDLE and the speed and direction control must be positioned fully forward.

4. Measure the amount of drift and record the direction of the drift.

Table 5

Test for Displacement Stop	
Test	**Specification**
Engine Speed	2860 ± 50 RPM
Drift	3 m (10 ft)

5. If the machine does not pass this test, refer to the Testing and Adjusting, "Maximum Runout Test".

Test for the Operation of the Two Speed Function (if equipped)

Use the following check in order to determine if the two speed function is operating correctly.

1. Fasten the seat belt and lower the armrest.

2. Start the engine. Run the engine at HIGH IDLE.

3. Disengage the parking brake.

4. Move the pilot operated hydraulic control all the way forward.

5. While you keep the machine at full speed, press the switch in order to activate the FAST mode. There should be a noticeable increase in the speed of the machine and the indicator for two speed should light. If there is not a noticeable increase in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

6. While the machine is still traveling, press the switch in order to deactivate the FAST mode. There should be a noticeable decrease in the speed of the machine and the indicator for two speed should shut off. If there is not a noticeable decrease in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

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i02752804

Hydraulic System Troubleshooting

SMCS - 5050-035

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

This section provides probable causes to known problems. Prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Perform a visual inspection of the machine. Refer to Testing and Adjusting, "Visual Inspection".

Troubleshooting Problem List and Probable Causes

Problem 1

The hydraulic oil temperature is too high.

Probable Cause

1. The hydraulic oil temperature sensor is malfunctioning.
2. The hydraulic oil is aerated.
3. A restriction of air flow through the oil cooler.
4. A restriction of oil flow through the oil cooler.
5. The ambient air temperature is too high.
6. Operating the machine with one or more relief valves open for an excessive period of time.
7. The oil cooler bypass valve is stuck in the OPEN position.

Problem 2

The hydraulic oil temperature is too low.

Probable Cause

1. There is excessive oil flow through the oil cooler.
2. The oil cooler, the oil tank and other components in the hydraulic system are not protected from cold air temperatures or winds.
3. The oil cooler bypass valve is stuck in the CLOSED position.
4. The ambient air temperature is too low.

Problem 3

There is a large amount of air in the oil.

Probable Cause

1. The hydraulic oil suction line between the tank and the pump may be leaking.
2. There is air in the hydraulic system after assembly, inspection, or testing.
3. Air is entering the hydraulic system during operation.

Problem 4

The fan speed is too low or too high.

Probable Cause

1. Check the relief valve for contamination.
2. If the fan speed is low at LOW IDLE, determine that the gear pump is functioning correctly by hooking up a flow meter. If the gear pump is functioning correctly, replace the fan motor.
3. If the fan speed is too low or too high at HIGH IDLE, adjust the relief valve. If the problem cannot be resolved by adjusting the relief valve, replace the relief valve.

Problem 5

The drive chain box is filling with hydraulic oil.

Probable Cause

1. The hydraulic tank has been overfilled. Overfilling the tank will cause oil to drain from the vent hose. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for the correct level.
2. The shaft seal on the drive motor is leaking.

Problem 6

There is no hydraulic oil flow out of the charge section of the gear pump.

Probable Cause

1. The linkage between the two sections of the gear pump has broken. Replace the gear pump.
2. There has been damage to the seals on the charge pump. Replace the gear pump.

Problem 7

Hydraulic oil flow out of the two sections of the gear pump is limited.

Probable Cause

1. Check the inlet line for a restriction.
2. The strainer for the inlet is clogged.
3. The oil level is too low.
4. The hydraulic oil temperature is too low.
5. The hydraulic oil is aerated.
6. The gear pump is worn.
7. There is a restriction or there is a leak in the hydraulic line from the hydraulic tank.
8. Check the mechanical linkage between the piston pump and the engine.

9. Check the mechanical linkage between the gear pump and the piston pump.

Problem 8

The hydraulic tank is pressurized.

Probable Cause

1. The breather for the hydraulic tank is clogged.

Problem 9

The fan motor is noisy.

Probable Cause

1. The makeup valve for the fan motor is stuck.

Problem 10

The lift circuit and the tilt circuit are not functioning properly.

Probable Cause

1. The main relief valve setting is too low.
2. The charge pressure is incorrect.
3. The pilot operated hydraulic control (work tool) is not functioning properly.
4. The control valve is not functioning properly.
5. The orifices for the pilot operated hydraulic control (work tool) are clogged.
6. The cylinder is not functioning properly.
7. The gear pump is not functioning properly.
8. One of the lines or one of the hoses is broken.
9. The diverter valve (if equipped) is not functioning properly.
10. The interlock system is not functioning properly.
11. The load is too heavy.
12. A line relief valve is set too low.
13. A load check valve on the control valve is stuck in the CLOSED position.

Problem 11

The auxiliary hydraulic system is not functioning.

1. The switch for the hydraulic shutoff valve is in the OFF position.

2. The auxiliary circuit switch is not functioning properly.
3. The fourth function control is not functioning properly.
4. The platform harness, the cab harness, or the harness for the pilot operated hydraulic control (work tool) is not functioning properly.
5. The auxiliary solenoids are not functioning properly.
6. The orifices for the pilot operated hydraulic control (work tool) are clogged.
7. The control valve is not functioning properly.
8. The work tool is not functioning properly.
9. The harness for the work tool is not functioning properly.
10. The ECM or the software is not functioning properly.
11. The line relief setting is too low.
12. The auxiliary circuit connections are not fully engaged.

Problem 12

All work tool functions and auxiliary functions are sluggish, erratic, or intermittent.

Probable Cause

1. The gear pump is not functioning properly.
2. The main relief setting is too low.
3. The pilot system pressure is incorrect.
4. The pilot operated hydraulic control (work tool) is not functioning properly.
5. The hydraulic system is contaminated.
6. The control valve and the spools have an excessive amount of wear.
7. The charge pressure is too low.
8. The line relief valves are set too low or the line relief valves are damaged.
9. The orifices on the hydraulic control are clogged.
10. The load check valve is partially closed.
11. The auxiliary solenoid is not getting an adequate amount of current or the solenoid is sticking.
12. The seals on the lift valve spool are damaged or worn.
13. The cylinders may have leaks.

14. The diverter valve (if equipped) is not functioning properly.
15. The ball valve is not fully closed.
16. The power supply from the engine is low.

Problem 13

The gear pump makes noise and the cylinder rods move erratically.

Probable Cause

1. The hydraulic oil is aerated.
2. The viscosity of the oil is incorrect.
3. The setting of the main relief valve is too low.
4. There is a loose connection of the oil line on the inlet side of the pump.
5. The gear pump has too much wear.
6. The line relief valve is set too low.

Problem 14

The oil pressure in the hydraulic system is low.

Probable Cause

1. The setting of the main relief valve is too low.
2. The gear pump has too much wear.
3. The control valve and the valve spools have an excessive amount of wear.
4. The setting of the line relief valves is too low.
5. The pilot pressure is too low.

Problem 15

The work tool moves while the hydraulic control is in the HOLD position.

Probable Cause

1. A spool in the pilot operated hydraulic control is sticking.
2. The control valve and the valve spool have an excessive amount of wear.
3. A piston seal in a cylinder has excessive wear.
4. There is a external leak between the bank valve and the cylinder that is drifting.
5. The seals on the control valve could be worn.

6. The ball valve is not fully closed.
7. The load check valve could be stuck in the control valve.
8. The line relief valve in the lift circuit is set too low or the relief valve is stuck in the OPEN position.

Problem 16

The work tool droops when the hydraulic control is moved from the HOLD position to the RAISE position.

Probable Causes

1. The hydraulic oil is aerated.
2. The piston seals of the lift cylinder are worn.
3. The control valve and the valve spool have an excessive amount of wear.
4. The load check valve on the control valve may be open or leaking.

Problem 17

The work tool droops when the hydraulic control is moved from the HOLD position to the TILT FORWARD position.

Probable Causes

1. The hydraulic oil is aerated.
2. The piston seals of the lift cylinder are worn.
3. The control valve and the valve spool have an excessive amount of wear.
4. The line relief valves are damaged or worn.

Problem 18

The work tool will not lower to the ground when the engine is stopped.

Probable Cause

1. The accumulator is not properly charged.
2. The pilot pressure is low.
3. The seals on the lift valve section may be damaged or worn.
4. Charge pressure may be leaking past a solenoid in the interlock system.
5. The pilot operated hydraulic control (work tool) is not functioning properly.
6. The interlock system is not functioning properly.

Problem 19

The machine has poor hydraulic performance when the engine is at high idle.

Probable Cause

1. The setting for the corresponding line relief valve or for the main relief valve may be incorrect.
2. The gear pump may be worn.
3. The pilot pressure is low.
4. The cylinder may have internal leaks.

Problem 20

The line relief valves are noisy.

Probable Cause

1. The line relief valve is adjusted too low or the line relief valve is damaged.
2. The main relief valve is set too high.

Problem 21

There is instability in the hydraulic system.

Probable Cause

1. The diverter valve (if equipped) is damaged or worn.
2. The hydraulic oil is aerated.
3. The gear pump has excessive wear.

Problem 22

The diverter valve (if equipped) is not functioning properly.

Probable Cause

1. The electrical connection between the machine and the diverter valve has been broken.
2. The solenoid on the diverter valve is not functioning.
3. The spool in the diverter valve is stuck in the OPEN position.
4. The cylinder may have internal leaks.

Problem 23

The diverter valve (if equipped) is not making the bucket level with the ground.

Probable Cause

1. The diverter valve is out of adjustment.

2. The cylinder may have internal leaks.

3. The hydraulic lines for the lift circuit or the hydraulic lines for the tilt circuit may have leaks.

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i02722217

System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Use the following procedure to release the pressure in the hydraulic system. Perform this procedure before any work is done to the hydraulic system.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the pilot accumulator.
2. Stop the engine. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Move the pilot operated hydraulic controls through all of the positions.
4. Turn the engine start switch to the OFF position.
5. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.

The pressure in the hydraulic system has now been released.

Note: Some pilot lines on the downstream side of the accumulator may still contain pressurized oil. Use caution when you disconnect these pilot lines.

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i02712962

Hydraulic Oil Contamination - Test

SMCS - 5050-008

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Use the following procedure to sample the oil in the hydraulic system.

Note: If the oil becomes contaminated, premature component failure could result. Contaminated oil can also contribute to overheating.

1. Start the engine and run the engine at HIGH IDLE.
2. Actuate all hydraulic cylinders through a minimum of 10 full cycles.
3. Install a jumper line between the auxiliary lines. Cycle the auxiliary flow for one minute.
4. Lower the work tool to the ground.
5. Allow the engine to run at LOW IDLE.

   Note: Do not operate the hydraulic controls.
6. Open the engine access door.



Illustration 1 g01051544

Note: Remove any dirt or debris on the sampling valve.

7. Draw a 50 mL (1.7 fl oz) oil sample through the scheduled oil sampling valve. The level of the contaminants must be less than or equal to the values in ISO 18/15. To meet this specification, the concentration of contaminants must be less than or equal to the values in the following Table 1.

Table 1

Hydraulic Oil Contamination	
Particle Size (Microns)	**Maximum Number of Particles in a 50 mL Sample**
>5	125000
>15	16000

8. If the concentration of contaminants is higher than the values in the table, flush the hydraulic system. Refer to Testing and Adjusting, "Filling and Flushing the Hydraulic System - Test" for the proper procedure.

9. If the concentration of contaminants continues to be higher than the values in the table, change the hydraulic oil. Refer to the Operation and Maintenance Manual, "Hydraulic System Oil - Change" for further information.

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i02938500

Main Relief Valve - Test and Adjust

SMCS - 5069-081; 5069-025

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
6V-4143	Coupler As	2
177-7861	Hose As	1
6V-3989	Fitting	1
8T-0860	Pressure Gauge (40000 kPa (5800 psi))	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Perform the main relief valve test in order to determine if the main relief valve for the work tool is damaged or improperly set.

1. Engage the parking brake. Stop the engine.
2. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.



Illustration 1 g01055240

(1) Test port

3. Connect one end of the **177-7861** Hose to the test port (1) for the work tool. Connect the **8T -0860** Gauge to the other end of the **177-7861** Hose .
4. Route the test hose so that the cab will not rest on the hose. Securely bolt the cab to the frame.

5. Sit in the operator's seat. Fasten the seat belt. Lower the armrest. Start the engine. Disengage the parking brake.

6. Set the engine to HIGH IDLE.



Illustration 2 g00788651

Pilot operated hydraulic control (work tool)

7. Move the pilot operated control lever for the work tool to the full LOWER position. Hold the control lever until the lift arms are fully lowered and a stall condition exists.

   Note: Do not stall the hydraulic system for more than 10 seconds. If necessary, release the work tool from the stall condition. Release the work tool for 30 seconds and repeat the following step.

8. Record the system pressure for the work tool during the stall condition. Move the control lever for the work tool to the NEUTRAL position.

Table 2

MAIN RELIEF PRESSURE	
Machine	**Main Relief Pressure**
236B/ 246B/ 252B/ 262B	23000 ± 700 kPa (3336 ± 102 psi)

9. Release the hydraulic control from the stall condition. Tilt the work tool until the work tool is parallel with the ground. Stop the engine.

10. If the pressure reading is within specifications, proceed to step 23. If the pressure reading is not to specifications, the main relief valve needs to be adjusted. Proceed to step 11.

11. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

12. Raise the cab of the machine.

13. If your machine uses a relief valve (Type 1) then proceed to Step 14. If your machine uses a relief valve (Type 2) proceed to Step 18.



Illustration 3 g01383119

Main relief valve for the work tool

Note: The following steps are for machines that use a relief valve (Type 1).

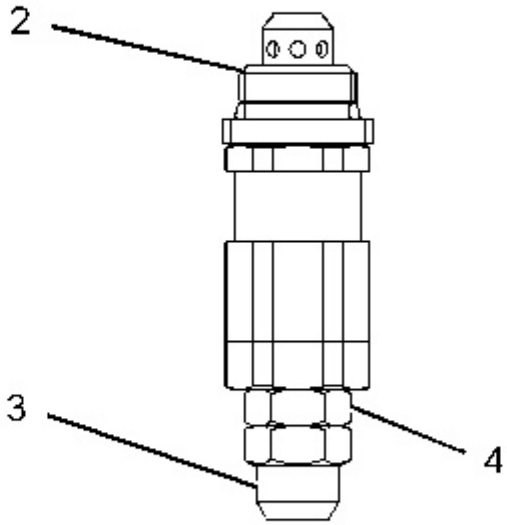


Illustration 4 g01355287

(2) Main relief valve (Type 1) for the work tool

(3) Cap

(4) Locknut

14. Remove end cap (3) from main relief valve (2) .

15. Loosen locknut (4) . The adjustment screw is under the end cap (3) . Turn the adjustment screw clockwise in order to increase the relief valve setting. Turn the adjustment screw counterclockwise in order to decrease the relief valve setting.

16. Tighten locknut (4) and install cap (3) .

17. Lower the cab and repeat steps 5 through 10.



Illustration 5 g01383119

Main relief valve for the work tool

Note: The following steps are for machines that use a relief valve (Type 2).

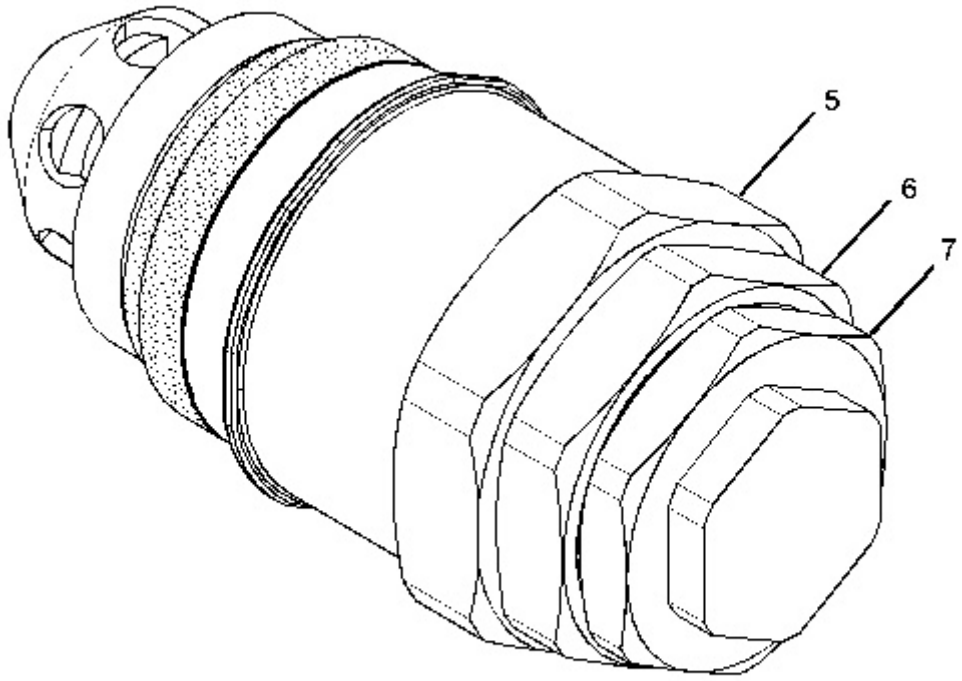


Illustration 6 g01355281

(5) Main relief valve (Type 2) for the work tool

(6) Locknut

(7) Adjusting nut

18. To adjust the relief valve pressure, hold the valve body (5) in position. Then loosen the locknut (6) at the same time.
19. Hold the adjusting nut (7) stationary. Loosen the locknut (6) toward the adjusting nut.
20. To adjust the pressure, increase the pressure by turning the adjusting nut (7) clockwise. Turn the adjusting nut counterclockwise in order to decrease the pressure.

    Note: Relief valve pressure should always be set on the rise.
21. Set the relief valve to the desired pressure. Hold the adjusting nut (7) in place. Secure the locknut (6) against the valve base.
22. Lower the cab and repeat steps 5 through 10.
23. Raise the cab and remove the test equipment.
24. Lower the cab and bolt down the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation".

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i02940109

Line Relief Valve - Test and Adjust

SMCS - 5117-081-L9; 5117-025-L9

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system. Refer to the Testing and Adjusting, "Visual Inspection".

The following test is performed in order to determine if a line relief valve for the work tool is damaged or improperly set.

Machine Test (Pressure)

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Perform the Machine Test (Pressure) in order to determine if the line relief valve is set too low.

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
6V-4143	Coupler Assemblies	2
177-7861	Hose As	1
6V-3989	Fitting	1
8T-0860	Pressure Gauge (40000 kPa (5800 psi))	1

Stall Test (Boom Lower)

Perform the following test in order to determine if the main relief valve is set properly.

1. Perform the Testing and Adjusting, "Main Relief Valve - Test and Adjust".
2. Record the main relief valve pressure setting.

Table 2

MAIN RELIEF PRESSURE	
Machine	**Main Relief Pressure**
236B/ 246B/ 252B/ 262B	23000 ± 700 kPa (3336 ± 102 psi)

3. Do not disconnect the pressure gauge.

Stall Test (Boom Raise)

Perform the following test in order to determine if the line relief valve for the lift raise is set too low.

1. If the pressure gauge is not attached, attach the pressure gauge. Refer to Testing and Adjusting, "Main Relief Valve - Test and Adjust".

2. Sit in the operator's seat. Fasten the seat belt. Lower the armrest. Start the engine. Disengage the parking brake.

3. Run the engine at HIGH IDLE.

NOTICE

Do not stall the hydraulic system for more than 10 seconds. If necessary, release the work tool from the stall condition and wait 30 seconds before you repeat the following step.

---

4. Press the pilot operated hydraulic control backward in order to raise the boom. Continue pressing the pilot operated hydraulic control backward in order to stall the boom.

5. Record the pressure on the pressure gauge.

6. Compare the test pressure to the main relief valve pressure setting that was recorded in table 2.

    - If the test pressure is less than the main relief valve pressure setting, then the line relief valve is set too low. Perform the "Bench Test and Adjust" in order to adjust the line relief valve pressure setting.

    - If the test pressure is equal to the main relief valve pressure setting, then the line relief valve pressure setting may be correct or the line relief valve pressure setting may be too high. Perform the "Bench Test and Adjust" in order to adjust the line relief valve pressure setting.

7. Repeat the "Stall Test (Boom Raise)" for the Tilt Forward, for the Tilt Back, and for the Auxiliary circuit.

Bench Test and Adjust

Perform the Bench Test and Adjust in order to adjust the line relief valve pressure setting.

Table 3

REQUIRED TOOLS			
Tool	**Part Number**	**Description**	**Qty**
A	3S-6224	Electric Hydraulic Pump Gp	1
	3B-7722	Pipe Bushing	2

	7J-8611	Pipe Elbow	1
	8F-0024	Hose As	2
	1P-2375	Quick Connect Couplers	2
B	299-1731	Test Manifold Gp	1
	6V-3965	Fitting As	3
	6V-8398	O-Ring Seal	3
C	8T-0860	Pressure Gauge (40000 kPa (5802 psi))	1
	1P-2376	Quick Connect Coupler	2

Table 4

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
1P-2377	Plug As	2
030-8370	Pipe Adapter	2

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

---

1. Lower the boom to the ground.
2. Engage the parking brake. Stop the engine.
3. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.
4. Turn the key to the OFF position.
5. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.

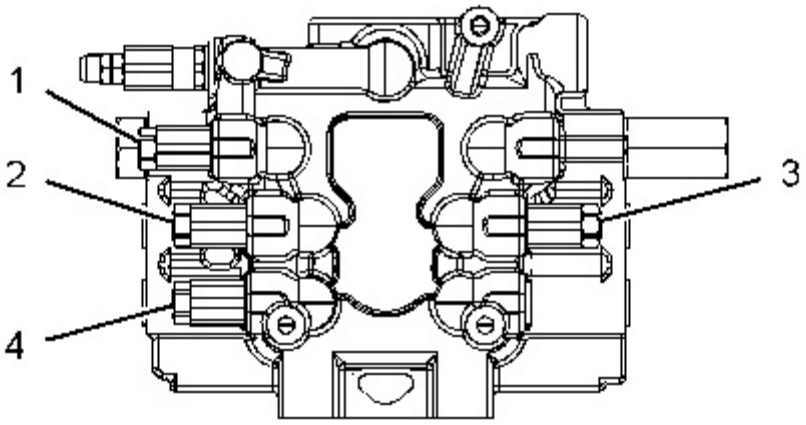


Illustration 1 g01138070

(1) Line relief valve for Lift Raise

(2) Line relief valve for Tilt Forward

(3) Line relief valve for Tilt Back

(4) Line relief valve for Auxiliary

6. Remove the line relief valve that will be tested.

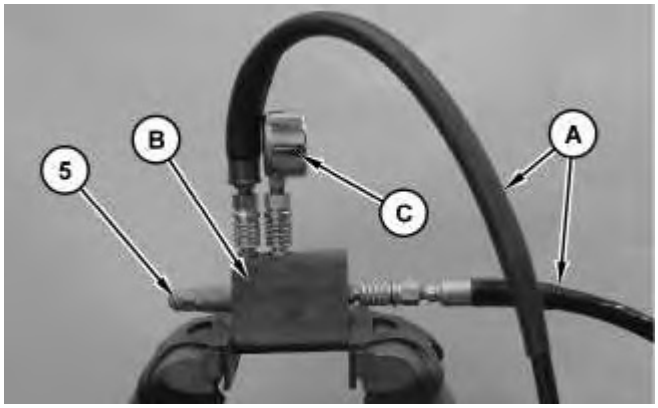


Illustration 2 g01357866

(5) Line Relief Valve

(A) Tooling

(B) Tooling

(C) Tooling

7. Assemble tooling (B) , as shown. Secure tooling (B) in a suitable holding device.
8. Install tooling (A) to tooling (B) .
9. Install tooling (C) to tooling (B) .
10. Install the line relief valve (5) that will be tested. Install relief valve (5) to tooling (B) .
11. Turn the electric hydraulic pump to the ON position. Check for leaks at the connection.

NOTICE

The 3S-6224 Electric Hydraulic Pump only has a 7.6 L (2 US gal) reservoir. Pump damage may result if the pump is operated with an empty reservoir.

12. Slowly increase the pressure. Record the pressure, when the line relief valve opens. Compare this pressure to Table 5.
13. Stop the pump.

Table 5

LINE RELIEF VALVE PRESSURES	
Position	**236B/ 246B/ 252B/ 262B**
Lift Cylinder Head RAISE position	27600 ± 700 kPa (4003 ± 102 psi)
Tilt Cylinder Head TILT FORWARD position	24500 ± 700 kPa (3554 ± 102 psi)
Tilt Cylinder Rod TILT BACK position	27600 ± 700 kPa (4003 ± 102 psi)
Auxiliary Circuit	24500 ± 700 kPa (3554 ± 102 psi)

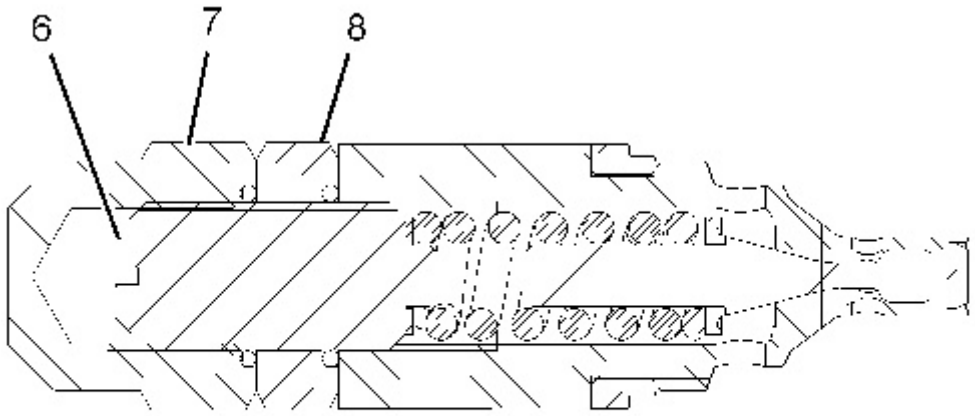


Illustration 3 g01355331

(6) Adjustment screw

(7) Cap

(8) Locknut

14. If the line relief valve is within the specification, go to Step 16. If the line relief valve is not within the specification, then an adjustment is required.

    a. Remove cap (7) . Loosen locknut (8) and turn adjustment screw (6) clockwise in order to increase pressure. Turn adjustment screw (6) counterclockwise in order to decrease pressure.

    b. Check the oil level in **3S-6224** Electric Hydraulic Pump and refill the oil if it is necessary. Repeat Steps 11, 12, 13, and 14.

Note: If you are unable to adjust the line relief valve to the correct specification, replace the old line relief valve with a new line relief valve.

15. Tighten locknut (8) to a torque of 24 ± 3 N·m (18± 2 lb ft). Install the cap (7) and tighten the cap to a torque of 24 ± 3 N·m (18± 2 lb ft).

16. Remove the line relief valve from the manifold.

17. Install a new seal on the relief valve.

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i02938522

Accumulator (Pilot) - Test and Charge

SMCS - 5077-081-PS; 5077-045-PS

Charge Pressure Test

The following test is performed in order to check the charge pressure of the pilot oil accumulator.

Accumulator That Is Not Rechargeable

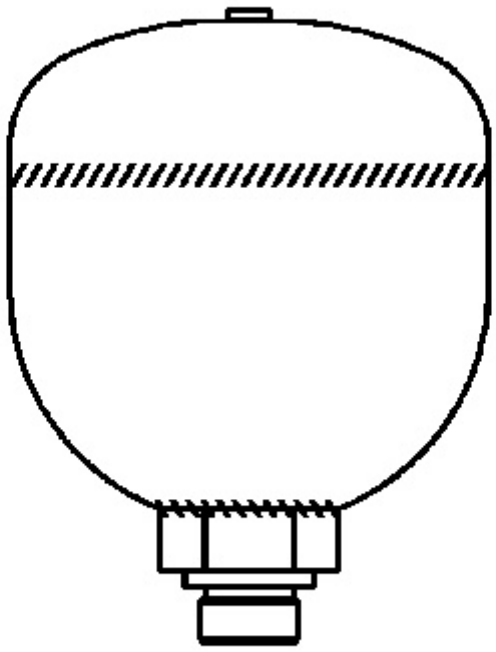


Illustration 1 g01136249

Typical accumulator that is not rechargeable

Perform this test if the pilot accumulator is not rechargeable.

Table 1

Required Tools		
Part Number	**Description**	**Qty**
3J-1907	O-Ring Seal	1
6V-3965	Fitting	1
6V-3989	Unvalved Fitting	1
6V-4143	Quick Connect Couplers	2
6V-5049	O-Ring Seal	1
7X-2444	Swivel Tee	1
8T-0856	Pressure Gauge (0 to 6000 kPa)	1
177-7860	Hose	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel.
2. Lower the work tool to the ground. Stop the engine.
3. Engage the parking brake.
4. Place chocks in front of the wheels and behind the wheels.
5. Turn the engine start switch key to the ON position.
6. Move the pilot valves to all positions in order to release the pressure in the hydraulic system.
7. Turn the engine start switch key to the OFF position.
8. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

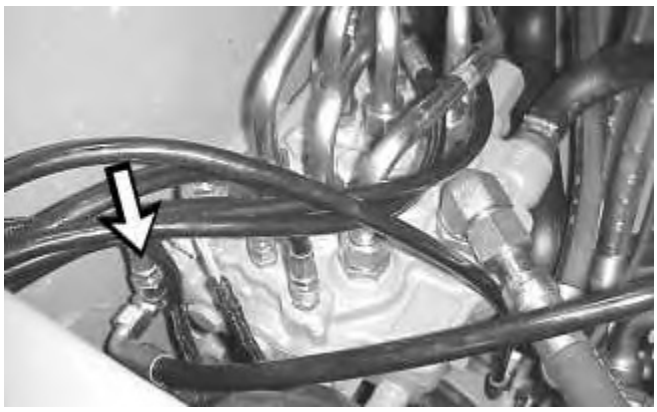


Illustration 2 g01138678

Supply line for the pilot operated hydraulic control (work tool)

9. Install **7X-2444** Swivel Tee and **6V-5049** O-Ring Seal to the end of the supply line for the pilot operated hydraulic control (work tool). Install **6V-3965** Fitting and **3J-1907** O-Ring Seal to the tee.

10. Attach **6V-3989** Unvalved Fitting to **8T-0856** Pressure Gauge .
11. Attach two **6V-4143** Quick Connect Couplers to **177-7860** Hose .
12. Attach one **6V-4143** Quick Connect Coupler to the **6V-3965** Fitting . Attach the other **6V-4143** Quick Connect Coupler to the **6V-3989** Unvalved Fitting .
13. Lower the cab. Do not pinch the hose.
14. Sit in the seat. Fasten the seat belt and lower the armrest.
15. Start the engine. Disengage the parking brake.
16. Run the engine at 2300 ± 25 RPM. The pilot pressure should rise to 3225 ± 200 kPa (468 ± 29 psi). If the pilot pressure is not correct, refer to Testing and Adjusting, "Hydrostatic System - Test and Adjust".
17. Use the hydraulic implement control in order to move the lift arms to the full RAISE position. Stop the engine.
18. Turn the engine start switch key to the ON position.
19. Use the hydraulic implement control in order to move the lift arms to the full LOWER position. The lift arms will lower. The pressure will decrease in one of the following ways:
    - The pressure decreases slowly until the pressure reaches 900 ± 100 kPa (130 ± 15 psi). Then, the pressure decreases rapidly. If this happens, the accumulator is properly charged. Proceed to Step 20.
    - If the pressure decreases rapidly, the accumulator is not properly charged. Replace the accumulator with a rechargeable accumulator. Refer to Disassembly and Assembly, "Accumulator - Remove and Install". Proceed to the Accumulator Charge.
20. Remove the chocks.

Test for Rechargeable Accumulator

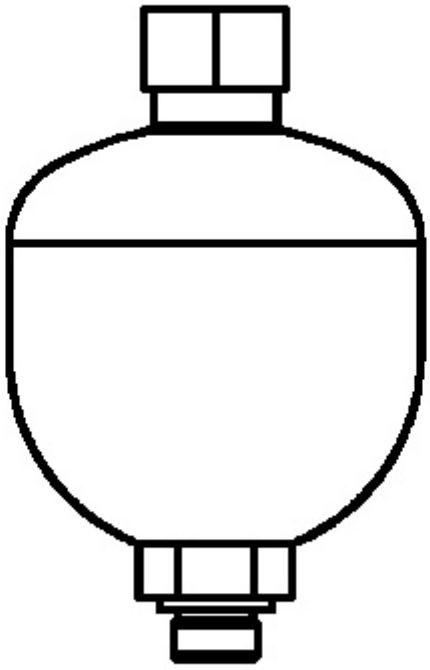


Illustration 3 g01138634

Typical rechargeable accumulator

Perform this test if the pilot accumulator is rechargeable.

Table 2

Required Tools		
Part Number	**Description**	**Qty**
152-2023	Nitrogen Charging Fitting Gp	1
175-5507	Nitrogen Charging Group	1

WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel.
2. Lower the work tool to the ground. Stop the engine.
3. Engage the parking brake.
4. Place chocks in front of the wheels and behind the wheels.

5. Turn the engine start switch key to the ON position.
6. Move the pilot valves to all positions in order to release the pressure in the hydraulic system.
7. Turn the engine start switch key to the OFF position.
8. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

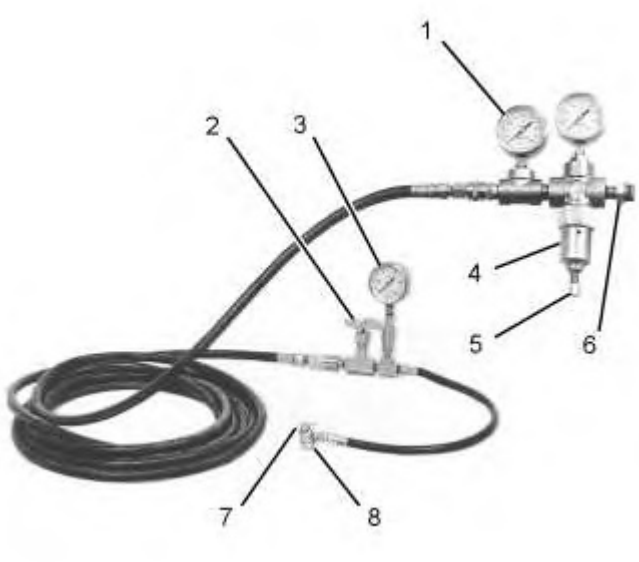


Illustration 4 g01138645

Nitrogen Charging Group

(1) Pressure gauge

(2) Valve

(3) Pressure gauge

(4) Regulator assembly

(5) Pressure regulating screw

(6) Nipple assembly for the nitrogen cylinder valve

(7) Valve handle

(8) Chuck

9. Turn the valve (2) completely in the clockwise direction. Turn the valve handle (7) completely in the counterclockwise direction.

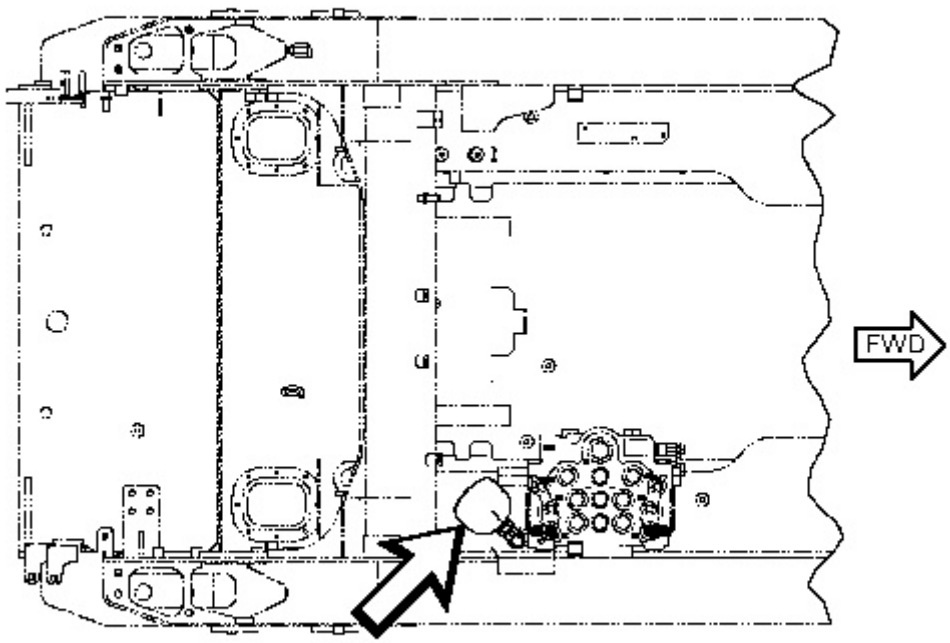


Illustration 5 g01136222

Location of the Accumulator

10. Install the chuck (8) to the accumulator.
11. Turn the valve handle (7) completely in the clockwise direction. The reading on the pressure gauge (3) should be 900 ± 100 kPa (130 ± 15 psi).
12. If the reading on the pressure gauge is too high, repeat steps 5 through 7. This ensures that there is no hydraulic oil in the accumulator. If the pressure is still high, slowly open valve (2) in order to lower the pressure. If the pressure is too low, proceed to the Accumulator Charge.
13. Close valve (2) . Close the valve on the nitrogen cylinder.
14. Turn the valve handle (7) completely in the counterclockwise direction.
15. Remove the chuck (8) from the accumulator.
16. Open the valve (2) . This will release the pressure between the valve (2) and the valve on the nitrogen cylinder. Remove the nipple assembly (6) from the nitrogen cylinder.
17. Lower the cab.
18. Fasten the seat belt. Start the engine.

19. Move the work tool to the full RAISE position. Stop the engine.

20. Turn the engine start switch key to the ON position.

21. Move the work tool to the full LOWER position. If the work tool lowers to the ground, proceed to step 20. If the work tool does not lower to the ground, start the engine and lower the work tool to the ground. Repeat steps 5 through 19.

    Note: If the work tool does not lower to the ground after charging the accumulator two times, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

22. Remove the chocks.

Accumulator Charge

The following procedure is performed in order to charge the rechargeable accumulator (pilot) to the correct precharge pressure.

Table 3

Required Tools		
Part Number	**Description**	**Qty**
152-2023	Nitrogen Charging Fitting Gp	1
175-5507	Nitrogen Charging Group	1

WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

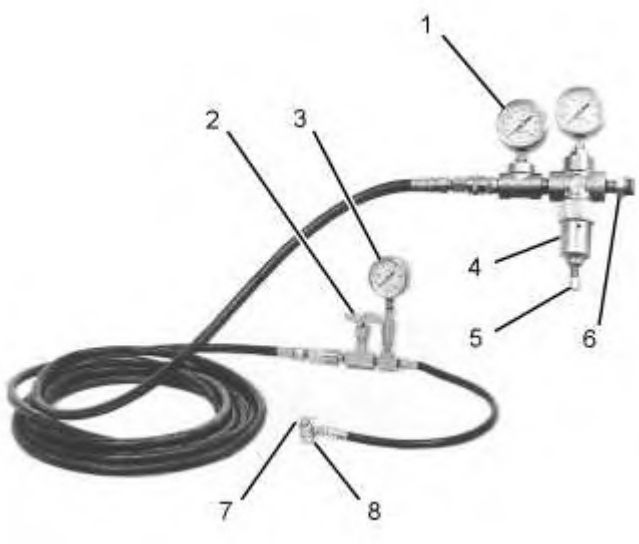


Illustration 6 g01138645

Nitrogen Charging Group

(1) Pressure gauge

(2) Valve

(3) Pressure gauge

(4) Regulator assembly

(5) Pressure regulating screw

(6) Nipple assembly for the nitrogen cylinder valve

(7) Valve handle

(8) Chuck

1. Perform Steps 1 to 10 of Charge Pressure Test (Rechargeable Accumulator) in order to install the **175-5507** Nitrogen Charging Group .
2. Turn the valve handle (7) completely in the clockwise direction. The reading on the pressure gauge (3) should be 900 ± 100 kPa (130 ± 15 psi).
3. If the reading on the pressure gauge is too high, repeat steps 5 through 7. This ensures that there is no hydraulic oil in the accumulator. If the pressure is still high, slowly open valve (2) in order to lower the pressure. If the reading on the pressure gauge is too low, use the following procedure in order to charge the accumulator:
    a. Connect the nipple assembly (6) to the nitrogen cylinder.
    b. Open the valve on the nitrogen cylinder. Adjust screw (5) on the regulator assembly (4) until the reading on pressure gauge (1) is 900 ± 100 kPa (130 ± 15 psi).
    c. Open valve (2) and charge the accumulator. Then, close valve (2) . If pressure gauge (3) and pressure gauge (1) show the same reading and the readings do not change, the accumulator has the correct charge.

       If the pressure reading on gauge (3) decreases, open valve (2) and allow more nitrogen to fill the accumulator.

       Perform this procedure until pressure gauge (3) and pressure gauge (1) show the same reading. Make sure that neither reading changes when valve (2) is closed.
4. Close valve (2) . Close the valve on the nitrogen cylinder.
5. Turn the valve handle (7) completely in the counterclockwise direction.
6. Remove the chuck (8) from the accumulator.
7. Open the valve (2) . This will release the pressure between the valve (2) and the valve on the nitrogen cylinder. Remove the nipple assembly (6) from the nitrogen cylinder.
8. Lower the cab.
9. Fasten the seat belt. Start the engine.

10. Move the work tool to the full RAISE position. Stop the engine.

11. Turn the engine start switch key to the ON position.

12. Move the work tool to the full LOWER position. If the work tool lowers to the ground, proceed to step 13. If the work tool does not lower to the ground, start the engine and lower the work tool to the ground. Repeat the Accumulator Charge.

    Note: If the work tool does not lower to the ground after charging the accumulator two times, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

13. Remove the chocks.

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Pilot System Pressure - Test

SMCS - 5050-032-PS

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
177-7861	Hose	3
6V-4143	Coupler Assemblies	6
8T-0856	Pressure Gauge with range 0 to 6000 kPa (870 psi)	3
6V-3989	Unvalved Nipple	3
7X-2444	Tee	1
6V-3965	Nipple	1
6V-5049	O-Ring Seal	1
3J-1907	O-Ring Seal	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the machine for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release".

The pilot system pressure test determines the pressure to the joystick controls. The pilot oil is supplied by the charge pump section of the gear pump.

1. Engage the parking brake. Stop the engine.
2. Block the wheels of the machine.
3. Raise the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation".

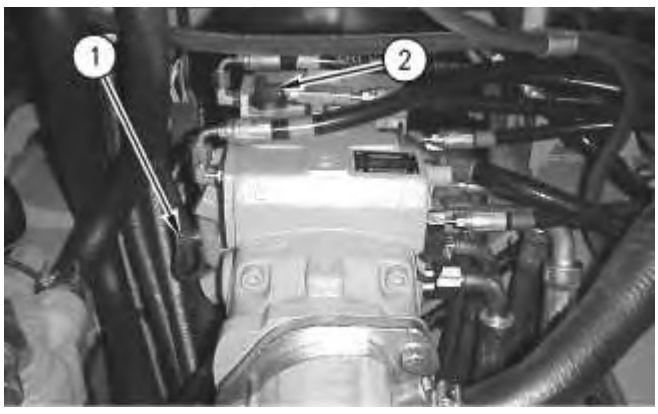


Illustration 1 g00788454

(1) Charge pressure tap

(2) Speed sensing pressure tap

4. Install a **6V-4143** Quick Connect Coupler to each end of **177-7861** Hoses . Install the **6V-3989** Fitting to the **8T-0856** Pressure Gauge . Connect the pressure gauge to the charge pressure tap (1) by using the hose and coupler assembly.

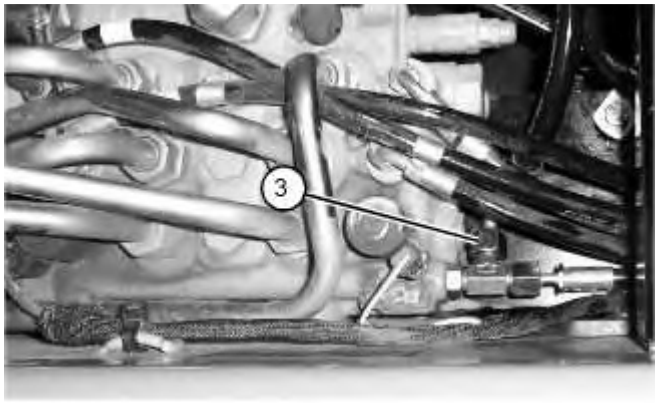


Illustration 2 g01055365

(3) Supply line for the work tool joystick control

5. Install a **6V-3965** Fitting As to the end of supply line (2) by using the **7X-2444** Tee . Use a **6V-5049** O-Ring Seal when you install the tee. Use a **3J-1907** O-Ring Seal when you connect the fitting assembly to the tee. The supply line is for the pilot operated hydraulic control (work tool).

6. Install a **6V-4143** Quick Connect Coupler to each end of the **177-7861** Hose As . Install the **6V-3989** Fitting to the **8T-0856** Pressure Gauge . Connect the pressure gauge to the pressure tap (3) on the pilot operated hydraulic control (work tool). Use the hose and coupler assembly.

7. Secure the three hydraulic lines so that the pressure gauges can be viewed by the operator during the test. The hoses should not be pinched when the cab is lowered.

8. Lower the cab.

9. Sit in the operator seat. Fasten the seat belt and lower the armrest.

10. Start the engine. Disengage the parking brake.

11. Run the engine at LOW IDLE. Record the charge pressure and speed sensing pressure. Set the engine RPM for all machines to the specification in 2.

12. Run the engine at HIGH IDLE. Record the charge pressure, speed sensing pressure, and pilot pressure. Set the engine RPM for all machines to the specification in 2.

Table 2

PILOT PRESSURES		
Engine Speed	**LOW IDLE**	**2300 ± 25 RPM**

Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)	3225 ± 200 kPa (468 ± 29 psi)
Pilot Pressure for the Work Tool	3100 ± 200 kPa (450 ± 29 psi)	3225 ± 200 kPa (468 ± 29 psi)

Note: If the pilot pressure is not within specifications, refer to Testing and Adjusting, "Hydrostatic System - Test and Adjust".

13. Reduce the engine to LOW IDLE. Stop the engine.
14. Raise the cab. Remove the test equipment.
15. Lower the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation". Remove the blocks.

Brake Test

This test will determine if the brakes are functioning correctly. This test will check the solenoid valve (brake) and the piston motor.

1. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

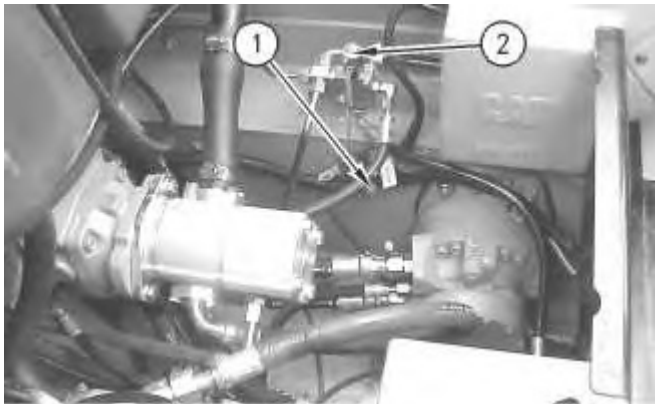


Illustration 3 g00790186

2. Disconnect electrical connection (1) for brake solenoid (2) .

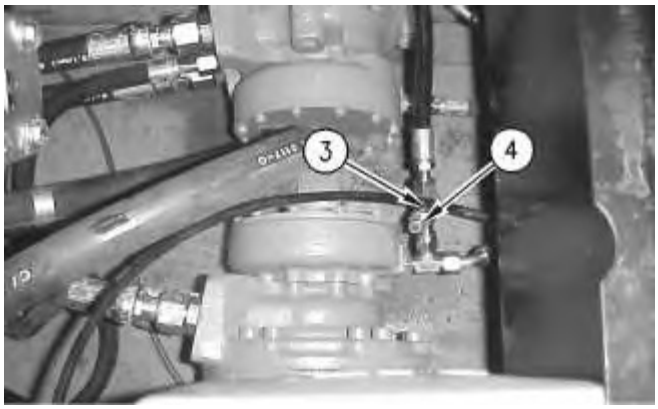


Illustration 4 g00790283

3. Install a **7X-2444** Tee (3) and a **6V-3965** Valved Nipple Assembly (4) in the hydraulic line.
4. Install a **8T-0855** Pressure Gauge to the valved nipple with a **177-7861** Hose .
5. Lower the cab. Make sure that the hydraulic line is not pinched.
6. Sit in the operator seat and fasten the seat belt. Lower the armrest.
7. Start the machine. Run the machine at Low Idle. The pressure gauge should read less than 300 kPa (44 psi). If the gauge does not read less than 300 kPa (44 psi), inspect the brake solenoid.
8. Stop the machine. Raise the cab and reconnect the brake solenoid.
9. Lower the cab. Sit in the operator seat and fasten the seat belt. Lower the armrest and start the machine. Set the governor at LOW IDLE.
10. Disengage the parking brake by pressing the parking brake switch. The pressure on the gauge should be 3100 ± 200 kPa (450 ± 29 psi).
11. If the pressure is not correct, inspect the following items: the brake solenoid, the voltage for the brake solenoid and the brake seal inside the piston motor.
12. If the brake solenoid is not functioning correctly, replace the solenoid.
13. When the test is completed, raise the cab and disconnect all gauges and hoses. Lower the cab and bolt the cab in place. Refer to Operation and Maintenance Manual, "Cab Support Operation".

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Pump Flow - Test

SMCS - 5073-032-TB; 5073-032-ON

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Table 1

Required Tools			
Item	**Part Number**	**Description**	**Qty**
A	9U-7400	Multitach Tool Gp	1
B	4C-9910	Portable Hydraulic Tester	1

Charge Pump

1. Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".



Illustration 1 g00592868

2. Open the engine access door. Install tooling (A) in order to measure engine speed. Use the reflective tape that is on the pulley for the engine crankcase. Ensure proper engine operation.

3. Stop the engine. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

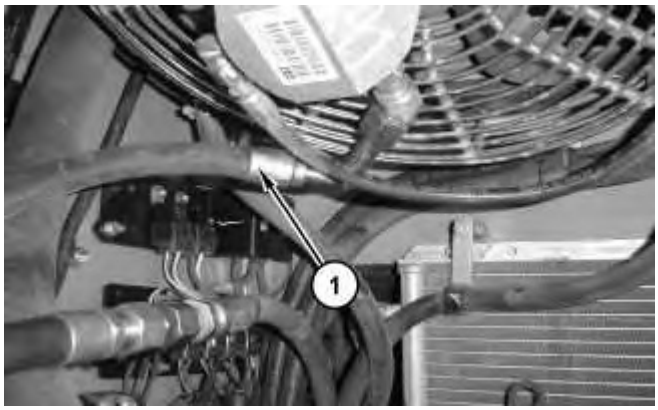


Illustration 2 g01356939

4. Disconnect the hose assembly (1) from the fan motor inlet. Install tooling (B). Connect the flow meter inlet to the hose assembly (1). Connect the outlet of the flow meter to the fan motor inlet. The flow meter is installed in-line to the outlet of the charge pump.

   Note: Damage to the pump and damage to the hoses may result from the high pressure that is created by the flow meter valve.

   Note: The flow meter valve must be fully open before installing the flow meter in-line.

   Note: Ensure that the outlet flow from the flow meter is returned to the fan motor inlet in order to maintain charge flow to the hystat pump.

5. Route the test lines and cables in order to avoid contact with the muffler. Secure the test instruments so that the test instruments are visible during the test.

6. Fasten the seat belt. Lower the armrest.

7. Start the engine. Run the engine at high idle.

8. The oil in the hydraulic system must be at an operating temperature of 45° ± 5°C (113° ± 9° F) throughout the test.

9. Set the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) by slowly adjusting the load valve on the flow meter.

   Note: Maintain the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) throughout the test.

10. Set the engine speed to 2000 ± 10 RPM. Ensure that engine speed is maintained throughout the test.

    Note: If necessary, readjust the pressure to 18000 ± 1000 kPa (2611 ± 145 psi).

11. Refer to Table 3 for the flow specification. Replace the pump if the specification is not met.

12. Unload the pump by adjusting the flow meter valve to the fully open position.

13. Stop the machine. Remove the Multitach Tool Gp (A) and the Portable Hydraulic Tester (B). Reconnect hydraulic lines.

Table 2

System Requirements	
Test	**Specification**
Pump Outlet Pressure	18000 ± 1000 kPa (2611 ± 145 psi)
Engine Speed	2000 ± 10 RPM
Oil Temperature	45° ± 5°C (113° ± 9° F)

Table 3

Charge Pump	
Machine Model	**Minimum Flow**
236B/ 246B/ 252B/ 262B	32 L/min (8.45 US gpm)

Work Tool Pump

1. Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".



Illustration 3 g00592868

2. Open the engine access door. Install tooling (A) in order to measure engine speed. Use the reflective tape that is on the pulley for the engine crankcase. Ensure proper engine operation.

3. Stop the engine. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.



Illustration 4 g01356942

4. Raise the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure. Disconnect hose assembly (1) and install tooling (B) in-line between the outlet of the work tool pump and the inlet of the control valve.

   Note: Damage to the pump and damage to the hoses may result from the high pressure that is created by the flow meter valve.

   Note: The flow meter valve must be fully open before installing the flow meter in-line.

5. Lower the cab. Route the hoses so that the cab does not rest on any of the hoses. Route the test lines and cables in order to avoid pinching the hydraulic lines when the cab is lowered. Secure the test instruments so that the test instruments are visible during the test.

6. Fasten the seat belt. Lower the armrest.

7. Start the engine. Run the engine at high idle.

   Note: The hydraulic oil temperature rises quickly as engine starts.

8. The oil in the hydraulic system must be at an operating temperature of 50° ± 10°C (122° ± 18°F) throughout test.

9. Set the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) by slowly adjusting the load valve on the flow meter.

   Note: Maintain the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) throughout the test.

10. Set the engine speed to 2000 ± 10 rpm.

    Note: If necessary, readjust the pressure to 18000 ± 1000 kPa (2611 ± 145 psi).

11. Refer to Table 5 for the flow specification. Replace the pump if the specification is not met.

12. Unload the pump by adjusting the flow meter valve to the fully open position.

13. Stop the machine. Remove the Multitach Tool Gp (A) and the Portable Hydraulic Tester (B). Reconnect hydraulic lines.

Table 4

System Requirements	
Test	**Specification**
Pump Outlet Pressure	18000 ± 1000 kPa (2611 ± 145 psi)
Engine Speed	2000 ± 10 RPM
Oil Temperature	50° ± 10°C (122° ± 18°F)

Table 5

Work Tool Pump	
Machine Model	**Minimum Flow**
236B/ 246B/ 252B/ 262B	50.9 L/min (13.45 US gpm)

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Worksheets - Troubleshoot

SMCS - 4350-035; 5050-035

The following tables are provided in order to record information as you perform the tests on the machine. Make copies of these tables so that the tables may be reused for other machines.

The worksheets are designed to be used for the following pressure tests:

- Engine idle
- Cycle times
- Drift checks
- Pump Flow
- Baseline for the hydrostatic system
- Hydrostatic system
- Pilot system
- Main relief valves
- Line relief valves

Troubleshooting Worksheets

The following tables are provided in order to record information as you perform the tests on the machine.

Table 1

MACHINE MODEL		**DATE**	
SERIAL NUMBER		**SERVICE METER HOURS**	
ENGINE SERIAL NUMBER		**ARRANGEMENT NUMBER**	

Table 2

LIFT CYLINDER SPEED TEST			
LIFT'S DIRECTION	**TIME (sec) (236B and 246B)**	**TIME (sec) (252B and 262B)**	**ACTUAL**
Raise	2.7 ± 0.5	4.8 ± 0.5	
Lower	2.7 ± 0.5	3.4 ± 0.5	
Float	2.8 ± 0.5	3.6 ± 0.5	

Table 3

TILT CYLINDER SPEED TEST		
TILT'S DIRECTION	**TIME (sec)**	**ACTUAL**
Tilt Forward	2.1 ± 0.5	
Tilt Back	1.6 ± 0.5	

Table 4

SPEED TEST FOR THE COUPLER CYLINDERS		
CYLINDER POSITION	**MAXIMUM TIME (sec)**	**ACTUAL**
Engaging the quick coupler	3	
Disengaging the quick coupler	3	

Table 5

LIFT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 6

TILT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 7

ENGINE IDLE		
TEST	**SPECIFICATION**	**ACTUAL**

High Idle	2860 ± 50 RPM	
Low Idle	1000 ± 50 RPM	

Table 8

BASELINE FOR THE HYDROSTATIC SYSTEM				
Oil Temperature Range 45° ± 5°C (113° ± 9°F)				
TEST	LOW IDLE		2300 ± 25 RPM	
	SPECIFICATION	ACTUAL	SPECIFICATION	ACTUAL
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Speed Sensing Pressure	950 ± 200 kPa (138 ± 29 psi)		2000 ± 150 kPa (290 ± 22 psi)	

Table 9

TEST	HIGH IDLE SPECIFICATION	ACTUAL
Fan Speed	2000 ± 50 RPM (236B and 252B) 2450 ± 50 RPM (246B and 262B)	
Demand Fan (if equipped)	1764 ± 50 RPM (246B and 262B)	

Table 10

HYDROSTATIC SYSTEM TESTS		
MAXIMUM RUNOUT HIGH IDLE		
Oil Temperature Range 45° ± 5°C (113° ± 9°F)		
TEST	SPECIFICATION	ACTUAL
RPM for left wheel for standard equipped machines	79 ± 6 (236B and 246B) (1) 74 ± 5 (252B and 262B) (1)	
RPM for right wheel for standard equipped machines	79 ± 6 (236B and 246B) (1) 74 ± 5 (252B and 262B) (1)	

RPM for the left wheel on machines that are equipped with two-speed capability in normal mode	66 ± 6 (236B and 246B) [1] 61 ± 5 (252B and 262B) [1]	
RPM for the right wheel on machines that are equipped with two-speed capability in normal mode	66 ± 6 (236B and 246B) [1] 61 ± 5 (252B and 262B) [1]	
Difference in RPM between wheels	1 RPM maximum	
MAXIMUM DISPLACEMENT STOP TEST		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Drift	3 m (10 ft)	
SINGLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2700 ± 200 RPM	
MB Pressure Pump 1	38300 ± 2000 kPa (5555 ± 290 psi)	
MB Pressure Pump 2	38300 ± 2000 kPa (5555 ± 290 psi)	
DOUBLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2300 ± 400 RPM	

[1] The wheel speeds must be within 1 RPM of each other.

Table 11

MAIN RELIEF VALVE PRESSURE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	
Main Relief	23000 ± 700 kPa (3336 ± 102 psi)	

Table 12

LINE RELIEF VALVE PRESSURE (MACHINE TEST)		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**

Lift Cylinder Head RAISE Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Head TILT FORWARD Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Rod TILT BACK Position	23000 ± 700 kPa (3336 ± 102 psi)	
Auxiliary Head	23000 ± 700 kPa (3336 ± 102 psi)	

Table 13

LINE RELIEF VALVE PRESSURE (BENCH TEST)		
HIGH IDLE		
TEST	**PRESSURE**	**ACTUAL**
Lift Cylinder RAISE	27600 ± 700 kPa (4003 ± 102 psi)	
Tilt Cylinder FORWARD	24500 ± 700 kPa (3554 ± 102 psi)	
Tilt Cylinder RACK BACK	27600 ± 700 kPa (4003 ± 102 psi)	
Auxiliary	24500 ± 700 kPa (3554 ± 102 psi)	

Table 14

PILOT SYSTEM PRESSURE TEST				
TEST	**LOW IDLE**		**2300 ± 25 RPM**	
	SPECIFICATION	**ACTUAL**	**SPECIFICATION**	**ACTUAL**
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Pilot Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	

Table 15

BRAKE TEST

LOW IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
Brake Line Pressure	3100 ± 200 kPa (450 ± 29 psi)	

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Machine Preparation

SMCS - 4350-035; 5050-035

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic system.

1. Move the machine to a smooth horizontal location. Move the machine away from other machines and personnel. Lower the bucket to the ground. Stop the engine.
2. Permit only one operator on the machine.
3. Block the front tires and the rear tires of the machine.
4. Place a barrier around the machine in order to keep personnel away from rotating machinery.
5. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Visual checks and measurements are the first steps during troubleshooting. Refer to Testing and Adjusting, "Visual Inspection". Next, perform the operational checks. Refer to Testing and Adjusting, "Operational Checks". Finally, perform the required tests and adjustments on the machine.

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Visual Inspection

SMCS - 4350-035; 5050-040

Before you perform this procedure, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the system is the first step when you troubleshoot a problem.



Illustration 1 g00696549

1. Check the hydraulic oil level in the sight glass for the hydraulic tank.
2. Look for air bubbles in the oil. Look for water in the oil.

   Note: Air bubbles may be caused by a fitting that is loose or damaged. A loose fitting or a damaged fitting allows air to enter the suction side of the system. This causes the oil to leak.
3. Add oil to the hydraulic system, if necessary. Refer to the Operation and Maintenance Manual for the recommended oil and for the correct procedure.
4. Check all lines, all hoses, and all connections for damage and for leaks. Look for fluid on the ground under the machine.

   Note: If fluid can leak out of a fitting or out of a connection, air can leak into the system.



Illustration 2 g01050319

5. Remove the hydraulic oil filter and inspect the filter for foreign material. A magnet will separate ferrous particles from nonferrous particles.

Next, perform the operational checks and last perform the instrument tests.

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Operational Checks

SMCS - 4350-535; 5050-535

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

The following operational checks can be used for the following items:

- find leakage in the system.
- determine whether the pilot operated hydraulic controls are functioning correctly.
- determine whether the pumps and motors are functioning correctly.
- determine whether the whole work tool system is functioning correctly.

In order for the hydraulic system to function properly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set properly will have an impact on other components in the system.

Note: When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Lift Cylinder Speed Test

Note: Perform the lift cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. If the automatic leveling switch is in the ON position, then turn the automatic leveling switch to the OFF position.
5. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
6. Operate the lift cylinder through at least five lift cycles. This will ensure that there is warm oil in the lift cylinders.
7. Tilt the bucket to the full TILT BACK position. Lower the bucket to the full LOWER position.
8. Raise the bucket from the full LOWER position. Record the time from the full LOWER position to the full RAISE position.
9. Lower the bucket from the full RAISE position. Record the time from the full RAISE position to the full LOWER position.
10. Raise the bucket to the full RAISE position. Move the hydraulic control to the FLOAT position. Record the time from the full RAISE position to the full LOWER position.

Table 1

TRAVEL TIME (SPEED) FOR THE LIFT CYLINDERS		
Position of the Hydraulic Control	**236B2**	**252B2**
RAISE	2.7 ± 0.5 seconds	4.8 ± 0.5 seconds
LOWER	2.7 ± 0.5 seconds	3.4 ± 0.5 seconds
FLOAT	2.8 ± 0.5 seconds	3.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Tilt Cylinder Speed Test

Note: Perform the tilt cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.

2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinders.
6. Tilt the bucket to the full TILT BACK position. Raise the bucket to the full RAISE position.
7. Tilt the bucket from the full TILT BACK position to the full DUMP position. Record the time from the full TILT BACK position to the full DUMP position.
8. Tilt the bucket from the full DUMP position to the full TILT BACK position. Record the time from the full DUMP position to the full TILT BACK position.
9. Lower the bucket to the ground.

Table 2

TRAVEL TIME (SPEED) FOR THE TILT CYLINDERS	
Position of the Hydraulic Control	**236B2/ 252B2**
DUMP	2.1 ± 0.5 seconds
TILT BACK	1.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Hydraulic Quick Coupler (if equipped)

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Press the switch in order to engage the quick coupler. Record the time that is needed to engage the quick coupler. Press the switch in order to disengage the quick coupler. Record the time that is needed to disengage the quick coupler.

Table 3

TRAVEL TIME (SPEED) FOR THE COUPLER CYLINDERS	
Engaging the quick coupler	3.0 seconds maximum
Disengaging the quick coupler	3.0 seconds maximum

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Drift Check (Lift and Tilt Cylinder)

Use this procedure to determine the amount of wear that occurs in the lift cylinders and the tilt cylinders.

Note: Perform the following tests with a general purpose bucket on the machine. If a general purpose bucket is not available, use a load weight of 200 kg (441 lb).

1. Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.
2. Run the engine at HIGH IDLE.
3. Operate the lift cylinders through at least five cycles. This will ensure that there is warm oil in the lift cylinder.
4. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinder.
5. Raise the bucket to the full RAISE position.
6. Tilt the bucket forward until the bucket is parallel with the ground.
7. Reduce the engine speed to LOW IDLE. Stop the engine.
8. Mark the cylinders.
9. Use a stopwatch to count for one minute. Measure the drift of the cylinders.

   Table 4

CYLINDER DRIFT		
Cylinders	**Time**	**Cylinder Drift**
Tilt Cylinders	1 minute	3 mm (0.118 inch)
Lift Cylinders	1 minute	3 mm (0.118 inch)

   Note: If the lift cylinder drift and/or the tilt cylinder drift exceeds the maximum, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

10. Start the engine and lower the bucket to the ground.

Test for Tracking of the Machine (Drift)

This test will determine if each displacement stop is adjusted correctly in each group of rotation. The two displacement stops adjust the maximum stroke of the swashplate in each of the groups of rotation in the forward direction.

Note: If the machine drifts to the same side in both forward and reverse, check the chain tension on both sides of the machine before you proceed with the test.

1. Move the machine to a testing location that is flat, level and 30.5 m (100 ft) long. Allow enough space on each side of the centerline for any machine drift that could exceed 3 m (10 ft).

   .

2. Inflate all four tires to the same air pressure.

3. Start the test outside the test area. The machine must enter the testing location in straight line travel and the machine must be traveling at full speed. The engine must be set to HIGH IDLE and the speed and direction control must be positioned fully forward.

4. Measure the amount of drift and record the direction of the drift.

Table 5

Test for Displacement Stop	
Test	**Specification**
Engine Speed	2860 ± 50 RPM
Drift	3 m (10 ft)

5. If the machine does not pass this test, refer to the Testing and Adjusting, "Maximum Runout Test".

Test for the Operation of the Two Speed Function (if equipped)

Use the following check in order to determine if the two speed function is operating correctly.

1. Fasten the seat belt and lower the armrest.

2. Start the engine. Run the engine at HIGH IDLE.

3. Disengage the parking brake.

4. Move the pilot operated hydraulic control all the way forward.

5. While you keep the machine at full speed, press the switch in order to activate the FAST mode. There should be a noticeable increase in the speed of the machine and the indicator for two speed should light. If there is not a noticeable increase in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

6. While the machine is still traveling, press the switch in order to deactivate the FAST mode. There should be a noticeable decrease in the speed of the machine and the indicator for two speed should shut off. If there is not a noticeable decrease in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

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Hydraulic System Troubleshooting

SMCS - 5050-035

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

This section provides probable causes to known problems. Prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Perform a visual inspection of the machine. Refer to Testing and Adjusting, "Visual Inspection".

Troubleshooting Problem List and Probable Causes

Problem 1

The hydraulic oil temperature is too high.

Probable Cause

1. The hydraulic oil temperature sensor is malfunctioning.
2. The hydraulic oil is aerated.
3. A restriction of air flow through the oil cooler.
4. A restriction of oil flow through the oil cooler.
5. The ambient air temperature is too high.
6. Operating the machine with one or more relief valves open for an excessive period of time.
7. The oil cooler bypass valve is stuck in the OPEN position.

Problem 2

The hydraulic oil temperature is too low.

Probable Cause

1. There is excessive oil flow through the oil cooler.
2. The oil cooler, the oil tank and other components in the hydraulic system are not protected from cold air temperatures or winds.
3. The oil cooler bypass valve is stuck in the CLOSED position.
4. The ambient air temperature is too low.

Problem 3

There is a large amount of air in the oil.

Probable Cause

1. The hydraulic oil suction line between the tank and the pump may be leaking.
2. There is air in the hydraulic system after assembly, inspection, or testing.
3. Air is entering the hydraulic system during operation.

Problem 4

The fan speed is too low or too high.

Probable Cause

1. Check the relief valve for contamination.
2. If the fan speed is low at LOW IDLE, determine that the gear pump is functioning correctly by hooking up a flow meter. If the gear pump is functioning correctly, replace the fan motor.
3. If the fan speed is too low or too high at HIGH IDLE, adjust the relief valve. If the problem cannot be resolved by adjusting the relief valve, replace the relief valve.

Problem 5

The drive chain box is filling with hydraulic oil.

Probable Cause

1. The hydraulic tank has been overfilled. Overfilling the tank will cause oil to drain from the vent hose. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for the correct level.
2. The shaft seal on the drive motor is leaking.

Problem 6

There is no hydraulic oil flow out of the charge section of the gear pump.

Probable Cause

1. The linkage between the two sections of the gear pump has broken. Replace the gear pump.
2. There has been damage to the seals on the charge pump. Replace the gear pump.

Problem 7

Hydraulic oil flow out of the two sections of the gear pump is limited.

Probable Cause

1. Check the inlet line for a restriction.
2. The strainer for the inlet is clogged.
3. The oil level is too low.
4. The hydraulic oil temperature is too low.
5. The hydraulic oil is aerated.
6. The gear pump is worn.
7. There is a restriction or there is a leak in the hydraulic line from the hydraulic tank.
8. Check the mechanical linkage between the piston pump and the engine.

9. Check the mechanical linkage between the gear pump and the piston pump.

Problem 8

The hydraulic tank is pressurized.

Probable Cause

1. The breather for the hydraulic tank is clogged.

Problem 9

The fan motor is noisy.

Probable Cause

1. The makeup valve for the fan motor is stuck.

Problem 10

The lift circuit and the tilt circuit are not functioning properly.

Probable Cause

1. The main relief valve setting is too low.
2. The charge pressure is incorrect.
3. The pilot operated hydraulic control (work tool) is not functioning properly.
4. The control valve is not functioning properly.
5. The orifices for the pilot operated hydraulic control (work tool) are clogged.
6. The cylinder is not functioning properly.
7. The gear pump is not functioning properly.
8. One of the lines or one of the hoses is broken.
9. The diverter valve (if equipped) is not functioning properly.
10. The interlock system is not functioning properly.
11. The load is too heavy.
12. A line relief valve is set too low.
13. A load check valve on the control valve is stuck in the CLOSED position.

Problem 11

The auxiliary hydraulic system is not functioning.

1. The switch for the hydraulic shutoff valve is in the OFF position.

2. The auxiliary circuit switch is not functioning properly.
3. The fourth function control is not functioning properly.
4. The platform harness, the cab harness, or the harness for the pilot operated hydraulic control (work tool) is not functioning properly.
5. The auxiliary solenoids are not functioning properly.
6. The orifices for the pilot operated hydraulic control (work tool) are clogged.
7. The control valve is not functioning properly.
8. The work tool is not functioning properly.
9. The harness for the work tool is not functioning properly.
10. The ECM or the software is not functioning properly.
11. The line relief setting is too low.
12. The auxiliary circuit connections are not fully engaged.

Problem 12

All work tool functions and auxiliary functions are sluggish, erratic, or intermittent.

Probable Cause

1. The gear pump is not functioning properly.
2. The main relief setting is too low.
3. The pilot system pressure is incorrect.
4. The pilot operated hydraulic control (work tool) is not functioning properly.
5. The hydraulic system is contaminated.
6. The control valve and the spools have an excessive amount of wear.
7. The charge pressure is too low.
8. The line relief valves are set too low or the line relief valves are damaged.
9. The orifices on the hydraulic control are clogged.
10. The load check valve is partially closed.
11. The auxiliary solenoid is not getting an adequate amount of current or the solenoid is sticking.
12. The seals on the lift valve spool are damaged or worn.
13. The cylinders may have leaks.

14. The diverter valve (if equipped) is not functioning properly.
15. The ball valve is not fully closed.
16. The power supply from the engine is low.

Problem 13

The gear pump makes noise and the cylinder rods move erratically.

Probable Cause

1. The hydraulic oil is aerated.
2. The viscosity of the oil is incorrect.
3. The setting of the main relief valve is too low.
4. There is a loose connection of the oil line on the inlet side of the pump.
5. The gear pump has too much wear.
6. The line relief valve is set too low.

Problem 14

The oil pressure in the hydraulic system is low.

Probable Cause

1. The setting of the main relief valve is too low.
2. The gear pump has too much wear.
3. The control valve and the valve spools have an excessive amount of wear.
4. The setting of the line relief valves is too low.
5. The pilot pressure is too low.

Problem 15

The work tool moves while the hydraulic control is in the HOLD position.

Probable Cause

1. A spool in the pilot operated hydraulic control is sticking.
2. The control valve and the valve spool have an excessive amount of wear.
3. A piston seal in a cylinder has excessive wear.
4. There is a external leak between the bank valve and the cylinder that is drifting.
5. The seals on the control valve could be worn.

6. The ball valve is not fully closed.
7. The load check valve could be stuck in the control valve.
8. The line relief valve in the lift circuit is set too low or the relief valve is stuck in the OPEN position.

Problem 16

The work tool droops when the hydraulic control is moved from the HOLD position to the RAISE position.

Probable Causes

1. The hydraulic oil is aerated.
2. The piston seals of the lift cylinder are worn.
3. The control valve and the valve spool have an excessive amount of wear.
4. The load check valve on the control valve may be open or leaking.

Problem 17

The work tool droops when the hydraulic control is moved from the HOLD position to the TILT FORWARD position.

Probable Causes

1. The hydraulic oil is aerated.
2. The piston seals of the lift cylinder are worn.
3. The control valve and the valve spool have an excessive amount of wear.
4. The line relief valves are damaged or worn.

Problem 18

The work tool will not lower to the ground when the engine is stopped.

Probable Cause

1. The accumulator is not properly charged.
2. The pilot pressure is low.
3. The seals on the lift valve section may be damaged or worn.
4. Charge pressure may be leaking past a solenoid in the interlock system.
5. The pilot operated hydraulic control (work tool) is not functioning properly.
6. The interlock system is not functioning properly.

Problem 19

The machine has poor hydraulic performance when the engine is at high idle.

Probable Cause

1. The setting for the corresponding line relief valve or for the main relief valve may be incorrect.
2. The gear pump may be worn.
3. The pilot pressure is low.
4. The cylinder may have internal leaks.

Problem 20

The line relief valves are noisy.

Probable Cause

1. The line relief valve is adjusted too low or the line relief valve is damaged.
2. The main relief valve is set too high.

Problem 21

There is instability in the hydraulic system.

Probable Cause

1. The diverter valve (if equipped) is damaged or worn.
2. The hydraulic oil is aerated.
3. The gear pump has excessive wear.

Problem 22

The diverter valve (if equipped) is not functioning properly.

Probable Cause

1. The electrical connection between the machine and the diverter valve has been broken.
2. The solenoid on the diverter valve is not functioning.
3. The spool in the diverter valve is stuck in the OPEN position.
4. The cylinder may have internal leaks.

Problem 23

The diverter valve (if equipped) is not making the bucket level with the ground.

Probable Cause

1. The diverter valve is out of adjustment.

2. The cylinder may have internal leaks.

3. The hydraulic lines for the lift circuit or the hydraulic lines for the tilt circuit may have leaks.

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System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Use the following procedure to release the pressure in the hydraulic system. Perform this procedure before any work is done to the hydraulic system.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the pilot accumulator.
2. Stop the engine. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Move the pilot operated hydraulic controls through all of the positions.
4. Turn the engine start switch to the OFF position.
5. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.

The pressure in the hydraulic system has now been released.

Note: Some pilot lines on the downstream side of the accumulator may still contain pressurized oil. Use caution when you disconnect these pilot lines.

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Hydraulic Oil Contamination - Test

SMCS - 5050-008

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Use the following procedure to sample the oil in the hydraulic system.

Note: If the oil becomes contaminated, premature component failure could result. Contaminated oil can also contribute to overheating.

1. Start the engine and run the engine at HIGH IDLE.
2. Actuate all hydraulic cylinders through a minimum of 10 full cycles.
3. Install a jumper line between the auxiliary lines. Cycle the auxiliary flow for one minute.
4. Lower the work tool to the ground.
5. Allow the engine to run at LOW IDLE.

   Note: Do not operate the hydraulic controls.
6. Open the engine access door.



Illustration 1 g01051544

Note: Remove any dirt or debris on the sampling valve.

7. Draw a 50 mL (1.7 fl oz) oil sample through the scheduled oil sampling valve. The level of the contaminants must be less than or equal to the values in ISO 18/15. To meet this specification, the concentration of contaminants must be less than or equal to the values in the following Table 1.

Table 1

Hydraulic Oil Contamination	
Particle Size (Microns)	**Maximum Number of Particles in a 50 mL Sample**
>5	125000
>15	16000

8. If the concentration of contaminants is higher than the values in the table, flush the hydraulic system. Refer to Testing and Adjusting, "Filling and Flushing the Hydraulic System - Test" for the proper procedure.

9. If the concentration of contaminants continues to be higher than the values in the table, change the hydraulic oil. Refer to the Operation and Maintenance Manual, "Hydraulic System Oil - Change" for further information.

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i02938818

Main Relief Valve - Test and Adjust

SMCS - 5069-081; 5069-025

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
6V-4143	Coupler As	2
177-7861	Hose As	1
6V-3989	Fitting	1
8T-0860	Pressure Gauge (40000 kPa (5800 psi))	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Perform the main relief valve test in order to determine if the main relief valve for the work tool is damaged or improperly set.

1. Engage the parking brake. Stop the engine.
2. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.



Illustration 1 g01055240

(1) Test port

3. Connect one end of the **177-7861** Hose to the test port (1) for the work tool. Connect the **8T -0860** Gauge to the other end of the **177-7861** Hose .
4. Route the test hose so that the cab will not rest on the hose. Securely bolt the cab to the frame.

5. Sit in the operator's seat. Fasten the seat belt. Lower the armrest. Start the engine. Disengage the parking brake.
6. Set the engine to HIGH IDLE.



Illustration 2 g00788651

Pilot operated hydraulic control (work tool)

7. Move the pilot operated control lever for the work tool to the full LOWER position. Hold the control lever until the lift arms are fully lowered and a stall condition exists.

   Note: Do not stall the hydraulic system for more than 10 seconds. If necessary, release the work tool from the stall condition. Release the work tool for 30 seconds and repeat the following step.

8. Record the system pressure for the work tool during the stall condition. Move the control lever for the work tool to the NEUTRAL position.

Table 2

MAIN RELIEF PRESSURE	
Machine	**Main Relief Pressure**
236B2/ 252B2	23000 ± 700 kPa (3336 ± 102 psi)

9. Release the hydraulic control from the stall condition. Tilt the work tool until the work tool is parallel with the ground. Stop the engine.
10. If the pressure reading is within specifications, proceed to step 23. If the pressure reading is not to specifications, the main relief valve needs to be adjusted. Proceed to step 11.
11. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.
12. Raise the cab of the machine.

13. If your machine uses a relief valve (Type 1) then proceed to Step 14. If your machine uses a relief valve (Type 2) proceed to Step 18.



Illustration 3 g01383119

Main relief valve for the work tool

Note: The following steps are for machines that use a relief valve (Type 1).

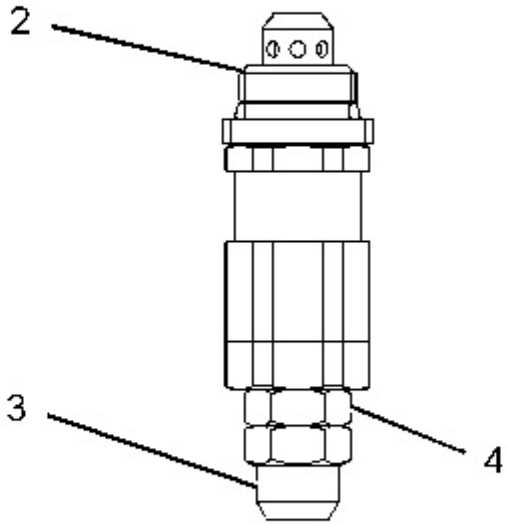


Illustration 4 g01355287

(2) Main relief valve (Type 1) for the work tool

(3) Cap

(4) Locknut

14. Remove end cap (3) from main relief valve (2) .

15. Loosen locknut (4). The adjustment screw is under the end cap (3). Turn the adjustment screw clockwise in order to increase the relief valve setting. Turn the adjustment screw counterclockwise in order to decrease the relief valve setting.

16. Tighten locknut (4) and install cap (3) .

17. Lower the cab and repeat steps 5 through 10.



Illustration 5 g01383119

Main relief valve for the work tool

Note: The following steps are for machines that use a relief valve (Type 2).

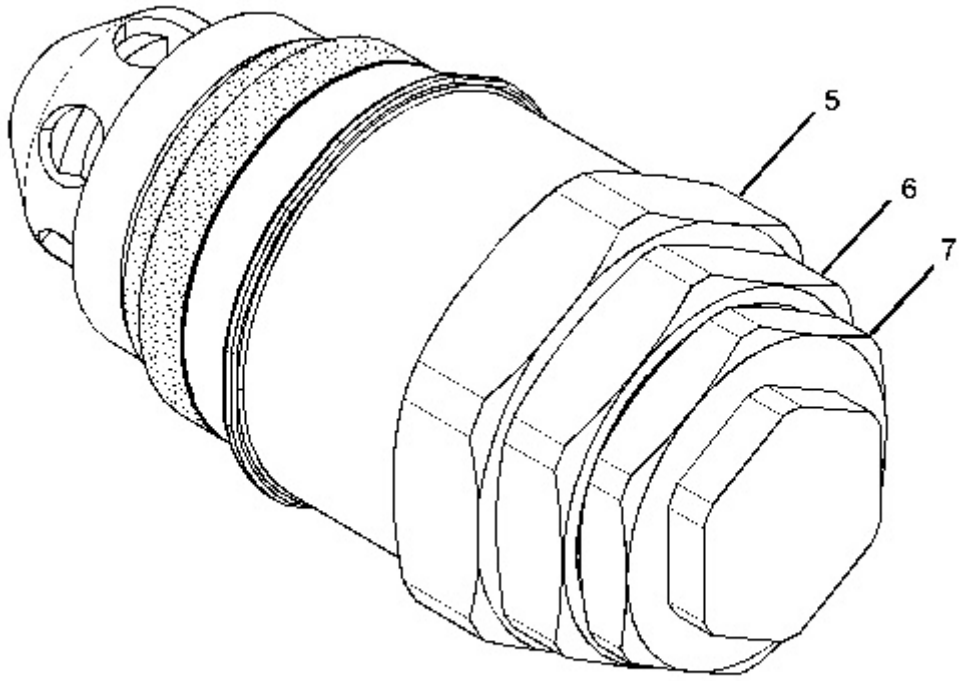


Illustration 6 g01355281

(5) Main relief valve (Type 2) for the work tool

(6) Locknut

(7) Adjusting nut

18. To adjust the relief valve pressure, hold the valve body (5) in position. Then loosen the locknut (6) at the same time.
19. Hold the adjusting nut (7) stationary. Loosen the locknut (6) toward the adjusting nut.
20. To adjust the pressure, increase the pressure by turning the adjusting nut (7) clockwise. Turn the adjusting nut counterclockwise in order to decrease the pressure.

    Note: Relief valve pressure should always be set on the rise.
21. Set the relief valve to the desired pressure. Hold the adjusting nut (7) in place. Secure the locknut (6) against the valve base.
22. Lower the cab and repeat steps 5 through 10.
23. Raise the cab and remove the test equipment.
24. Lower the cab and bolt down the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation".

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i02938879

Line Relief Valve - Test and Adjust

SMCS - 5117-081-L9; 5117-025-L9

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system. Refer to the Testing and Adjusting, "Visual Inspection".

The following test is performed in order to determine if a line relief valve for the work tool is damaged or improperly set.

Machine Test (Pressure)

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Perform the Machine Test (Pressure) in order to determine if the line relief valve is set too low.

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
6V-4143	Coupler Assemblies	2
177-7861	Hose As	1
6V-3989	Fitting	1
8T-0860	Pressure Gauge (40000 kPa (5800 psi))	1

Stall Test (Boom Lower)

Perform the following test in order to determine if the main relief valve is set properly.

1. Perform the Testing and Adjusting, "Main Relief Valve - Test and Adjust".
2. Record the main relief valve pressure setting.

Table 2

MAIN RELIEF PRESSURE	
Machine	**Main Relief Pressure**
236B2/ 252B2	23000 ± 700 kPa (3336 ± 102 psi)

3. Do not disconnect the pressure gauge.

Stall Test (Boom Raise)

Perform the following test in order to determine if the line relief valve for the lift raise is set too low.

1. If the pressure gauge is not attached, attach the pressure gauge. Refer to Testing and Adjusting, "Main Relief Valve - Test and Adjust".

2. Sit in the operator's seat. Fasten the seat belt. Lower the armrest. Start the engine. Disengage the parking brake.

3. Run the engine at HIGH IDLE.

NOTICE

Do not stall the hydraulic system for more than 10 seconds. If necessary, release the work tool from the stall condition and wait 30 seconds before you repeat the following step.

---

4. Press the pilot operated hydraulic control backward in order to raise the boom. Continue pressing the pilot operated hydraulic control backward in order to stall the boom.

5. Record the pressure on the pressure gauge.

6. Compare the test pressure to the main relief valve pressure setting that was recorded in table 2.

    - If the test pressure is less than the main relief valve pressure setting, then the line relief valve is set too low. Perform the "Bench Test and Adjust" in order to adjust the line relief valve pressure setting.

    - If the test pressure is equal to the main relief valve pressure setting, then the line relief valve pressure setting may be correct or the line relief valve pressure setting may be too high. Perform the "Bench Test and Adjust" in order to adjust the line relief valve pressure setting.

7. Repeat the "Stall Test (Boom Raise)" for the Tilt Forward, for the Tilt Back, and for the Auxiliary circuit.

Bench Test and Adjust

Perform the Bench Test and Adjust in order to adjust the line relief valve pressure setting.

Table 3

REQUIRED TOOLS			
Tool	**Part Number**	**Description**	**Qty**
A	3S-6224	Electric Hydraulic Pump Gp	1
	3B-7722	Pipe Bushing	2

	7J-8611	Pipe Elbow	1
	8F-0024	Hose As	2
	1P-2375	Quick Connect Couplers	2
B	299-1731	Test Manifold Gp	1
	6V-3965	Fitting As	3
	6V-8398	O-Ring Seal	3
C	8T-0860	Pressure Gauge (40000 kPa (5802 psi))	1
	1P-2376	Quick Connect Coupler	2

Table 4

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
1P-2377	Plug As	2
030-8370	Pipe Adapter	2

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

---

1. Lower the boom to the ground.
2. Engage the parking brake. Stop the engine.
3. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.
4. Turn the key to the OFF position.
5. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.

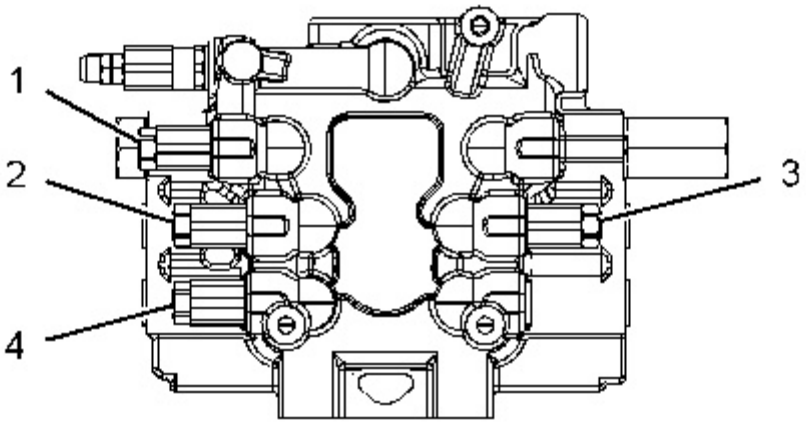


Illustration 1 g01138070

(1) Line relief valve for Lift Raise

(2) Line relief valve for Tilt Forward

(3) Line relief valve for Tilt Back

(4) Line relief valve for Auxiliary

6. Remove the line relief valve that will be tested.

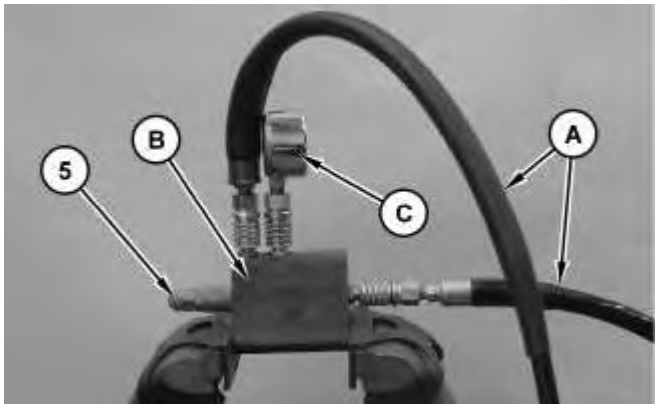


Illustration 2 g01357866

(5) Line Relief Valve

(A) Tooling

(B) Tooling

(C) Tooling

7. Assemble tooling (B), as shown. Secure tooling (B) in a suitable holding device.
8. Install tooling (A) to tooling (B) .
9. Install tooling (C) to tooling (B) .
10. Install the line relief valve (5) that will be tested. Install relief valve (5) to tooling (B) .
11. Turn the electric hydraulic pump to the ON position. Check for leaks at the connection.

NOTICE

The 3S-6224 Electric Hydraulic Pump only has a 7.6 L (2 US gal) reservoir. Pump damage may result if the pump is operated with an empty reservoir.

12. Slowly increase the pressure. Record the pressure, when the line relief valve opens. Compare this pressure to Table 5.
13. Stop the pump.

Table 5

LINE RELIEF VALVE PRESSURES	
Position	**236B2/ 252B2**
Lift Cylinder Head RAISE position	27600 ± 700 kPa (4003 ± 102 psi)
Tilt Cylinder Head TILT FORWARD position	24500 ± 700 kPa (3554 ± 102 psi)
Tilt Cylinder Rod TILT BACK position	27600 ± 700 kPa (4003 ± 102 psi)
Auxiliary Circuit	24500 ± 700 kPa (3554 ± 102 psi)

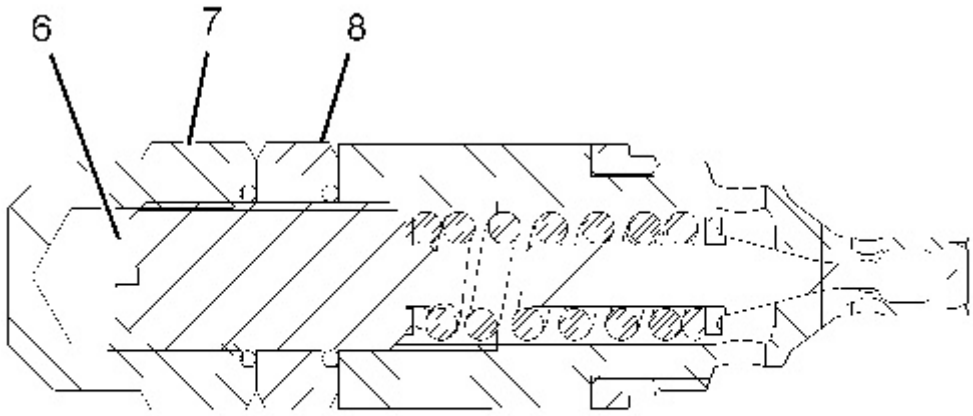


Illustration 3 g01355331

(6) Adjustment screw

(7) Cap

(8) Locknut

14. If the line relief valve is within the specification, go to Step 16. If the line relief valve is not within the specification, then an adjustment is required.

    a. Remove cap (7). Loosen locknut (8) and turn adjustment screw (6) clockwise in order to increase pressure. Turn adjustment screw (6) counterclockwise in order to decrease pressure.

    b. Check the oil level in **3S-6224** Electric Hydraulic Pump and refill the oil if it is necessary. Repeat Steps 11, 12, 13, and 14.

Note: If you are unable to adjust the line relief valve to the correct specification, replace the old line relief valve with a new line relief valve.

15. Tighten locknut (8) to a torque of 24 ± 3 N·m (18± 2 lb ft). Install the cap (7) and tighten the cap to a torque of 24 ± 3 N·m (18± 2 lb ft).

16. Remove the line relief valve from the manifold.

17. Install a new seal on the relief valve.

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i02938522

Accumulator (Pilot) - Test and Charge

SMCS - 5077-081-PS; 5077-045-PS

Charge Pressure Test

The following test is performed in order to check the charge pressure of the pilot oil accumulator.

Accumulator That Is Not Rechargeable

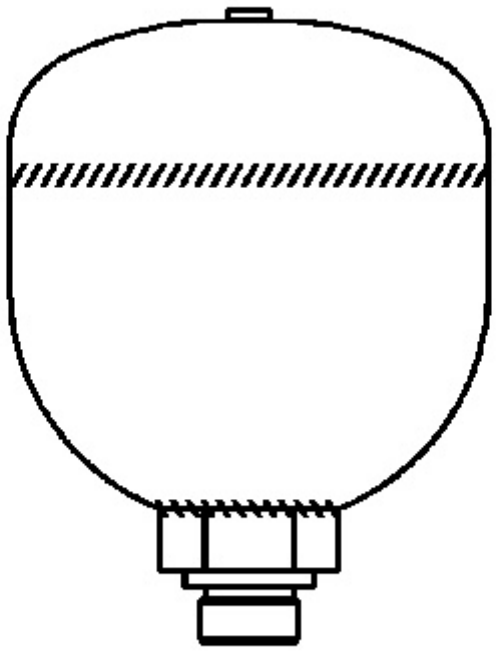


Illustration 1 g01136249

Typical accumulator that is not rechargeable

Perform this test if the pilot accumulator is not rechargeable.

Table 1

Required Tools		
Part Number	**Description**	**Qty**
3J-1907	O-Ring Seal	1
6V-3965	Fitting	1
6V-3989	Unvalved Fitting	1
6V-4143	Quick Connect Couplers	2
6V-5049	O-Ring Seal	1
7X-2444	Swivel Tee	1
8T-0856	Pressure Gauge (0 to 6000 kPa)	1
177-7860	Hose	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel.
2. Lower the work tool to the ground. Stop the engine.
3. Engage the parking brake.
4. Place chocks in front of the wheels and behind the wheels.
5. Turn the engine start switch key to the ON position.
6. Move the pilot valves to all positions in order to release the pressure in the hydraulic system.
7. Turn the engine start switch key to the OFF position.
8. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

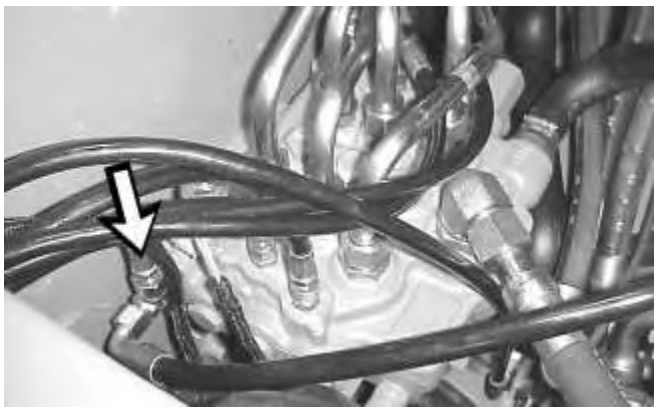


Illustration 2 g01138678

Supply line for the pilot operated hydraulic control (work tool)

9. Install **7X-2444** Swivel Tee and **6V-5049** O-Ring Seal to the end of the supply line for the pilot operated hydraulic control (work tool). Install **6V-3965** Fitting and **3J-1907** O-Ring Seal to the tee.

10. Attach **6V-3989** Unvalved Fitting to **8T-0856** Pressure Gauge .
11. Attach two **6V-4143** Quick Connect Couplers to **177-7860** Hose .
12. Attach one **6V-4143** Quick Connect Coupler to the **6V-3965** Fitting . Attach the other **6V-4143** Quick Connect Coupler to the **6V-3989** Unvalved Fitting .
13. Lower the cab. Do not pinch the hose.
14. Sit in the seat. Fasten the seat belt and lower the armrest.
15. Start the engine. Disengage the parking brake.
16. Run the engine at 2300 ± 25 RPM. The pilot pressure should rise to 3225 ± 200 kPa (468 ± 29 psi). If the pilot pressure is not correct, refer to Testing and Adjusting, "Hydrostatic System - Test and Adjust".
17. Use the hydraulic implement control in order to move the lift arms to the full RAISE position. Stop the engine.
18. Turn the engine start switch key to the ON position.
19. Use the hydraulic implement control in order to move the lift arms to the full LOWER position. The lift arms will lower. The pressure will decrease in one of the following ways:
    - The pressure decreases slowly until the pressure reaches 900 ± 100 kPa (130 ± 15 psi). Then, the pressure decreases rapidly. If this happens, the accumulator is properly charged. Proceed to Step 20.
    - If the pressure decreases rapidly, the accumulator is not properly charged. Replace the accumulator with a rechargeable accumulator. Refer to Disassembly and Assembly, "Accumulator - Remove and Install". Proceed to the Accumulator Charge.
20. Remove the chocks.

Test for Rechargeable Accumulator

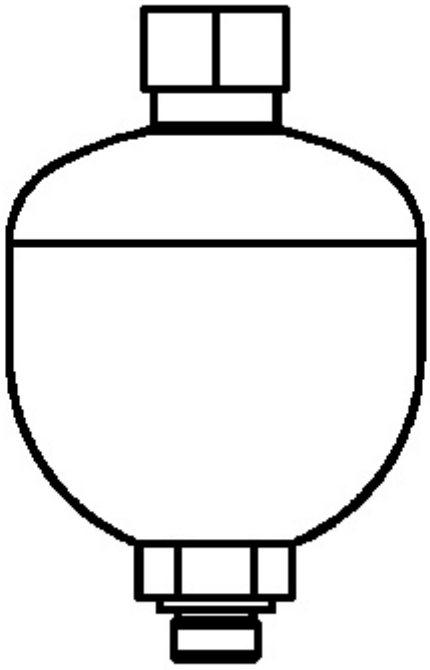


Illustration 3 g01138634

Typical rechargeable accumulator

Perform this test if the pilot accumulator is rechargeable.

Table 2

Required Tools		
Part Number	**Description**	**Qty**
152-2023	Nitrogen Charging Fitting Gp	1
175-5507	Nitrogen Charging Group	1

WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel.
2. Lower the work tool to the ground. Stop the engine.
3. Engage the parking brake.
4. Place chocks in front of the wheels and behind the wheels.

5. Turn the engine start switch key to the ON position.
6. Move the pilot valves to all positions in order to release the pressure in the hydraulic system.
7. Turn the engine start switch key to the OFF position.
8. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

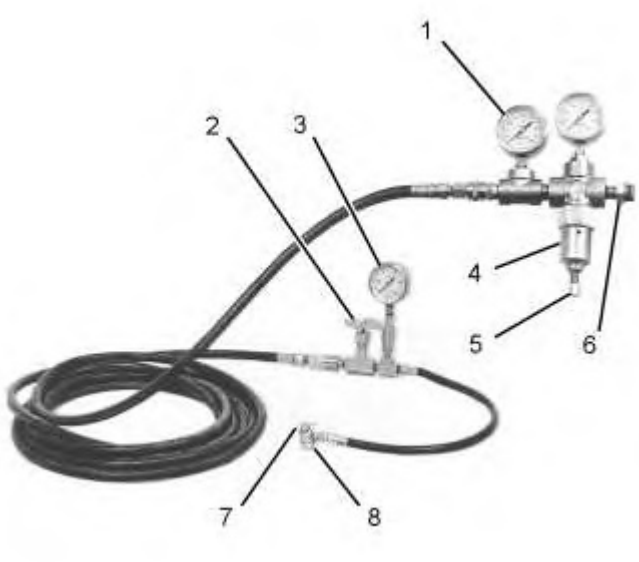


Illustration 4 g01138645

Nitrogen Charging Group

(1) Pressure gauge

(2) Valve

(3) Pressure gauge

(4) Regulator assembly

(5) Pressure regulating screw

(6) Nipple assembly for the nitrogen cylinder valve

(7) Valve handle

(8) Chuck

9. Turn the valve (2) completely in the clockwise direction. Turn the valve handle (7) completely in the counterclockwise direction.

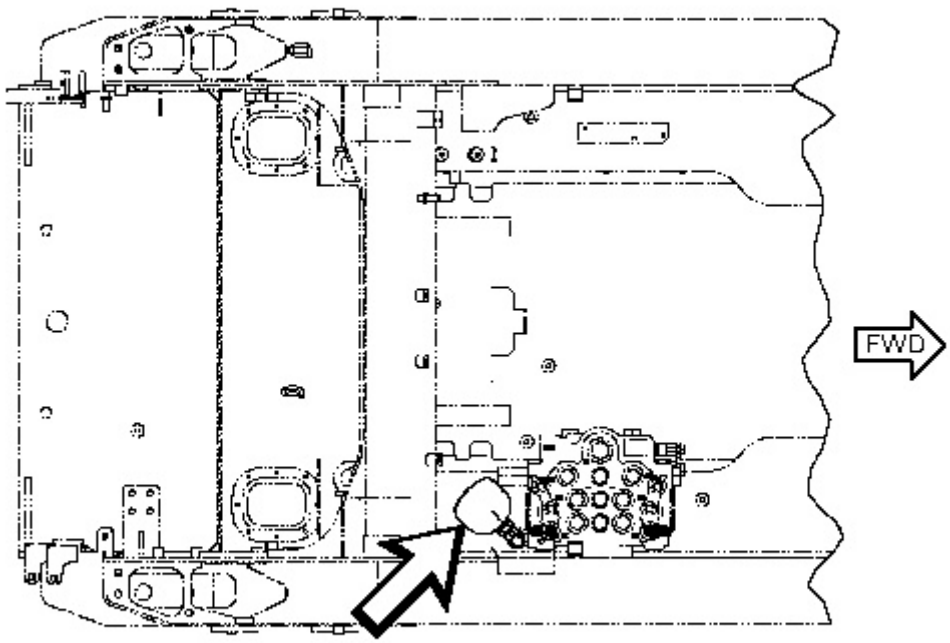


Illustration 5 g01136222

Location of the Accumulator

10. Install the chuck (8) to the accumulator.
11. Turn the valve handle (7) completely in the clockwise direction. The reading on the pressure gauge (3) should be 900 ± 100 kPa (130 ± 15 psi).
12. If the reading on the pressure gauge is too high, repeat steps 5 through 7. This ensures that there is no hydraulic oil in the accumulator. If the pressure is still high, slowly open valve (2) in order to lower the pressure. If the pressure is too low, proceed to the Accumulator Charge.
13. Close valve (2) . Close the valve on the nitrogen cylinder.
14. Turn the valve handle (7) completely in the counterclockwise direction.
15. Remove the chuck (8) from the accumulator.
16. Open the valve (2) . This will release the pressure between the valve (2) and the valve on the nitrogen cylinder. Remove the nipple assembly (6) from the nitrogen cylinder.
17. Lower the cab.
18. Fasten the seat belt. Start the engine.

19. Move the work tool to the full RAISE position. Stop the engine.

20. Turn the engine start switch key to the ON position.

21. Move the work tool to the full LOWER position. If the work tool lowers to the ground, proceed to step 20. If the work tool does not lower to the ground, start the engine and lower the work tool to the ground. Repeat steps 5 through 19.

    Note: If the work tool does not lower to the ground after charging the accumulator two times, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

22. Remove the chocks.

Accumulator Charge

The following procedure is performed in order to charge the rechargeable accumulator (pilot) to the correct precharge pressure.

Table 3

Required Tools		
Part Number	**Description**	**Qty**
152-2023	Nitrogen Charging Fitting Gp	1
175-5507	Nitrogen Charging Group	1

WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

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NOTICE

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Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation for Troubleshooting".

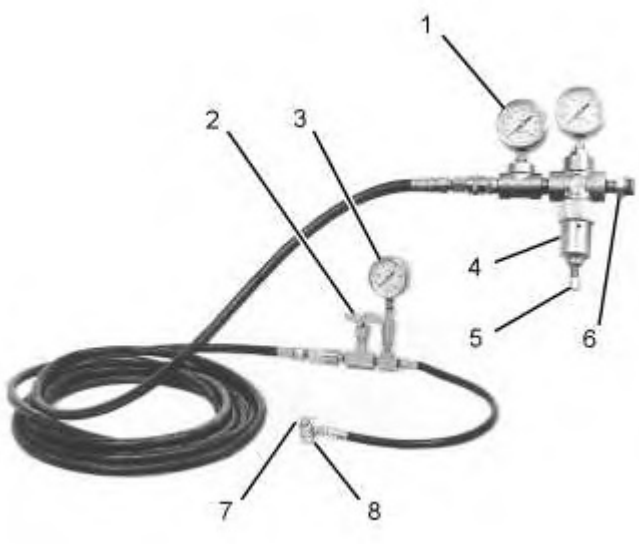


Illustration 6 g01138645

Nitrogen Charging Group

(1) Pressure gauge

(2) Valve

(3) Pressure gauge

(4) Regulator assembly

(5) Pressure regulating screw

(6) Nipple assembly for the nitrogen cylinder valve

(7) Valve handle

(8) Chuck

1. Perform Steps 1 to 10 of Charge Pressure Test (Rechargeable Accumulator) in order to install the **175-5507** Nitrogen Charging Group .
2. Turn the valve handle (7) completely in the clockwise direction. The reading on the pressure gauge (3) should be 900 ± 100 kPa (130 ± 15 psi).
3. If the reading on the pressure gauge is too high, repeat steps 5 through 7. This ensures that there is no hydraulic oil in the accumulator. If the pressure is still high, slowly open valve (2) in order to lower the pressure. If the reading on the pressure gauge is too low, use the following procedure in order to charge the accumulator:
    a. Connect the nipple assembly (6) to the nitrogen cylinder.
    b. Open the valve on the nitrogen cylinder. Adjust screw (5) on the regulator assembly (4) until the reading on pressure gauge (1) is 900 ± 100 kPa (130 ± 15 psi).
    c. Open valve (2) and charge the accumulator. Then, close valve (2) . If pressure gauge (3) and pressure gauge (1) show the same reading and the readings do not change, the accumulator has the correct charge.

       If the pressure reading on gauge (3) decreases, open valve (2) and allow more nitrogen to fill the accumulator.

       Perform this procedure until pressure gauge (3) and pressure gauge (1) show the same reading. Make sure that neither reading changes when valve (2) is closed.
4. Close valve (2) . Close the valve on the nitrogen cylinder.
5. Turn the valve handle (7) completely in the counterclockwise direction.
6. Remove the chuck (8) from the accumulator.
7. Open the valve (2) . This will release the pressure between the valve (2) and the valve on the nitrogen cylinder. Remove the nipple assembly (6) from the nitrogen cylinder.
8. Lower the cab.
9. Fasten the seat belt. Start the engine.

10. Move the work tool to the full RAISE position. Stop the engine.

11. Turn the engine start switch key to the ON position.

12. Move the work tool to the full LOWER position. If the work tool lowers to the ground, proceed to step 13. If the work tool does not lower to the ground, start the engine and lower the work tool to the ground. Repeat the Accumulator Charge.

    Note: If the work tool does not lower to the ground after charging the accumulator two times, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

13. Remove the chocks.

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i04321530

Pilot System Pressure - Test

SMCS - 5050-032-PS

Table 1

REQUIRED TOOLS		
Part Number	**Description**	**Qty**
177-7861	Hose	3
6V-4143	Coupler Assemblies	6
8T-0856	Pressure Gauge with range 0 to 6000 kPa (870 psi)	3
6V-3989	Unvalved Nipple	3
7X-2444	Tee	1
6V-3965	Nipple	1
6V-5049	O-Ring Seal	1
3J-1907	O-Ring Seal	1

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the machine for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection". Before any tests are performed, release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release".

The pilot system pressure test determines the pressure to the joystick controls. The pilot oil is supplied by the charge pump section of the gear pump.

1. Engage the parking brake. Stop the engine.
2. Block the wheels of the machine.
3. Raise the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation".

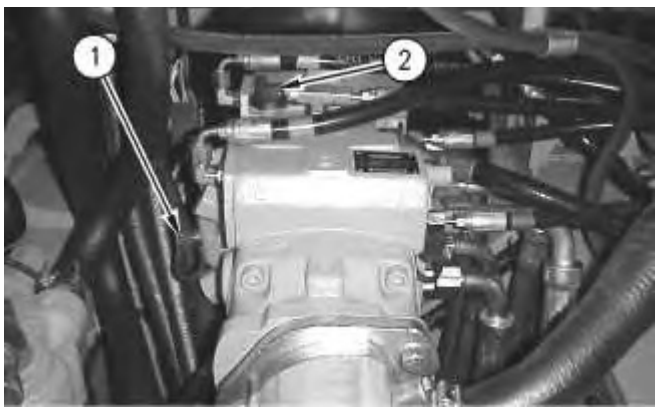


Illustration 1 g00788454

(1) Charge pressure tap

(2) Speed sensing pressure tap

4. Install a **6V-4143** Quick Connect Coupler to each end of **177-7861** Hoses . Install the **6V-3989** Fitting to the **8T-0856** Pressure Gauge . Connect the pressure gauge to the charge pressure tap (1) by using the hose and coupler assembly.

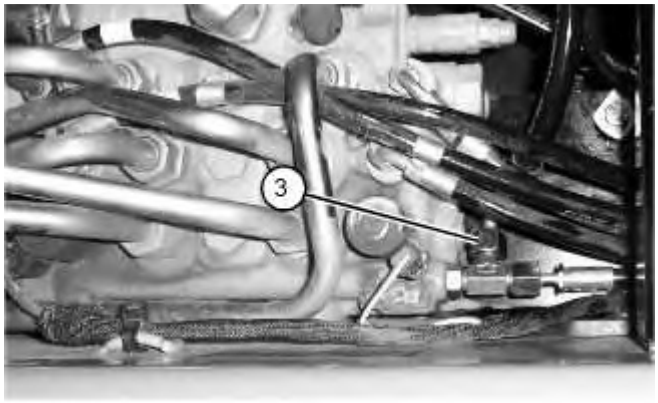


Illustration 2 g01055365

(3) Supply line for the work tool joystick control

5. Install a **6V-3965** Fitting As to the end of supply line (2) by using the **7X-2444** Tee . Use a **6V-5049** O-Ring Seal when you install the tee. Use a **3J-1907** O-Ring Seal when you connect the fitting assembly to the tee. The supply line is for the pilot operated hydraulic control (work tool).

6. Install a **6V-4143** Quick Connect Coupler to each end of the **177-7861** Hose As . Install the **6V-3989** Fitting to the **8T-0856** Pressure Gauge . Connect the pressure gauge to the pressure tap (3) on the pilot operated hydraulic control (work tool). Use the hose and coupler assembly.

7. Secure the three hydraulic lines so that the pressure gauges can be viewed by the operator during the test. The hoses should not be pinched when the cab is lowered.

8. Lower the cab.

9. Sit in the operator seat. Fasten the seat belt and lower the armrest.

10. Start the engine. Disengage the parking brake.

11. Run the engine at LOW IDLE. Record the charge pressure and speed sensing pressure. Set the engine RPM for all machines to the specification in 2.

12. Run the engine at HIGH IDLE. Record the charge pressure, speed sensing pressure, and pilot pressure. Set the engine RPM for all machines to the specification in 2.

Table 2

PILOT PRESSURES		
Engine Speed	**LOW IDLE**	**2300 ± 25 RPM**

Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)	3225 ± 200 kPa (468 ± 29 psi)
Pilot Pressure for the Work Tool	3100 ± 200 kPa (450 ± 29 psi)	3225 ± 200 kPa (468 ± 29 psi)

Note: If the pilot pressure is not within specifications, refer to Testing and Adjusting, "Hydrostatic System - Test and Adjust".

13. Reduce the engine to LOW IDLE. Stop the engine.
14. Raise the cab. Remove the test equipment.
15. Lower the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation". Remove the blocks.

Brake Test

This test will determine if the brakes are functioning correctly. This test will check the solenoid valve (brake) and the piston motor.

1. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation".

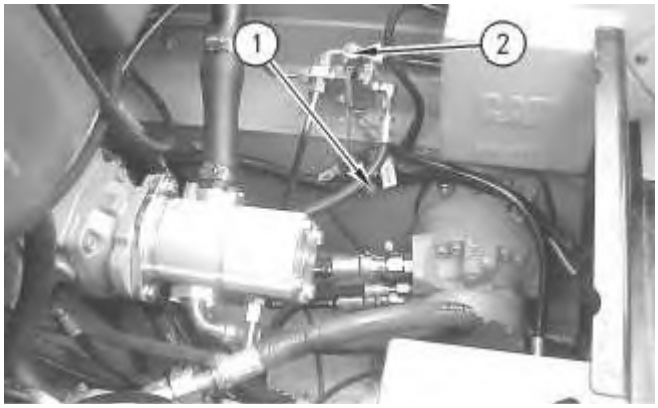


Illustration 3 g00790186

2. Disconnect electrical connection (1) for brake solenoid (2) .

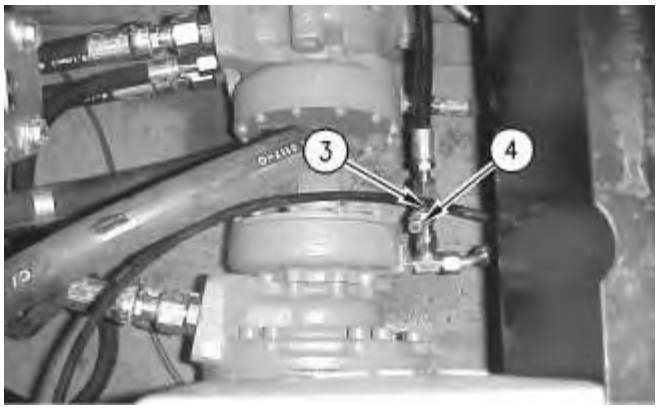


Illustration 4 g00790283

3. Install a **7X-2444** Tee (3) and a **6V-3965** Valved Nipple Assembly (4) in the hydraulic line.
4. Install a **8T-0855** Pressure Gauge to the valved nipple with a **177-7861** Hose .
5. Lower the cab. Make sure that the hydraulic line is not pinched.
6. Sit in the operator seat and fasten the seat belt. Lower the armrest.
7. Start the machine. Run the machine at Low Idle. The pressure gauge should read less than 300 kPa (44 psi). If the gauge does not read less than 300 kPa (44 psi), inspect the brake solenoid.
8. Stop the machine. Raise the cab and reconnect the brake solenoid.
9. Lower the cab. Sit in the operator seat and fasten the seat belt. Lower the armrest and start the machine. Set the governor at LOW IDLE.
10. Disengage the parking brake by pressing the parking brake switch. The pressure on the gauge should be 3100 ± 200 kPa (450 ± 29 psi).
11. If the pressure is not correct, inspect the following items: the brake solenoid, the voltage for the brake solenoid and the brake seal inside the piston motor.
12. If the brake solenoid is not functioning correctly, replace the solenoid.
13. When the test is completed, raise the cab and disconnect all gauges and hoses. Lower the cab and bolt the cab in place. Refer to Operation and Maintenance Manual, "Cab Support Operation".

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Pump Flow - Test

SMCS - 5073-032-TB; 5073-032-ON

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Table 1

Required Tools			
Item	**Part Number**	**Description**	**Qty**
A	9U-7400	Multitach Tool Gp	1
B	4C-9910	Portable Hydraulic Tester	1

Charge Pump

1. Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".



Illustration 1 g00592868

2. Open the engine access door. Install tooling (A) in order to measure engine speed. Use the reflective tape that is on the pulley for the engine crankcase. Ensure proper engine operation.

3. Stop the engine. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

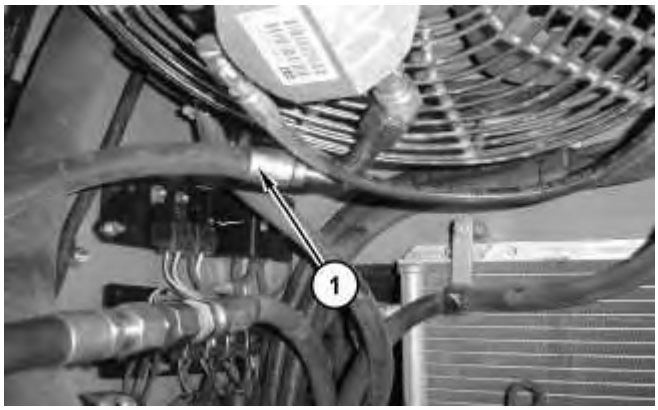


Illustration 2 g01356939

4. Disconnect the hose assembly (1) from the fan motor inlet. Install tooling (B). Connect the flow meter inlet to the hose assembly (1). Connect the outlet of the flow meter to the fan motor inlet. The flow meter is installed in-line to the outlet of the charge pump.

   Note: Damage to the pump and damage to the hoses may result from the high pressure that is created by the flow meter valve.

   Note: The flow meter valve must be fully open before installing the flow meter in-line.

   Note: Ensure that the outlet flow from the flow meter is returned to the fan motor inlet in order to maintain charge flow to the hystat pump.

5. Route the test lines and cables in order to avoid contact with the muffler. Secure the test instruments so that the test instruments are visible during the test.

6. Fasten the seat belt. Lower the armrest.

7. Start the engine. Run the engine at high idle.

8. The oil in the hydraulic system must be at an operating temperature of 50° ± 10°C (122° ± 18°F) throughout the test.

9. Set the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) by slowly adjusting the load valve on the flow meter.

   Note: Maintain the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) throughout the test.

10. Set the engine speed to 2000 ± 10 RPM. Ensure that engine speed is maintained throughout the test.

    Note: If necessary, readjust the pressure to 18000 ± 1000 kPa (2611 ± 145 psi).

11. Refer to Table 3 for the flow specification. Replace the pump if the specification is not met.

12. Unload the pump by adjusting the flow meter valve to the fully open position.

13. Stop the machine. Remove the Multitach Tool Gp (A) and the Portable Hydraulic Tester (B). Reconnect hydraulic lines.

Table 2

System Requirements	
Test	**Specification**
Pump Outlet Pressure	18000 ± 1000 kPa (2611 ± 145 psi)
Engine Speed	2000 ± 10 RPM
Oil Temperature	50° ± 10°C (122° ± 18°F)

Table 3

Charge Pump	
Machine Model	**Minimum Flow**
236B2/ 252B2	32 L/min (8.45 US gpm)

Work Tool Pump

1. Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".



Illustration 3 g00592868

2. Open the engine access door. Install tooling (A) in order to measure engine speed. Use the reflective tape that is on the pulley for the engine crankcase. Ensure proper engine operation.

3. Stop the engine. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.



Illustration 4 g01356942

4. Raise the cab. Refer to the Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure. Disconnect hose assembly (1) and install tooling (B) in-line between the outlet of the work tool pump and the inlet of the control valve.

   Note: Damage to the pump and damage to the hoses may result from the high pressure that is created by the flow meter valve.

   Note: The flow meter valve must be fully open before installing the flow meter in-line.

5. Lower the cab. Route the hoses so that the cab does not rest on any of the hoses. Route the test lines and cables in order to avoid pinching the hydraulic lines when the cab is lowered. Secure the test instruments so that the test instruments are visible during the test.

6. Fasten the seat belt. Lower the armrest.

7. Start the engine. Run the engine at high idle.

   Note: The hydraulic oil temperature rises quickly as engine starts.

8. The oil in the hydraulic system must be at an operating temperature of 50° ± 10°C (122° ± 18°F) throughout test.

9. Set the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) by slowly adjusting the load valve on the flow meter.

   Note: Maintain the pump outlet pressure to 18000 ± 1000 kPa (2611 ± 145 psi) throughout the test.

10. Set the engine speed to 2000 ± 10 rpm.

    Note: If necessary, readjust the pressure to 18000 ± 1000 kPa (2611 ± 145 psi).

11. Refer to Table 5 for the flow specification. Replace the pump if the specification is not met.

12. Unload the pump by adjusting the flow meter valve to the fully open position.

13. Stop the machine. Remove the Multitach Tool Gp (A) and the Portable Hydraulic Tester (B). Reconnect hydraulic lines.

Table 4

System Requirements	
Test	**Specification**
Pump Outlet Pressure	18000 ± 1000 kPa (2611 ± 145 psi)
Engine Speed	2000 ± 10 RPM
Oil Temperature	50° ± 10°C (122° ± 18°F)

Table 5

Work Tool Pump	
Machine Model	**Minimum Flow**
236B2/ 252B2	50.9 L/min (13.45 US gpm)

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Worksheets - Troubleshoot

SMCS - 4350-035; 5050-035

The following tables are provided in order to record information as you perform the tests on the machine. Make copies of these tables so that the tables may be reused for other machines.

The worksheets are designed to be used for the following pressure tests:

- Engine idle
- Cycle times
- Drift checks
- Pump Flow
- Baseline for the hydrostatic system
- Hydrostatic system
- Pilot system
- Main relief valves
- Line relief valves

Troubleshooting Worksheets

The following tables are provided in order to record information as you perform the tests on the machine.

Table 1

MACHINE MODEL		**DATE**	
SERIAL NUMBER		**SERVICE METER HOURS**	
ENGINE SERIAL NUMBER		**ARRANGEMENT NUMBER**	

Table 2

LIFT CYLINDER SPEED TEST			
LIFT'S DIRECTION	**TIME (sec) (236B2)**	**TIME (sec) (252B2)**	**ACTUAL**
Raise	2.7 ± 0.5	4.8 ± 0.5	
Lower	2.7 ± 0.5	3.4 ± 0.5	
Float	2.8 ± 0.5	3.6 ± 0.5	

Table 3

TILT CYLINDER SPEED TEST		
TILT'S DIRECTION	**TIME (sec)**	**ACTUAL**
Tilt Forward	2.1 ± 0.5	
Tilt Back	1.6 ± 0.5	

Table 4

SPEED TEST FOR THE COUPLER CYLINDERS		
CYLINDER POSITION	**MAXIMUM TIME (sec)**	**ACTUAL**
Engaging the quick coupler	3	
Disengaging the quick coupler	3	

Table 5

LIFT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 6

TILT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 7

ENGINE IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	

Low Idle 236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	1000 ± 50 RPM	
Low Idle 236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	1100 ± 50 RPM	

Table 8

BASELINE FOR THE HYDROSTATIC SYSTEM				
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**				
TEST	**LOW IDLE**		**2300 ± 25 RPM**	
	SPECIFICATION	**ACTUAL**	**SPECIFICATION**	**ACTUAL**
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Speed Sensing Pressure	950 ± 200 kPa (138 ± 29 psi)		2000 ± 150 kPa (290 ± 22 psi)	

Table 9

TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Fan Speed	2000 ± 50 RPM 236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	
	2100 ± 50 RPM 236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	

Table 10

HYDROSTATIC SYSTEM TESTS		
MAXIMUM RUNOUT HIGH IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
RPM for left wheel for standard equipped machines	79 ± 6 (236B2) [(1)] 74 ± 5 (252B2) [(1)]	

RPM for right wheel for standard equipped machines	79 ± 6 (236B2) [1] 74 ± 5 (252B2) [1]	
RPM for the left wheel on machines that are equipped with two-speed capability in slow speed mode (speed 1)	66 ± 6 (236B2) [1] 61 ± 5 (252B2) [1]	
RPM for the right wheel on machines that are equipped with two-speed capability in slow speed mode (speed 1)	66 ± 6 (236B2) [1] 61 ± 5 (252B2) [1]	
Difference in RPM between wheels	1 RPM maximum	
MAXIMUM DISPLACEMENT STOP TEST		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Drift	3 m (10 ft)	
SINGLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2700 ± 200 RPM	
MB Pressure Pump 1	38300 ± 2000 kPa (5555 ± 290 psi)	
MB Pressure Pump 2	38300 ± 2000 kPa (5555 ± 290 psi)	
DOUBLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2300 ± 400 RPM	

[1] The wheel speeds must be within 1 RPM of each other.

Table 11

MAIN RELIEF VALVE PRESSURE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	
Main Relief	23000 ± 700 kPa (3336 ± 102 psi)	

Table 12

LINE RELIEF VALVE PRESSURE (MACHINE TEST)

TEST	HIGH IDLE SPECIFICATION	ACTUAL
Lift Cylinder Head RAISE Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Head TILT FORWARD Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Rod TILT BACK Position	23000 ± 700 kPa (3336 ± 102 psi)	
Auxiliary Head	23000 ± 700 kPa (3336 ± 102 psi)	

Table 13

LINE RELIEF VALVE PRESSURE (BENCH TEST)		
HIGH IDLE		
TEST	PRESSURE	ACTUAL
Lift Cylinder RAISE	27600 ± 700 kPa (4003 ± 102 psi)	
Tilt Cylinder FORWARD	24500 ± 700 kPa (3554 ± 102 psi)	
Tilt Cylinder RACK BACK	27600 ± 700 kPa (4003 ± 102 psi)	
Auxiliary	24500 ± 700 kPa (3554 ± 102 psi)	

Table 14

PILOT SYSTEM PRESSURE TEST				
TEST	LOW IDLE		2300 ± 25 RPM	
	SPECIFICATION	ACTUAL	SPECIFICATION	ACTUAL
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Pilot Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	

Table 15

BRAKE TEST		
LOW IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
Brake Line Pressure	3100 ± 200 kPa (450 ± 29 psi)	

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03938017

MID 106 - CID 1939 - FMI 03

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the auxiliary hydraulics high flow diverter solenoid. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

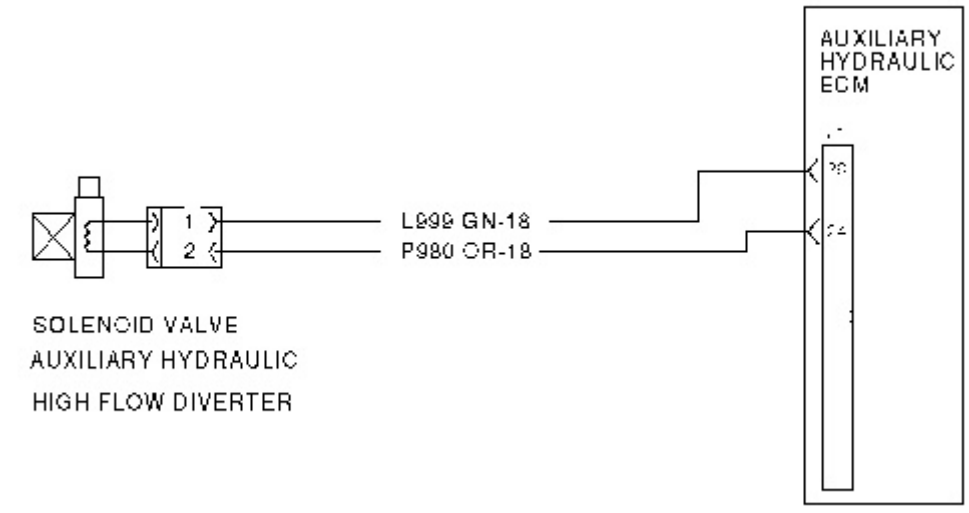


Illustration 1 g01035497

Schematic for the auxiliary hydraulics high flow diverter solenoid

Test Step 1. CHECK FOR A SHORT TO + BATTERY IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 24 (wire P980-OR) to the following contacts of the wiring harness: contact 1, contact 5, contact 58, contact 26 and contact 40.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms.

  Repair: The ECM is unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machines options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i05539030

MID 106 - CID 1939 - FMI 06

SMCS - 5479-038

Conditions Which Generate This Code:

(Auxiliary Hydraulic Boost Flow Supply Solenoid - Current Above Normal)

This diagnostic code is associated with the auxiliary hydraulics high flow supply solenoid. The FMI 06 means that the ECM determined that the current is above normal. The circuit is possibly shorted to ground or the circuit is shorted together.

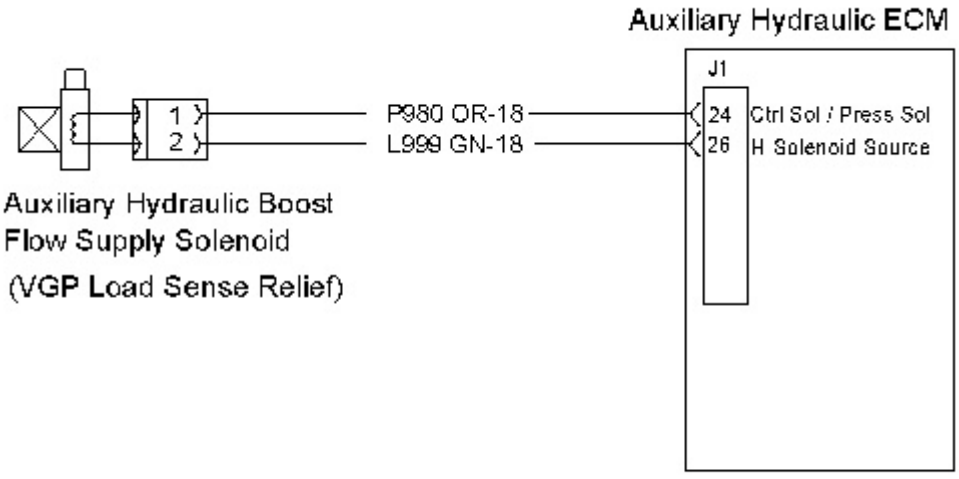


Illustration 1 g03508499

Schematic of the Auxiliary Hydraulic Boost Flow Supply Solenoid (VGP Load Sense Relief Solenoid)

Conditions that could cause this diagnostic code to be activated are:

- The energize circuit of the solenoid is shorted to a ground source.
- The solenoid has failed.
- The ECM has failed. ECM failure is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes. Clear any created diagnostic codes after the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active 1939-6 diagnostic code, changes to a 1939-5 diagnostic code, when the solenoid is disconnected.

Results:

- **OK -** The active 1939-6 diagnostic code changes to a 1939-5 code when the solenoid is disconnected. The solenoid circuit in the machine harness is correct.

  Repair: The solenoid has failed. Repeat this test to verify the solenoid failure.Temporarily connect a new solenoid to the harness and verify that the replacement solenoid has cleared the diagnostic code. If the 1939-6 code is no longer active, permanently install the new solenoid.Verify that there are no active diagnostic codes for the solenoid. Clear any logged diagnostic codes.

  STOP

- **NOT OK -** The CID 1939-6 diagnostic code remains active. Disconnecting the solenoid did not change the status of the active diagnostic code. The solenoid is not the cause of the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

The solenoid remains disconnected from the machine harness.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the Auxiliary Hydraulic ECM.

D. Measure the resistance from contact 24 (wire P980-OR) to frame ground. Measure the resistance from contact 24 (wire P980-OR) to the other contacts that are used in the Auxiliary Hydraulic ECM connector.

E. While observing the resistance measurements, wiggle the machine harness connectors for the switch panel and the solenoid. Gently pull on the wires and gently move the wires around.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the harness and connectors.

Results:

- **OK -** Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3

- **NOT OK -** One or more of the resistance measurements is less than 5000 ohms. The resistance measurement is indicating that a short is present in the machine harness. The short is between wire P980-OR and either frame ground or the circuit with the low resistance measurement.

  Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

  STOP

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, corrosion, or chafing. Refer to Testing and Adjusting, "Electrical Connector - Inspect" in this manual.

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened securely.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine and check the status of the 1939-6 diagnostic code.

Expected Result:

The CID 1939 FMI 6 diagnostic code is no longer active.

Results:

- **OK -** 1939-6 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors. Resume normal machine operation.

  STOP

- **NOT OK -** 1939-6 is still active. The diagnostic code has not been corrected.

  Repair: The ECM is unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machines options. Also verify that the values that are present on the machine configuration screen are installed correctly. If the 1939-6 diagnostic code still exists perform the test steps again.
  Ensure that you have the latest version of software for your specific ECM. Refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program" section of this manual for the correct procedure.
  If the ECM was reflashed, turn the disconnect switch to the ON position. Turn the key start switch to the ON position and verify that the ECM has cleared the problem.
  If the 1939-6 diagnostic code is still present, contact the Technical Communicator for your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, see Testing and Adjusting, "Electronic Control Module (ECM) - Replace" in this manual.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03938018

MID 106 - CID 1940 - FMI 03

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the auxiliary hydraulics high flow diverter solenoid. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

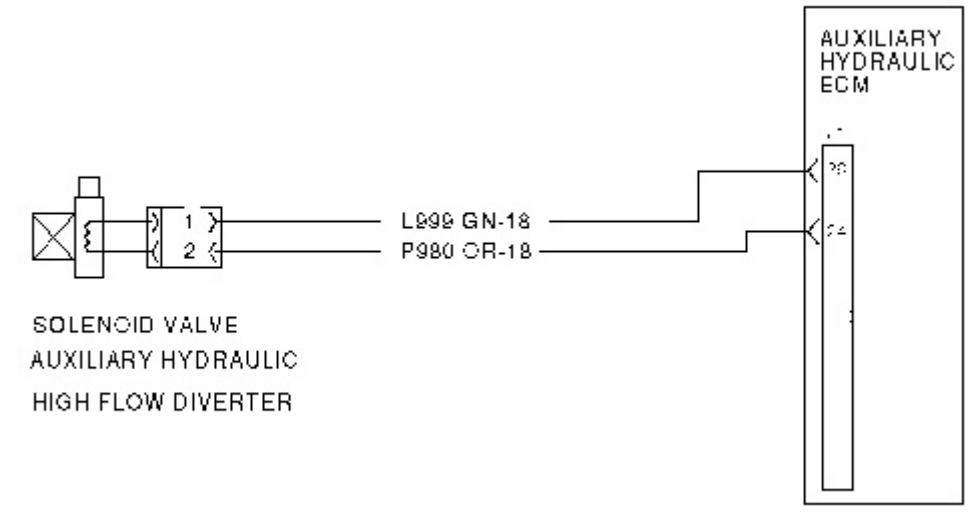


Illustration 1 g01035497

Schematic for the auxiliary hydraulics high flow diverter solenoid

Test Step 1. CHECK FOR A SHORT TO + BATTERY IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 24 (wire P980-OR) to the following contacts of the wiring harness: contact 1, contact 5, contact 58, contact 26 and contact 40.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms.

  Repair: The ECM is unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machines options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistances were less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i03938234

MID 106 - CID 1940 - FMI 05

SMCS - 5479-038

Conditions Which Generate This Code:

This diagnostic code is associated with the auxiliary hydraulics high flow diverter solenoid. The FMI 05 means that the ECM determined that the current is below normal. An open circuit will cause this code.

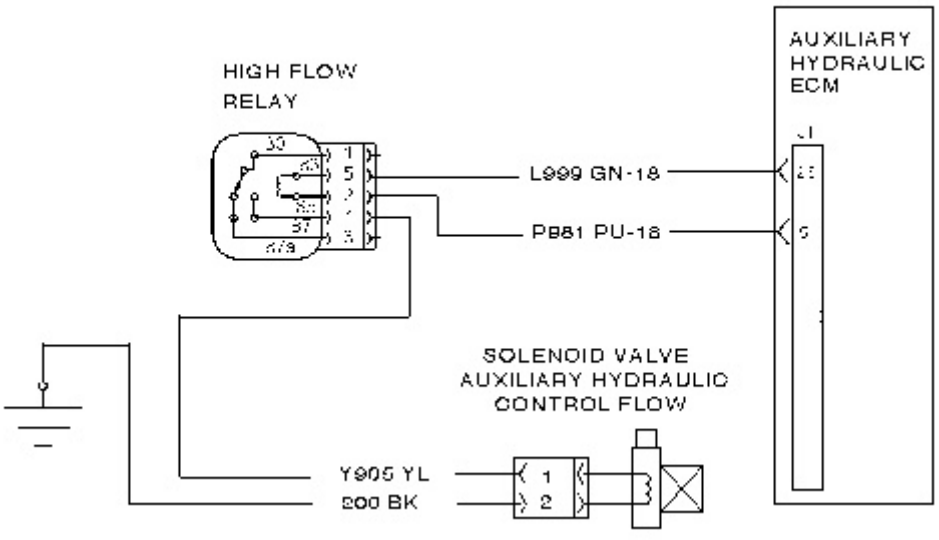


Illustration 1 g01042001

Schematic of the auxiliary hydraulics high flow diverter solenoid

Test Step 1. CHECK FOR AN OPEN WINDING IN THE SOLENOID

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the solenoid valve (2 speed).

D. Measure the resistance of the coil from contact 1 to contact 2 of the connector.

Expected Result:

The resistance should be approximately 2.2 Ohms.

Results:

- **OK -** The resistance is approximately 2.2 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is considerably greater than 2.2 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  STOP

Test Step 2. CHECK FOR AN OPEN IN THE WIRE HARNESS

A. Reconnect the connector for the solenoid valve (high flow).

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 5 (wire P981-PU) to contact 26 (wire L999-GN) of the wire harness connector.

Expected Result:

The resistance should be approximately three Ohms.

Results:

- **OK -** The resistance is approximately three Ohms.

  Repair: The ECM is unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machines options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistance was considerably greater than three Ohms.

  Repair: There is an open in the wire harness or a bad connection in a connector. Locate the open wire. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

STOP

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i05543249

MID 106 - CID 1940 - FMI 06

SMCS - 5479-038

Conditions Which Generate This Code:

(Auxiliary Hydraulic Boost Flow Diverter Solenoid - Current Above Normal)

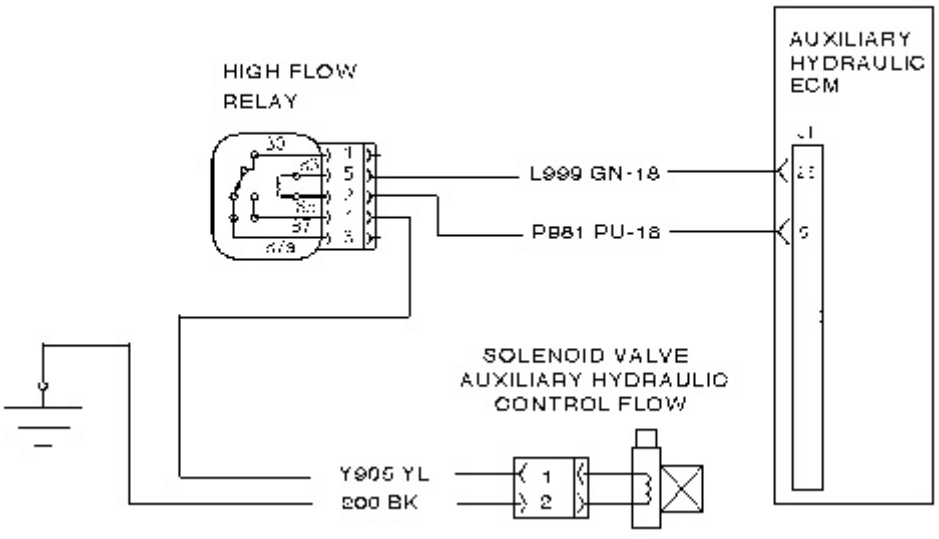


Illustration 1 g01042001

Schematic of the auxiliary hydraulics high flow diverter solenoid

This diagnostic code is associated with the retarder solenoid. The FMI 06 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. ECM failure is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 1940 FMI 06 is active before performing this procedure.**

Note: Use a digital multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Observe the status of the diagnostic code.

C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The FMI 06 changes to FMI 05 when the solenoid is disconnected.

Results:

- **YES -** The FMI 06 changes to FMI 05 when the solenoid is disconnected. The circuit is correct.

  Repair: The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP

- **NO -** The FMI 06 remains active. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. The solenoid remains disconnected from the machine harness.

C. Disconnect the machine harness connectors from the ECM.

D. At the machine harness connector, measure the resistance from the signal contact J1-5 (wire P981-PU) to all contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **OK -** Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- **NOT OK -** Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-5 (wire P981-PU) and the circuit with the low resistance measurement.

  Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test" in this manual. Repair or replace the machine harness.

  STOP

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing. Refer to Testing and Adjusting, "Electrical Connector - Inspect" in this manual.

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

C. Reconnect all of the harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are fastened.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Check the status of the CID 1940 FMI 06.

Expected Result:

The CID 1940 FMI 06 is active.

Results:

- **YES -** The CID 1940 FMI 06 is active. The diagnostic code has not been corrected.

  Repair: The ECM is unlikely to have failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, contact the dealership Technical Communicator (TC) for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace ".

  STOP

- **NO -** The CID 1940 FMI 06 is not active. The problem does not exist at this time.

  Repair: The initial code was probably caused by a poor electrical connection or a shorted harness connector that was disconnected and reconnected. Resume normal machine operation.

  STOP

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i01786720

Hydraulic System Pressure - Release

SMCS - 5050-553-PX

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Release Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Lower the armrest.
2. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Press each side of the auxiliary hydraulic control switch (A1 and A2) for one to two seconds in order to release the auxiliary system pressure. Keep the joystick control in the NEUTRAL position while you press the auxiliary hydraulic control switch (A1 and A2).

4. Engage the parking brake.
5. Start the engine and run the engine for at least 15 seconds in order to recharge the accumulator.
6. Turn the engine start switch to the OFF position.
7. Do not raise the armrest.
8. Immediately, turn the engine start switch to the ON position. Disengage the parking brake.
9. Move both of the joystick controls through all of the operating positions in order to release the hydraulic pressure in the work tool system and the hydrostatic system.
10. Turn the engine start switch to the OFF position.

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i03898085

Disconnecting Snap To Connect Fittings

SMCS - 7554-X6

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disconnection Procedure

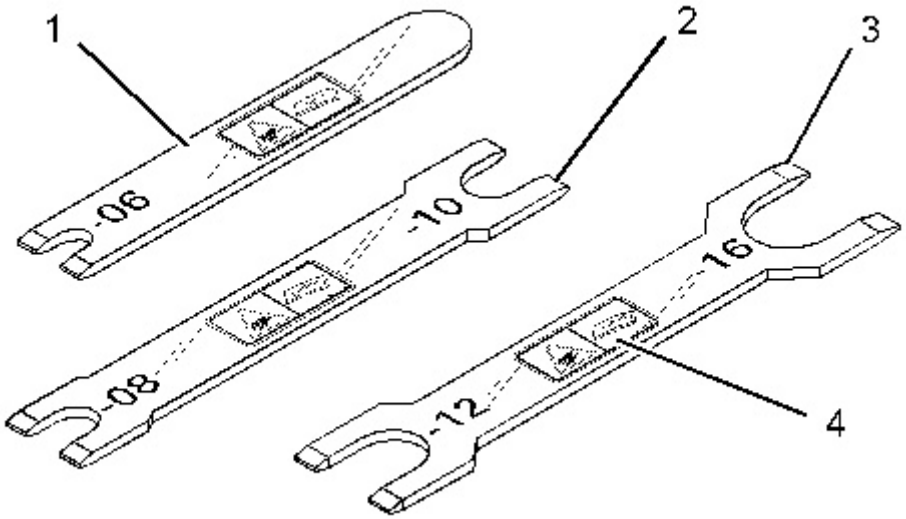


Illustration 1 g02145423

Table 1

304-1165 Tool Kit			
Item	**Part No.**	**description**	**Fitting Size**
1	304-1166	STC Wrench	-06
2	304-1167	STC Wrench	-08 and -10
3	304-1168	STC Wrench	-12 and -16
4	341-2603	Warning Film	-
-	304-2721	Tool Pouch	-

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

NOTICE

Using the incorrect size snap to connect (STC) wrench can cause slippage, resulting in personal injury. Always verify that the STC wrench size matches the size fitting to be disconnected.

1. Lower all work tools and attachments to the ground.
2. Release the system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".
3. Clean the connection that is to be disassembled. Clean the surrounding area in order to ensure that the connection is free of all dirt, dust, and grit.
4. Pressure can be trapped in circuits after the engine has stopped. Personal injury or death can result if all pressures are not released. Ensure that the pressure is zero in the line that is being disconnected.

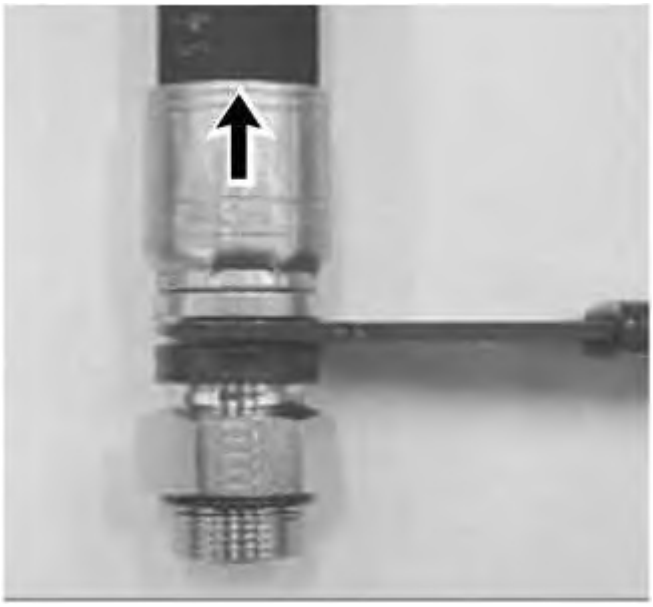


Illustration 2 g02141795

5. Select the designated release tool for the size of the connection. Using the wrong tool may result in damage to the coupling, or cause slippage, resulting in unsafe conditions.

   Note: Prying on the connection may result in damage to the release sleeve, requiring hose replacement.

6. Insert the release tool behind the release sleeve, so that the release tool is perpendicular to the connection. Fully insert the release tool in order to cause the release sleeve to move and separate the retaining ring. The coupling may now be separated.

7. Pull on the hose in the direction parallel to the axis of connection while keeping the release tool engaged. Pulling the hose at an angle may result in extra force required to disconnect the connection.

8. Cover both ends of the connection with recommended plugs or caps in order to avoid contamination.

Connection Procedure

1. Clean the connection that is to be assembled. Ensure that the connection is free of all dirt, dust, and grit.



Illustration 3 g02141956

Note: If the release sleeve is damaged during the connection or disconnection of the STC connection, the male portion must be replaced with new parts.

Note: Do not use the rubber sleeve as leverage to push the male half into the female half of the STC connection.

2. Align the STC fitting on the hose assembly with the STC connector. Push the hose fitting into the mating connector until you feel a definite snap and a solid stop.
3. Pull straight back on the connection. An improperly made connection will disconnect.

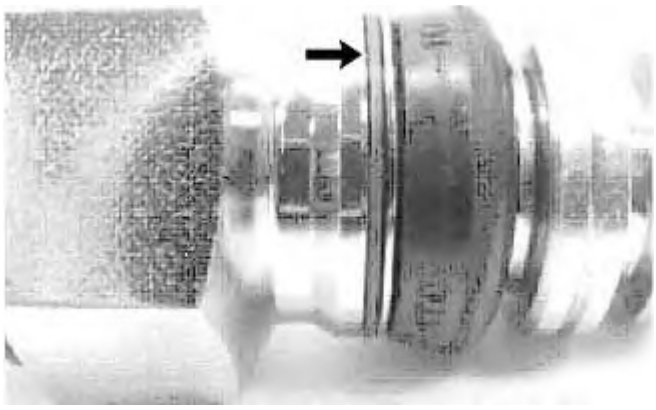


Illustration 4 g02141958

Red ring, on an improper connection.

4. Check for a visible red ring. An improper assembly shows the red ring.

Note: For more information on the operation and the maintenance of Snap to Connect wrenches, refer to Tool Operating Manual, NEHS1083.

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i02676118

System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

Release Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the accumulator.
2. Stop the engine. Keep the armrests in the LOWERED position. Turn the engine start switch to the ON position. Push the parking brake switch.
3. Move the hydraulic operated controls through all of the positions.
4. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.
5. Turn the engine start switch to the OFF position.

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02676118

System Pressure - Release

SMCS - 5050-553-PX

Release Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the accumulator.
2. Stop the engine. Keep the armrests in the LOWERED position. Turn the engine start switch to the ON position. Push the parking brake switch.
3. Move the hydraulic operated controls through all of the positions.
4. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.
5. Turn the engine start switch to the OFF position.

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i01786720

Hydraulic System Pressure - Release

SMCS - 5050-553-PX

Release Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Lower the armrest.
2. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Press each side of the auxiliary hydraulic control switch (A1 and A2) for one to two seconds in order to release the auxiliary system pressure. Keep the joystick control in the NEUTRAL position while you press the auxiliary hydraulic control switch (A1 and A2).
4. Engage the parking brake.
5. Start the engine and run the engine for at least 15 seconds in order to recharge the accumulator.
6. Turn the engine start switch to the OFF position.

7. Do not raise the armrest.
8. Immediately, turn the engine start switch to the ON position. Disengage the parking brake.
9. Move both of the joystick controls through all of the operating positions in order to release the hydraulic pressure in the work tool system and the hydrostatic system.
10. Turn the engine start switch to the OFF position.

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02044190

Accumulator - Remove and Install

SMCS - 5077-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

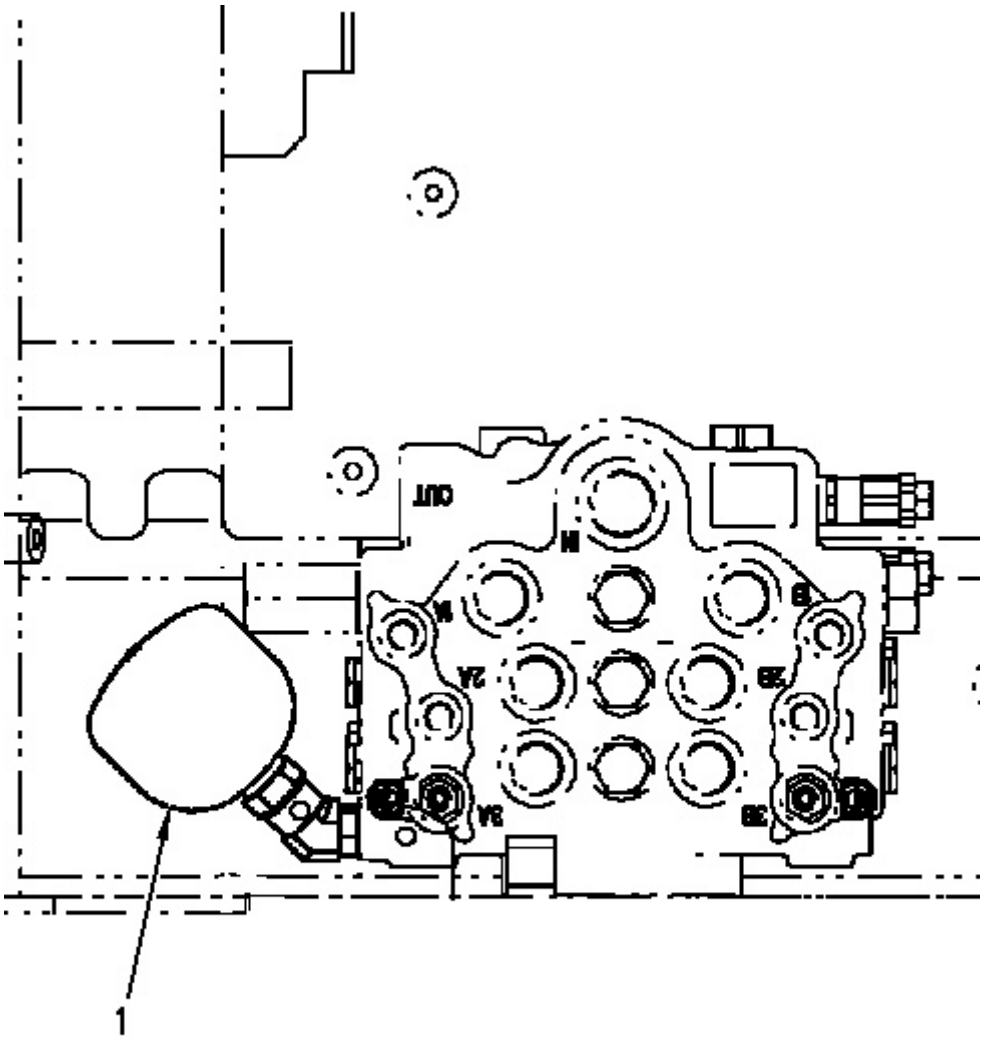


Illustration 1 g00897731

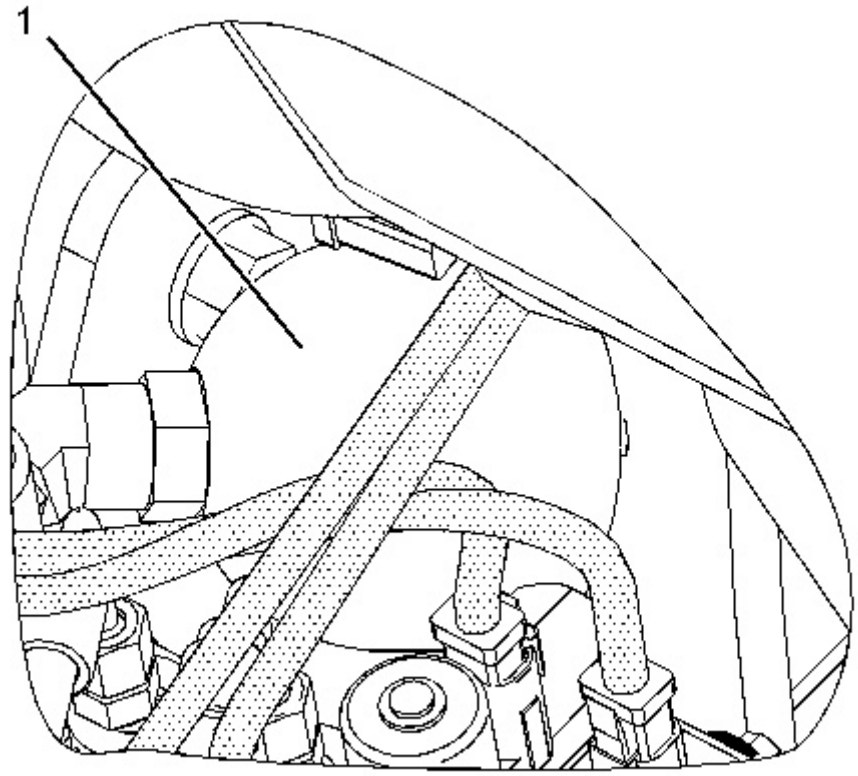


Illustration 2 g01049851

1. Remove accumulator (1) .

Installation procedure

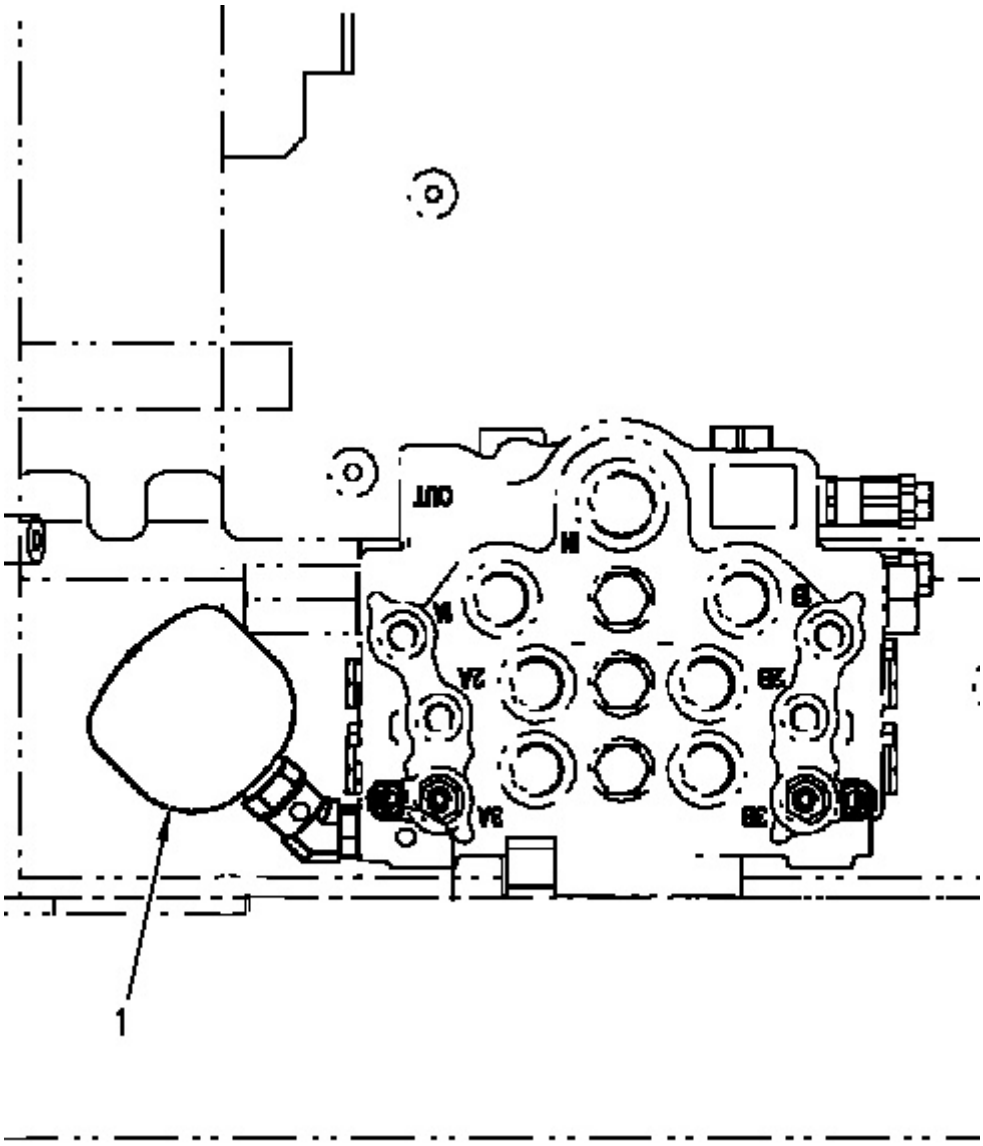


Illustration 3 g00897731

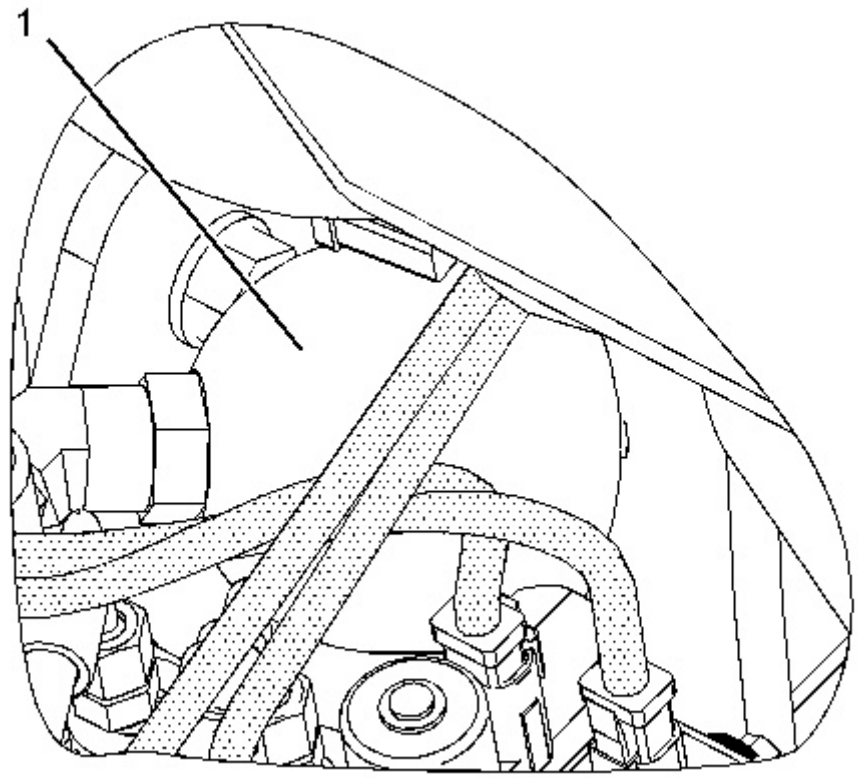


Illustration 4 g01049851

1. Install accumulator (1). Tighten accumulator (1) to a torque of 30 ± 5 N·m (22 ± 4 lb ft).
2. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

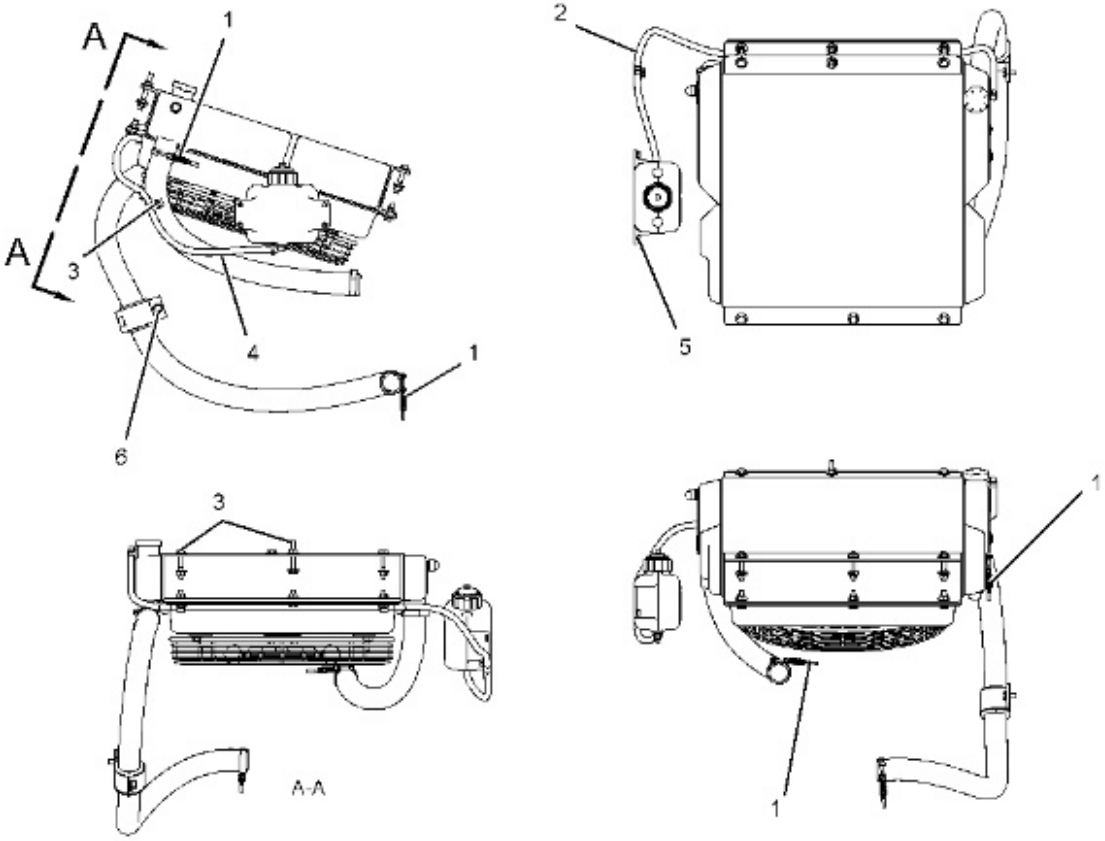


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

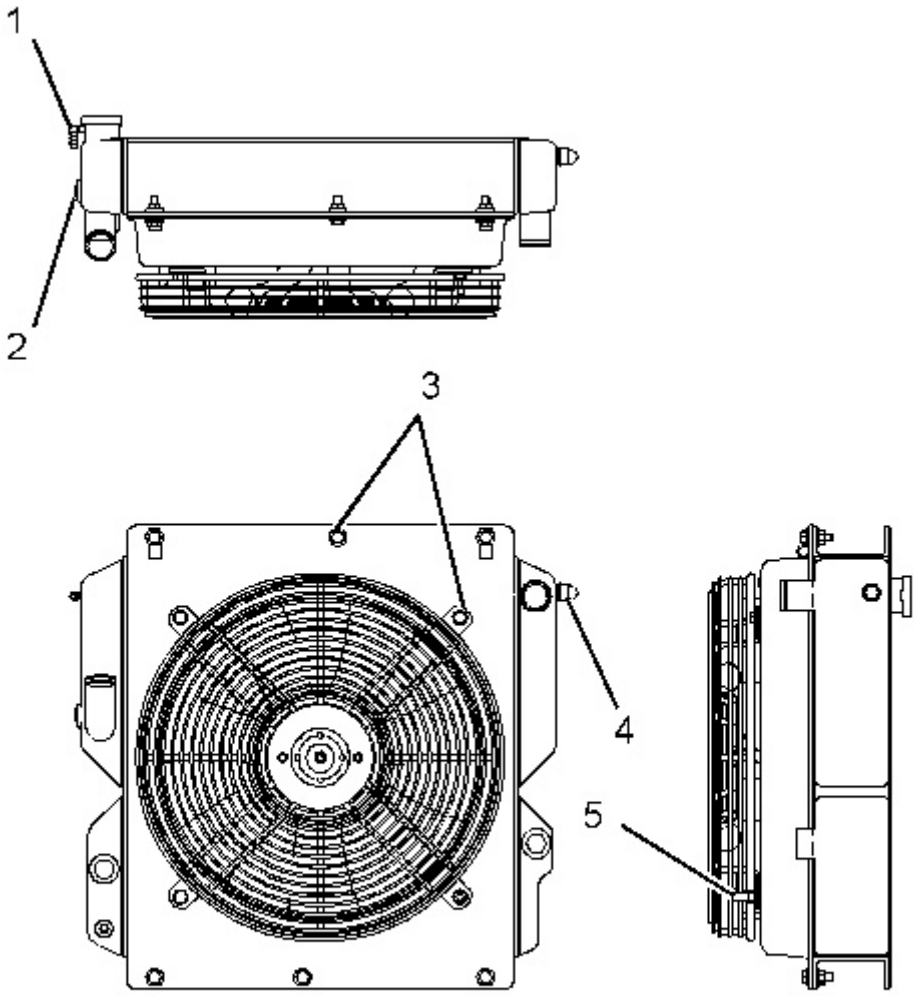


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

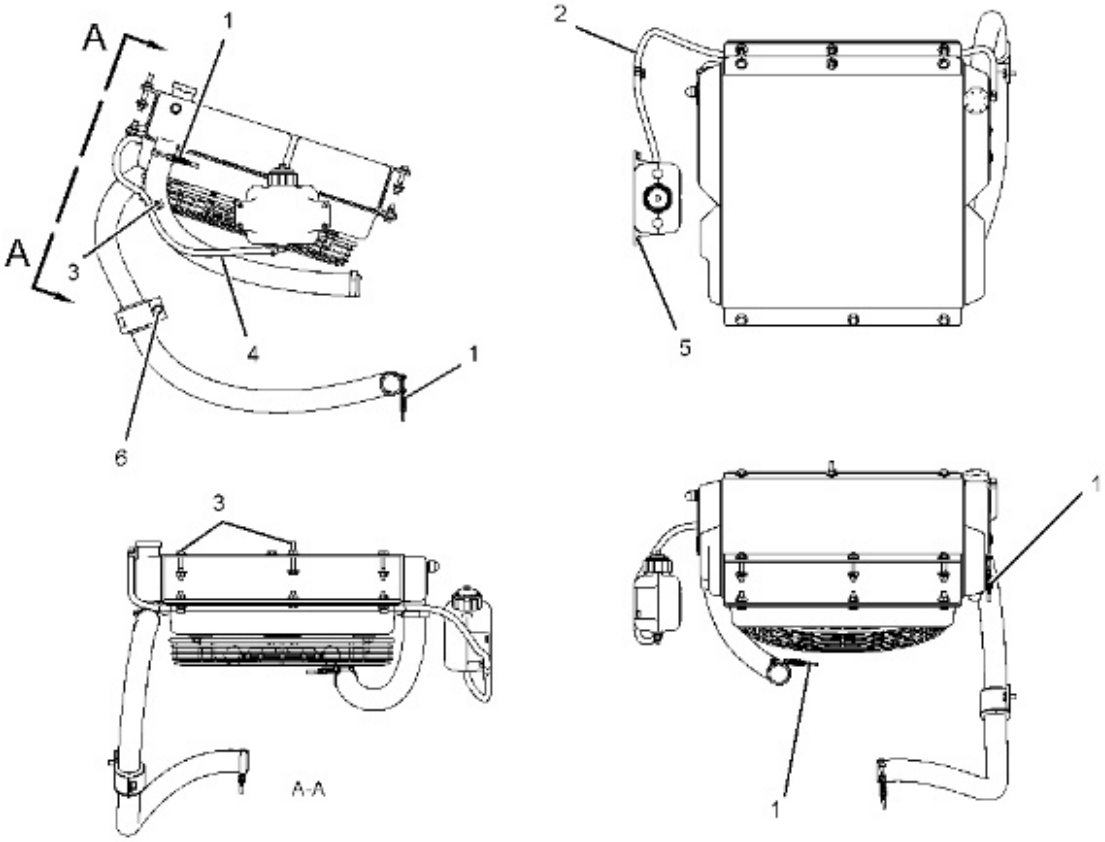


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

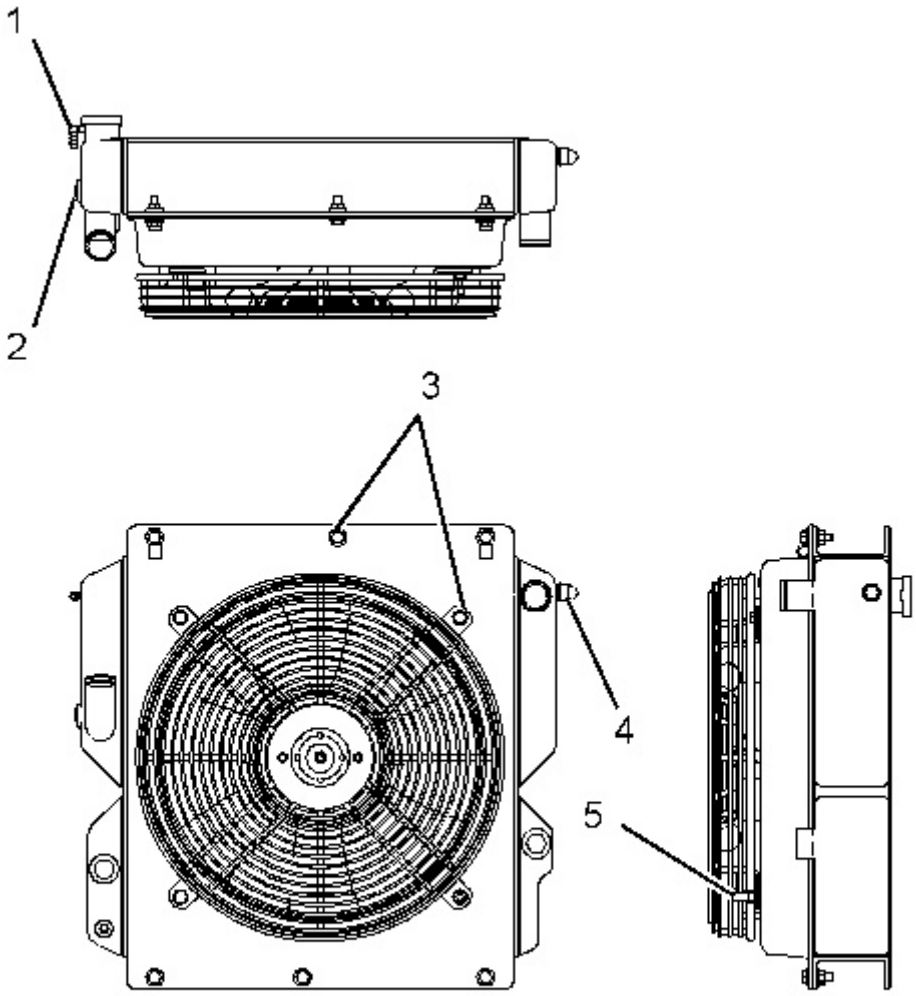


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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i02783363

Radiator and Hydraulic Oil Cooler - Remove

SMCS - 1353-011; 1374-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3
B	8T-4133	Nut	1
C	8T-4121	Hard Washer	1

Start By:

A. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

1. Drain the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

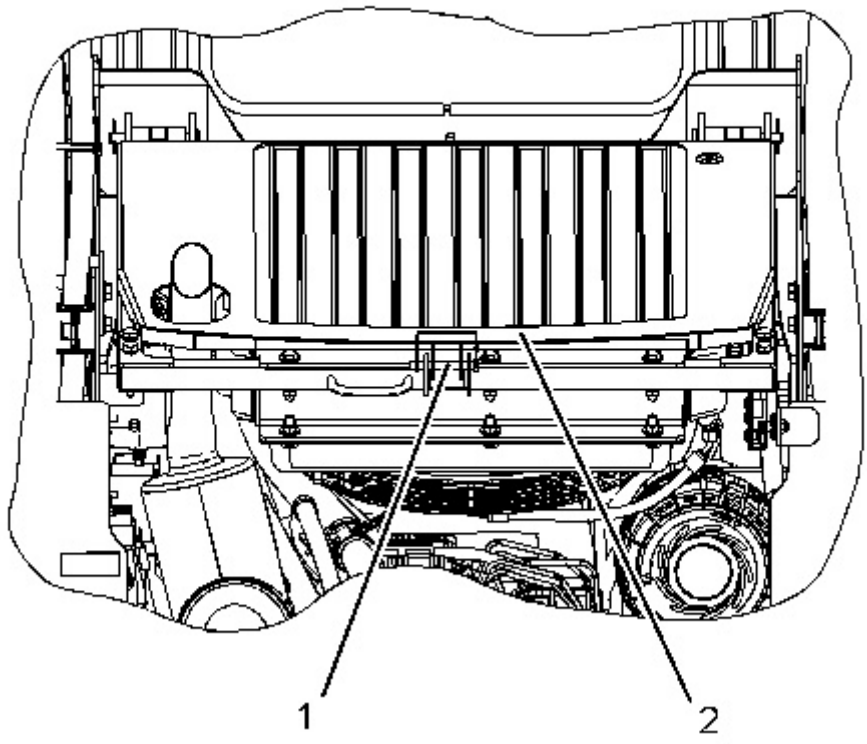


Illustration 1 g01042083

2. Remove pin (1) . Raise radiator guard (2) .

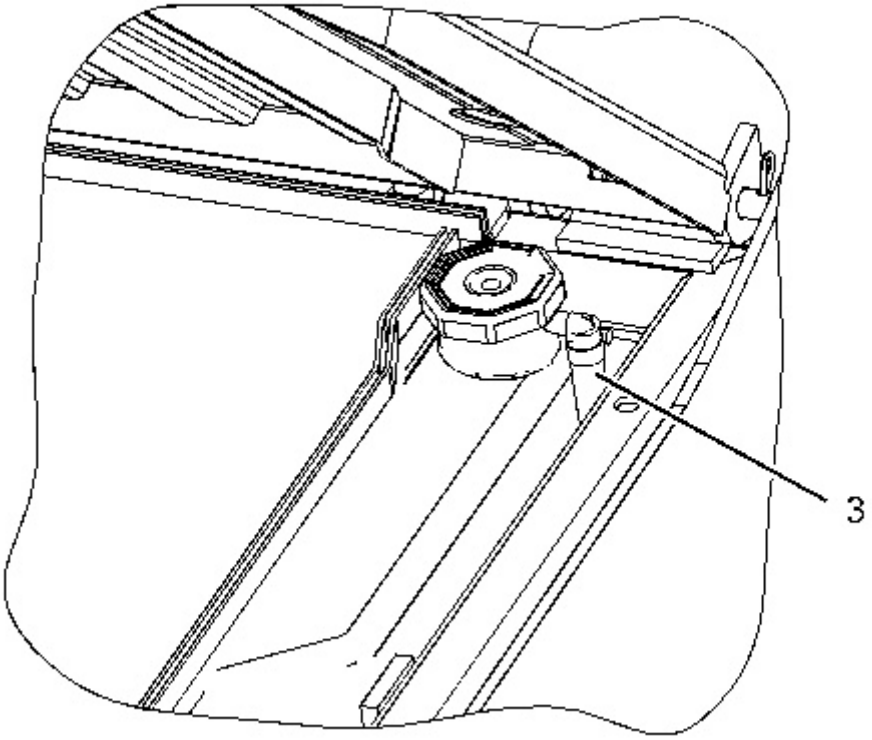


Illustration 2 g01042099

3. Disconnect hose (3) .



Illustration 3 g01390286

Typical Example

4. Attach a suitable lifting device to the radiator assembly, as shown. This will support the radiator assembly when the struts are removed. The weight of the radiator assembly is approximately 60 kg (130 lb).

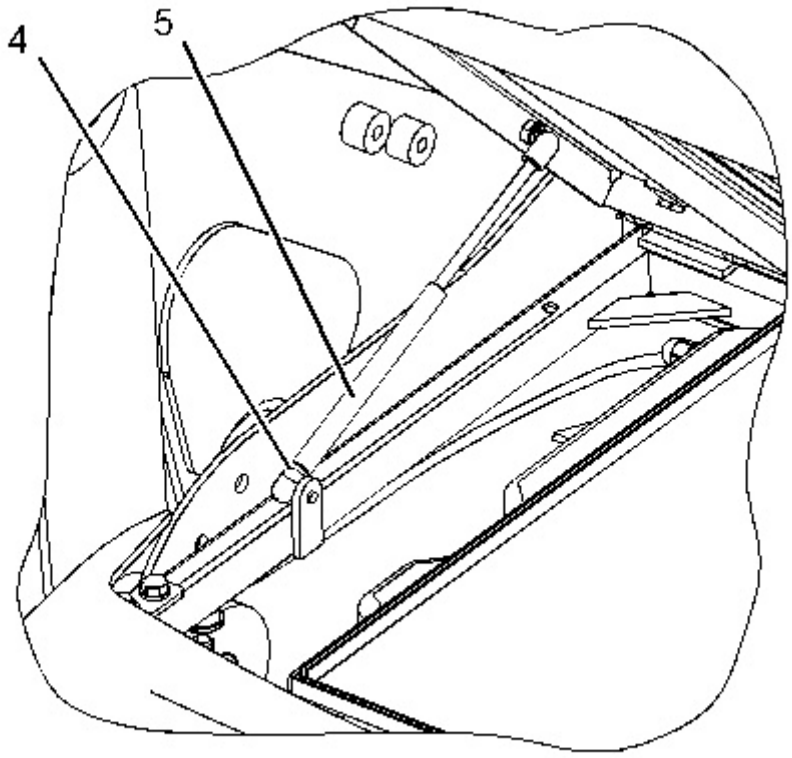


Illustration 4 g01096078

5. Remove clips (4) and disconnect strut (5) .

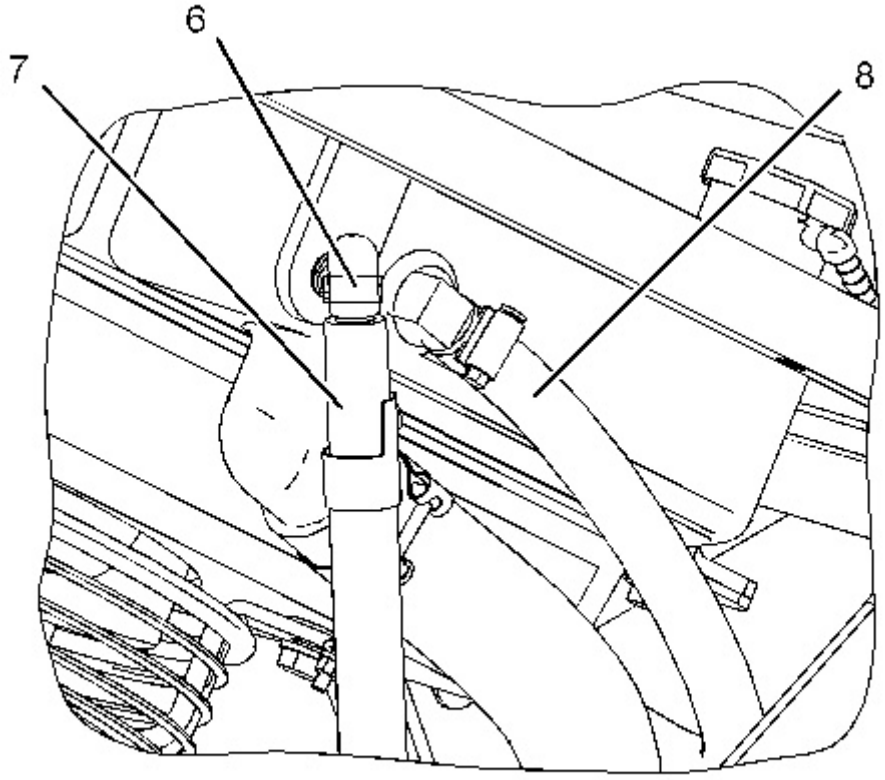


Illustration 5 g01096079

6. Remove clip (6) and remove strut (7) . Disconnect hose (8) .

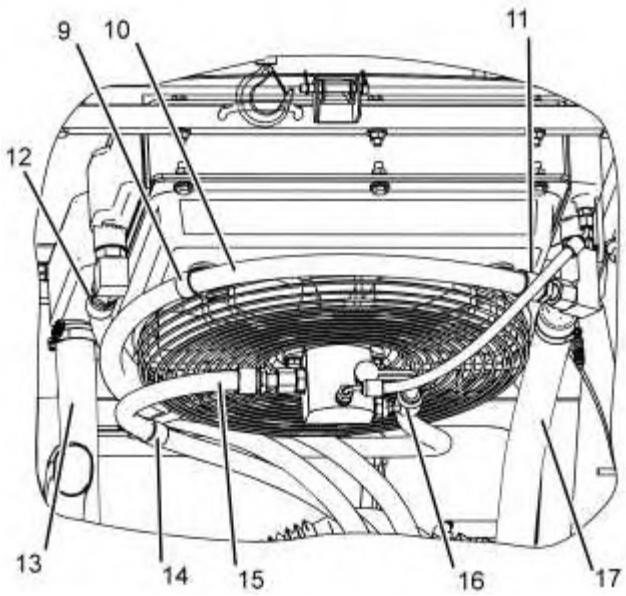


Illustration 6 g01390300

7. Remove clips (9) , (11) and (14) . Disconnect hose assemblies (10) and (12) , and hoses (13) and (17) . Disconnect hose assembly (15) . Use the suitable lifting device that was attached in Step 4 in order to lower the radiator assembly.

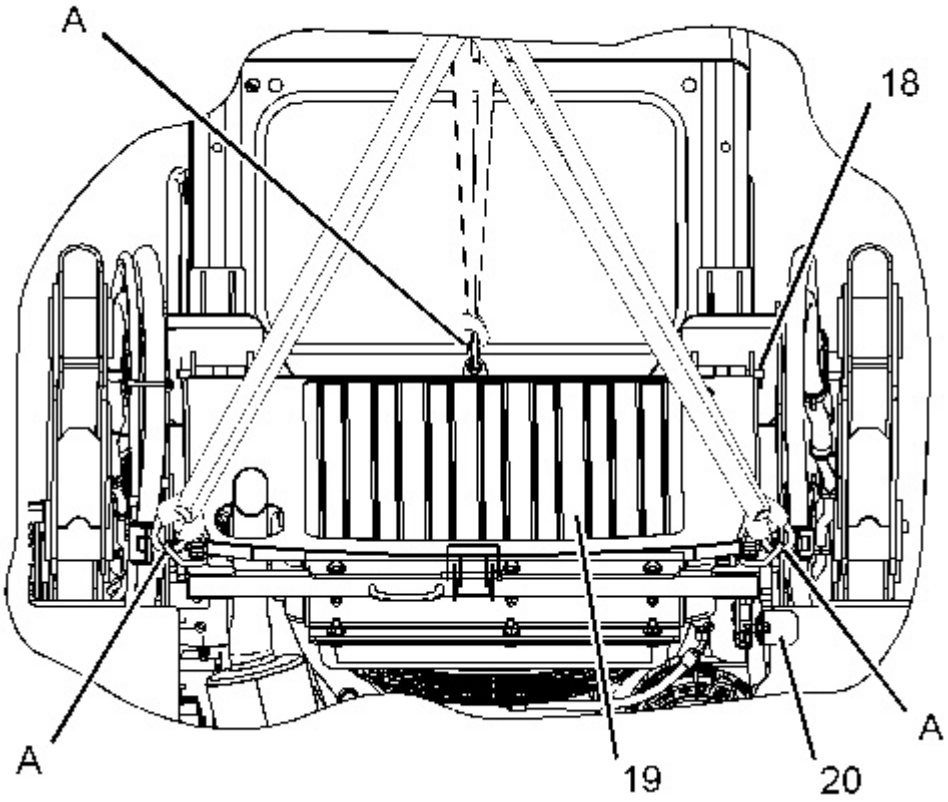


Illustration 7 g01043746

8. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Remove the cotter pins and remove pins (18) from each side of the machine.

9. Release latch (20) and remove radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb).

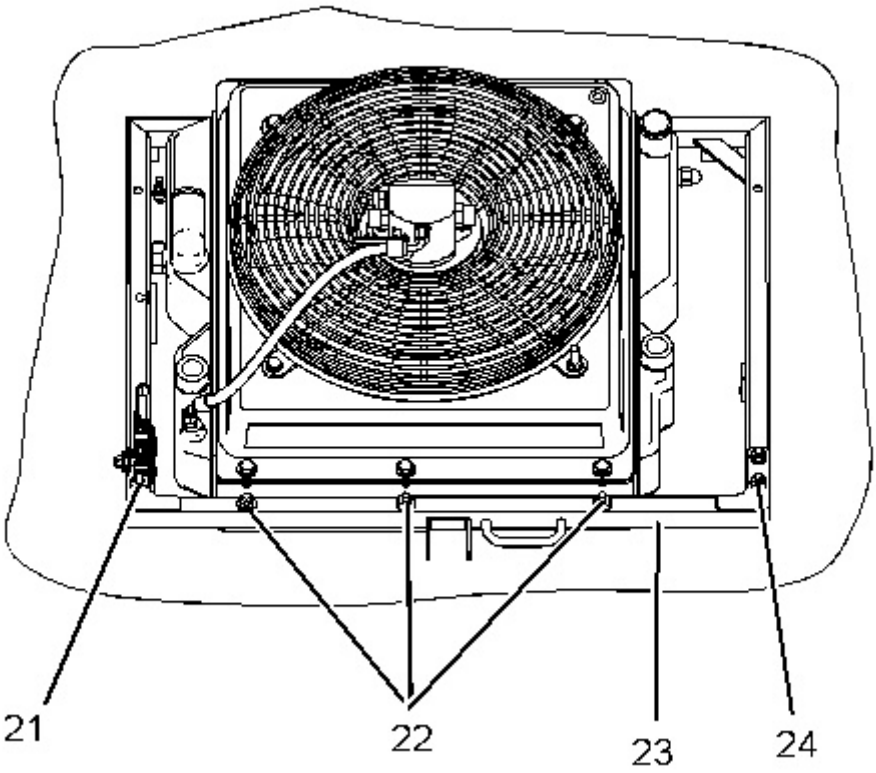


Illustration 8 g01092595

10. Remove bolts (21) , (22) and (24) . Remove the radiator support (23) .

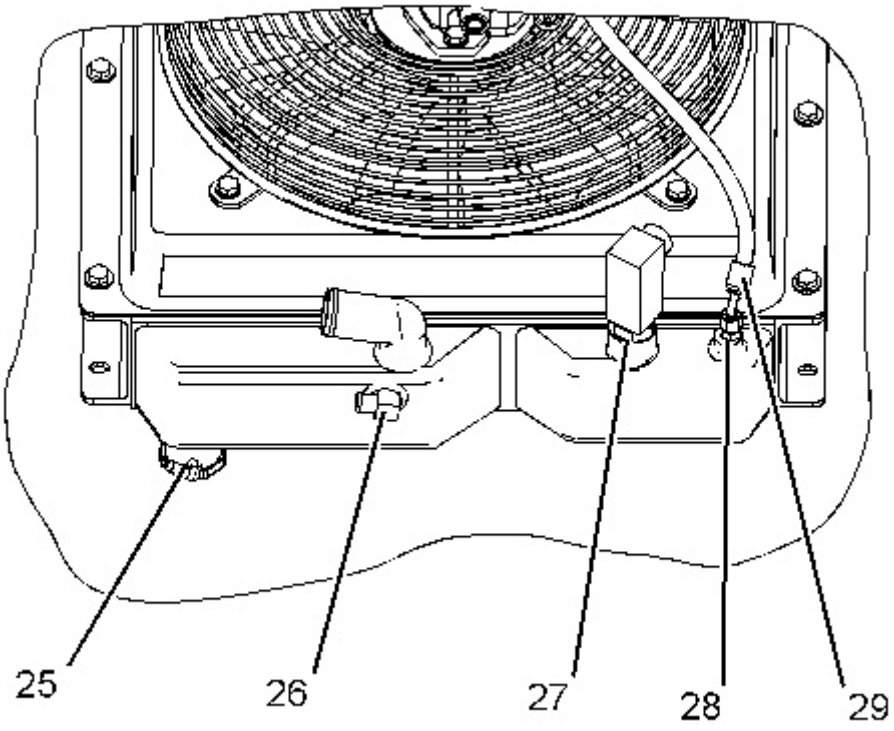


Illustration 9 g01043891

11. Disconnect hose assembly (29) . Remove fittings (25) , (26) , (27) and (28) .

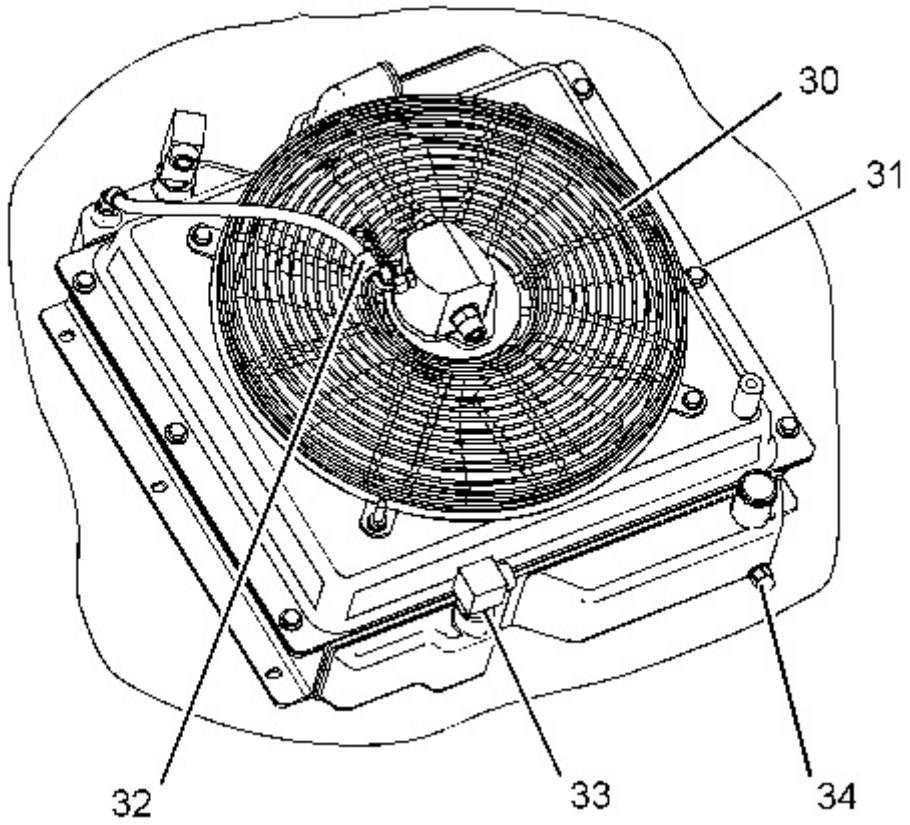


Illustration 10 g01092599

12. Disconnect hose assembly (32) , fitting (33) , sight glass (34) , six bolts (31) , the radiator shroud, and fan assembly (30) .

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02783657

Radiator and Hydraulic Oil Cooler - Install

SMCS - 1353-012; 1374-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3

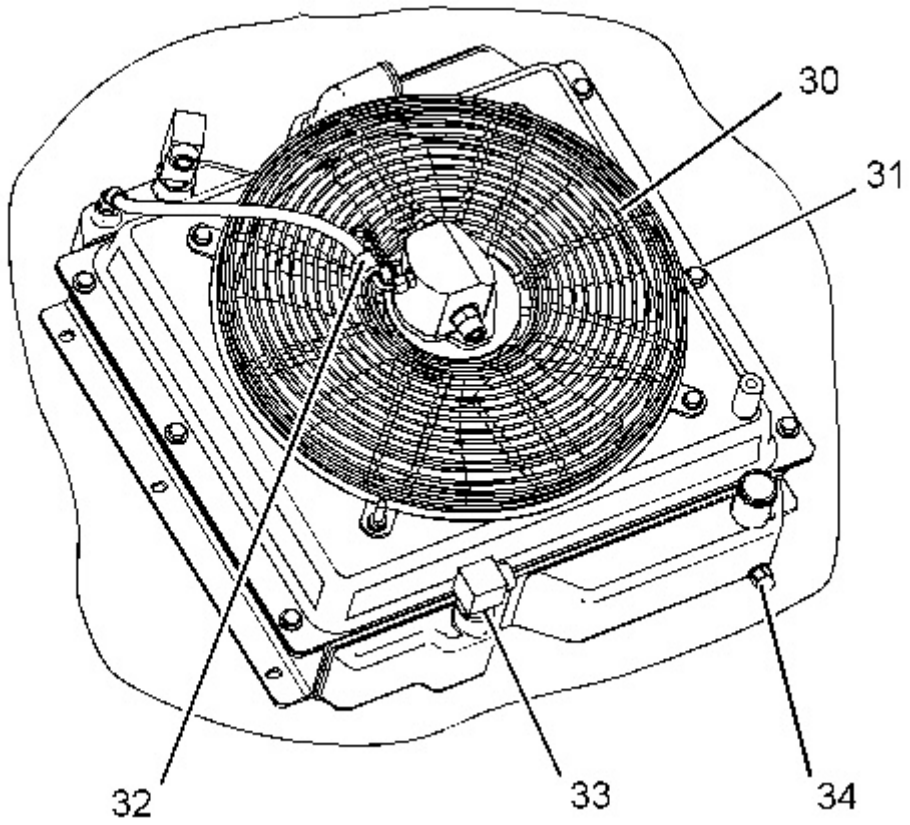


Illustration 1 g01092599

1. Position the radiator shroud and fan assembly (30) . Install six bolts (31) . Tighten bolts (31) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install sight glass (34) . Tighten sight glass (34) to a torque of 15 ± 2 N·m (11 ± 1 lb ft). Install fitting (33) and connect hose assembly (32) .

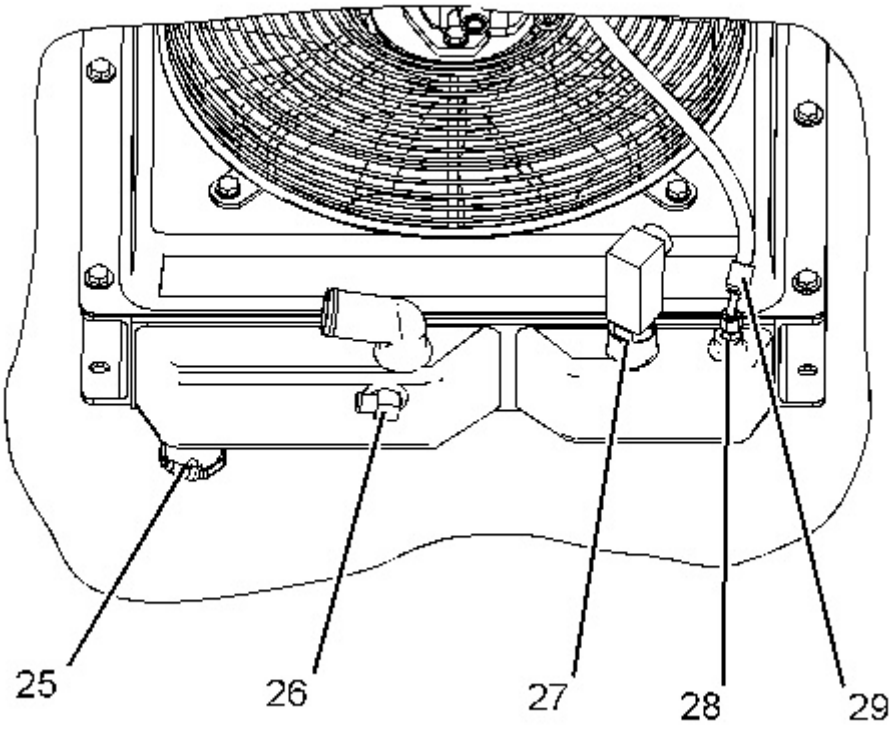


Illustration 2 g01043891

2. Install fittings (25) , (26) , (27) and (28) . Connect hose assembly (29) .

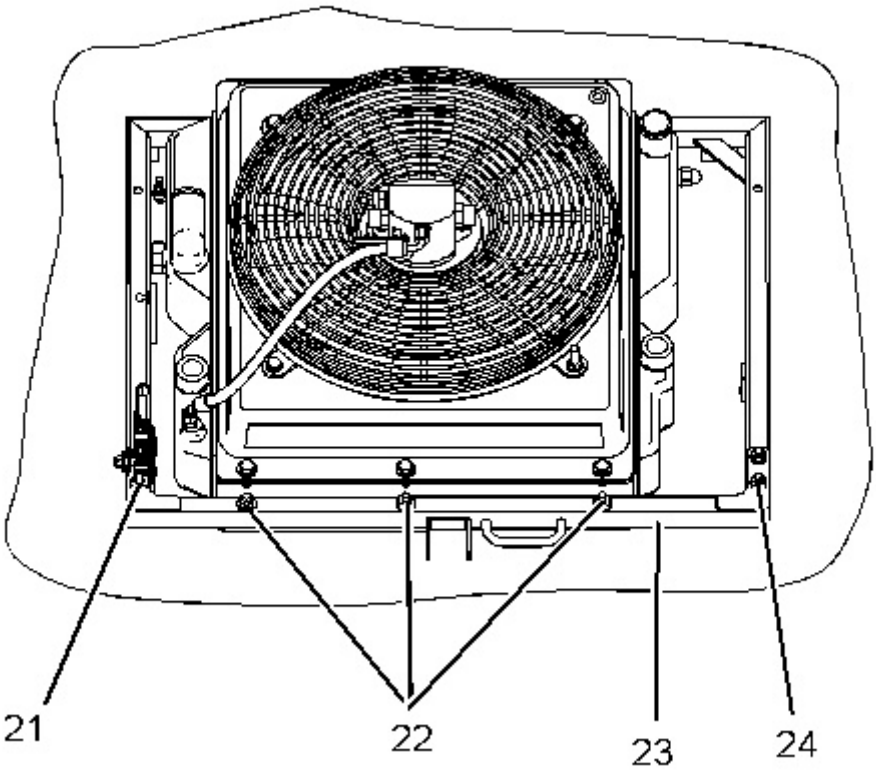


Illustration 3 g01092595

3. Install radiator support (23) and bolts (21) , (22) and (24) . Tighten bolts (21) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

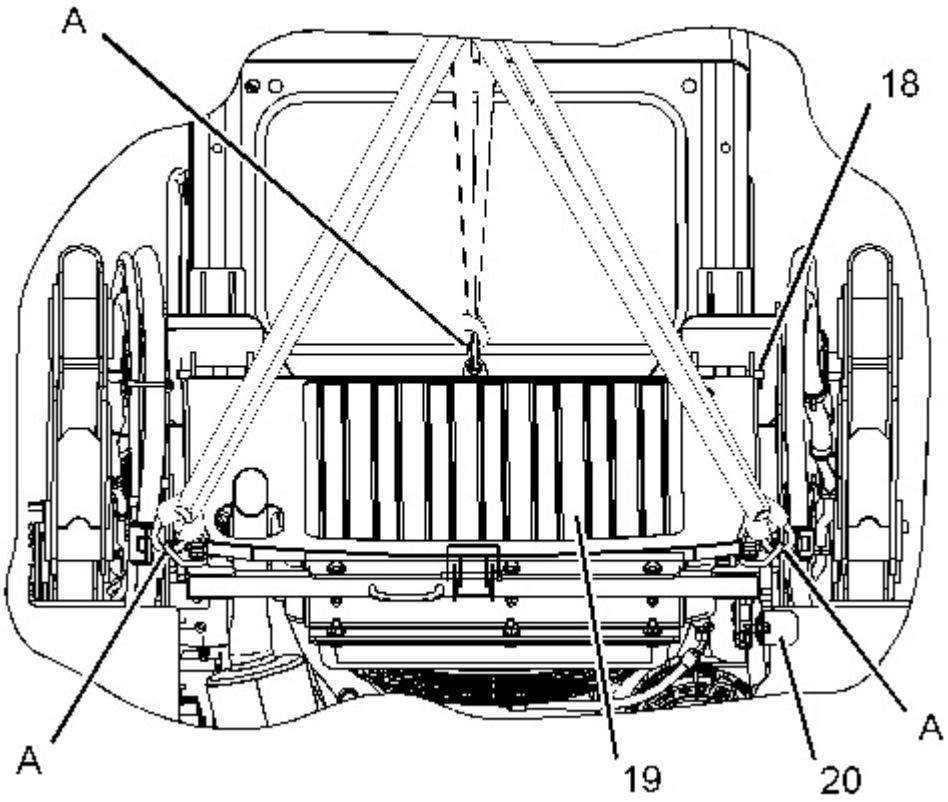


Illustration 4 g01043746

4. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Install radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb). Install pins (18) to each side of the machine and install the cotter pins. Engage latch (20) .



Illustration 5 g01390286

Typical Example

5. Attach a suitable lifting device to the radiator assembly, as shown. The weight of the radiator assembly is approximately 60 kg (130 lb). Use the suitable lifting device in order to raise the radiator, as shown. This will hold the radiator assembly in position until the struts are installed.

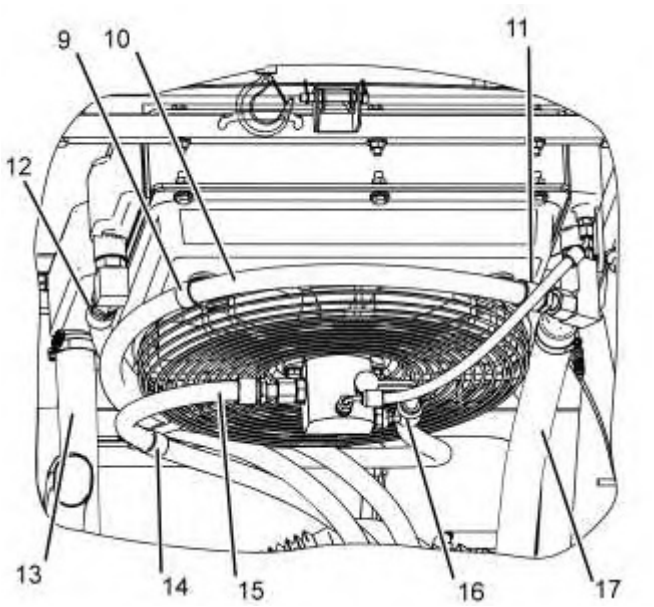


Illustration 6 g01390300

6. Connect hose assemblies (10) and (12) and hoses (13) and (17) . Connect hose assembly (15) . Install clips (9) , (11) , and (14) . Connect hose assembly (16) .

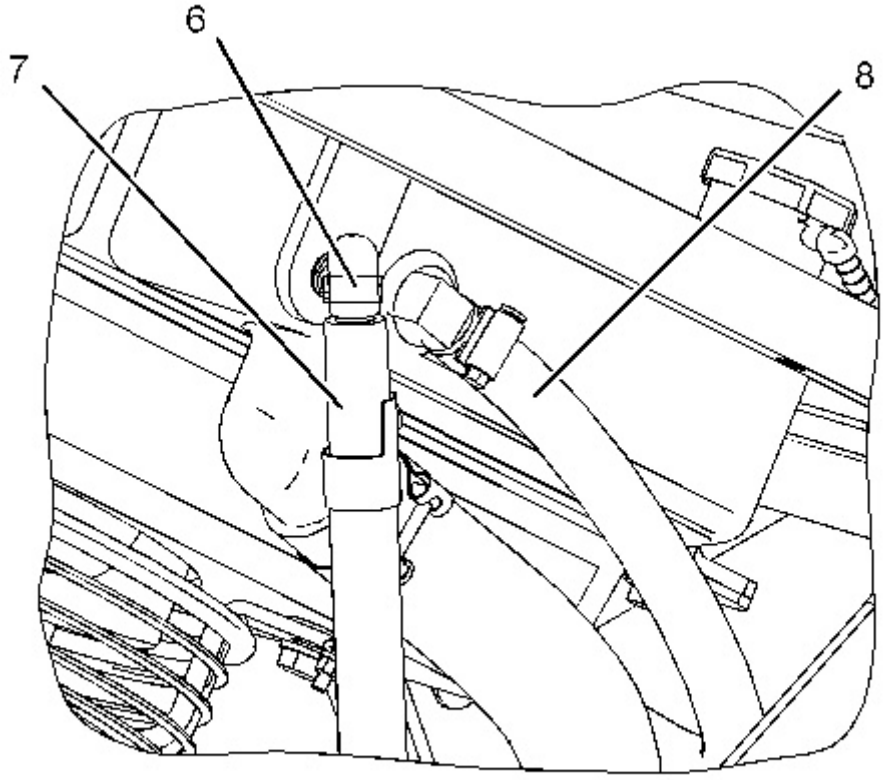


Illustration 7 g01096079

7. Install strut (7) and clip (6) . Connect hose (8) . Remove Tooling (A) .

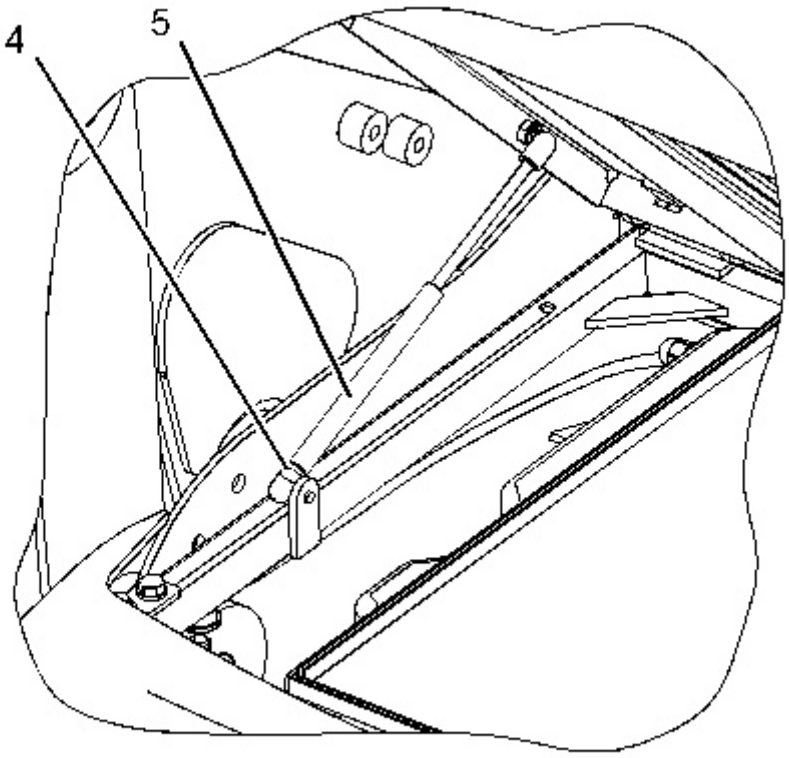


Illustration 8 g01096078

8. Connect struts (5) and install clips (4) .

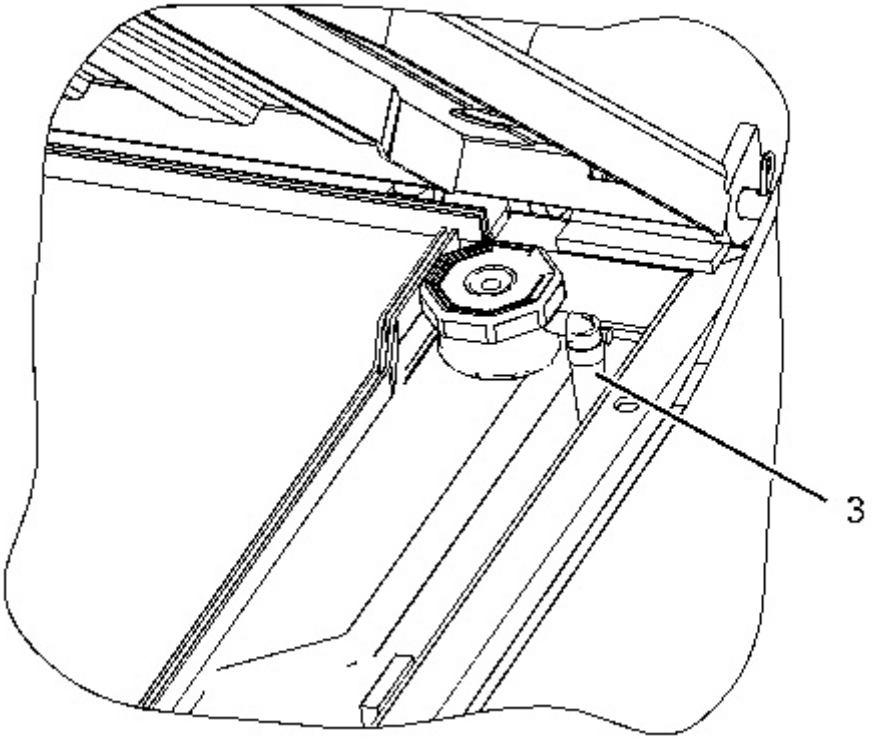


Illustration 9 g01042099

9. Connect hose (3) .

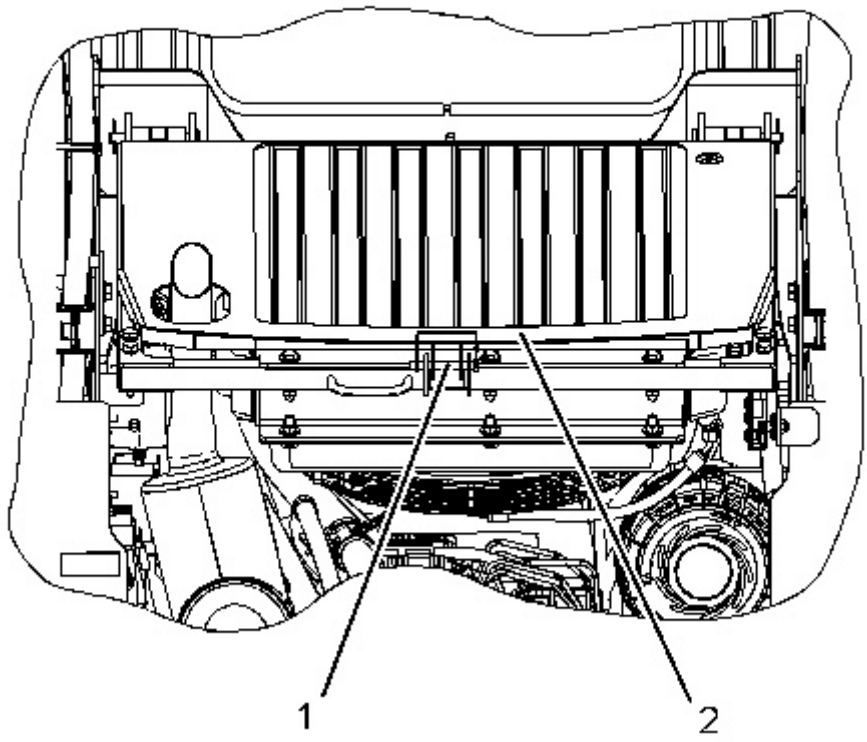


Illustration 10 g01042083

10. Lower radiator guard (2) and install pin (1) .

11. Fill the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

12. Check the level of the hydraulic oil system. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02783363

Radiator and Hydraulic Oil Cooler - Remove

SMCS - 1353-011; 1374-011

Removal Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3
B	8T-4133	Nut	1
C	8T-4121	Hard Washer	1

Start By:

A. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

At operating temperature, the engine coolant is hot and under pressure.

Steam can cause personal injury.

Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand.

Remove the fill cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

1. Drain the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

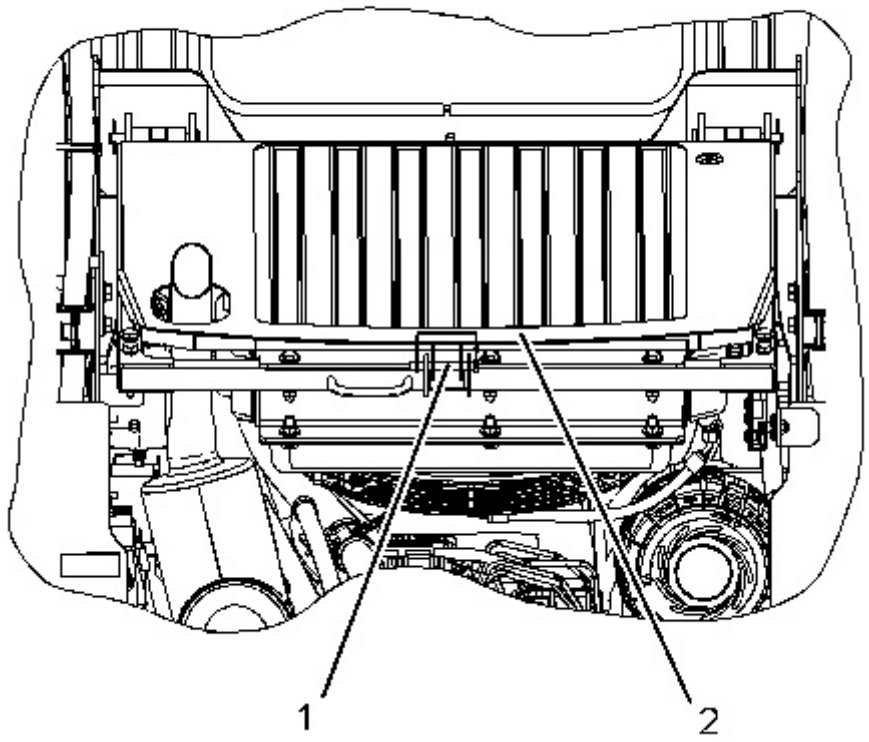


Illustration 1 g01042083

2. Remove pin (1) . Raise radiator guard (2) .

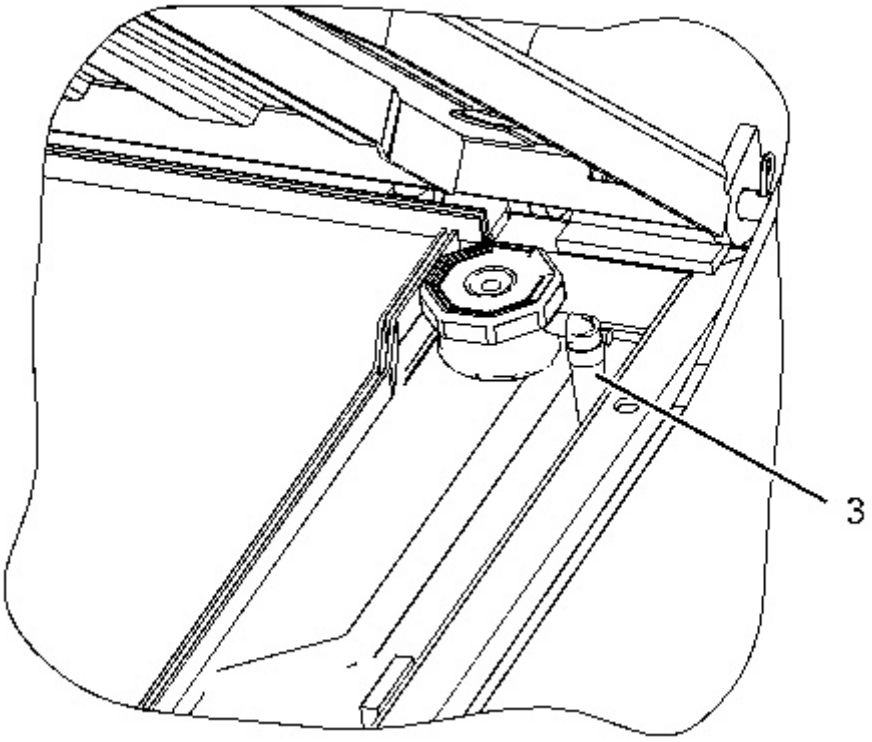


Illustration 2 g01042099

3. Disconnect hose (3) .



Illustration 3 g01390286

Typical Example

4. Attach a suitable lifting device to the radiator assembly, as shown. This will support the radiator assembly when the struts are removed. The weight of the radiator assembly is approximately 60 kg (130 lb).

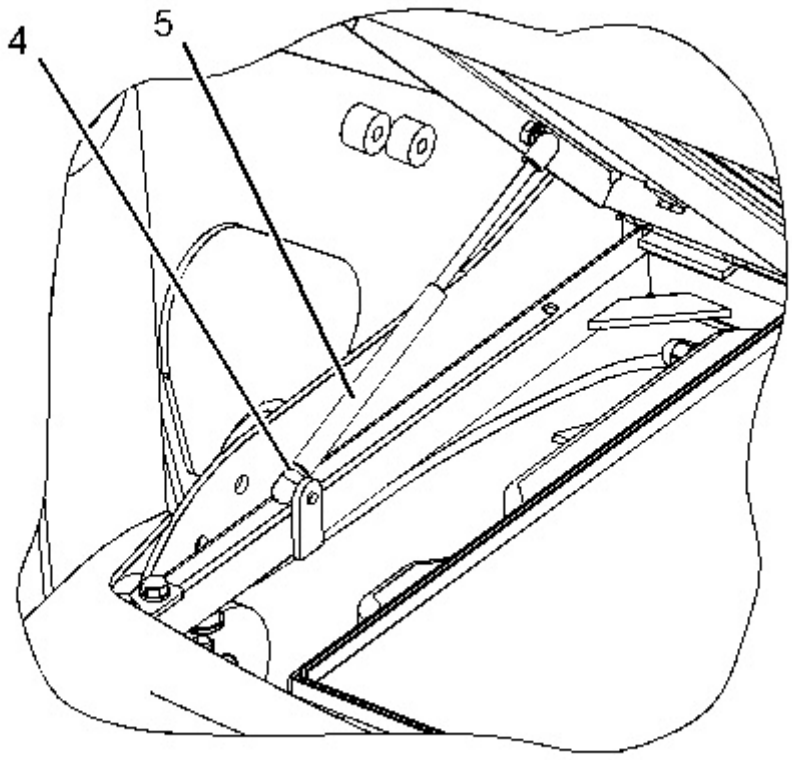


Illustration 4 g01096078

5. Remove clips (4) and disconnect strut (5) .

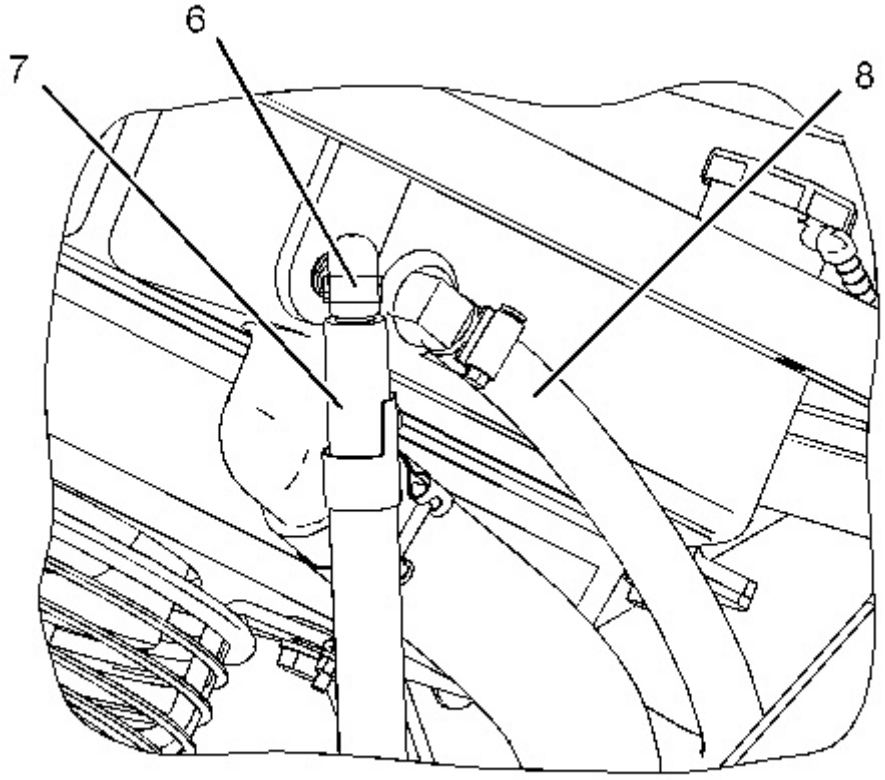


Illustration 5 g01096079

6. Remove clip (6) and remove strut (7) . Disconnect hose (8) .

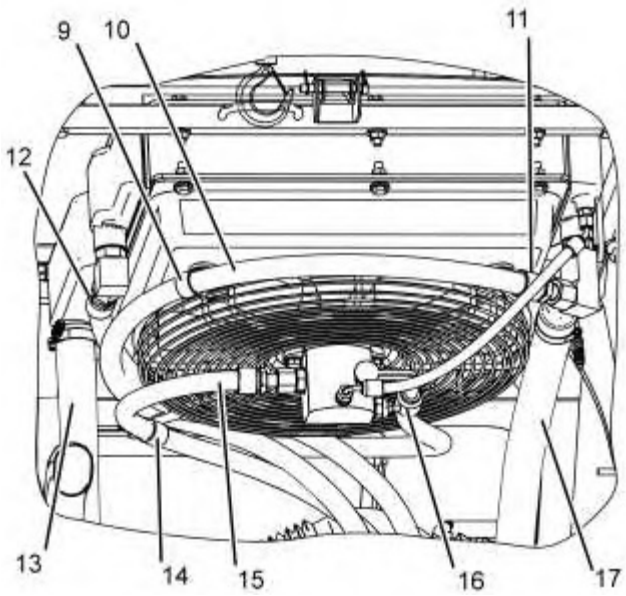


Illustration 6 g01390300

7. Remove clips (9) , (11) and (14) . Disconnect hose assemblies (10) and (12) , and hoses (13) and (17) . Disconnect hose assembly (15) . Use the suitable lifting device that was attached in Step 4 in order to lower the radiator assembly.

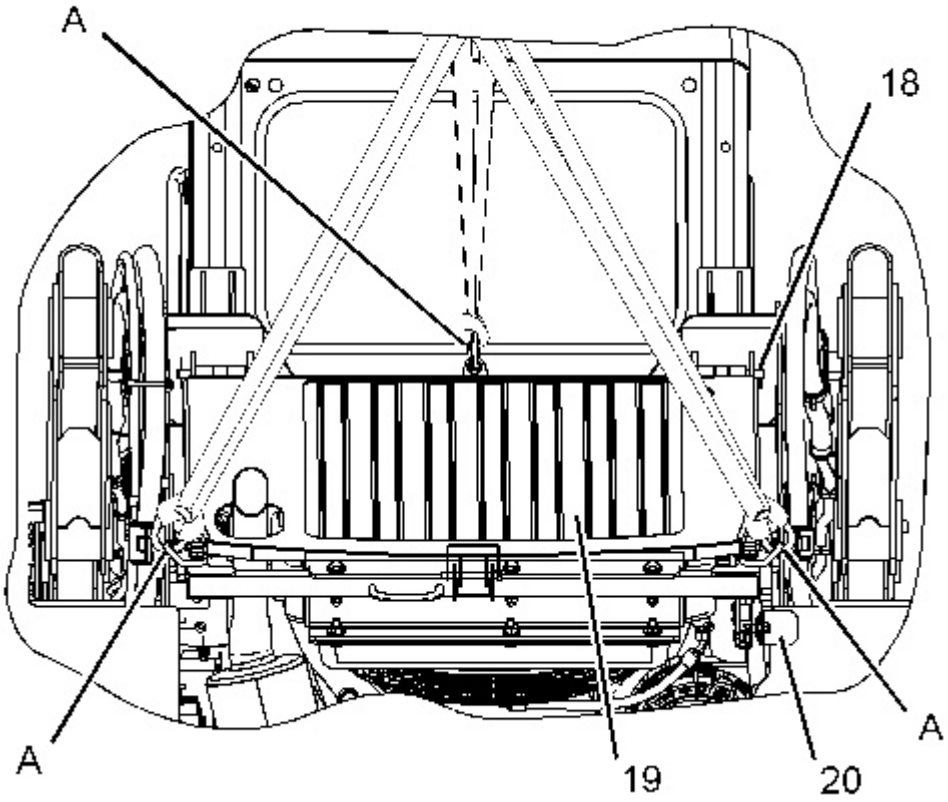


Illustration 7 g01043746

8. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Remove the cotter pins and remove pins (18) from each side of the machine.

9. Release latch (20) and remove radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb).

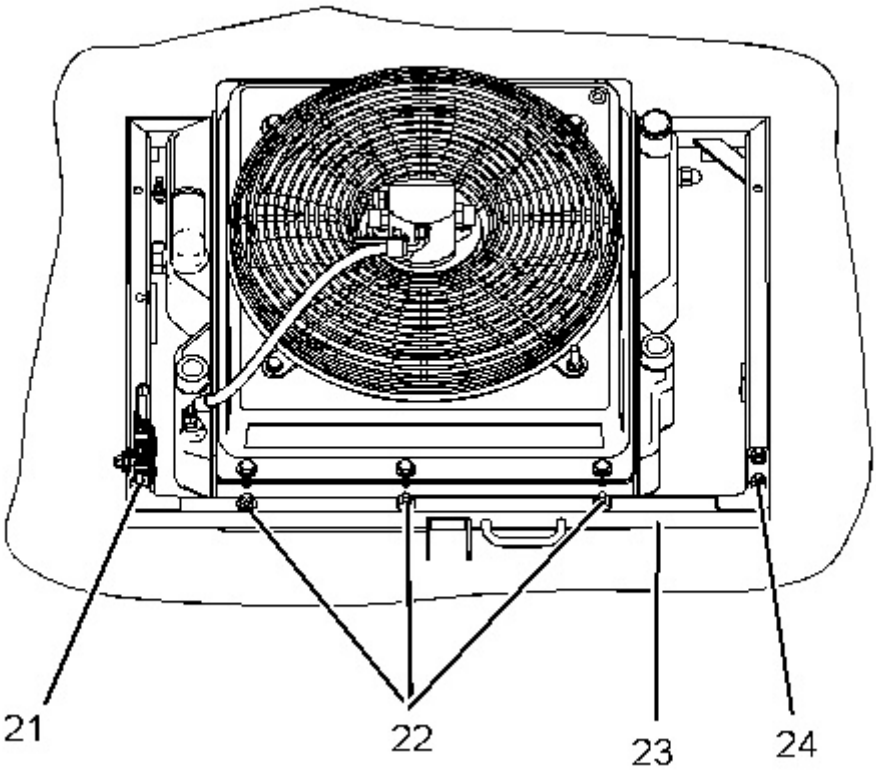


Illustration 8 g01092595

10. Remove bolts (21) , (22) and (24) . Remove the radiator support (23) .

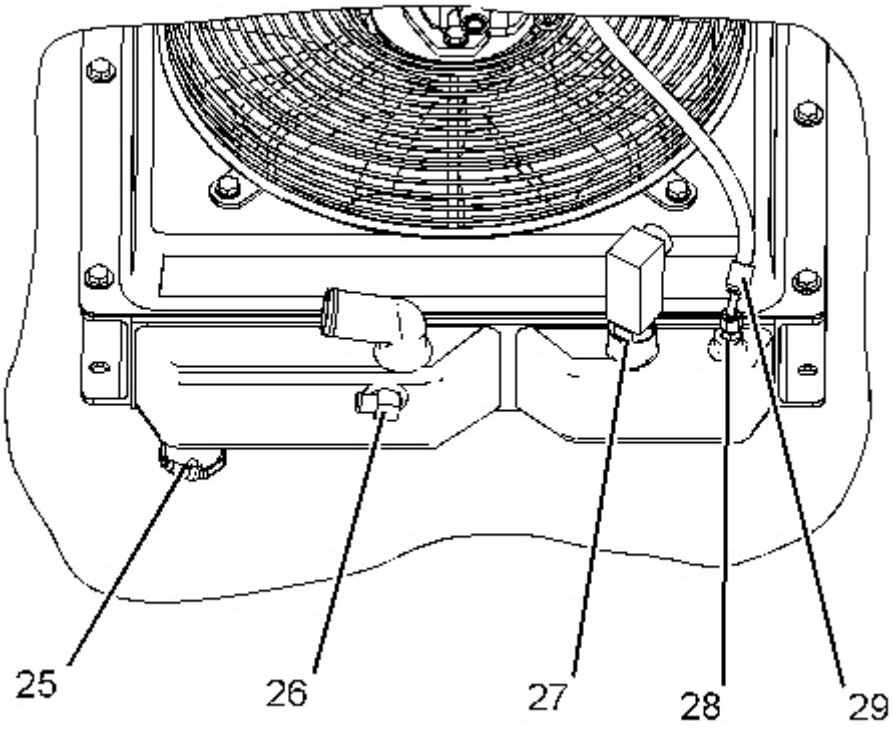


Illustration 9 g01043891

11. Disconnect hose assembly (29) . Remove fittings (25) , (26) , (27) and (28) .

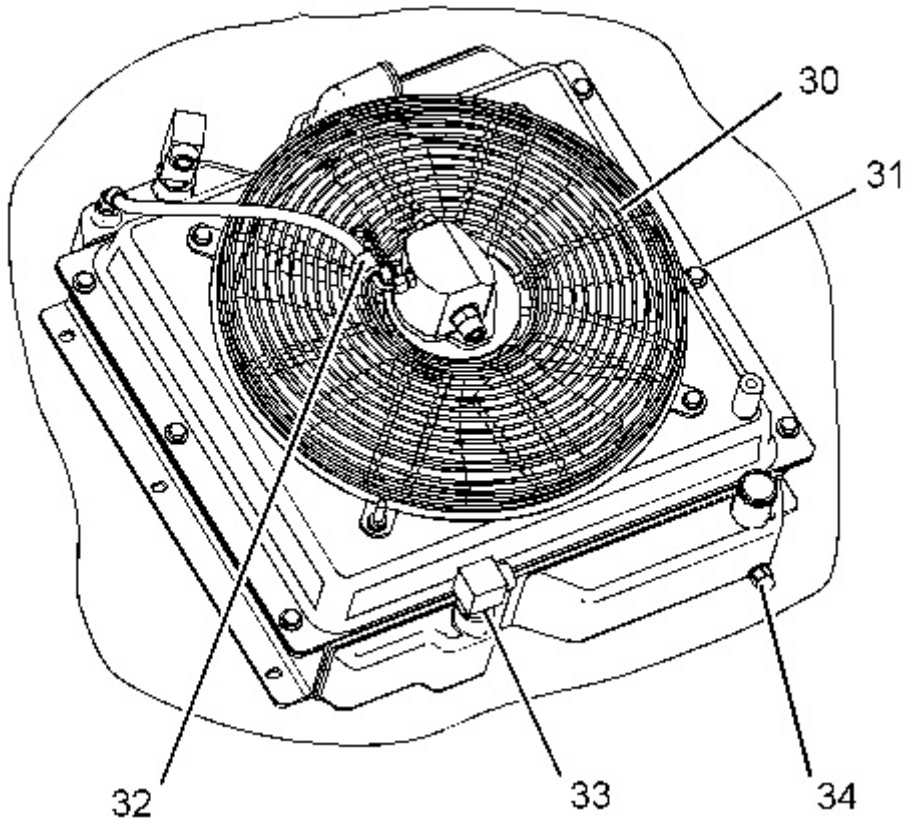


Illustration 10 g01092599

12. Disconnect hose assembly (32) , fitting (33) , sight glass (34) , six bolts (31) , the radiator shroud, and fan assembly (30) .

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Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02783657

Radiator and Hydraulic Oil Cooler - Install

SMCS - 1353-012; 1374-012

Installation Procedure

Table 1

Required Parts			
Tool	**Part Number**	**Description**	**Qty**
A	138-7573	Link Bracket	3

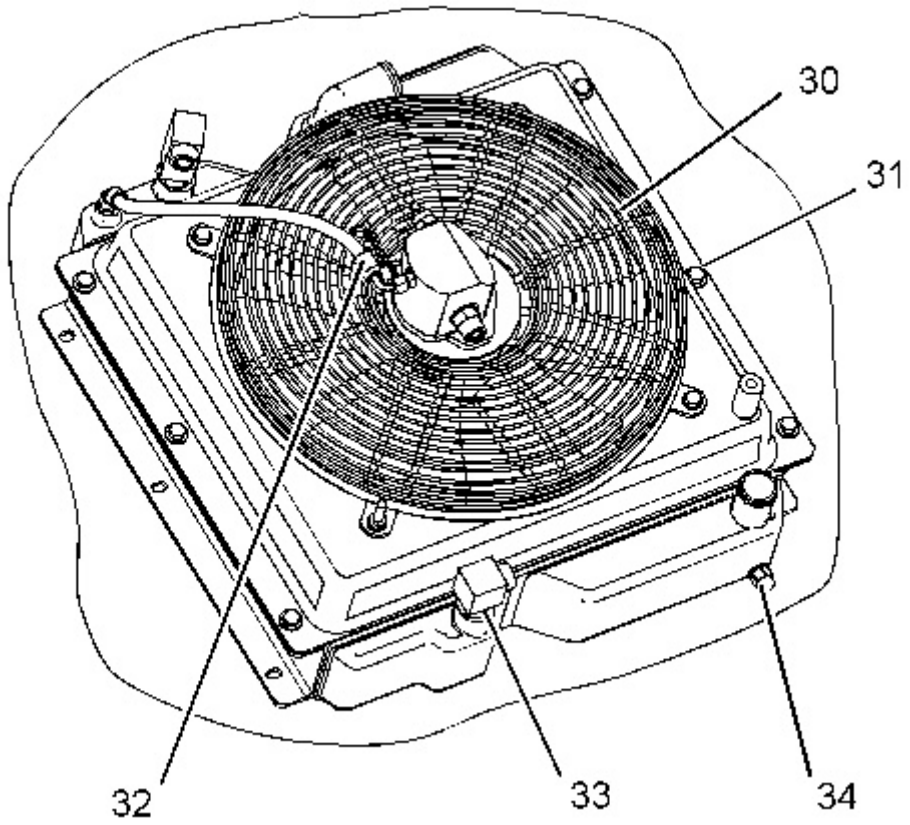


Illustration 1 g01092599

1. Position the radiator shroud and fan assembly (30) . Install six bolts (31) . Tighten bolts (31) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Install sight glass (34) . Tighten sight glass (34) to a torque of 15 ± 2 N·m (11 ± 1 lb ft). Install fitting (33) and connect hose assembly (32) .

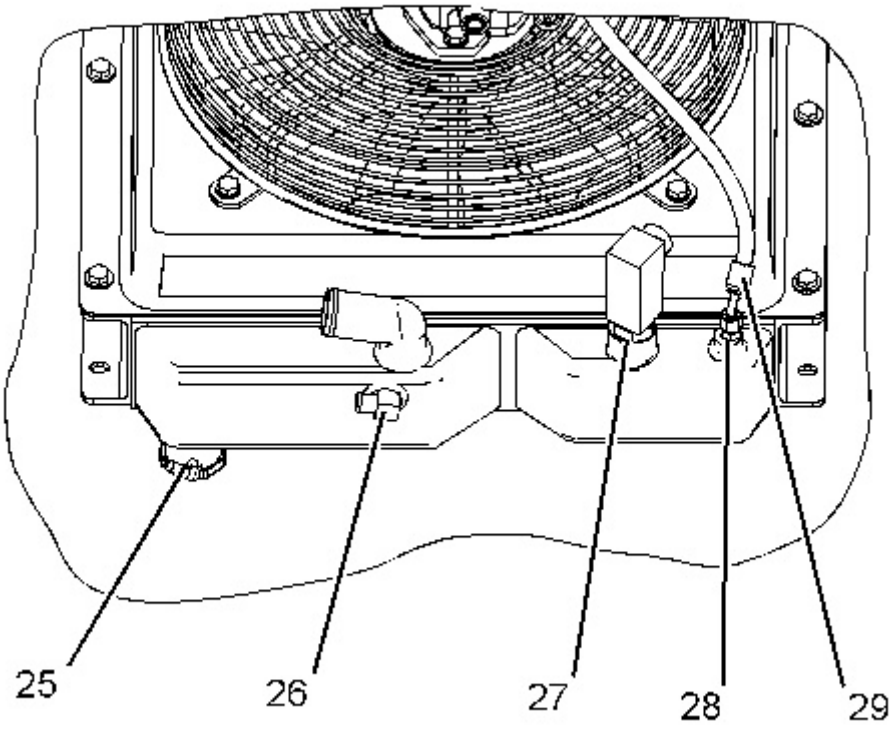


Illustration 2 g01043891

2. Install fittings (25) , (26) , (27) and (28) . Connect hose assembly (29) .

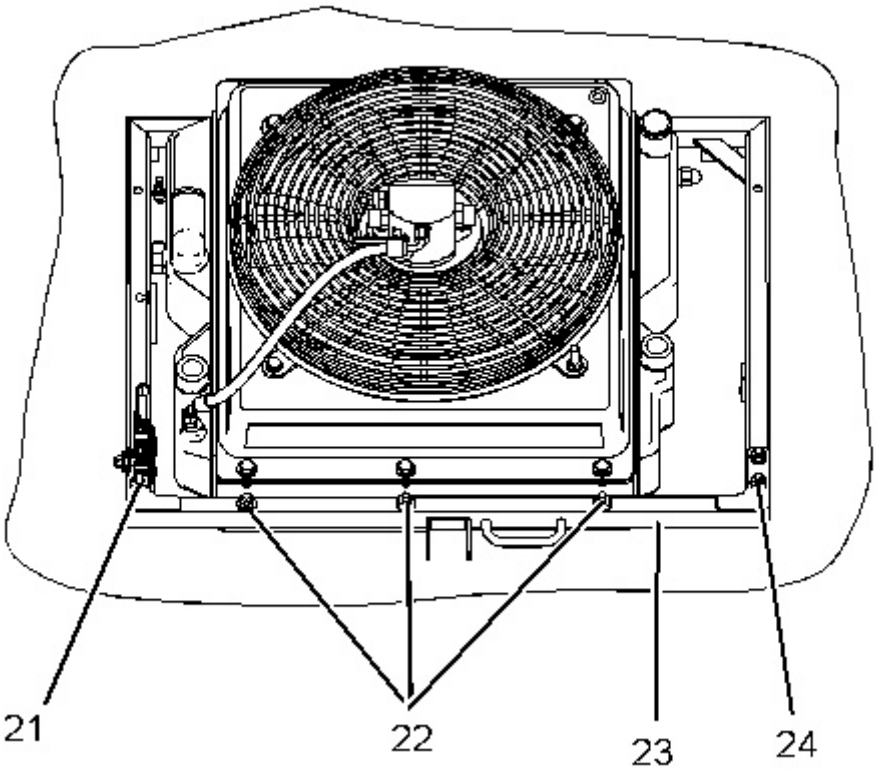


Illustration 3 g01092595

3. Install radiator support (23) and bolts (21) , (22) and (24) . Tighten bolts (21) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

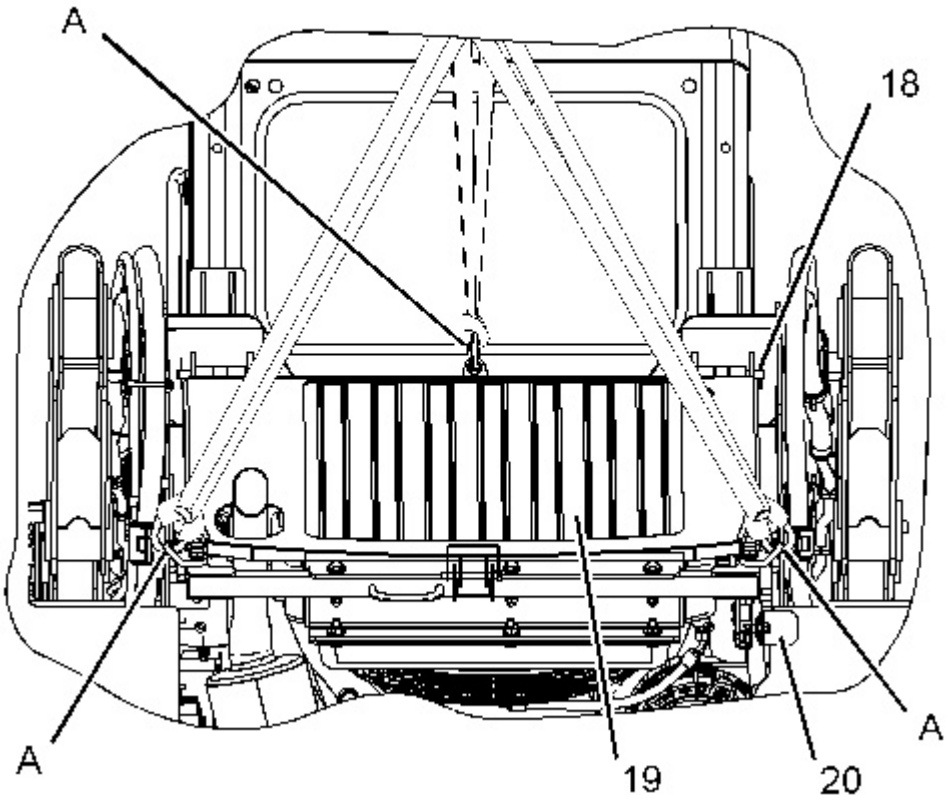


Illustration 4 g01043746

4. Attach Tooling (A) and a suitable lifting device to radiator assembly (19) , as shown. Install radiator assembly (19) . The weight of radiator assembly (19) is approximately 60 kg (130 lb). Install pins (18) to each side of the machine and install the cotter pins. Engage latch (20) .



Illustration 5 g01390286

Typical Example

5. Attach a suitable lifting device to the radiator assembly, as shown. The weight of the radiator assembly is approximately 60 kg (130 lb). Use the suitable lifting device in order to raise the radiator, as shown. This will hold the radiator assembly in position until the struts are installed.

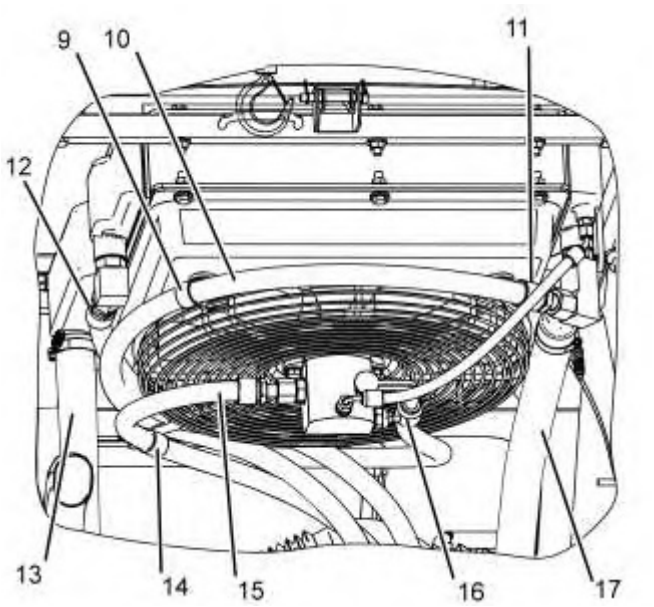


Illustration 6 g01390300

6. Connect hose assemblies (10) and (12) and hoses (13) and (17) . Connect hose assembly (15) . Install clips (9) , (11) , and (14) . Connect hose assembly (16) .

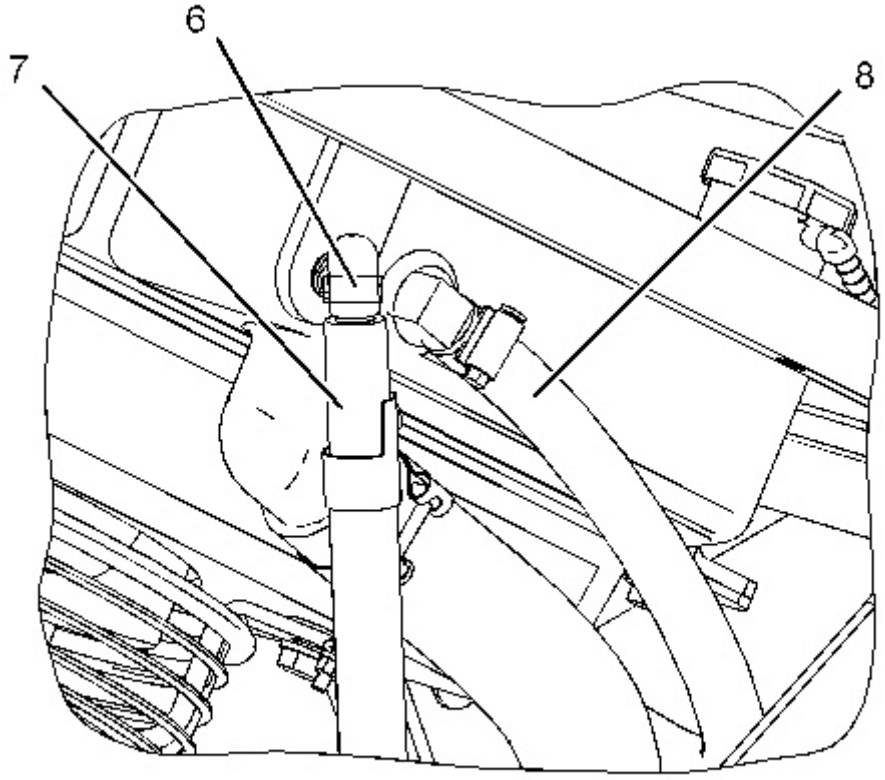


Illustration 7 g01096079

7. Install strut (7) and clip (6) . Connect hose (8) . Remove Tooling (A) .

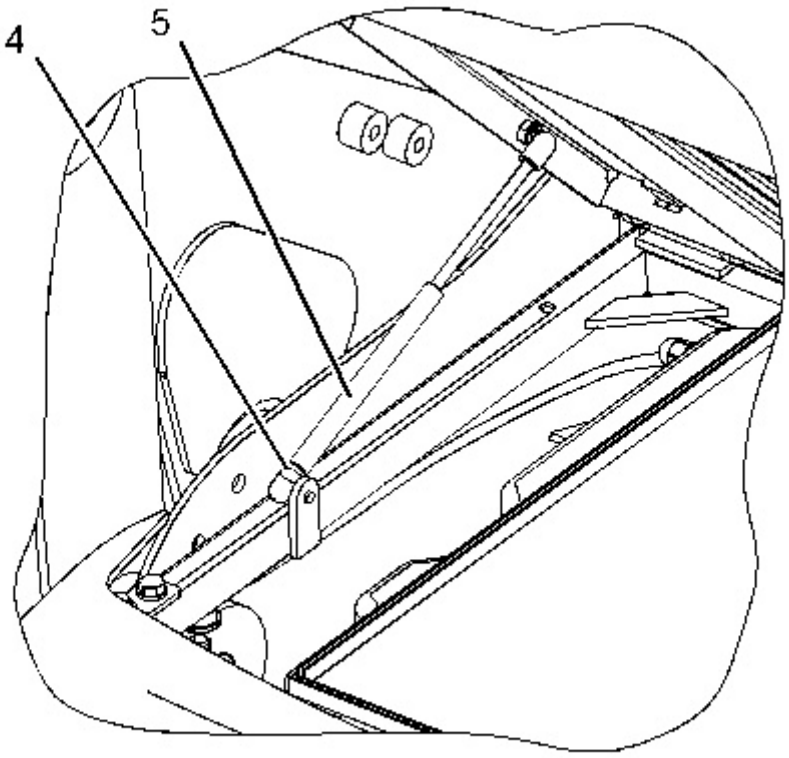


Illustration 8 g01096078

8. Connect struts (5) and install clips (4) .

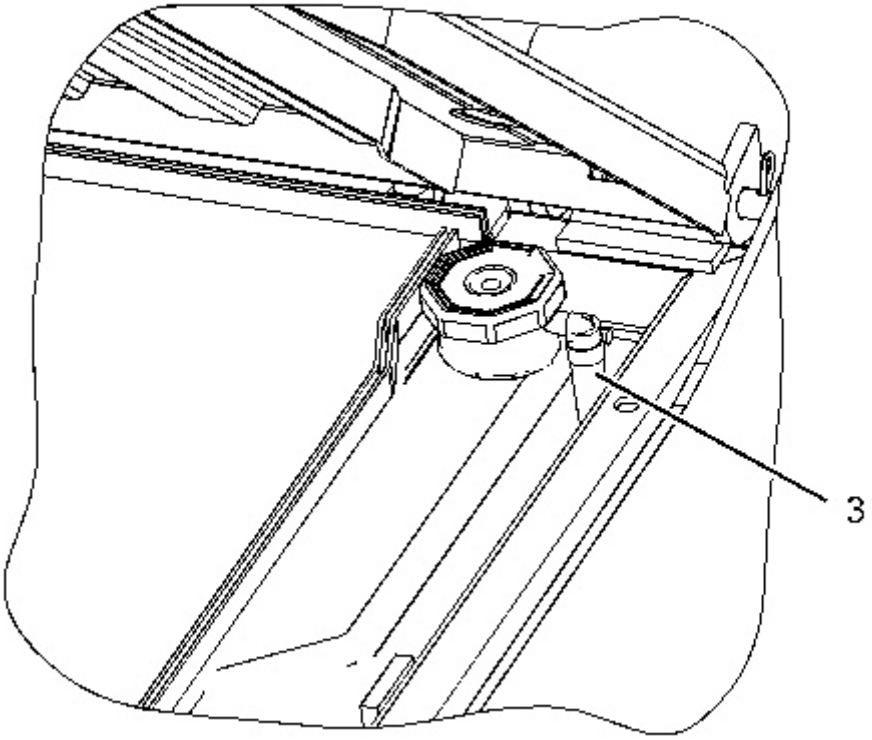


Illustration 9 g01042099

9. Connect hose (3) .

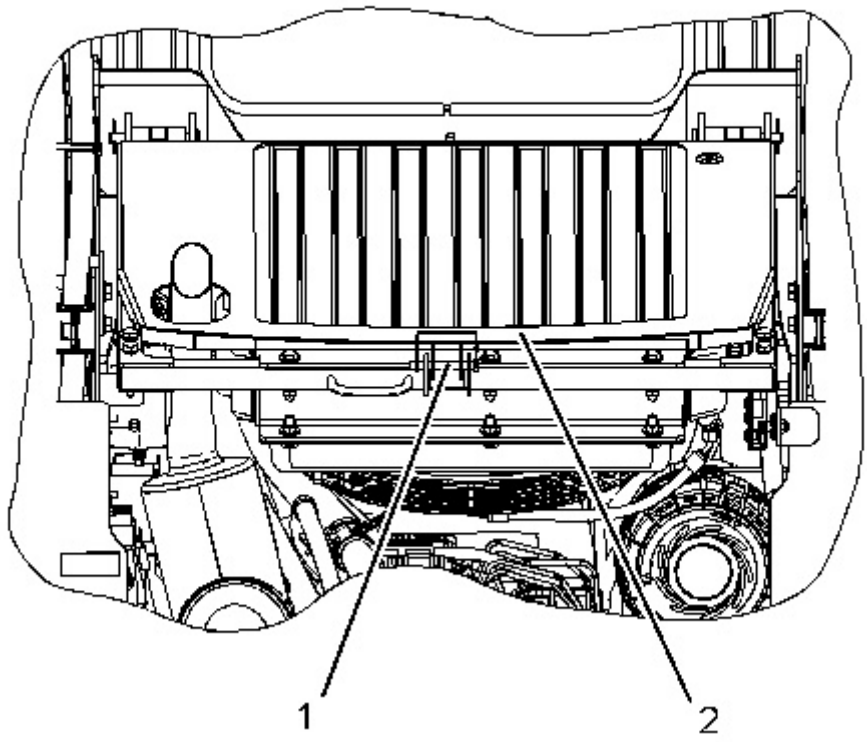


Illustration 10 g01042083

10. Lower radiator guard (2) and install pin (1) .

11. Fill the coolant from the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Coolant (ELC) - Change".

12. Check the level of the hydraulic oil system. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854900

Lift Cylinder

SMCS - 5102

S/N - HEN1-6749

S/N - PAT1-UP

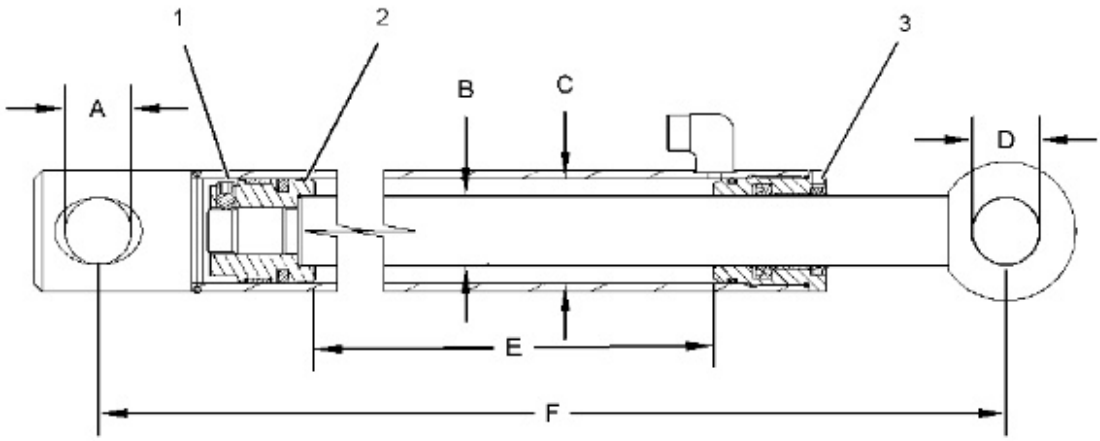


Illustration 1 g01421920

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (1) .

(1) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(2) Torque for the piston head end of the rod ... 415 ± 25 N·m (310 ± 18 lb ft)

Distance across the flats of the piston head ... 46 mm (1.8 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (3) for cylinder.

(3) Torque for the head ... 275 ± 25 N·m (200 ± 18 lb ft)

(A) Inside diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 40 mm (1.6 inch)

(C) Bore in the hydraulic cylinder ... 60 mm (2.4 inch)

(D) Inner diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(E) Stroke of the cylinder ... 715.00 ± 1.25 mm (28.150 ± 0.049 inch)

(F) Closed length of the cylinder (pin to pin) ... 950.00 ± 0.85 mm (37.401 ± 0.033 inch)

Extended length of the cylinder ... 1665.00 ± 2.10 mm (65.551 ± 0.083 inch)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02855277

Lift Cylinder

SMCS - 5102

S/N - HEN1-6749

S/N - PDT1-UP

S/N - SCP1-4599

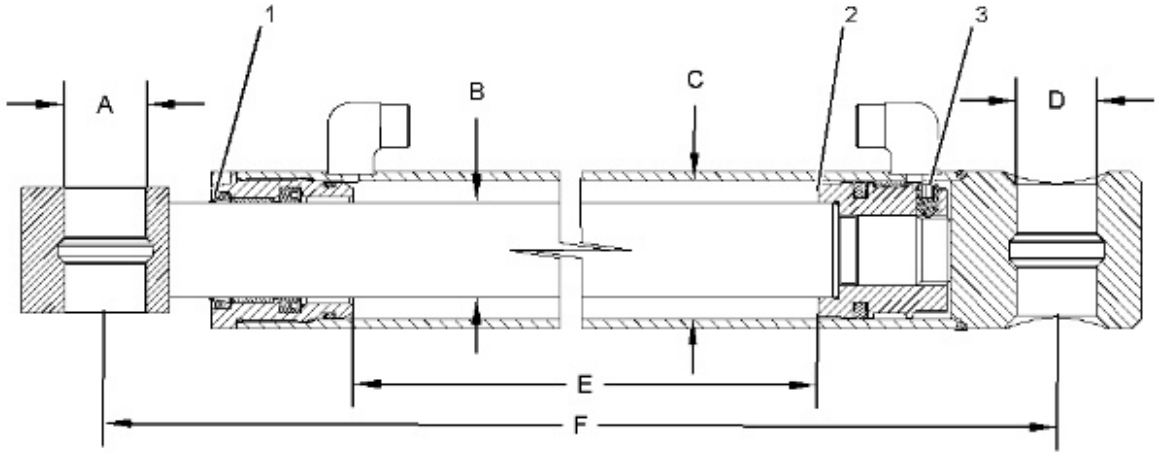


Illustration 1 g01422320

(A) Inside diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 45 mm (1.8 inch)

(C) Bore in the hydraulic cylinder ... 65 mm (2.6 inch)

(D) Diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (1) for cylinder.

(1) Torque for the head ... 295 ± 25 N·m (220 ± 18 lb ft)

(2) Torque for the piston head end of the rod ... 485 ± 25 N·m (360 ± 18 lb ft)

Distance across the flats of the piston head ... 46 mm (1.8 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (3) .

(3) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(E) Stroke of the cylinder ... 935.00 ± 1.25 mm (36.811 ± 0.049 inch)

(F) Closed length of the cylinder ... 1165.00 ± 0.75 mm (45.866 ± 0.030 inch)

Extended length of the cylinder ... 2100.0 ± 2.0 mm (82.68 ± 0.08 inch)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02855308

Tilt Cylinder

SMCS - 5104

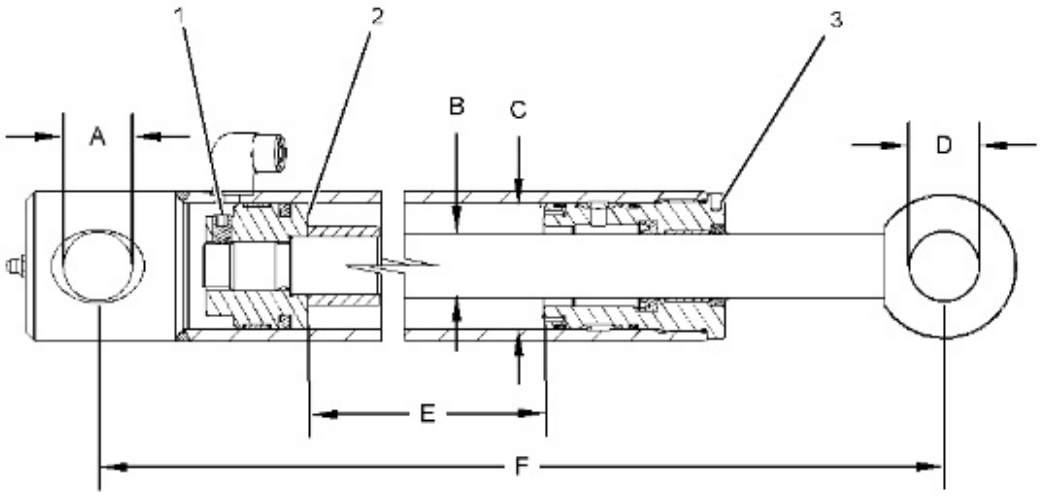


Illustration 1 g01422331

(A) Inside diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 35 mm (1.4 inch)

(C) Bore of the hydraulic cylinder ... 70 mm (2.8 inch)

(D) Inside diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (1) .

(1) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(2) Torque for the piston head end of the rod ... 485 ± 25 N·m (360 ± 18 lb ft)

Distance across the flats of the piston head ... 55 mm (2.2 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (3) for cylinder.

(3) Torque for the head ... 325 ± 25 N·m (240 ± 18 lb ft)

(E) Stroke of the cylinder ... 354.00 ± 1.25 mm (13.937 ± 0.049 inch)

(F) Closed length of the cylinder ... 620.00 ± 0.85 mm (24.409 ± 0.033 inch)

Extended length of the cylinder ... 974.00 ± 2.10 mm (38.346 ± 0.083 inch)

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i03039940

Coupler Cylinder

SMCS - 5133

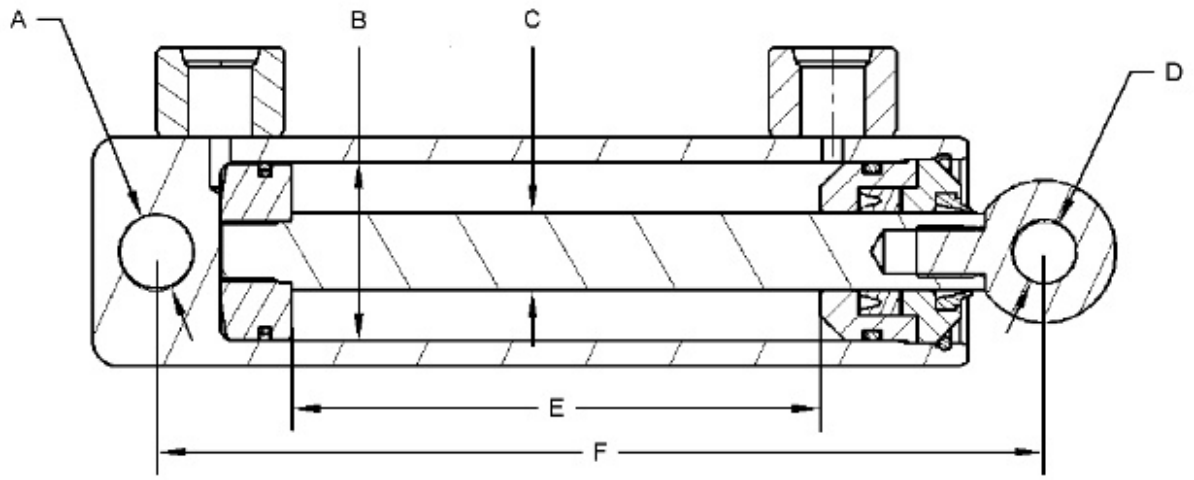


Illustration 1 g01543134

Note: Before assembly, all bores must be free of paint. Apply **5P-0960** Grease Cartridge to all the bores.

(A) Bore of the cap end ... 14.50 to 14.60 mm (0.571 to 0.575 inch)

(B) Bore of the cylinder assembly ... 35 mm (1.4 inch)

(C) Outside diameter of the rod assembly ... 15 mm (0.6 inch)

(D) Bore of the rod eye ... 12.50 to 12.60 mm (0.492 to 0.496 inch)

(E) Length of stroke ... 103.5 ± 1.5 mm (4.07 ± 0.06 inch)

(F) Closed length ... 174.0 ± 1.2 mm (6.85 ± 0.05 inch)

Extended length ... 277.5 ± 2.5 mm (10.93 ± 0.10 inch)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865358

Lift Arm Cylinder and Mounting

SMCS - 5102-MT; 5102; 5104-MT; 5104; 6119-S/C

S/N - HEN1-6749

S/N - PAT1-UP

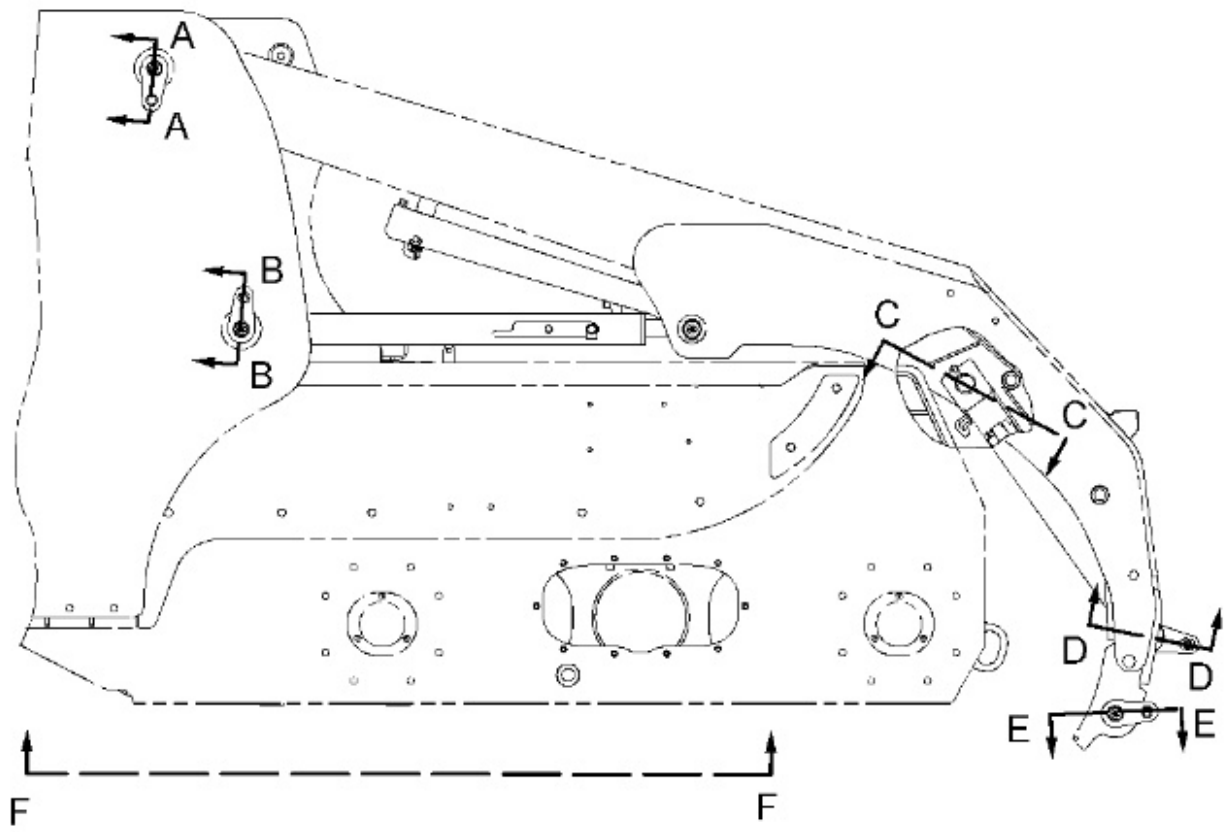


Illustration 1 g01020905

Note: Before assembly, all pins, bores and bearings must be clean. All pins, bores and bearings must be lubricated with the lubricant that is being sealed. Lubricate the entire cylindrical surface of all pins.

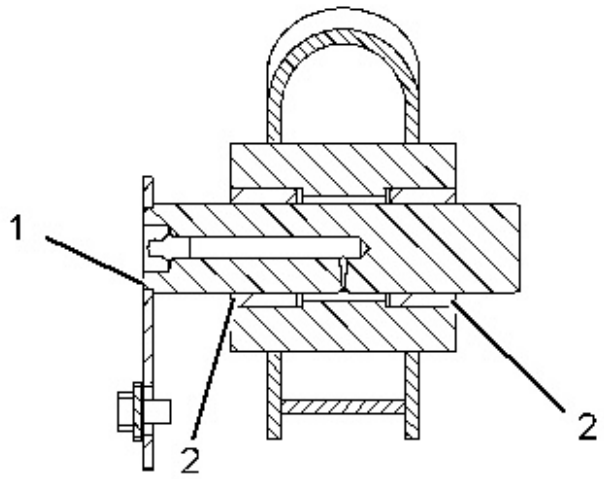


Illustration 2 g01427677

Section A-A

(1) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(2) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

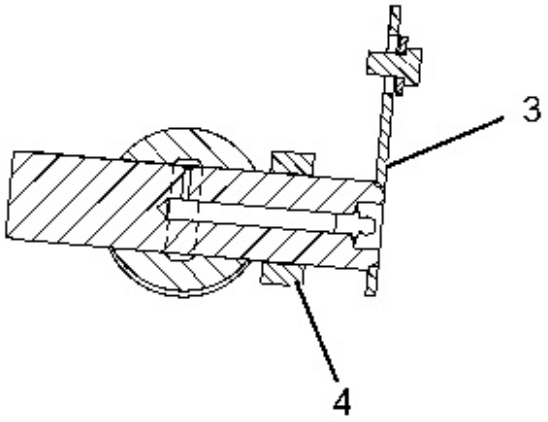


Illustration 3 g01427673

Section B-B

(3) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(4) **142-9142** Spacer

Quantity ... 2
Thickness of one spacer ... 18.0 mm (0.71 inch)

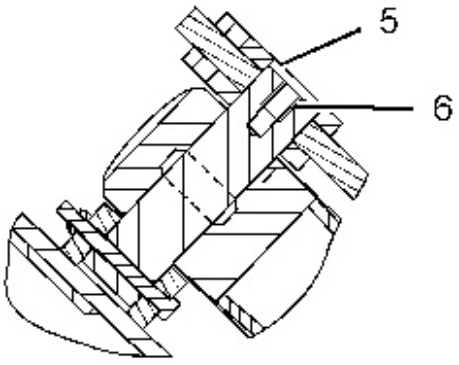


Illustration 4 g01427669

Section C-C

(5) **142-9093** Pin

Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 150.0 ± 1.5 mm (5.91 ± 0.06 inch)
Thread (6) for pin removal ... M12 X 1.75
Depth of threads ... 18.0 ± 1.5 mm (0.71 ± 0.06 inch)

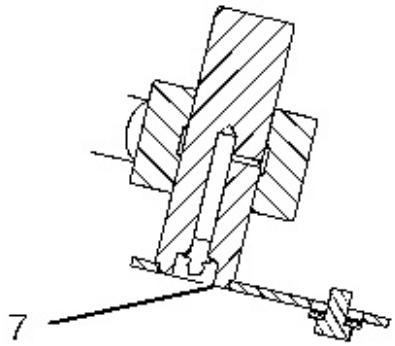


Illustration 5 g01427667

Section D-D

(7) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

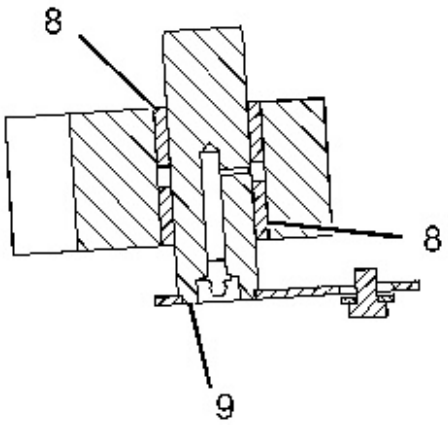


Illustration 6 g01427663

Section E-E

(8) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

(9) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

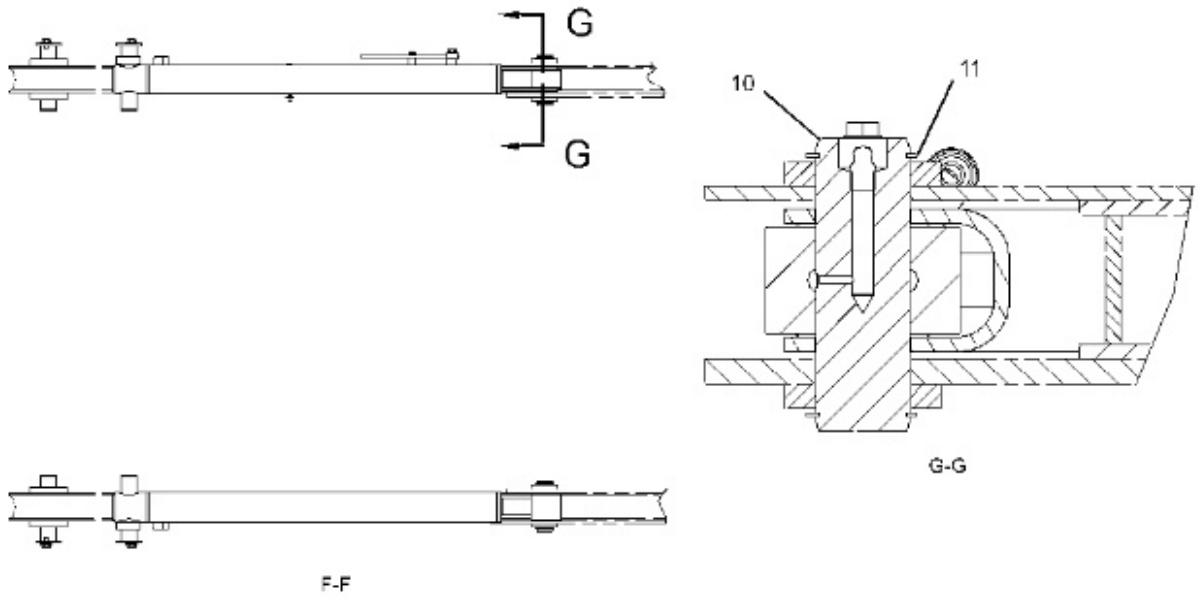


Illustration 7 g01427351

(10) **142-9094** Pin

Quantity ... 2
Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 120.0 ± 1.0 mm (4.72 ± 0.04 inch)
Width of the groove ... 1.52 ± 0.10 mm (0.060 ± 0.004 inch)

(11) **1H-8134** Retaining Ring

Quantity ... 4
Internal diameter ... 35.23 + 0.25 - 0.38 mm (1.387 + 0.010 - 0.015 inch)
Thickness of one retainer ring ... 1.27 ± 0.05 mm (0.050 ± 0.002 inch)

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i02854900

Lift Cylinder

SMCS - 5102

S/N - HEN6750-UP

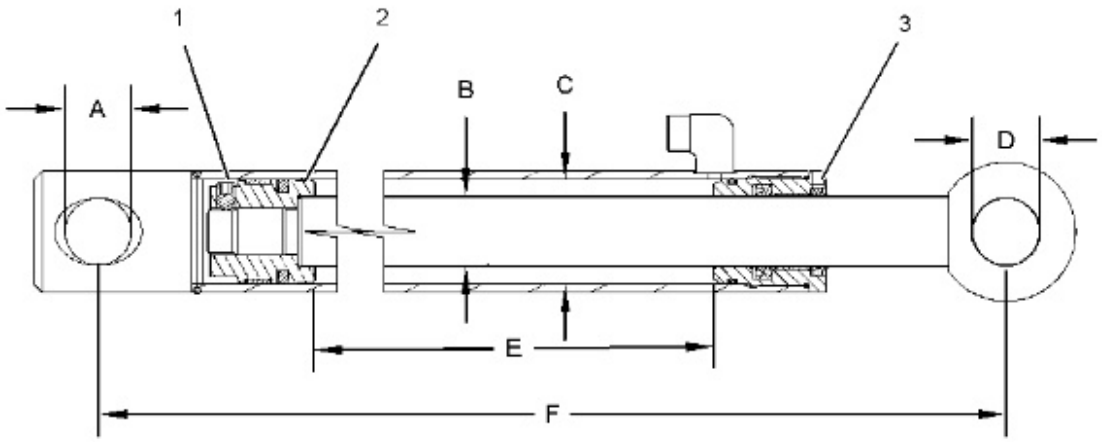


Illustration 1 g01421920

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (1) .

(1) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(2) Torque for the piston head end of the rod ... 415 ± 25 N·m (310 ± 18 lb ft)

Distance across the flats of the piston head ... 46 mm (1.8 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (3) for cylinder.

(3) Torque for the head ... 275 ± 25 N·m (200 ± 18 lb ft)

(A) Inside diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 40 mm (1.6 inch)

(C) Bore in the hydraulic cylinder ... 60 mm (2.4 inch)

(D) Inner diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(E) Stroke of the cylinder ... 715.00 ± 1.25 mm (28.150 ± 0.049 inch)

(F) Closed length of the cylinder (pin to pin) ... 950.00 ± 0.85 mm (37.401 ± 0.033 inch)

Extended length of the cylinder ... 1665.00 ± 2.10 mm (65.551 ± 0.083 inch)

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Lift Cylinder

SMCS - 5102

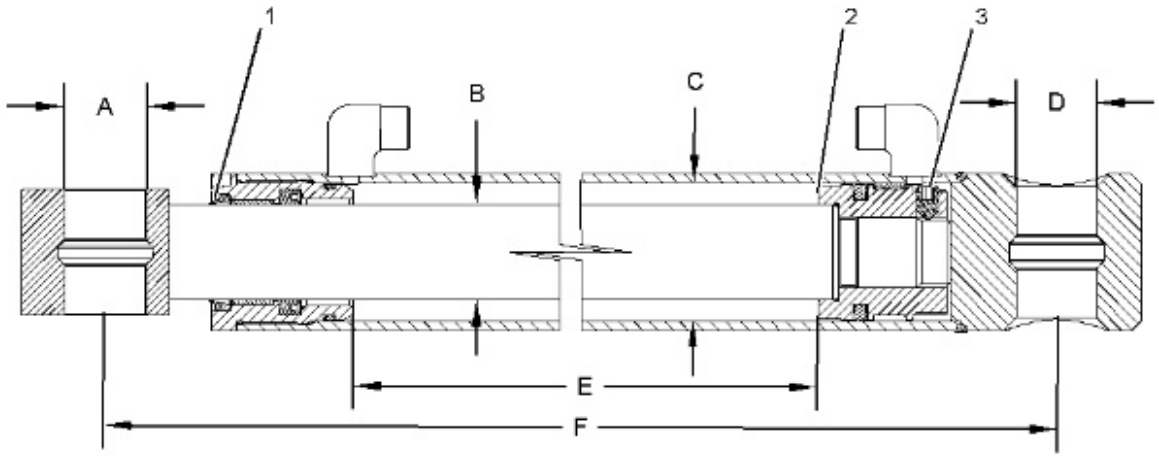


Illustration 1 g01422320

(A) Inside diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 45 mm (1.8 inch)

(C) Bore in the hydraulic cylinder ... 65 mm (2.6 inch)

(D) Diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (1) for cylinder.

(1) Torque for the head ... 295 ± 25 N·m (220 ± 18 lb ft)

(2) Torque for the piston head end of the rod ... 485 ± 25 N·m (360 ± 18 lb ft)

Distance across the flats of the piston head ... 46 mm (1.8 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (3) .

(3) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(E) Stroke of the cylinder ... 935.00 ± 1.25 mm (36.811 ± 0.049 inch)

(F) Closed length of the cylinder ... 1165.00 ± 0.75 mm (45.866 ± 0.030 inch)

Extended length of the cylinder ... 2100.0 ± 2.0 mm (82.68 ± 0.08 inch)

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Tilt Cylinder

SMCS - 5104

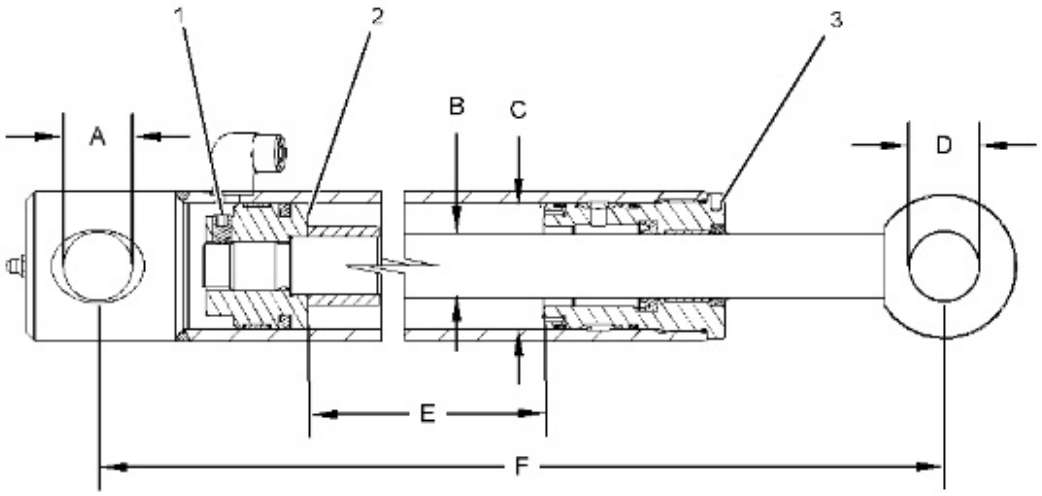


Illustration 1 g01422331

(A) Inside diameter of the hole in the trunnion end ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

(B) Outside diameter of the rod ... 35 mm (1.4 inch)

(C) Bore of the hydraulic cylinder ... 70 mm (2.8 inch)

(D) Inside diameter of the rod eye ... 38.20 ± 0.05 mm (1.504 ± 0.002 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the setscrew (1) .

(1) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 2 lb ft)

(2) Torque for the piston head end of the rod ... 485 ± 25 N·m (360 ± 18 lb ft)

Distance across the flats of the piston head ... 55 mm (2.2 inch)

Note: Before assembly, apply **9S-3263** Thread Lock Compound to the threads of the head (3) for cylinder.

(3) Torque for the head ... 325 ± 25 N·m (240 ± 18 lb ft)

(E) Stroke of the cylinder ... 354.00 ± 1.25 mm (13.937 ± 0.049 inch)

(F) Closed length of the cylinder ... 620.00 ± 0.85 mm (24.409 ± 0.033 inch)

Extended length of the cylinder ... 974.00 ± 2.10 mm (38.346 ± 0.083 inch)

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i03039940

Coupler Cylinder

SMCS - 5133

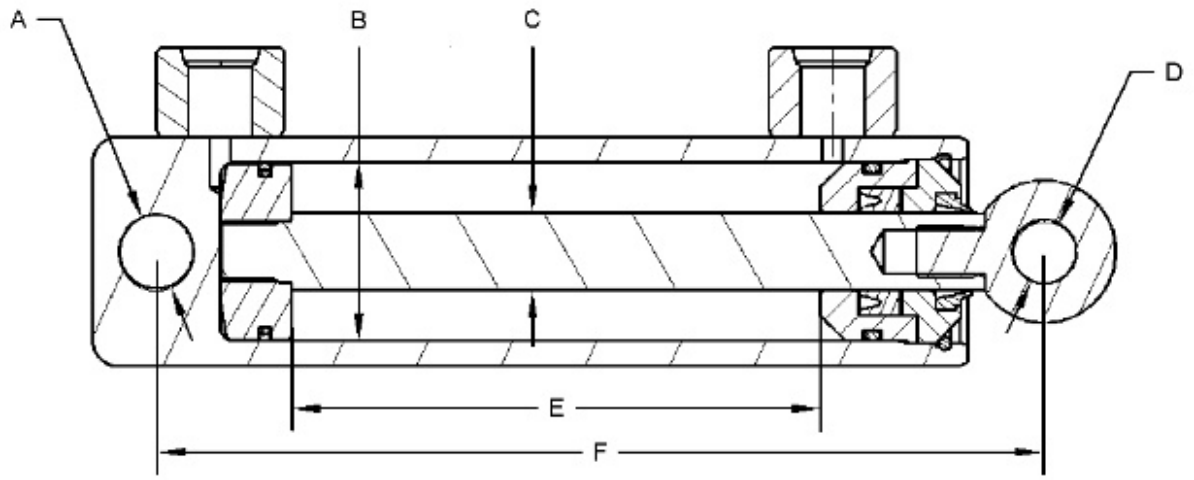


Illustration 1 g01543134

Note: Before assembly, all bores must be free of paint. Apply **5P-0960** Grease Cartridge to all the bores.

(A) Bore of the cap end ... 14.50 to 14.60 mm (0.571 to 0.575 inch)

(B) Bore of the cylinder assembly ... 35 mm (1.4 inch)

(C) Outside diameter of the rod assembly ... 15 mm (0.6 inch)

(D) Bore of the rod eye ... 12.50 to 12.60 mm (0.492 to 0.496 inch)

(E) Length of stroke ... 103.5 ± 1.5 mm (4.07 ± 0.06 inch)

(F) Closed length ... 174.0 ± 1.2 mm (6.85 ± 0.05 inch)

Extended length ... 277.5 ± 2.5 mm (10.93 ± 0.10 inch)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865358

Lift Arm Cylinder and Mounting

SMCS - 5102-MT; 5102; 5104-MT; 5104; 6119-S/C

S/N - HEN6750-UP

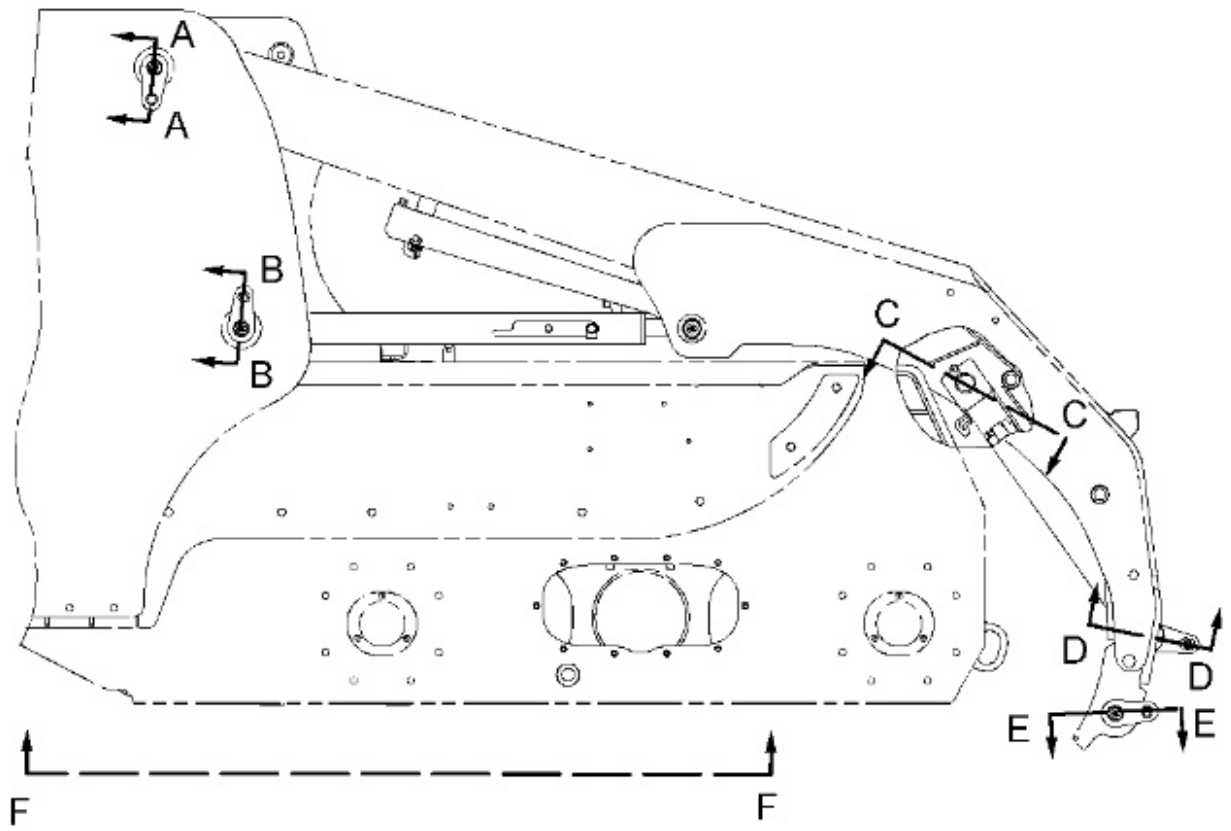


Illustration 1 g01020905

Note: Before assembly, all pins, bores and bearings must be clean. All pins, bores and bearings must be lubricated with the lubricant that is being sealed. Lubricate the entire cylindrical surface of all pins.

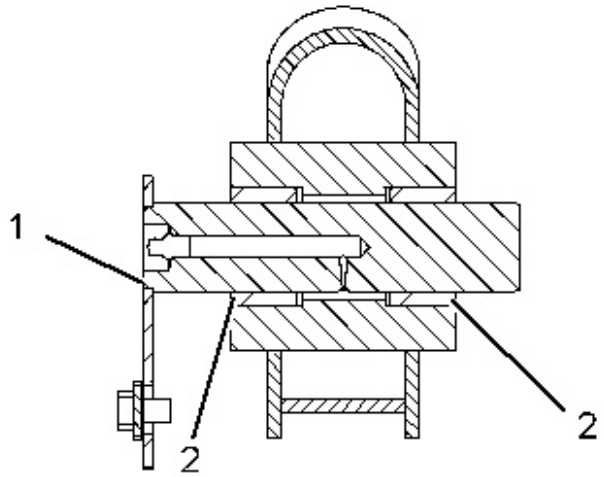


Illustration 2 g01427677

Section A-A

(1) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(2) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

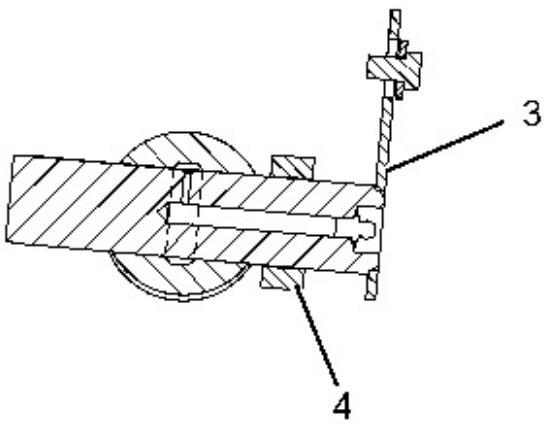


Illustration 3 g01427673

Section B-B

(3) **142-9090** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 157.0 ± 1.5 mm (6.18 ± 0.06 inch)

(4) **142-9142** Spacer

Quantity ... 2
Thickness of one spacer ... 18.0 mm (0.71 inch)

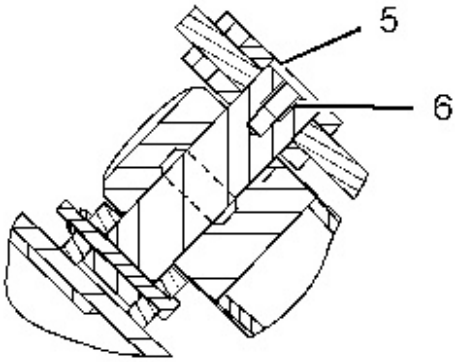


Illustration 4 g01427669

Section C-C

(5) **142-9093** Pin

Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 150.0 ± 1.5 mm (5.91 ± 0.06 inch)
Thread (6) for pin removal ... M12 X 1.75
Depth of threads ... 18.0 ± 1.5 mm (0.71 ± 0.06 inch)

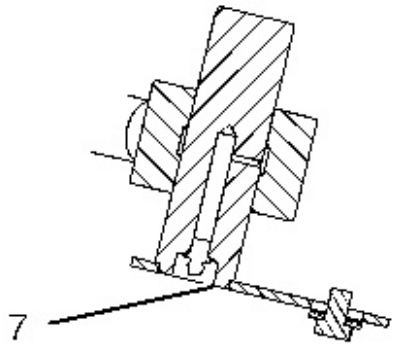


Illustration 5 g01427667

Section D-D

(7) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

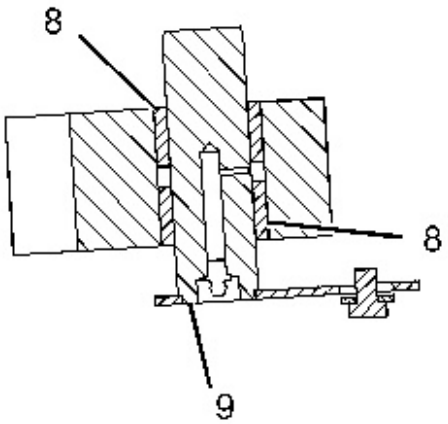


Illustration 6 g01427663

Section E-E

(8) **6K-4148** Sleeve Bearing

Quantity ... 4
Inside diameter of the bearing after assembly ... 38.21 ± 0.03 mm (1.504 ± 0.001 inch)

(9) **142-9091** Pin As

Quantity ... 2
Outside diameter ... 38.030 ± 0.030 mm (1.4972 ± 0.0012 inch)
Length ... 125.0 ± 1.5 mm (4.92 ± 0.06 inch)

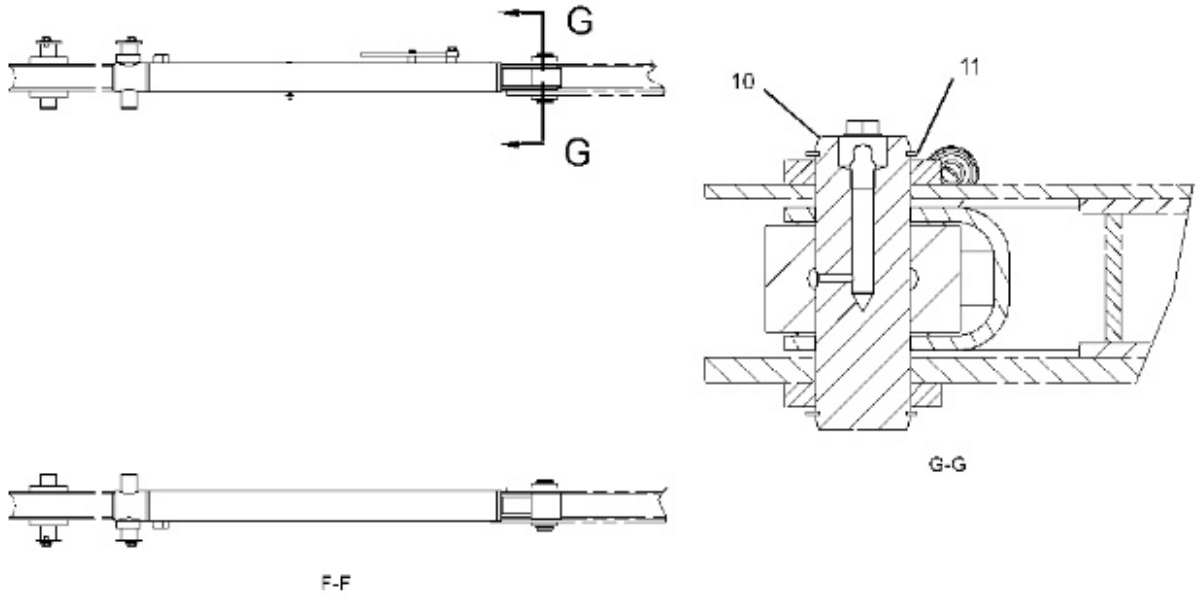


Illustration 7 g01427351

(10) **142-9094** Pin

Quantity ... 2
Outside diameter ... 38.03 ± 0.03 mm (1.497 ± 0.001 inch)
Length ... 120.0 ± 1.0 mm (4.72 ± 0.04 inch)
Width of the groove ... 1.52 ± 0.10 mm (0.060 ± 0.004 inch)

(11) **1H-8134** Retaining Ring

Quantity ... 4
Internal diameter ... 35.23 + 0.25 - 0.38 mm (1.387 + 0.010 - 0.015 inch)
Thickness of one retainer ring ... 1.27 ± 0.05 mm (0.050 ± 0.002 inch)

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i02156145

Tilt Cylinder - Remove

SMCS - 5104-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

REQUIRED TOOLS			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3034	Repair Stand Set	2
B	4C-5655	Adapter	1
	5F-7345	Threaded Rod (5/8 inch by 18 NF by 16 inch)	1
	1P-0074	Slide Hammer Puller Gp	1
	6B-6683	Nuts	2
ZZ	6V-9509	Face Seal Plug	4
	6v-9830	Cap As	4

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Remove the quick coupler. Refer to Disassembly and Assembly, "Quick Coupler - Remove and Install".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

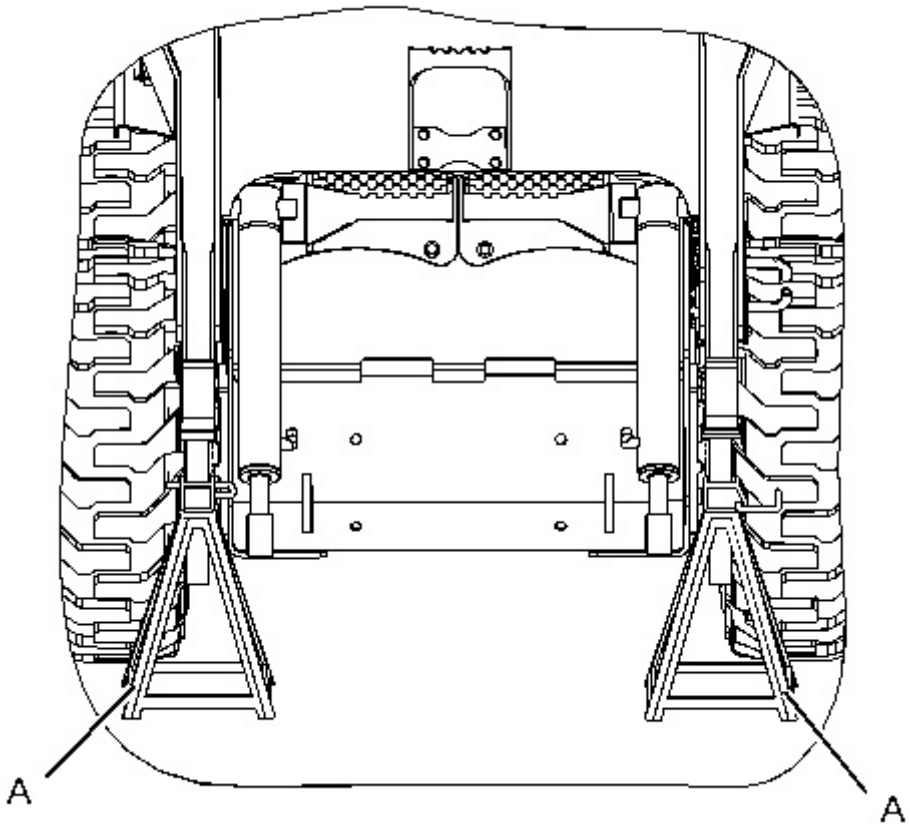


Illustration 1 g01052437

1. Use Tooling (A) to support the lift arms.

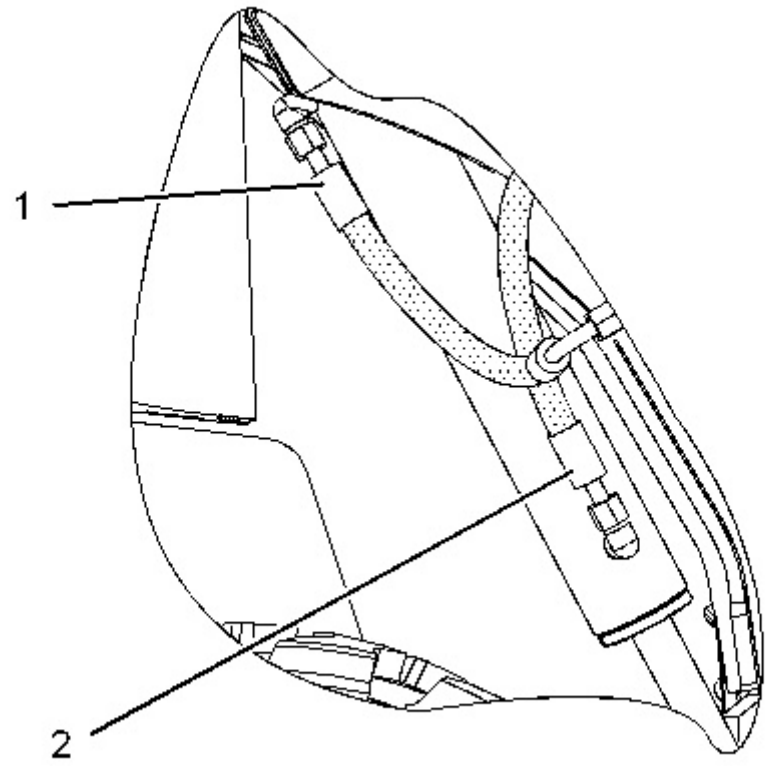


Illustration 2 g01052444

2. Disconnect hose assembly (1). Disconnect hose assembly (2) .

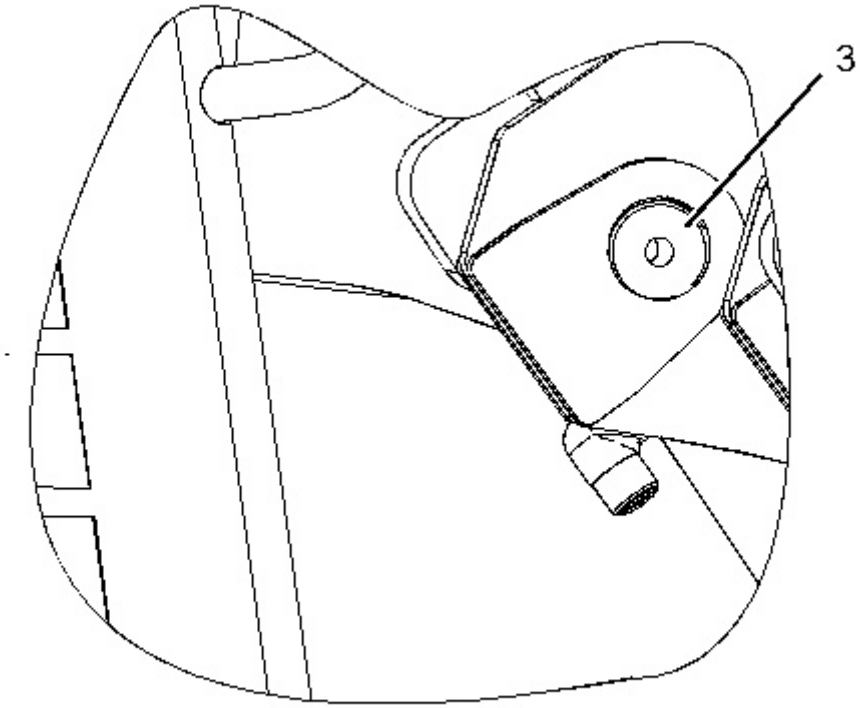


Illustration 3 g01052463

3. Remove the bolt that is located on the back side of pin (3) .

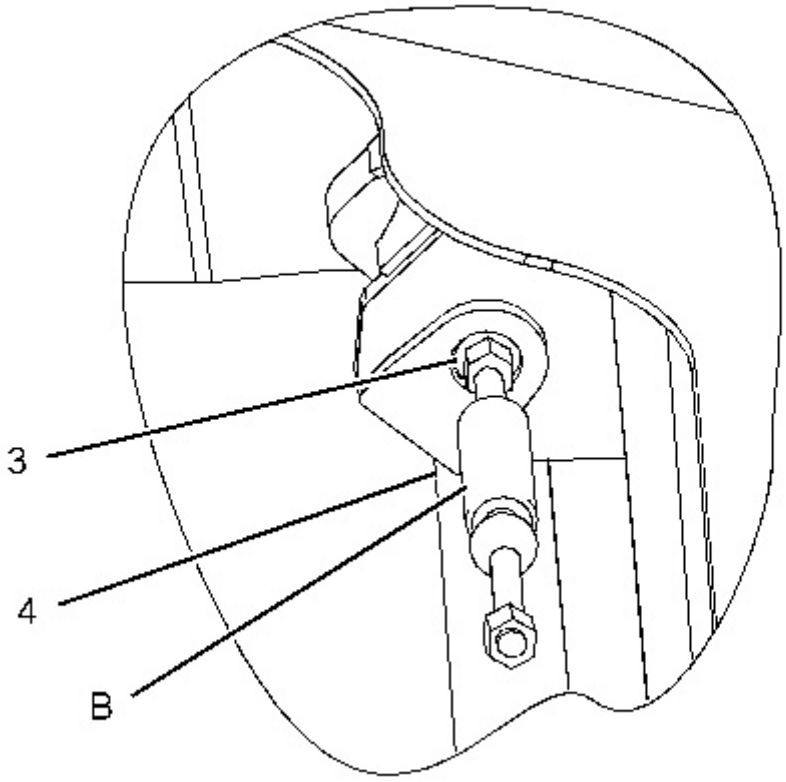


Illustration 4 g01052473

4. Use a suitable lifting device (not shown) to support tilt cylinder (4). Use Tooling (B) to remove pin (3). Remove cylinder (4) .
5. Repeat Steps 2 through 4 for the other side.

Disassembly and Assembly Information

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	127-4904	Repair Stand	1
D	195-4609	Seal Pick	1
E	5P-0960	Molybdenum Grease	1

WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

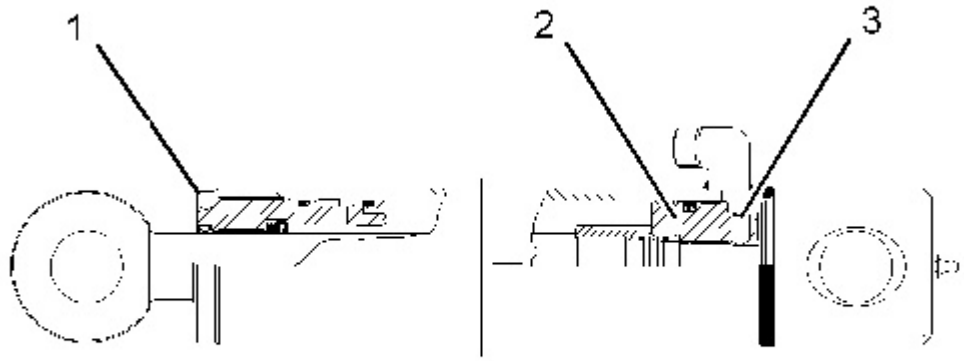


Illustration 5 g01052481

(1) Torque for the head ... 325 ± 25 N·m (240 ± 18 lb ft)

(2) Torque for the piston ... 485 ± 25 N·m (357.7166 ± 18.4390 lb ft)

(3) Torque for the setscrew ... 23 ± 2.5 N·m (17 ± 2 lb ft)

Note: Lubricate seals and sealing lips with Tooling (E) before assembly.

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i02155239

Tilt Cylinder - Install

SMCS - 5104-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3034	Repair Stand Set	2

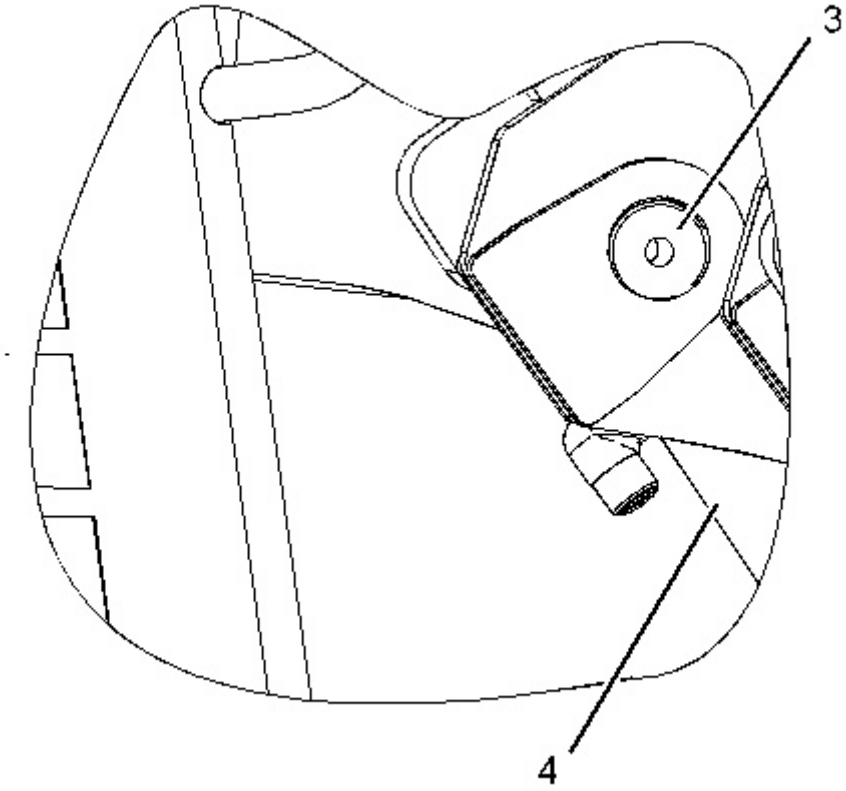


Illustration 1 g01052500

1. Use a suitable lifting device (not shown) in order to position tilt cylinder (4). Install pin (3). Install the bolt (not shown) into the back of pin (3) .

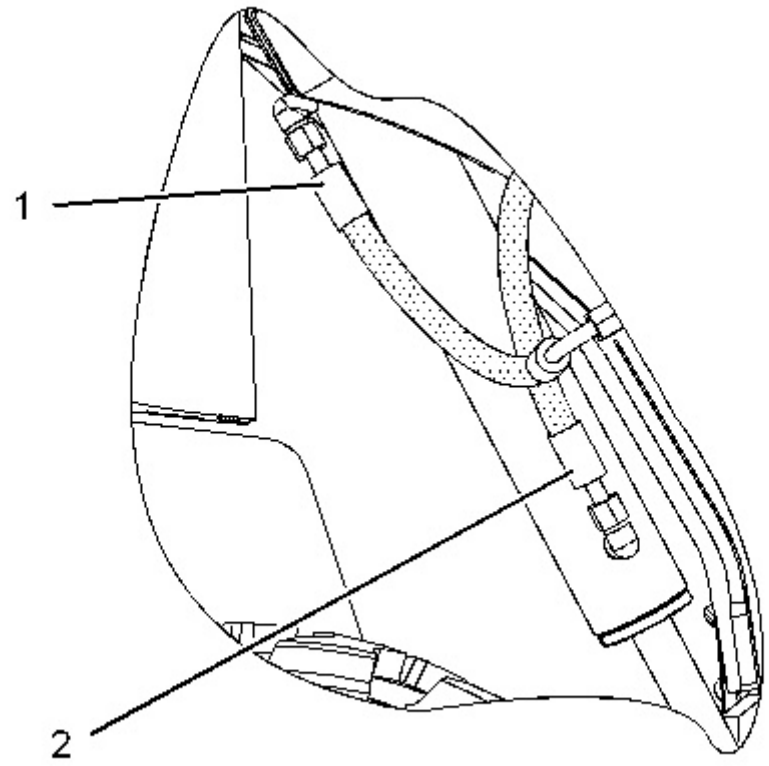


Illustration 2 g01052444

2. Connect hose assemblies (1) and (2) .

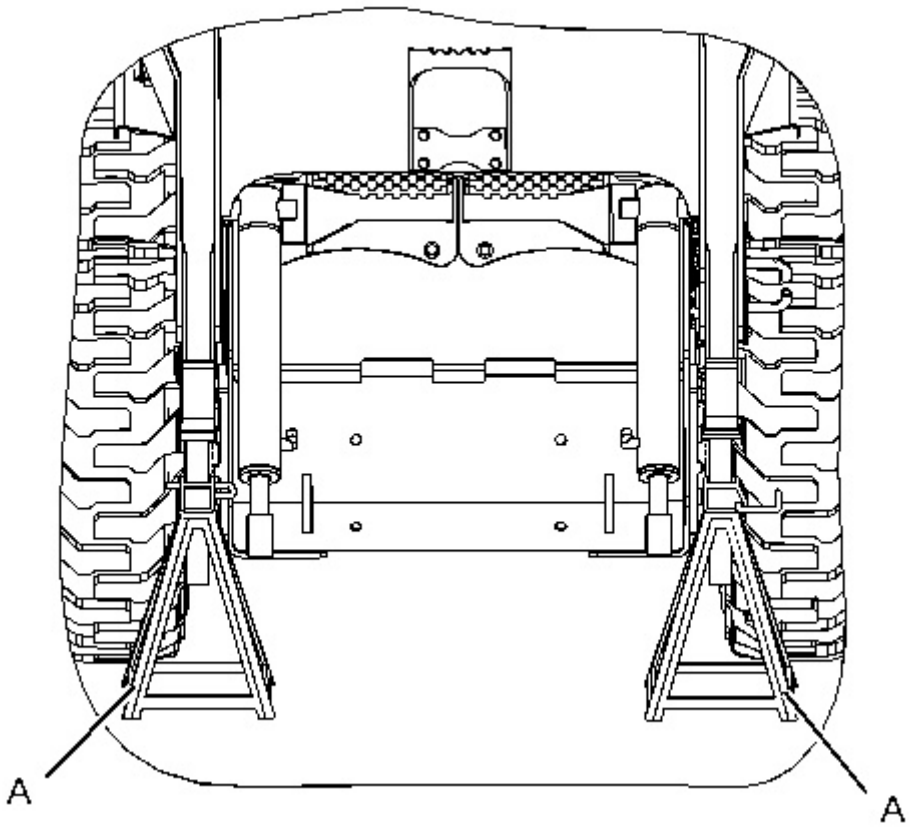


Illustration 3 g01052437

3. Remove Tooling (A) from the lift arms.

End By: Install the quick coupler. Refer to Disassembly and Assembly, "Quick Coupler - Remove and Install".

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i02161406

Lift Cylinder - Remove - Extended Reach Machines

SMCS - 5102-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1860	Retaining Ring Pliers	1
B	140-7742	Sleeve	1
ZZ	6V-6509	Face Seal Plug (13/16 - 16 THD)	3
	6V-9830	Cap As (13/16 - 16 THD)	3

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.



Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

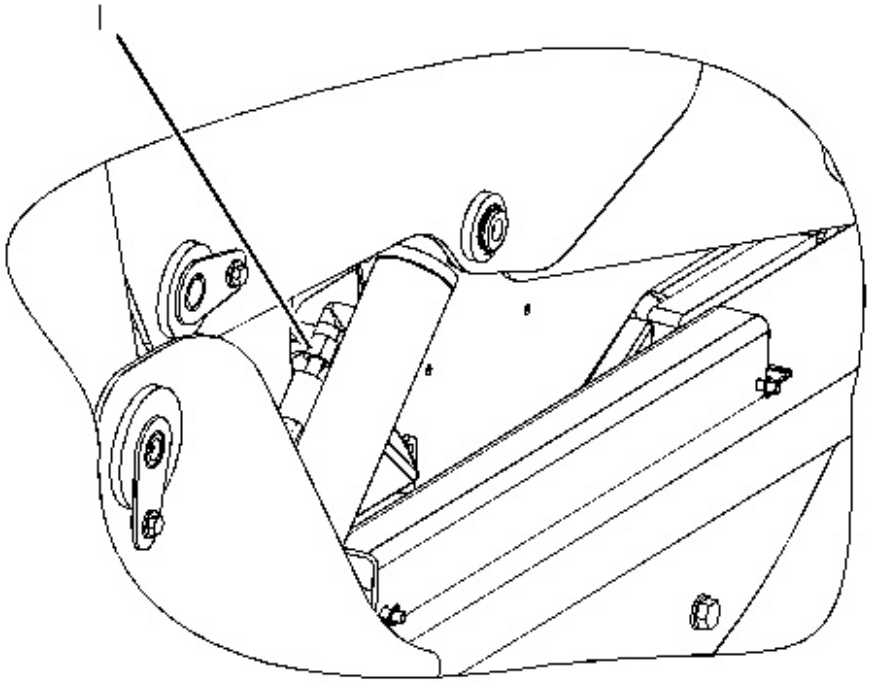


Illustration 1 g01053371

1. Disconnect hose assembly (1) .

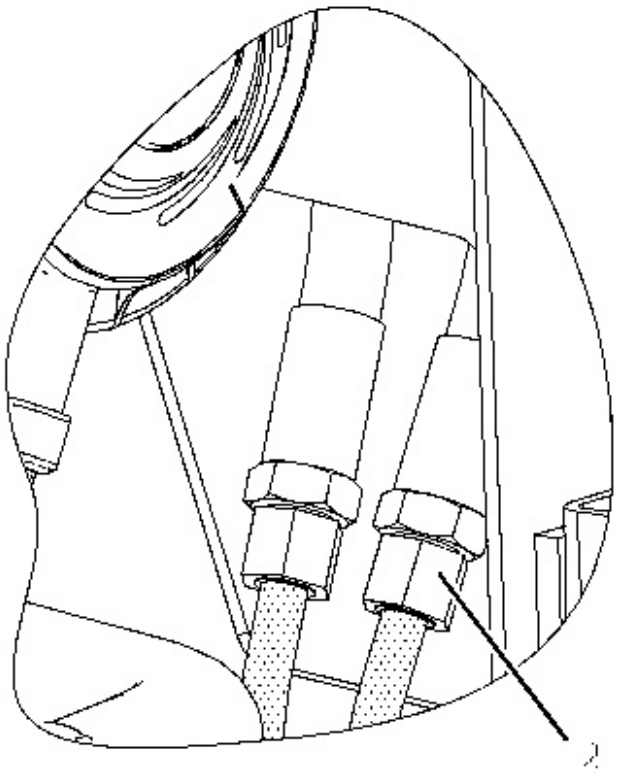


Illustration 2 g01053465

2. Disconnect hose assembly (2) .

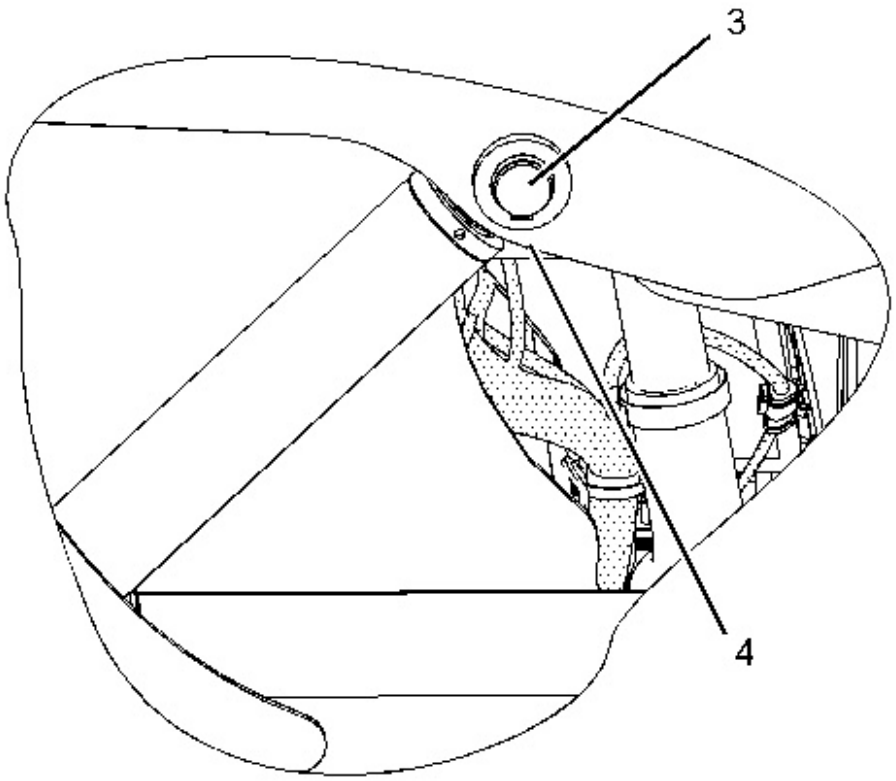


Illustration 3 g01053486

3. Use Tooling (A) (not shown) in order to remove retaining ring (4). Remove pin (3) .
4. Repeat steps 1 through 3 for the other side of the machine.

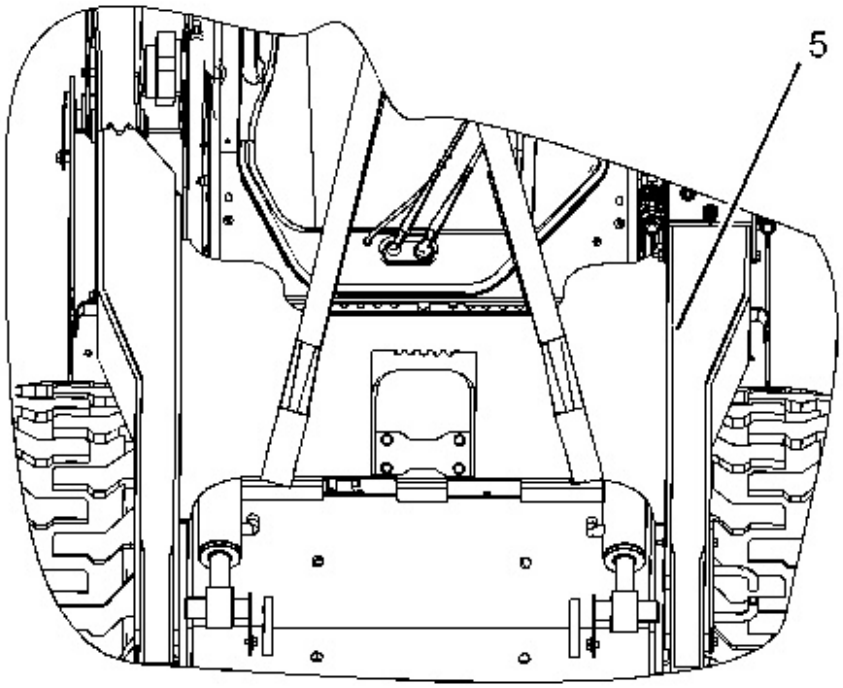


Illustration 4 g01053488

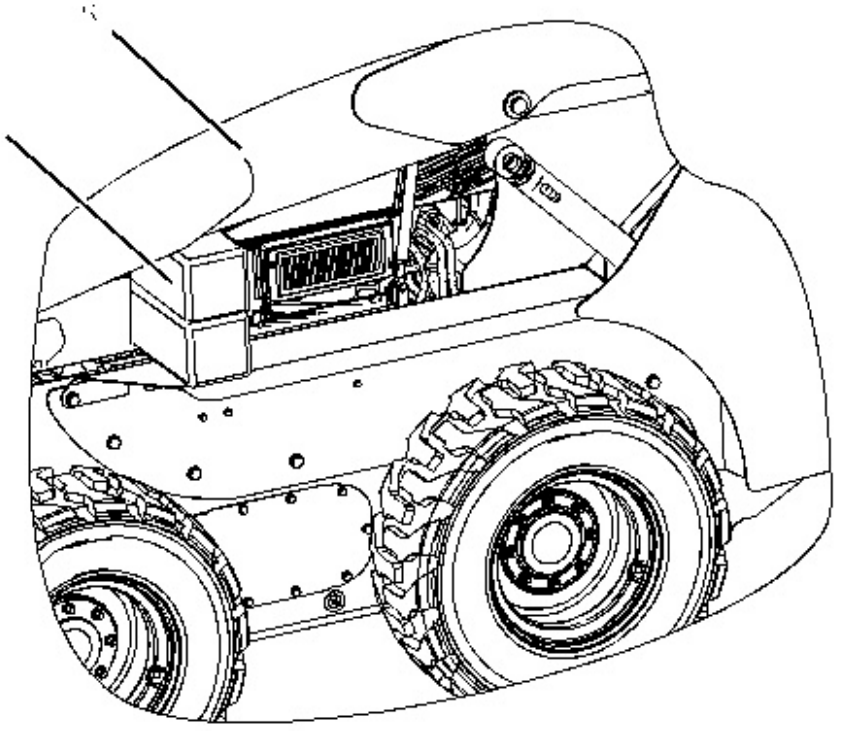


Illustration 5 g01053511

5. Attach a suitable lifting device to lift arms (5), as shown. Use the suitable lifting device with Tooling (B) to raise the lift arms by approximately 305 mm (12 inch). Lower lift arms (5) onto suitable cribbing (6), as shown.

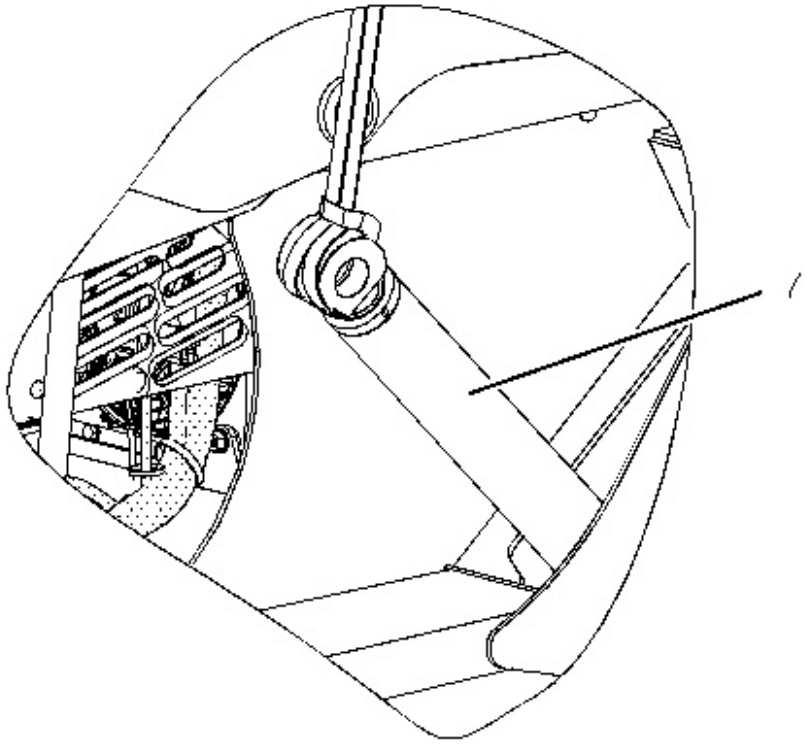


Illustration 6 g01053560

6. Attach a suitable lifting device with Tooling (B) to lift cylinder (7). The weight of the lift cylinder is approximately 33 kg (73 lb).

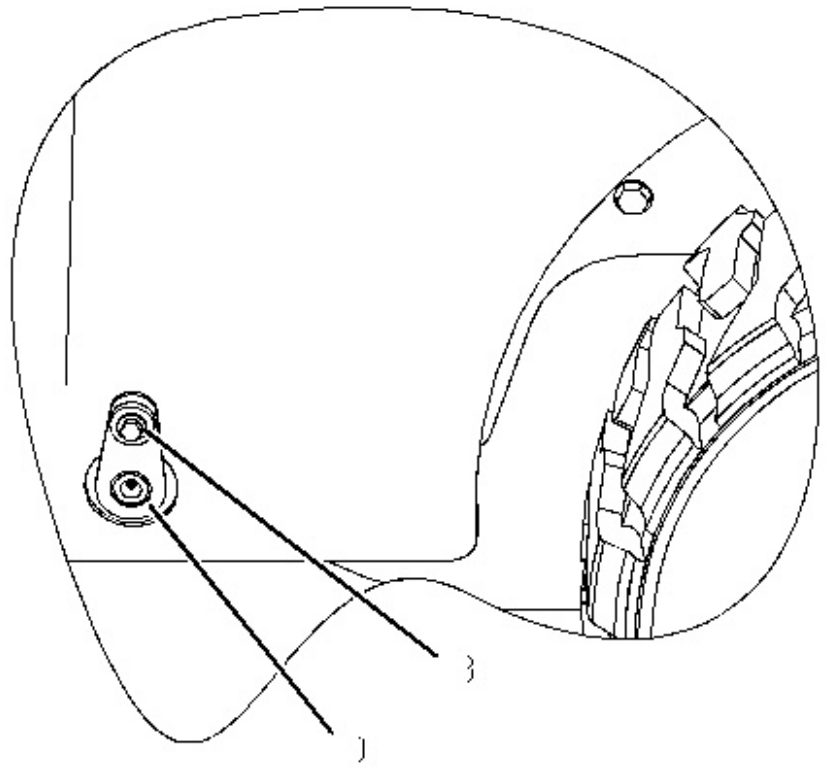


Illustration 7 g01053575

7. Remove bolt (8) and pin assembly (9). Remove the lift cylinder.

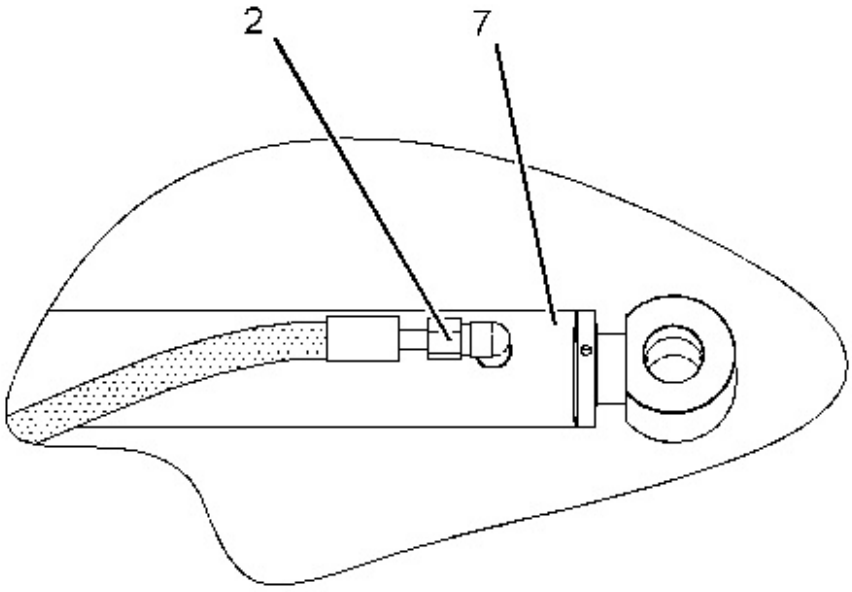


Illustration 8 g01053583

8. Remove hose assembly (2) from lift cylinder (7) .
9. Repeat steps 6 through 8 for the other lift cylinder.

Disassembly and Assembly

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	127-4904	Repair Stand	1
D	195-4609	Seal Pick	1
E	5P-0960	Molybdenum Grease	1
G	9S-3263	Thread Lock Compound	1

WARNING

Cylinders equipped with lock valves can remain pressurized for very long periods of time, even with the hoses removed.

Failure to relieve pressure before removing a lock valve or disassembling a cylinder can result in personal injury or death.

Ensure all pressure is relieved before removing a lock valve or disassembling a cylinder.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

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Dispose of all fluids according to local regulations and mandates.

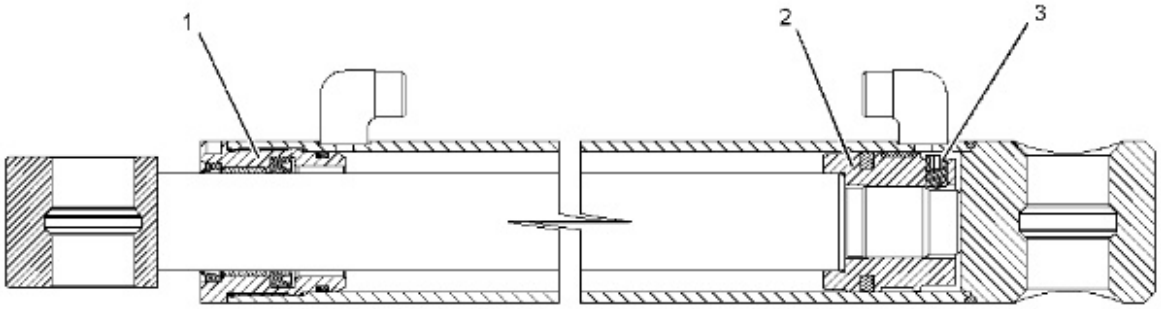


Illustration 9 g01054633

(1) Torque for the end cap ... 295 ± 25 N·m (217 ± 18 lb ft)

(2) Torque for the piston ... 485 ± 25 N·m (357 ± 18 lb ft)

(3) Torque for the setscrew ... 22.5 ± 2.5 N·m (17 ± 1 lb ft)

Note: Apply Tooling (G) to the threads when you are servicing the cylinder.

Note: Lubricate seals and sealing lips with Tooling (E) before assembly.

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02155572

Lift Cylinder - Remove - Radial Arc Machines

SMCS - 5102-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1860	Retaining Ring Pliers	1
ZZ	6V-6509	Face Seal Plug (13/16 by 16)	4
	6V-9830	Cap As (13/16 by 16)	4

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

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Dispose of all fluids according to local regulations and mandates.

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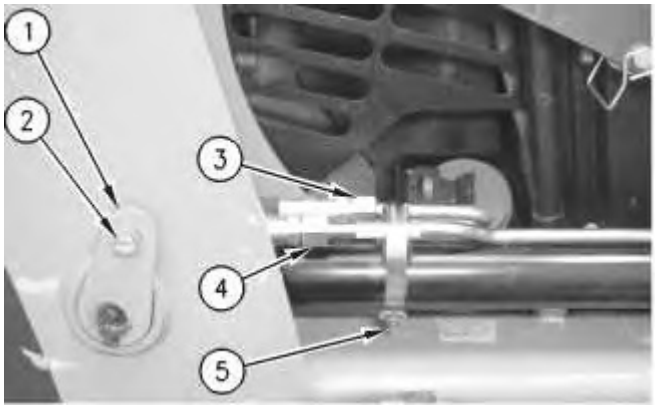


Illustration 1 g00891203

1. Loosen clamp (5). Disconnect tube assembly (3). Disconnect tube assembly (4). Remove bolt (2). Remove pin assembly (1) .

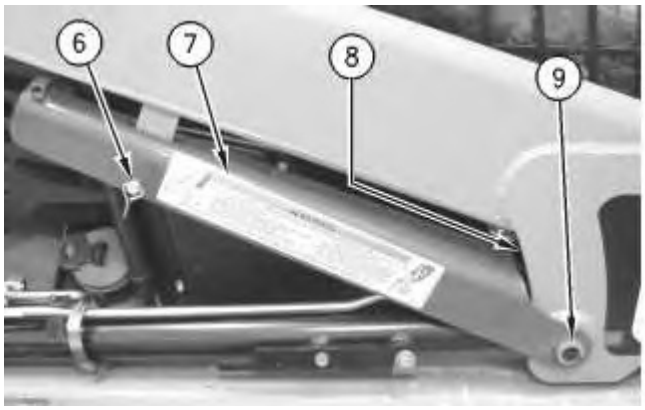


Illustration 2 g00891204

Note: The lift arm brace does not exist on the other side.

2. Remove pin (6). Lower the lift arm brace (7). Use Tooling (A) to remove retaining ring (8). Remove pin (9). Remove the lift arm brace (7) .

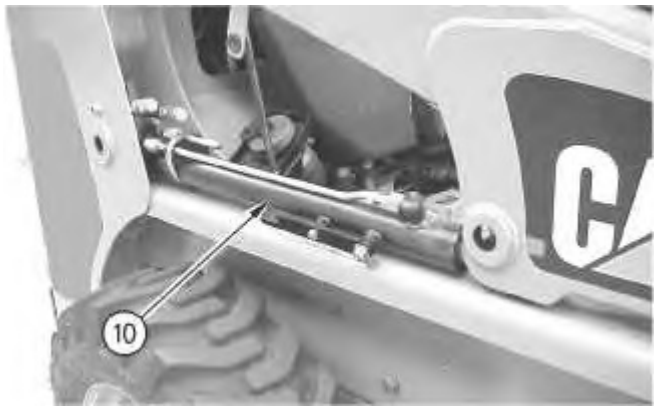


Illustration 3 g00888089

3. Remove cylinder assembly (10) .
4. Repeat Steps 1 through 3 for the other side.

Disassembly and Assembly

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
B	5P-0960	Molybdenum Grease	1
C	195-4609	Seal Pick	1

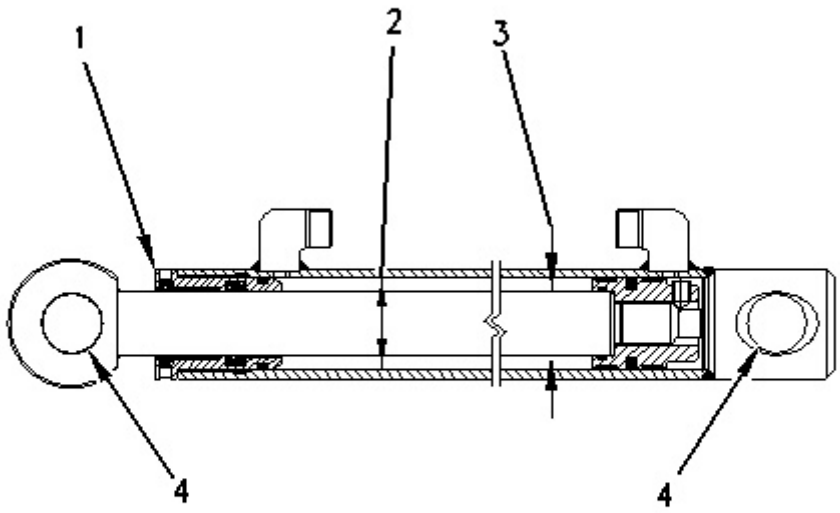


Illustration 4 g00657563

Use Tooling (B) to lubricate all bores.

(1) Torque for head ... 235 ± 15 N·m (173 ± 11 lb ft)

(2) Diameter of new cylinder ... 50 ± .15 mm (1.970± 0.010 inch)

(3) Diameter of new rod ... 35.00 ± .15 mm (1.380 ± 0.010 inch)

(4) Diameter of pin bore ... 31.92 ± .05 mm (1.257 ± 0.002 inch)

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i02161415

Lift Cylinder - Install - Extended Reach Machines

SMCS - 5102-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-1860	Retaining Ring Pliers	1
B	140-7742	Sleeve	1

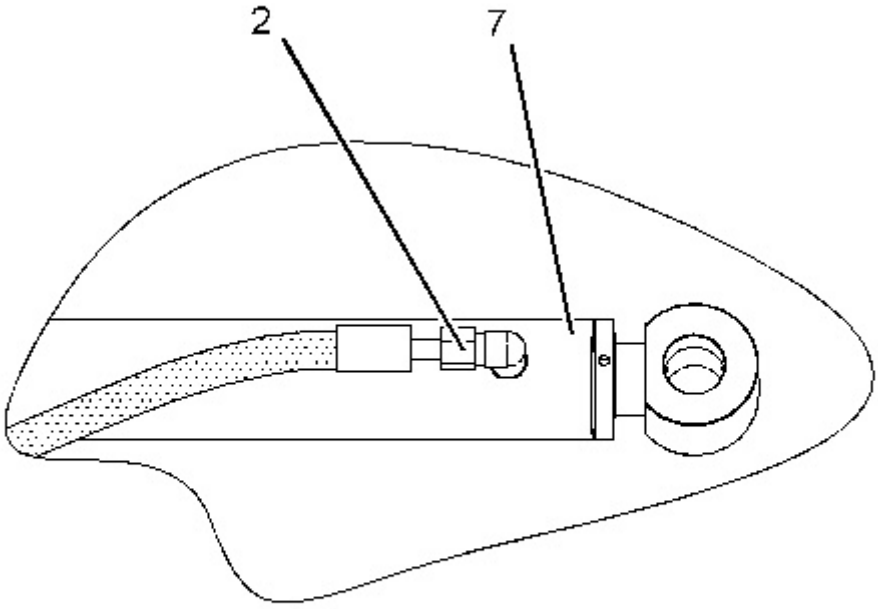


Illustration 1 g01053583

1. Install hose assembly (2) onto lift cylinder (7) .

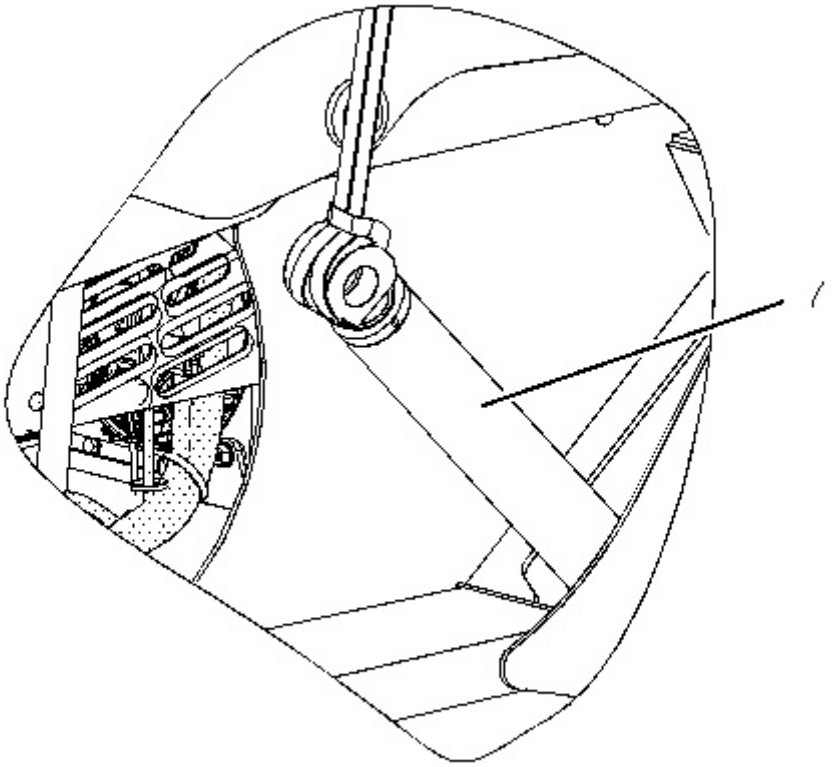


Illustration 2 g01053560

2. Attach a suitable lifting device with Tooling (B) to lift cylinder (7). The weight of the lift cylinder is approximately 33 kg (73 lb). install the lift cylinder.

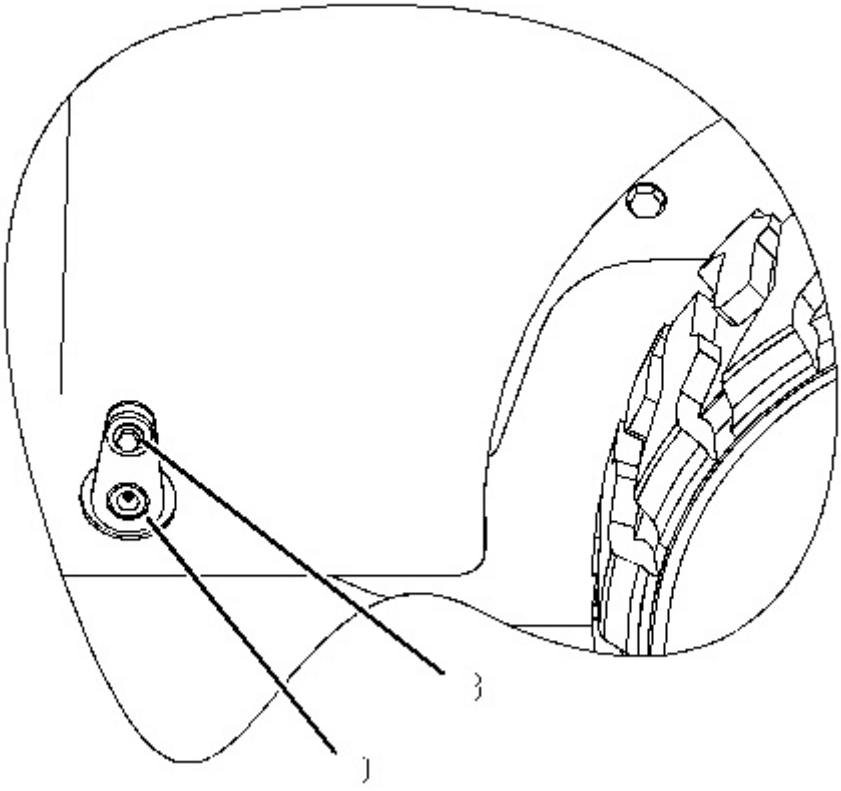


Illustration 3 g01053575

3. Install pin assembly (9). Install bolt (8) .
4. Repeat steps 1 through 3 for the other lift cylinder.

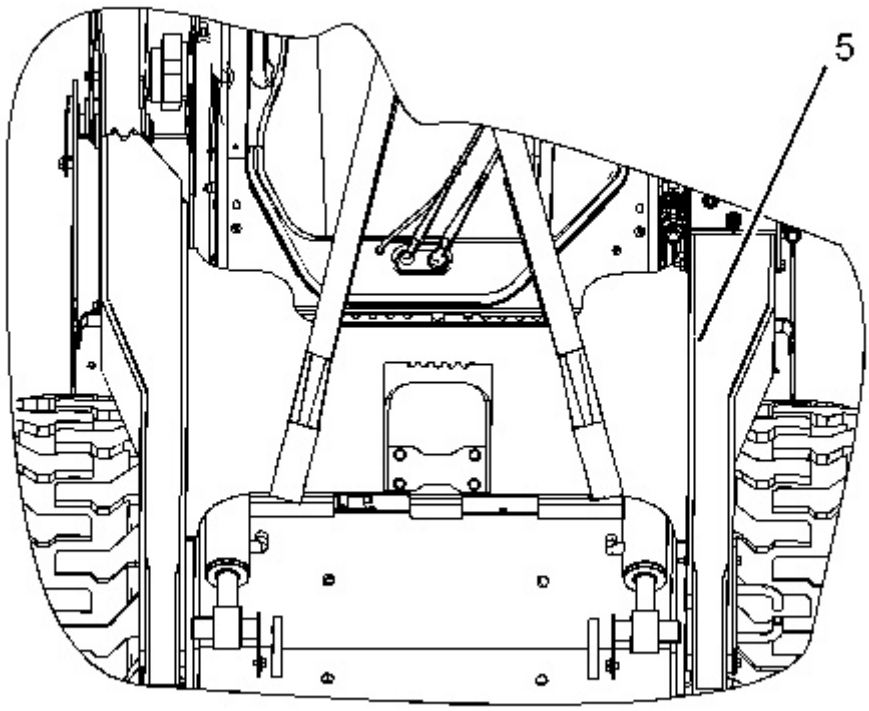


Illustration 4 g01053488

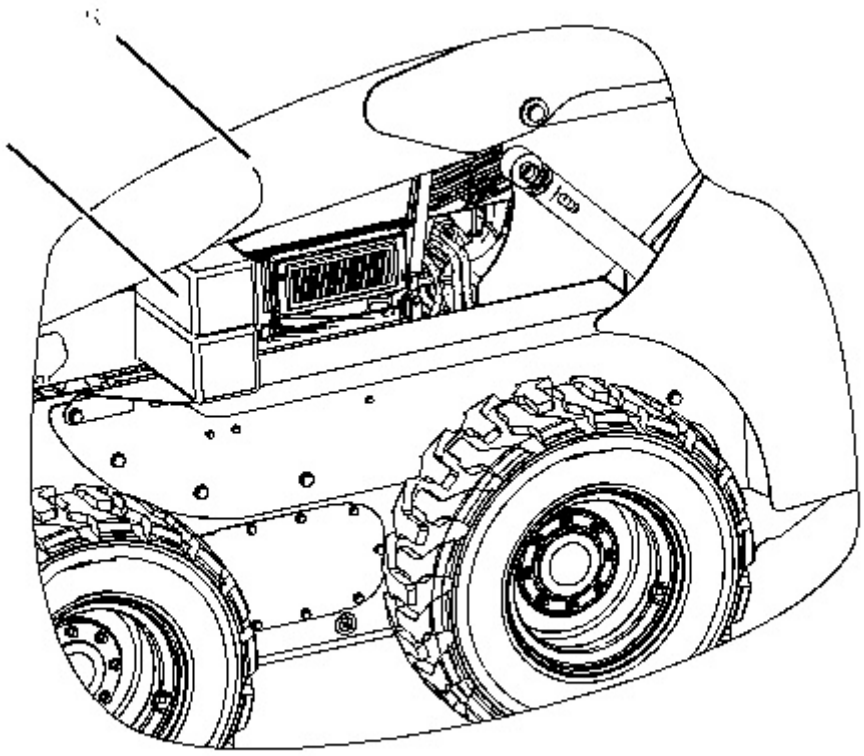


Illustration 5 g01053511

5. Attach a suitable lifting device to lift arms (5), as shown. Use the suitable lifting device with Tooling (B) to raise the lift arms by approximately 305 mm (12 inch). Remove cribbing (6) and lower lift arms (5) .

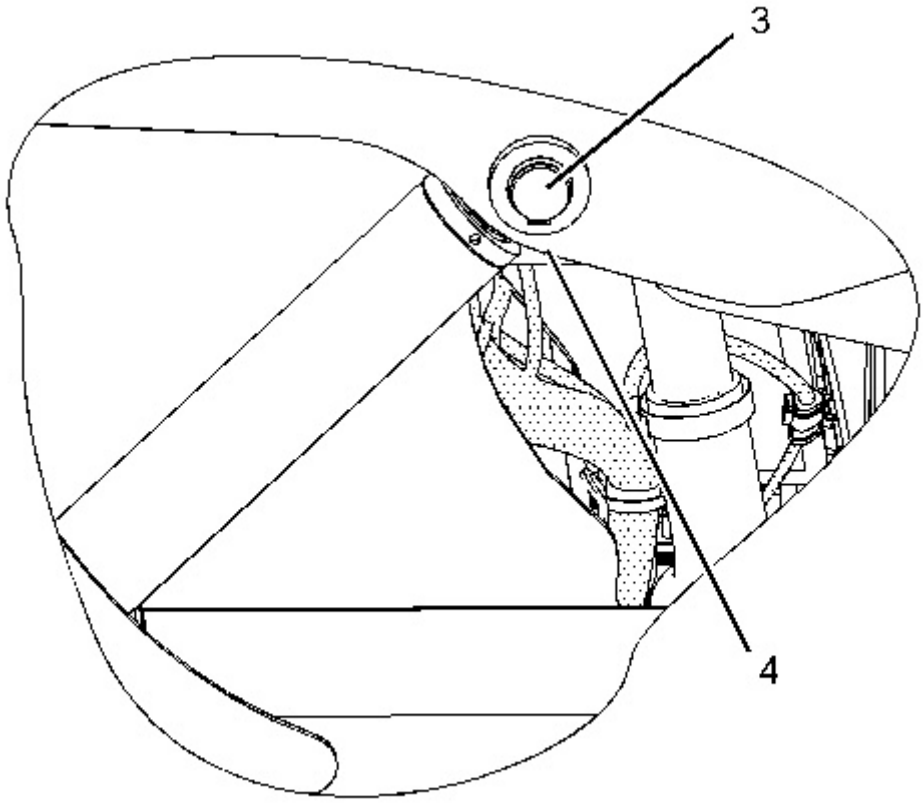


Illustration 6 g01053486

6. Install pin (3). Use Tooling (A) in order to install retaining ring (4) (not shown).

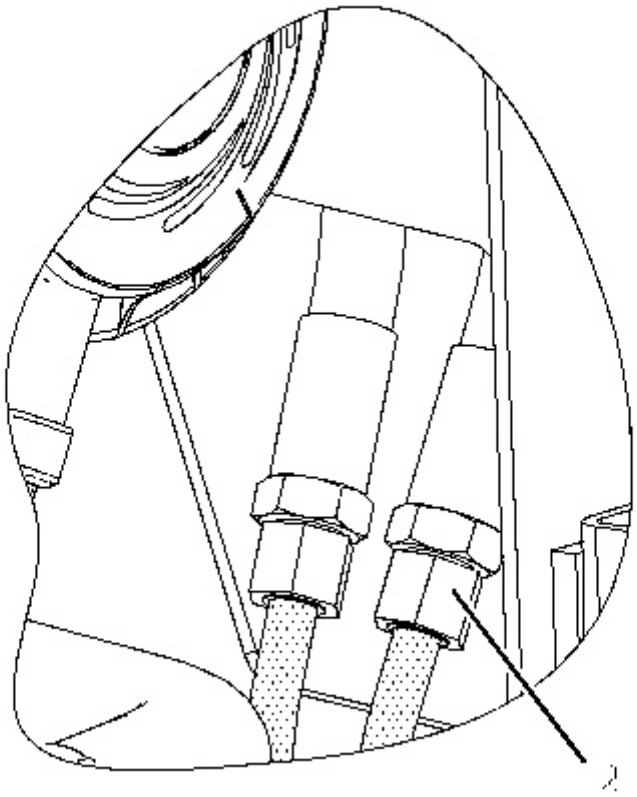


Illustration 7 g01053465

7. Connect hose assembly (2) .

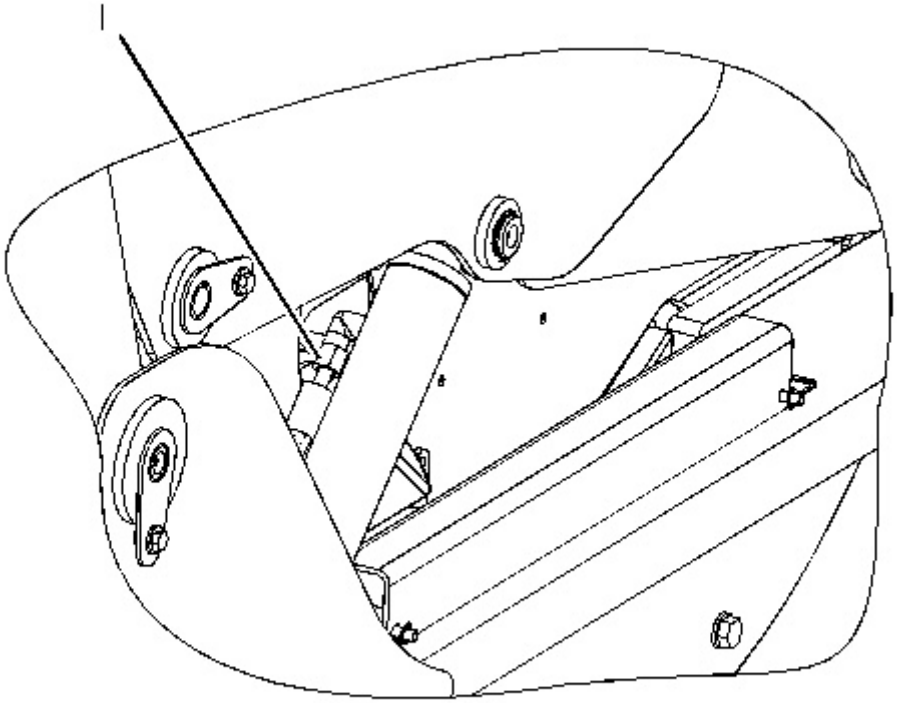


Illustration 8 g01053371

8. Connect hose assembly (1) .

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i02155646

Lift Cylinder - Install - Radial Arc Machines

SMCS - 5102-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

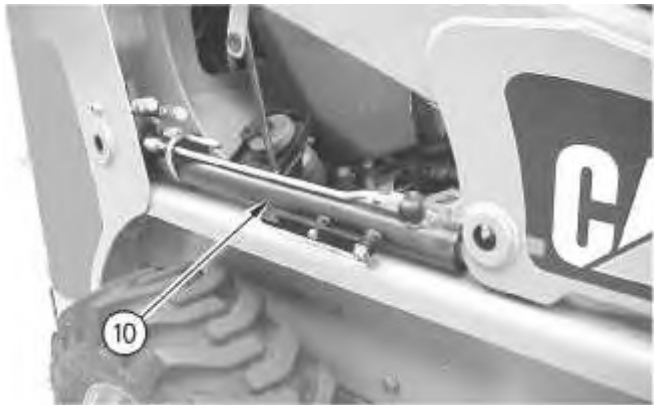


Illustration 1 g00888089

1. Install cylinder assembly (10) .

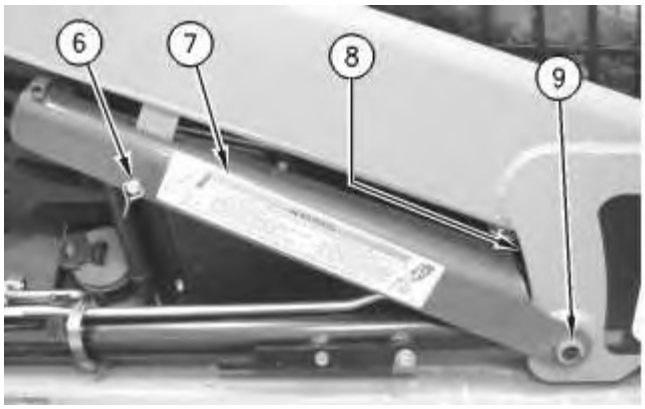


Illustration 2 g00891204

Note: The lift arm brace does not exist on the other side.

2. Install the lift arm brace (7). Install pin (9). Use Tooling (A) to install retaining ring (8). Raise the lift arm brace (7). Install pin (6) .

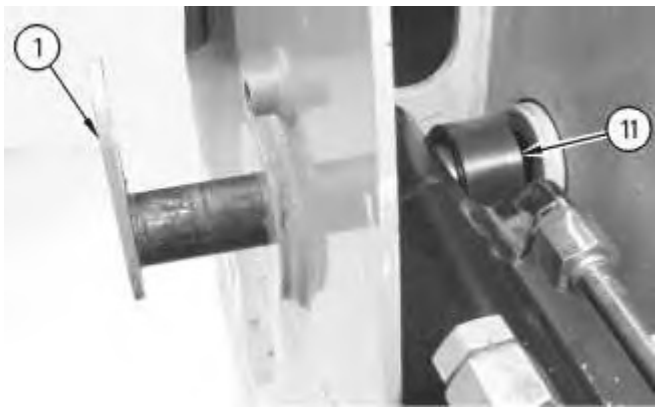


Illustration 3 g00891294

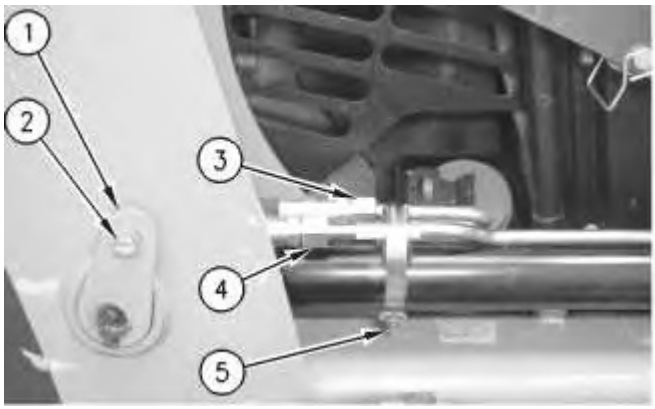


Illustration 4 g00891203

3. Place spacer (11) to the inside of the machine. Install pin assembly (1) .
4. Install bolt (2). Connect tube assembly (4). Connect tube assembly (3). Tighten clamp (5) .
5. Repeat Steps 1 through Step 4 for the other side.
6. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, SEBU7494, "Hydraulic System Oil Level - Check".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02853434

Return Manifold

SMCS - 3154-M9; 5264

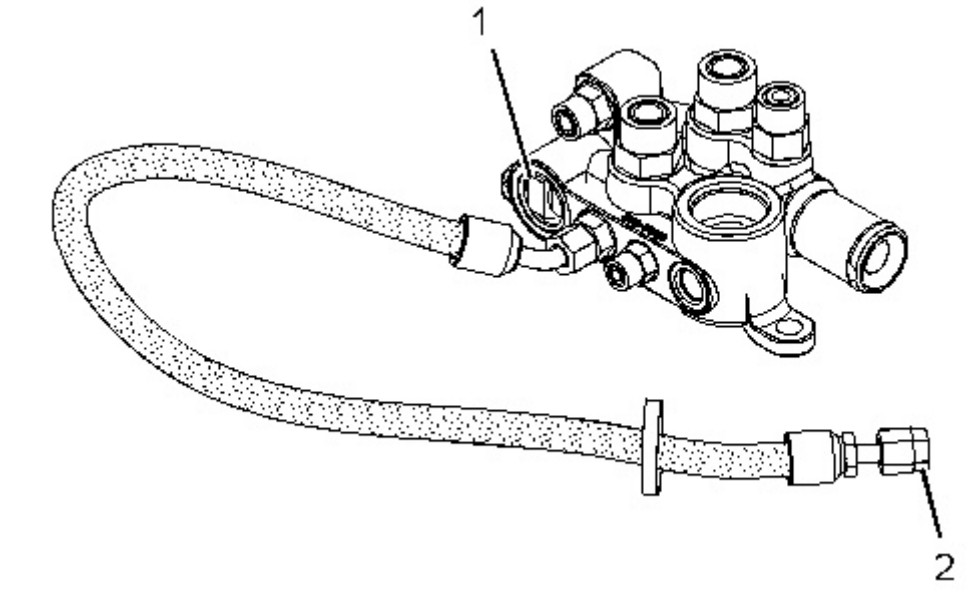


Illustration 1 g01421143

(1) **212-6604** Spring

Length under test force ... 17.85 mm (0.703 inch)
Test force ... 52 N (12 lb)
Free length after test ... 22.35 mm (0.880 inch)
Outside diameter ... 21.59 mm (0.850 inch)

(2) Torque for the plug assembly ... 22 ± 3 N·m (16 ± 2 lb ft)

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Return Manifold

SMCS - 3154-M9; 5264

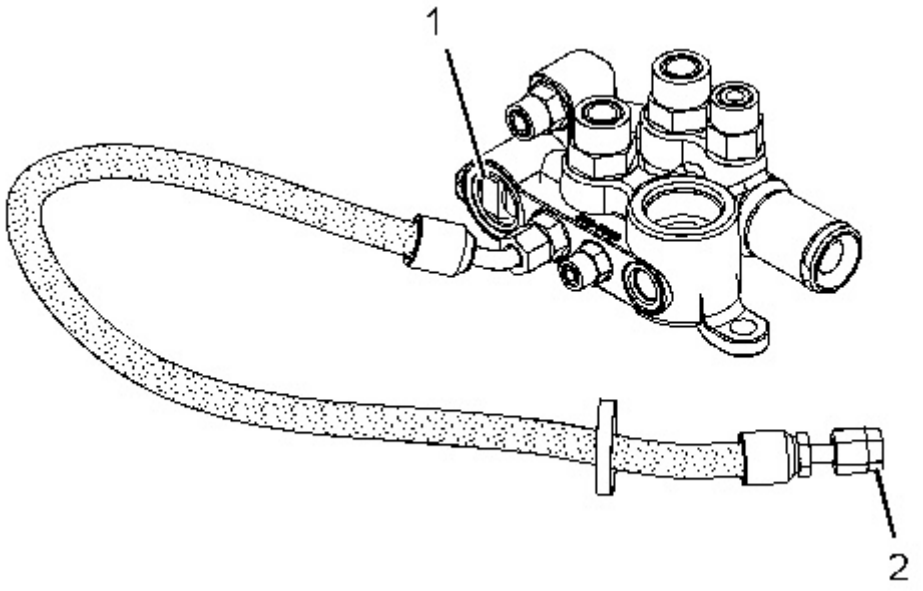


Illustration 1 g01421143

(1) **212-6604** Spring

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Test force ... 52 N (12 lb)
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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856143

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

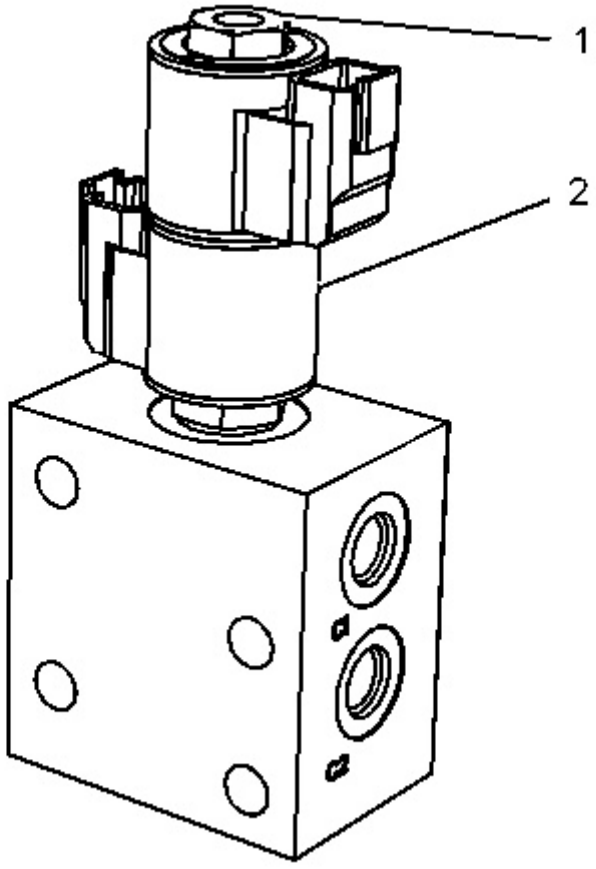


Illustration 1 g01422597

(2) **249-7160** Solenoid Valve Gp

Torque for the nut (1) ... 5.8 ± 1.0 N·m (50 ± 9 lb in)
Final installation torque ... 30 ± 3 N·m (265 ± 27 lb in)
Operating temperature range ... −40 to 105 °C (−40 to 221 °F)

Nominal voltage for operation ... 12 VDC
Maximum voltage for operation at 121 °C (250 °F) ... 14.5 VDC
Minimum current for valve actuation ... 0.92 Amperes
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 10.3 ± 0.6 Ohms
Minimum voltage for valve actuation with the coil at 40 °C (104 °F) ... 10.8 VDC
Maximum wattage for continuous duty ... 14 Watts

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856147

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

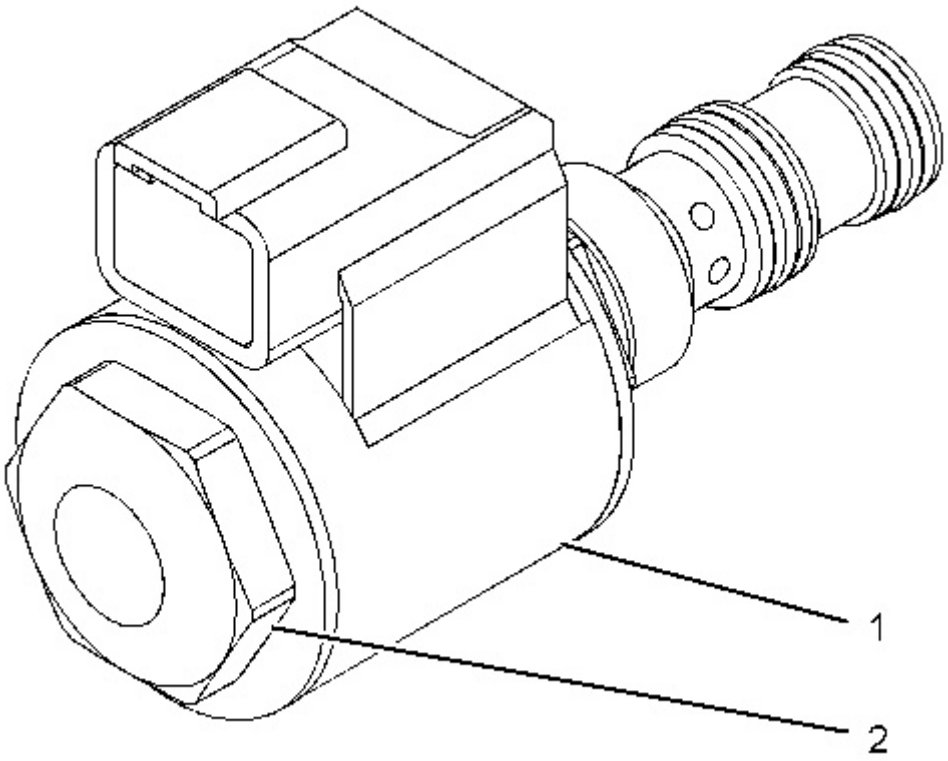


Illustration 1 g01422599

(1) **259-8194** Solenoid Valve Gp

Torque for the nut (2) ... 5.3 ± 1.5 N·m (45 ± 13 lb in)
Installation torque ... 24 ± 3 N·m (210 ± 27 lb in)
Operating voltage ... 12 VDC

Maximum voltage for valve actuation at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for valve actuation with the coil at 25 °C (77 °F) ... 10.2 VDC
Maximum wattage for continuous duty with the coil at a temperature of 25 °C (77 °F) ... 16.3 Watts
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 8.8 ± 0.5 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)

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Control Manifold (Quick Coupler)

SMCS - 5264; 5479

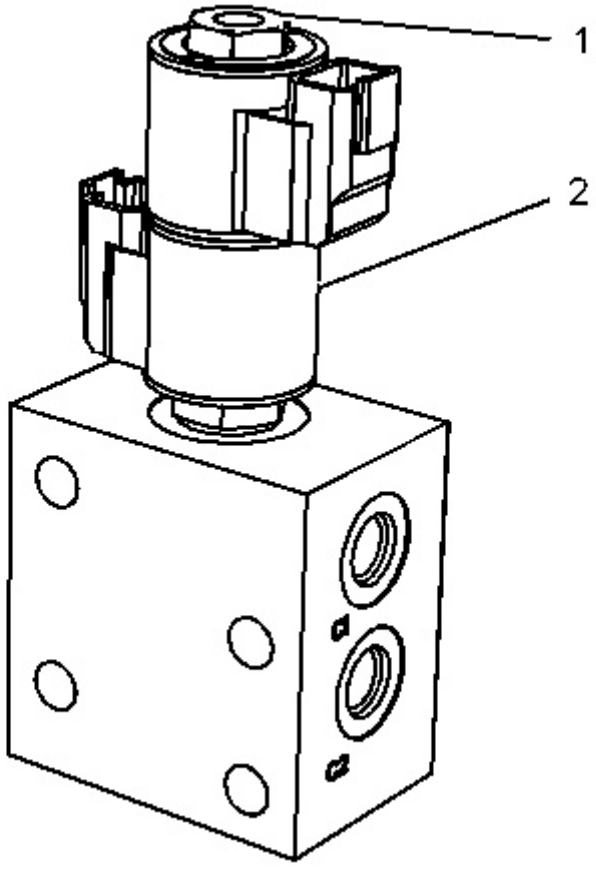


Illustration 1 g01422597

(2) **249-7160** Solenoid Valve Gp

Torque for the nut (1) ... 5.8 ± 1.0 N·m (50 ± 9 lb in)
Final installation torque ... 30 ± 3 N·m (265 ± 27 lb in)
Operating temperature range ... −40 to 105 °C (−40 to 221 °F)

Nominal voltage for operation ... 12 VDC
Maximum voltage for operation at 121 °C (250 °F) ... 14.5 VDC
Minimum current for valve actuation ... 0.92 Amperes
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 10.3 ± 0.6 Ohms
Minimum voltage for valve actuation with the coil at 40 °C (104 °F) ... 10.8 VDC
Maximum wattage for continuous duty ... 14 Watts

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856147

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

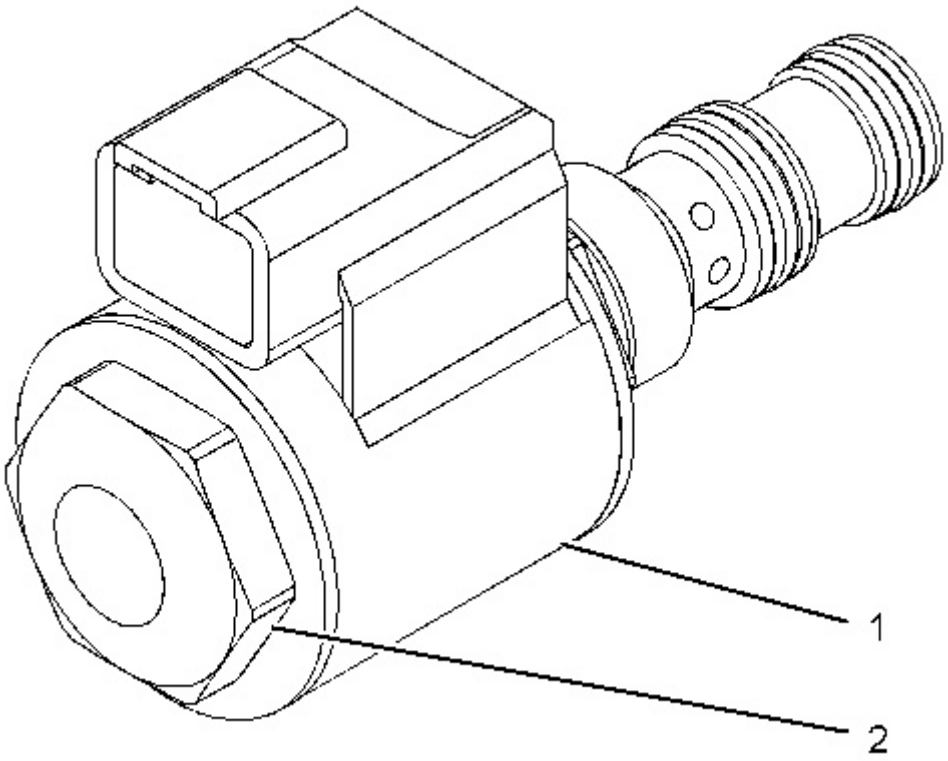


Illustration 1 g01422599

(1) **259-8194** Solenoid Valve Gp

Torque for the nut (2) ... 5.3 ± 1.5 N·m (45 ± 13 lb in)
Installation torque ... 24 ± 3 N·m (210 ± 27 lb in)
Operating voltage ... 12 VDC

Maximum voltage for valve actuation at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for valve actuation with the coil at 25 °C (77 °F) ... 10.2 VDC
Maximum wattage for continuous duty with the coil at a temperature of 25 °C (77 °F) ... 16.3 Watts
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 8.8 ± 0.5 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

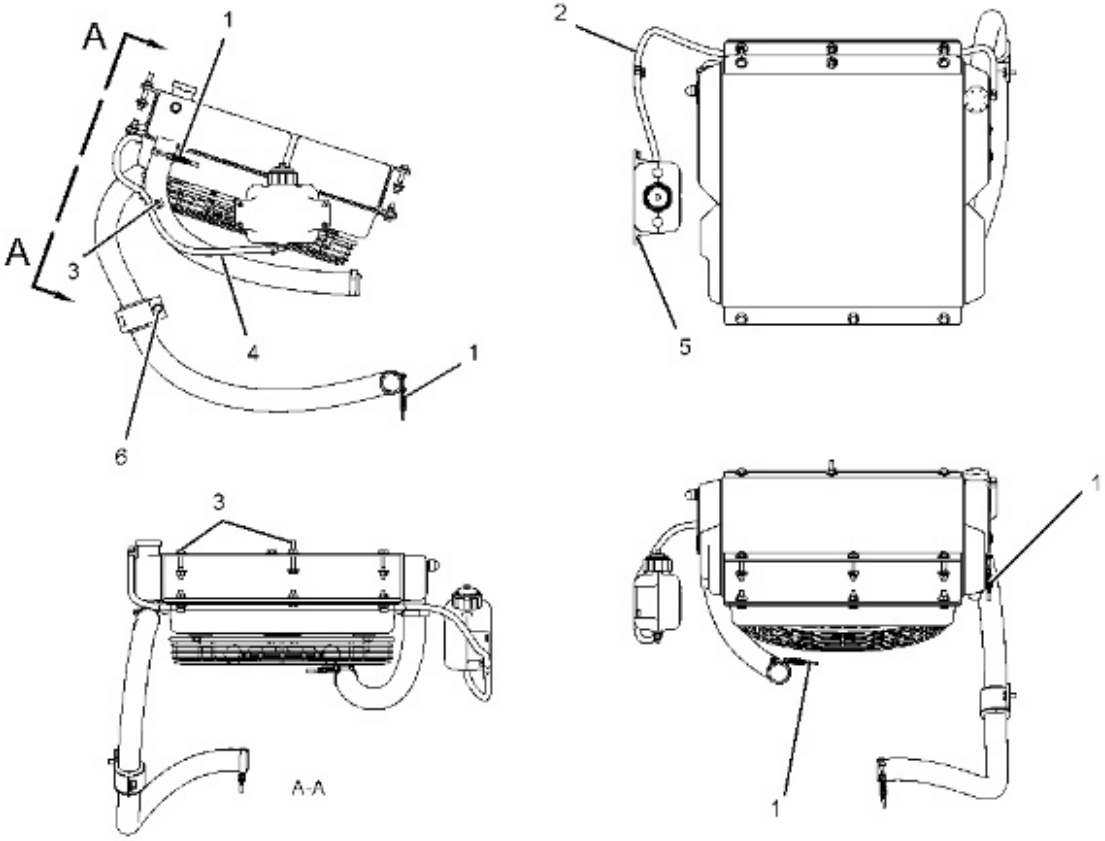


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

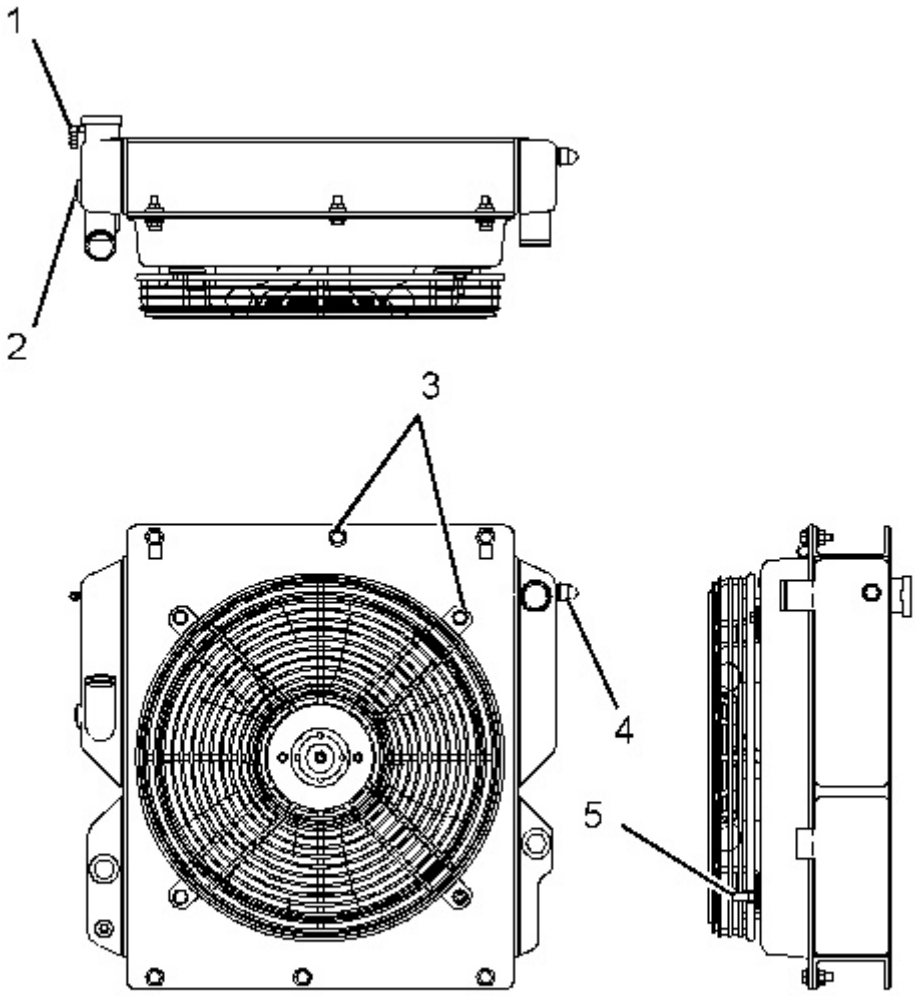


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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i02854767

Gear Motor (Fan)

SMCS - 1386-GT

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

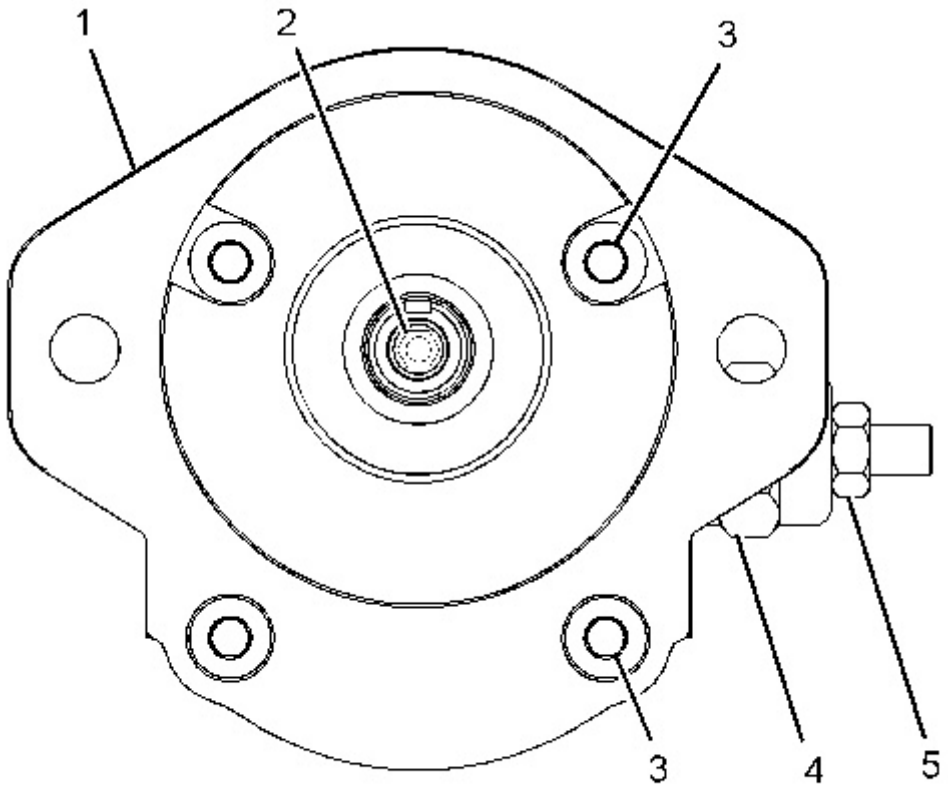


Illustration 1 g01421849

(1) **289-6384** Gear Motor Gp

Rotation ... Clockwise
Displacement per revolution ... 13.34 cc (0.814 in^3)
Maximum continuous pressure ... 15000 kPa (2176 psi)
Intermittent pressure ... 18000 kPa (2611 psi)
Peak pressure ... 20000 kPa (2901 psi)
Minimum rotation at a pressure of 15000 kPa (2176 psi) ... 500 rpm
Maximum rotation at a pressure of 15000 kPa (2176 psi) ... 3500 rpm
Minimum operating temperature ... -40 °C (-40 °F)
Maximum temperature for continuous operation ... 93 °C (199.4 °F)
Maximum temperature for intermittent operation ... 105 °C (224.6 °F)
Setting for the relief valve at a flow rate of 35 L/min (9.2 US gpm) and a temperature of 50 °C (122 °F) ... 21000 kPa (3050 psi)

(2) Torque for the bolt ... 30 ± 7 N·m (22 ± 5 lb ft)

(3) Torque for the four bolts ... 45 ± 3 N·m (33 ± 2 lb ft)

(4) Torque for the nut ... 7 N·m (60 lb in)

(5) Torque for the relief valve group ... 30 N·m (22 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854062

Radiator and Hydraulic Oil Cooler

SMCS - 1351; 1356; 1386

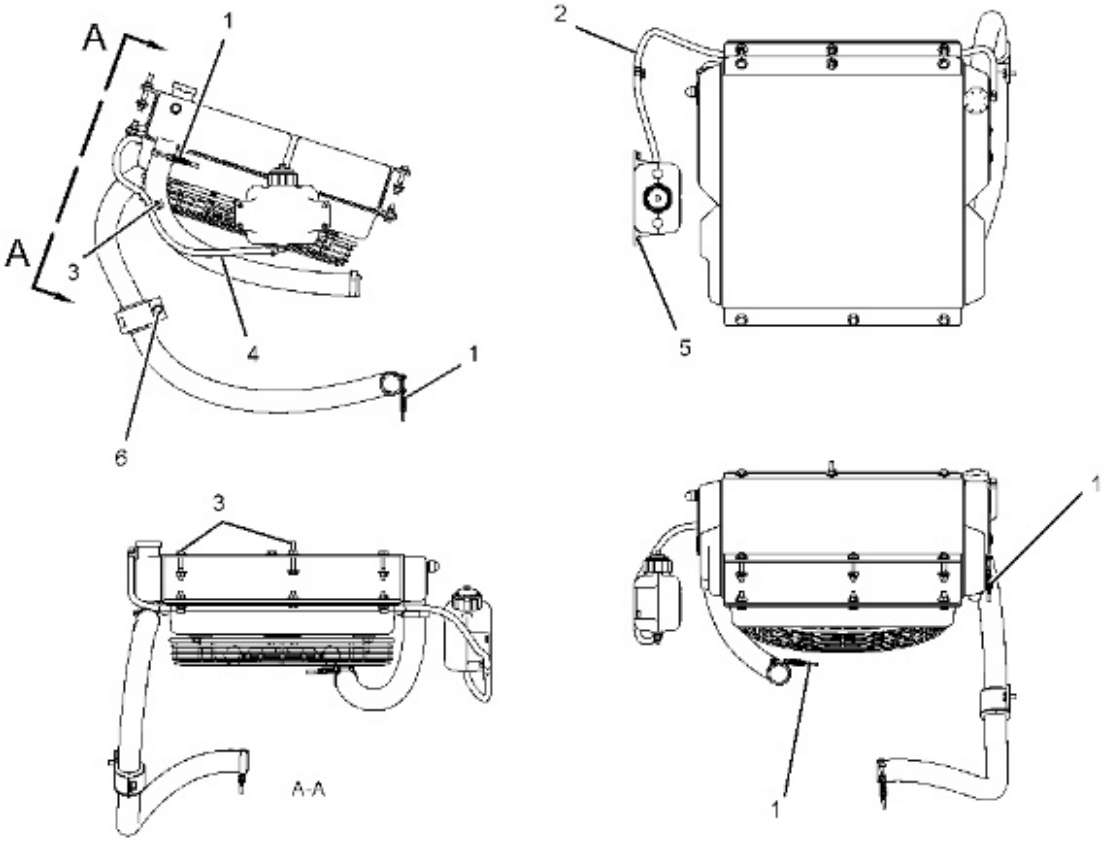


Illustration 1 g01421482

Typical example

Note: Orient the four clamps (1) according to Illustration 1.

(1) Torque for the four clamps ... 7.5 ± 1.0 N·m (65 ± 9 lb in)

(2) Ensure sufficient hose length in order to accommodate the cooler pivot. As required, adjust the hose.

(3) Torque for the seven bolts ... 30 ± 7 N·m (265 ± 60 lb in)

(4) Pull any excess slack from this section of the hose.

(5) Torque for the two locknuts ... 15 ± 3 N·m (135 ± 27 lb in)

(6) Torque for the locking bolt ... 33 N·m (290 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854068

Radiator and Hydraulic Oil Cooler (Fan)

SMCS - 1351; 1356; 1386

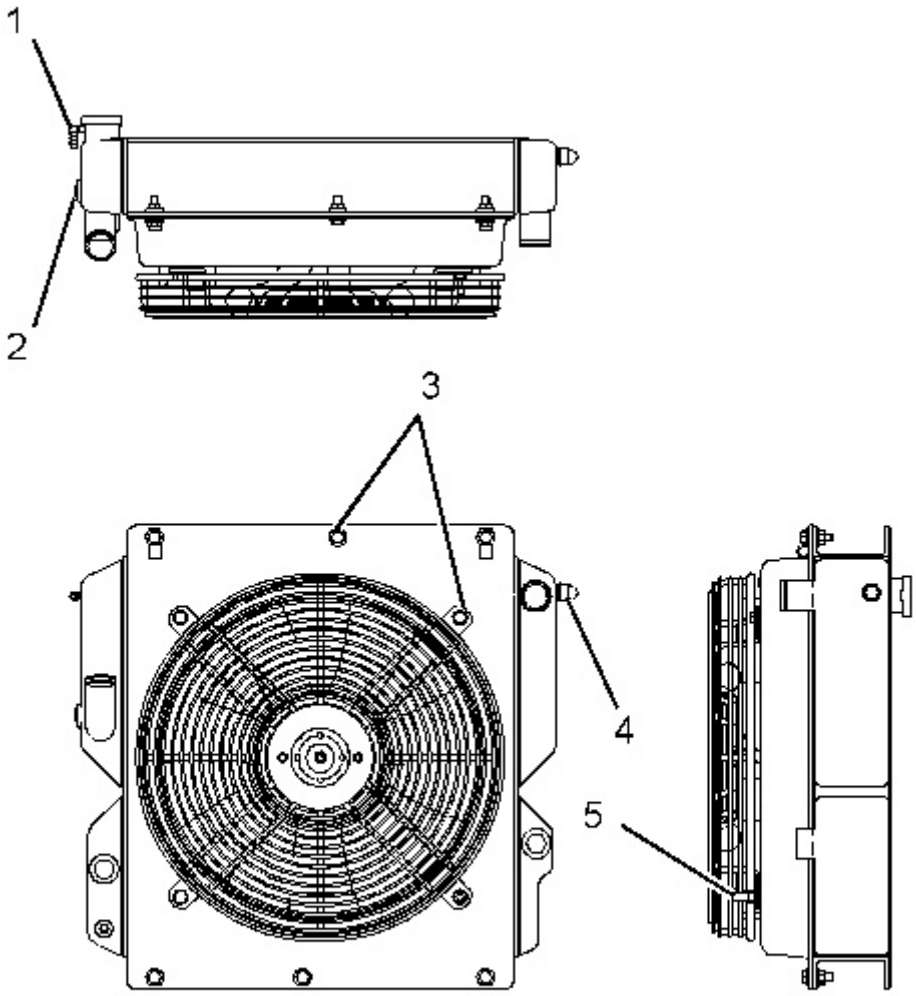


Illustration 1 g01421492

(1) Apply **5P-3413** Pipe Sealant to the threads of the fitting.

(2) Apply **5P-3413** Pipe Sealant to the threads of the pipe plug.

(3) Torque for the nine bolts ... 30 ± 7 N·m (22 ± 5 lb ft)

(4) Torque for the sight gauge ... 15 ± 2 N·m (11 ± 1 lb ft)

(5) Torque for the stud ... 30 ± 7 N·m (22 ± 5 lb ft)

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i02854767

Gear Motor (Fan)

SMCS - 1386-GT

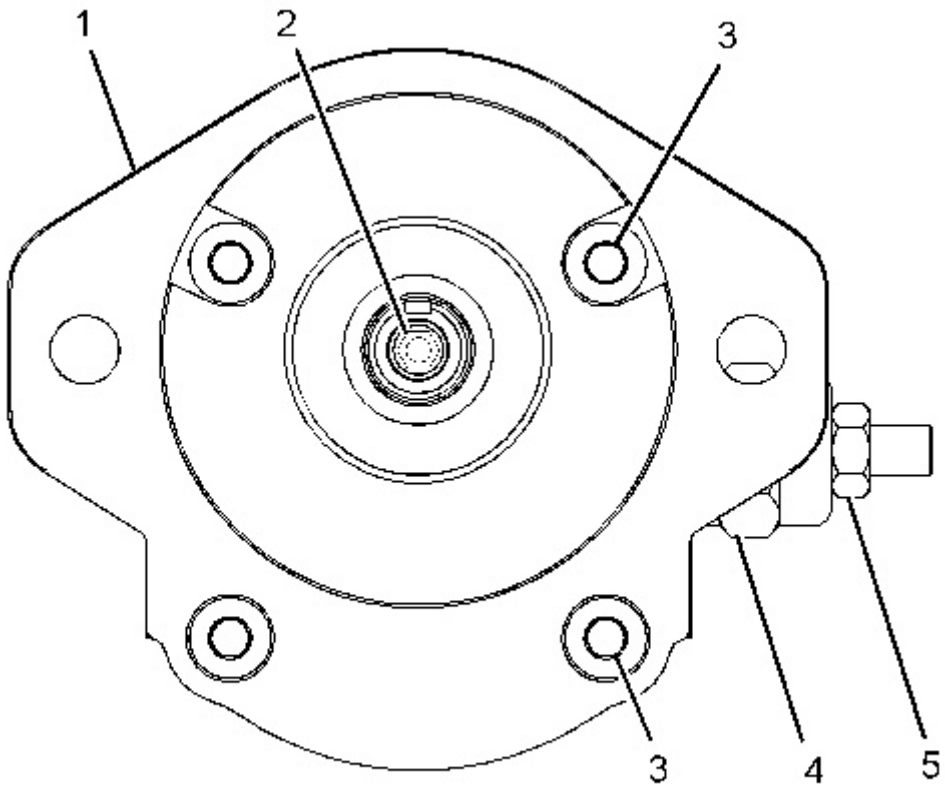


Illustration 1 g01421849

(1) **289-6384** Gear Motor Gp

Rotation ... Clockwise
Displacement per revolution ... 13.34 cc (0.814 in^3)
Maximum continuous pressure ... 15000 kPa (2176 psi)

Intermittent pressure ... 18000 kPa (2611 psi)
Peak pressure ... 20000 kPa (2901 psi)
Minimum rotation at a pressure of 15000 kPa (2176 psi) ... 500 rpm
Maximum rotation at a pressure of 15000 kPa (2176 psi) ... 3500 rpm
Minimum operating temperature ... -40 °C (-40 °F)
Maximum temperature for continuous operation ... 93 °C (199.4 °F)
Maximum temperature for intermittent operation ... 105 °C (224.6 °F)
Setting for the relief valve at a flow rate of 35 L/min (9.2 US gpm) and a temperature of 50 °C (122 °F) ... 21000 kPa (3050 psi)

(2) Torque for the bolt ... 30 ± 7 N·m (22 ± 5 lb ft)

(3) Torque for the four bolts ... 45 ± 3 N·m (33 ± 2 lb ft)

(4) Torque for the nut ... 7 N·m (60 lb in)

(5) Torque for the relief valve group ... 30 N·m (22 lb ft)

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Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02154575

Gear Motor (Fan) - Remove

SMCS - 1386-011-GT

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
ZZ	6V-9829	Cap As	1
	6V-9508	Face Seal Plug	1
	6V-9831	Cap As	2
	6V-9510	Face Seal Plug	2

Start By:

A. Release the pressure in the hydraulic oil system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Tilt the radiator.

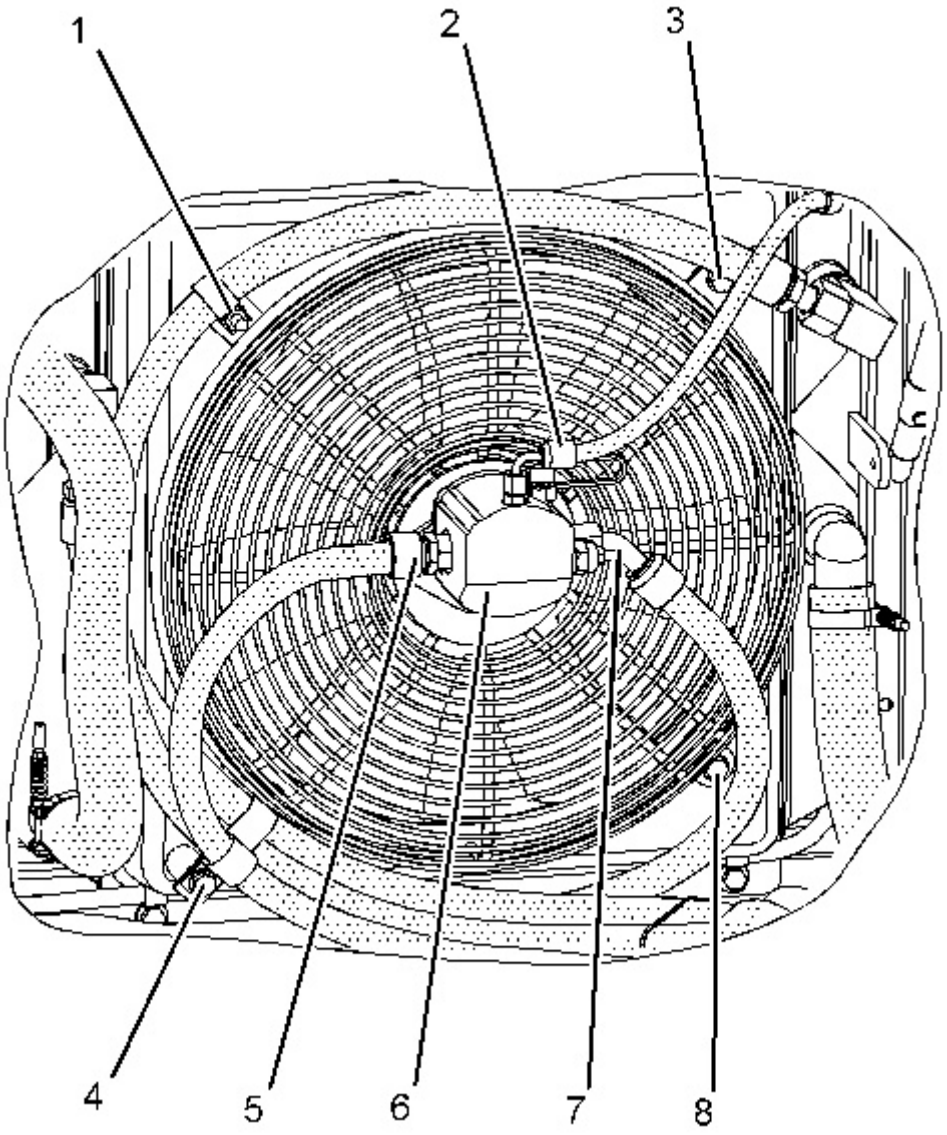


Illustration 1 g01092406

2. Disconnect hose assemblies (2), (5) and (7). Remove four bolts (1), (3), (4) and (8). Remove fan drive assembly (6) .

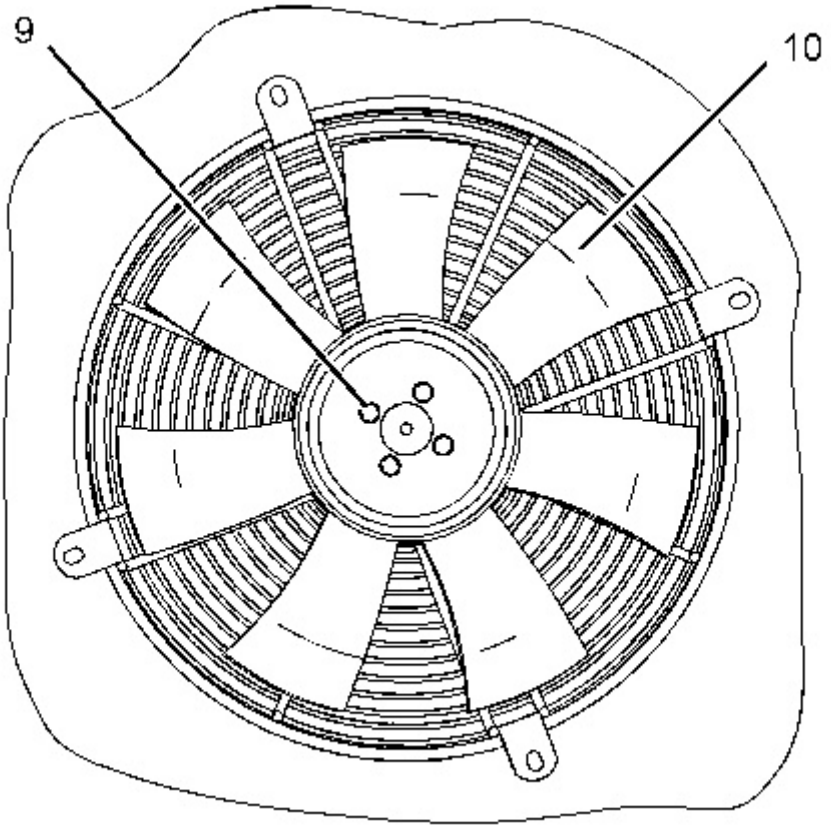


Illustration 2 g01092444

3. Remove bolts (9). Remove fan (10) .

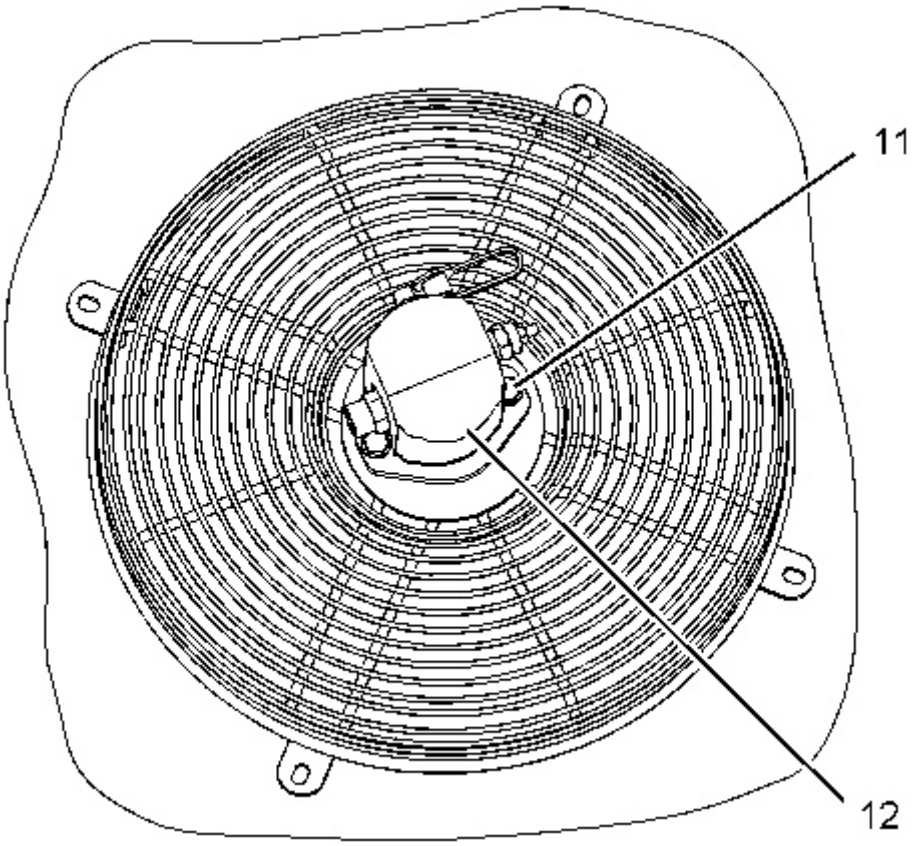


Illustration 3 g01092446

4. Remove bolts (11) and remove fan motor (12) .

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02154632

Gear Motor (Fan) - Install

SMCS - 1386-012-GT

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

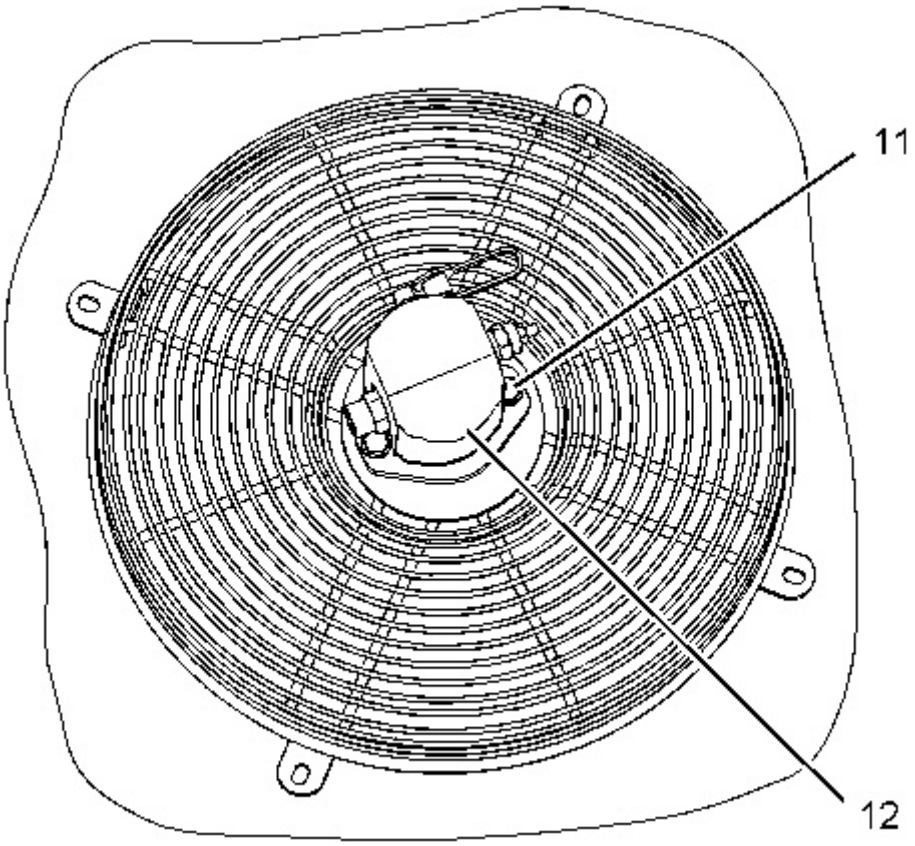


Illustration 1 g01092446

1. Install fan motor (12). Install bolts (11) .

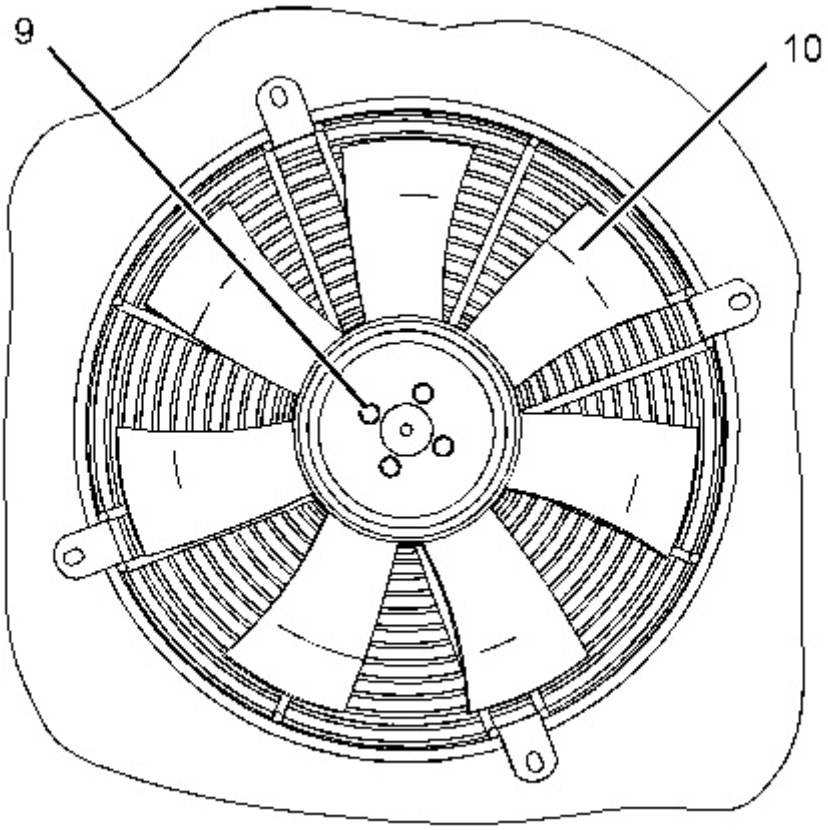


Illustration 2 g01092444

2. Install fan (10). Install bolts (9). Torque bolts (9) to 30 ± 7 N·m (22 ± 5 lb ft).

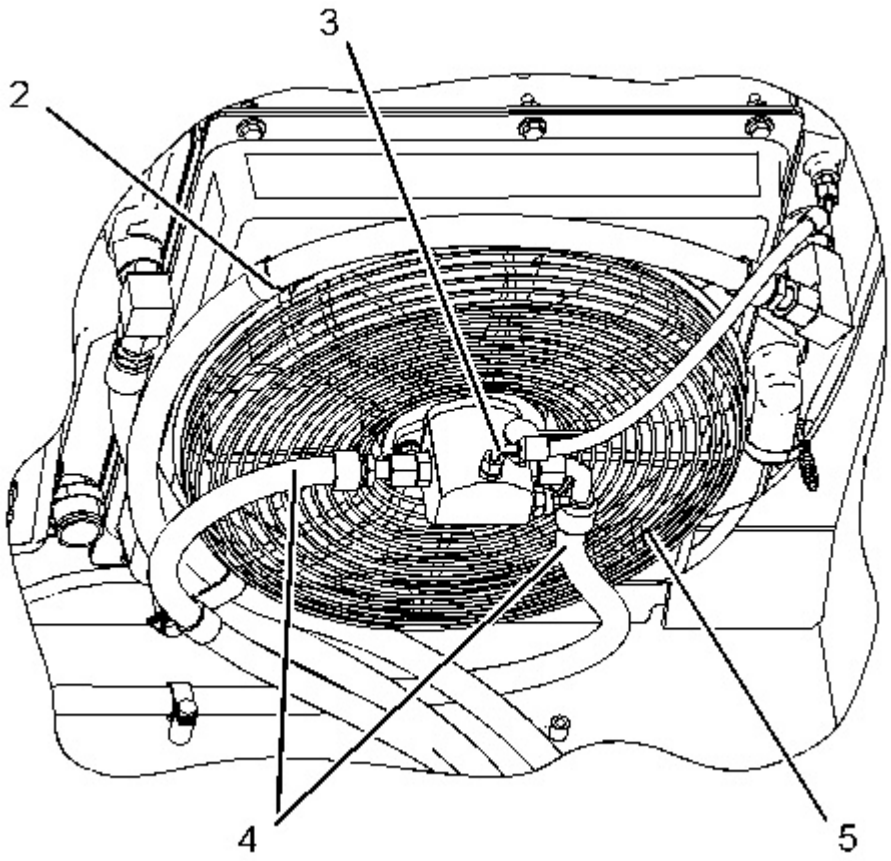


Illustration 3 g01041846

3. Install fan drive assembly (6). Install bolts (1), (3), (4) and (8). Tighten bolts (1), (3), (4) and (8) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Connect hose assemblies (2), (5) and (7) .
4. Tilt the radiator back into the operating position.
5. Check the level of the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Level - Check".
6. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02154575

Gear Motor (Fan) - Remove

SMCS - 1386-011-GT

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
ZZ	6V-9829	Cap As	1
	6V-9508	Face Seal Plug	1
	6V-9831	Cap As	2
	6V-9510	Face Seal Plug	2

Start By:

A. Release the pressure in the hydraulic oil system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Tilt the radiator.

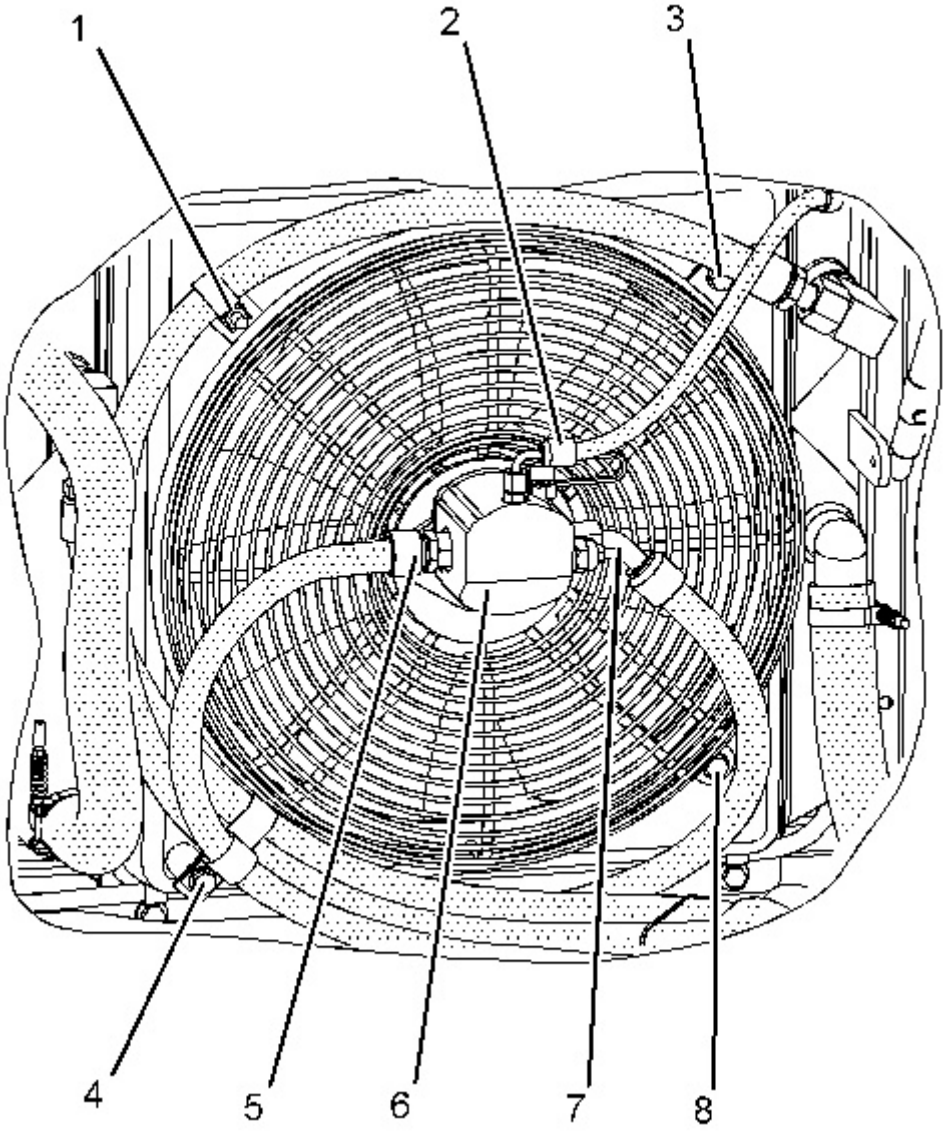


Illustration 1 g01092406

2. Disconnect hose assemblies (2), (5) and (7). Remove four bolts (1), (3), (4) and (8). Remove fan drive assembly (6) .

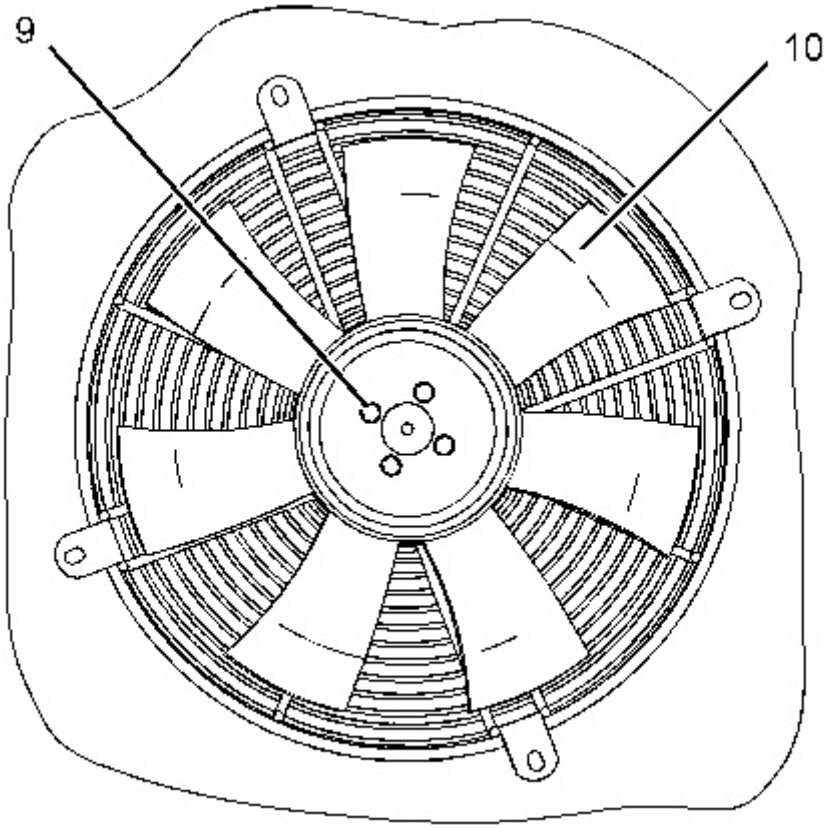


Illustration 2 g01092444

3. Remove bolts (9). Remove fan (10) .

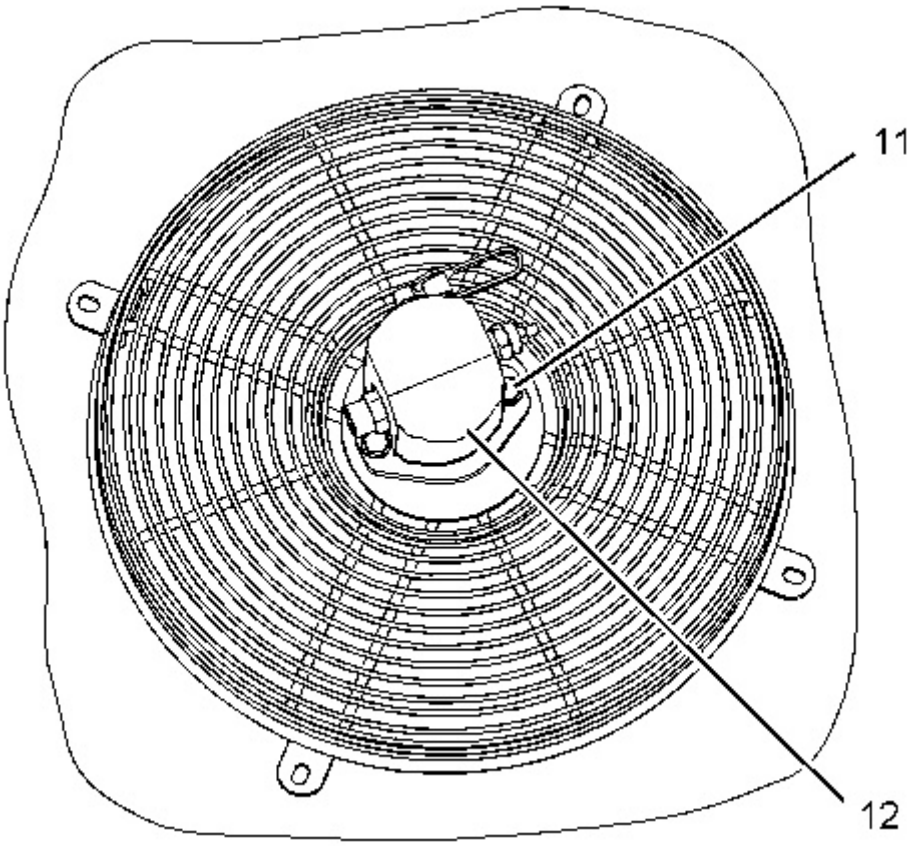


Illustration 3 g01092446

4. Remove bolts (11) and remove fan motor (12) .

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i02154632

Gear Motor (Fan) - Install

SMCS - 1386-012-GT

Installation Procedure

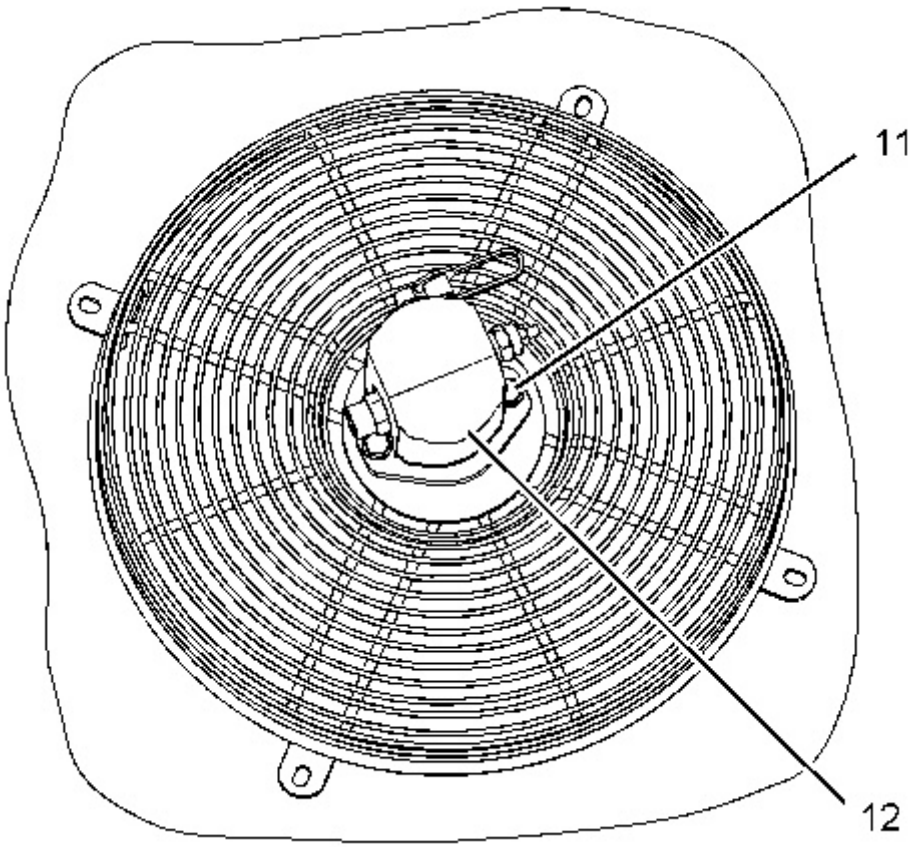


Illustration 1 g01092446

1. Install fan motor (12). Install bolts (11) .

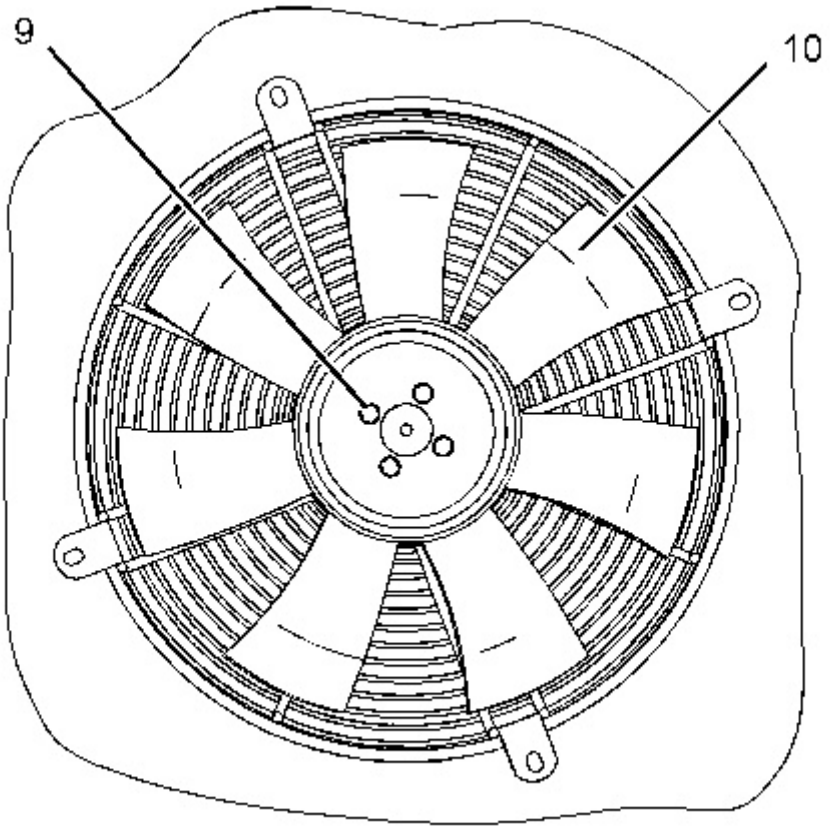


Illustration 2 g01092444

2. Install fan (10). Install bolts (9). Torque bolts (9) to 30 ± 7 N·m (22 ± 5 lb ft).

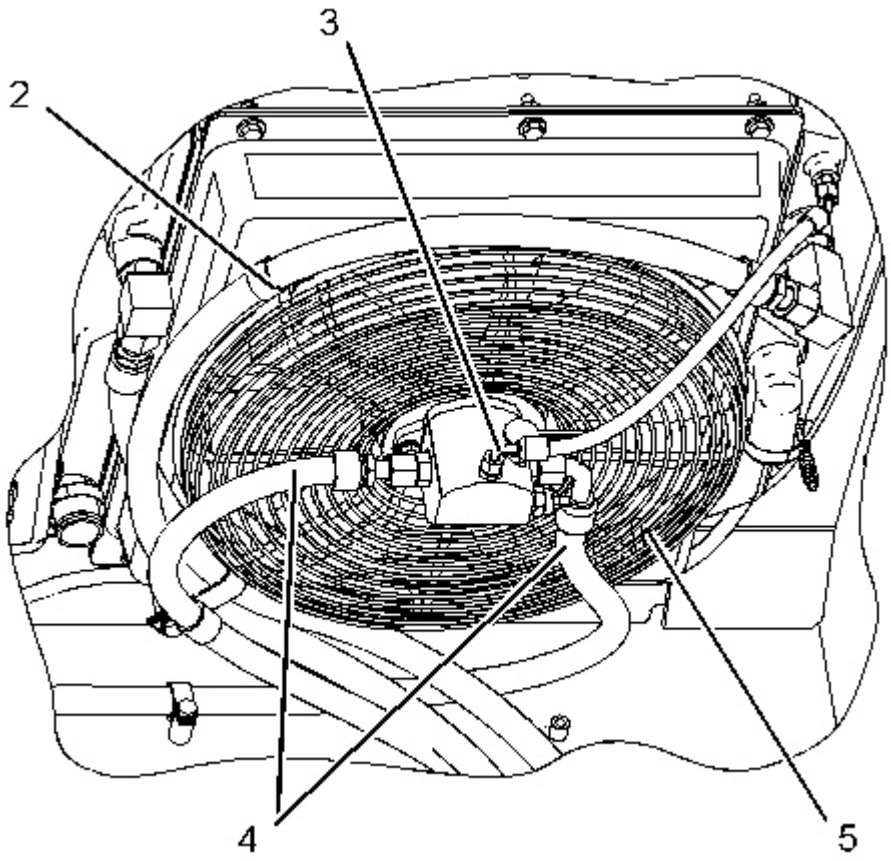


Illustration 3 g01041846

3. Install fan drive assembly (6). Install bolts (1), (3), (4) and (8). Tighten bolts (1), (3), (4) and (8) to a torque of 30 ± 7 N·m (22 ± 5 lb ft). Connect hose assemblies (2), (5) and (7) .
4. Tilt the radiator back into the operating position.
5. Check the level of the cooling system. Refer to Operation and Maintenance Manual, "Cooling System Level - Check".
6. Check the hydraulic oil level. Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check".

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i02868271

Gear Pump

SMCS - 5073

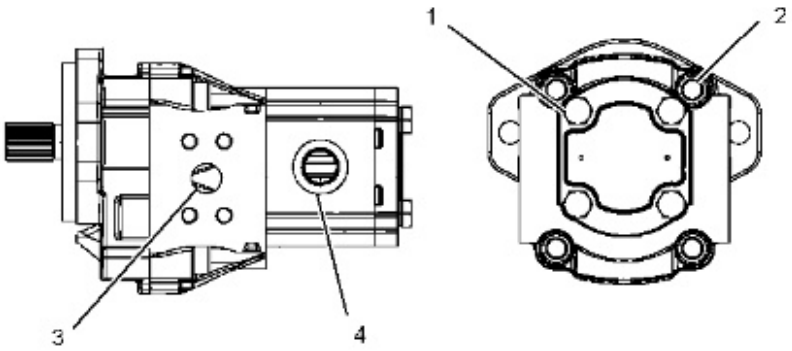


Illustration 1 g01428724

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 29.06 cc (1.77 in^3)
Continuous operating pressure ... 26000 kPa (3779 psi)
Intermittent operating pressure ... 28000 kPa (4062 psi)
Peak operating pressure ... 30000 kPa (4351 psi)
Maximum operating temperature for continuous operation ... 93 °C (200 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum speed ... 3300 rpm
Minimum speed ... 500 rpm
Cold starting temperature for short term ... −40 °C (−40 °F)

(4) Port

Displacement per revolution ... 18.3 cc (1.12 in^3)
Continuous operating pressure ... 25000 kPa (3626 psi)

Intermittent operating pressure ... 28000 kPa (4062 psi)
Peak operating pressure ... 30000 kPa (4351 psi)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02894291

Gear Pump

SMCS - 5073

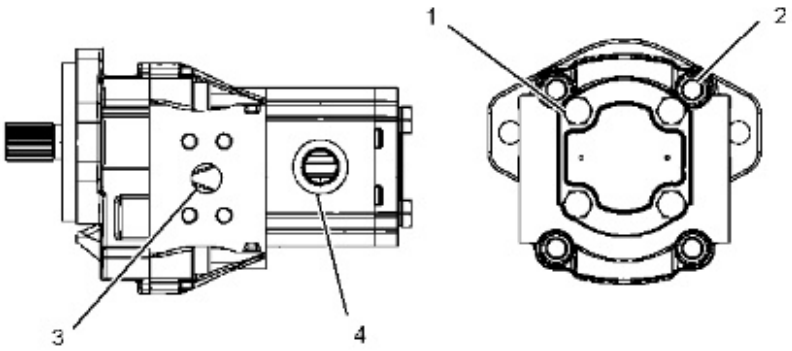


Illustration 1 g01428724

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 29.06 cc (1.8 in^3)
Continuous operating pressure ... 26000 kPa (3750 psi)
Intermittent operating pressure ... 28000 kPa (4050 psi)
Peak operating pressure ... 30000 kPa (4350 psi)
Maximum speed ... 3300 rpm
Minimum speed ... 500 rpm
Maximum operating temperature for continuous operation ... 93 °C (200 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Cold starting temperature for short term ... -40 °C (-40 °F)

(4) Port

Displacement per revolution ... 18.3 cc (1.1 in^3)
Continuous operating pressure ... 25000 kPa (3650 psi)

Intermittent operating pressure ... 28000 kPa (4050 psi)
Peak operating pressure ... 30000 kPa (4350 psi)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868247

Gear Pump

SMCS - 5073

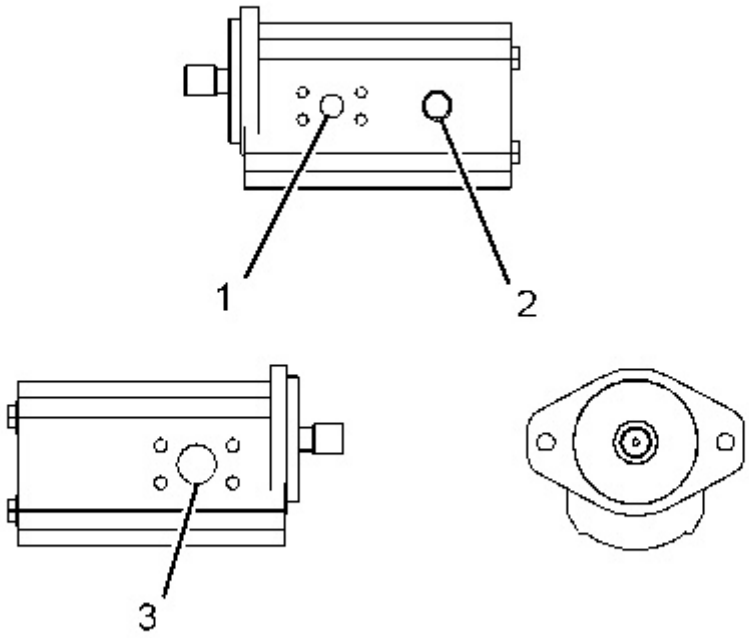


Illustration 1 g01428695

(3) Inlet port

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Port

Approximate displacement per revolution ... 29.0 cc (1.8 in^3)
Maximum continuous operating pressure ... 27600 kPa (4000 psi)
Flow at an idle speed of 1000 ± 50 rpm ... 20.00 ± 1.45 L/min (5.3 ± 0.4 US gpm)
Flow at an idle speed of 2860 ± 50 rpm ... 82.94 ± 1.45 L/min (22.0 ± 0.4 US gpm)
Maximum operating temperature for continuous operation ... 90 °C (194 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum gauge operating pressure at inlet port ... 200 kPa (29 psi)

(2) Port

Approximate displacement per revolution ... 18.0 cc (1.1 in^3)
Maximum continuous operating pressure ... 10000 kPa (1450 psi)
Flow at an idle speed of 1000 ± 50 rpm ... 18.0 ± 0.9 L/min (4.8 ± 0.2 US gpm)
Flow at an idle speed of 2860 ± 50 rpm ... 51.48 ± 0.90 L/min (13.6 ± 0.2 US gpm)
Maximum operating temperature for continuous operation ... 90 °C (194 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum gauge operating pressure at inlet port ... 200 kPa (29 psi)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02869383

Gear Pump

SMCS - 5073

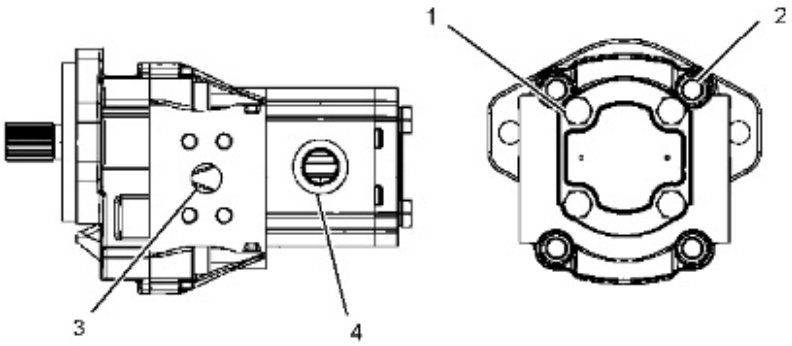


Illustration 1 g01429063

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 19.5 cc (1.18 in^3)
Maximum operating pressure ... 23000 kPa (3336 psi)
Temperature range ... −25 to 95 °C (−13 to 203 °F)
Inlet pressure range ... 70 to 300 kPa (10.2 to 43.5 psi)
Maximum speed ... 3250 rpm

(4) Port

Displacement per revolution ... 16.5 cc (1 in^3)
Maximum operating pressure ... 20000 kPa (2901 psi)
Temperature range ... −25 to 95 °C (−13 to 203 °F)
Inlet pressure range ... 70 to 300 kPa (10.2 to 43.5 psi)
Maximum speed ... 3250 rpm

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868271

Gear Pump

SMCS - 5073

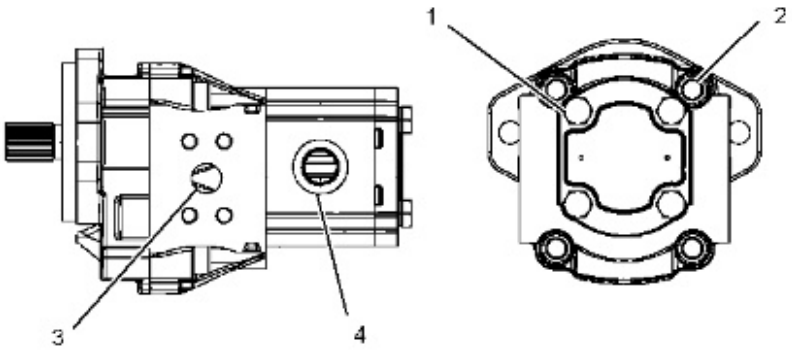


Illustration 1 g01428724

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 29.06 cc (1.77 in^3)
Continuous operating pressure ... 26000 kPa (3779 psi)
Intermittent operating pressure ... 28000 kPa (4062 psi)
Peak operating pressure ... 30000 kPa (4351 psi)
Maximum operating temperature for continuous operation ... 93 °C (200 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum speed ... 3300 rpm
Minimum speed ... 500 rpm
Cold starting temperature for short term ... −40 °C (−40 °F)

(4) Port

Displacement per revolution ... 18.3 cc (1.12 in^3)
Continuous operating pressure ... 25000 kPa (3626 psi)

Intermittent operating pressure ... 28000 kPa (4062 psi)
Peak operating pressure ... 30000 kPa (4351 psi)

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i02894291

Gear Pump

SMCS - 5073

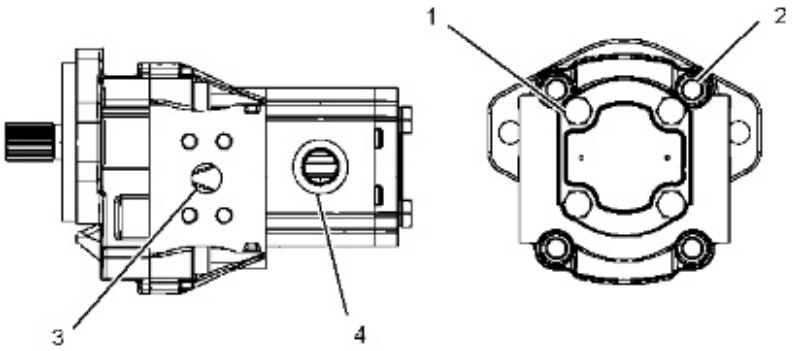


Illustration 1 g01428724

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 29.06 cc (1.8 in^3)
Continuous operating pressure ... 26000 kPa (3750 psi)
Intermittent operating pressure ... 28000 kPa (4050 psi)
Peak operating pressure ... 30000 kPa (4350 psi)
Maximum speed ... 3300 rpm
Minimum speed ... 500 rpm
Maximum operating temperature for continuous operation ... 93 °C (200 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Cold starting temperature for short term ... -40 °C (-40 °F)

(4) Port

Displacement per revolution ... 18.3 cc (1.1 in^3)
Continuous operating pressure ... 25000 kPa (3650 psi)

Intermittent operating pressure ... 28000 kPa (4050 psi)
Peak operating pressure ... 30000 kPa (4350 psi)

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i02868247

Gear Pump

SMCS - 5073

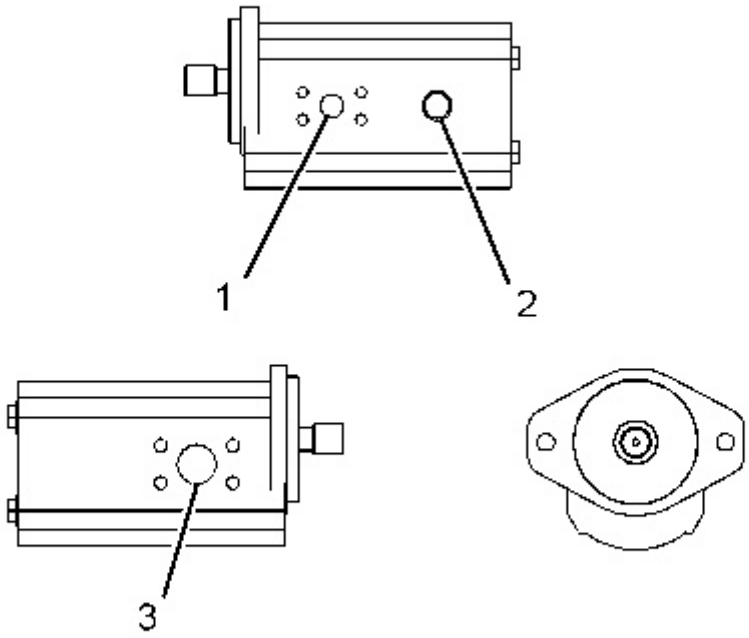


Illustration 1 g01428695

(3) Inlet port

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Port

Approximate displacement per revolution ... 29.0 cc (1.8 in^3)
Maximum continuous operating pressure ... 27600 kPa (4000 psi)
Flow at an idle speed of 1000 ± 50 rpm ... 20.00 ± 1.45 L/min (5.3 ± 0.4 US gpm)
Flow at an idle speed of 2860 ± 50 rpm ... 82.94 ± 1.45 L/min (22.0 ± 0.4 US gpm)
Maximum operating temperature for continuous operation ... 90 °C (194 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum gauge operating pressure at inlet port ... 200 kPa (29 psi)

(2) Port

Approximate displacement per revolution ... 18.0 cc (1.1 in^3)
Maximum continuous operating pressure ... 10000 kPa (1450 psi)
Flow at an idle speed of 1000 ± 50 rpm ... 18.0 ± 0.9 L/min (4.8 ± 0.2 US gpm)
Flow at an idle speed of 2860 ± 50 rpm ... 51.48 ± 0.90 L/min (13.6 ± 0.2 US gpm)
Maximum operating temperature for continuous operation ... 90 °C (194 °F)
Maximum operating temperature for intermittent operation ... 105 °C (221 °F)
Maximum gauge operating pressure at inlet port ... 200 kPa (29 psi)

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i02869383

Gear Pump

SMCS - 5073

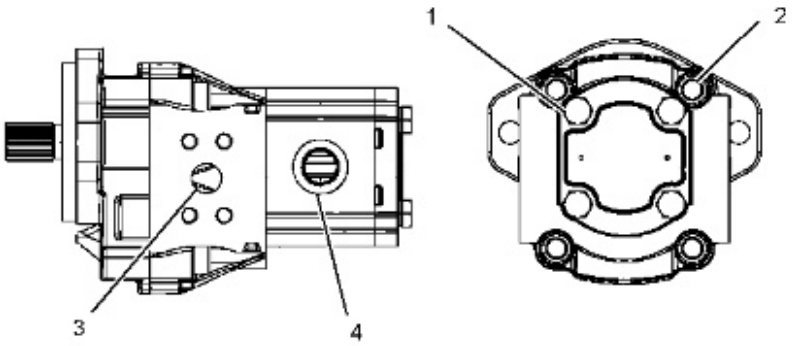


Illustration 1 g01429063

The rotation of the pump is clockwise when you view the pump from the shaft end.

(1) Torque for the four bolts ... 45 N·m (33 lb ft)

(2) Torque for the four bolts ... 140 N·m (105 lb ft)

(3) Port

Displacement per revolution ... 19.5 cc (1.18 in^3)
Maximum operating pressure ... 23000 kPa (3336 psi)
Temperature range ... −25 to 95 °C (−13 to 203 °F)
Inlet pressure range ... 70 to 300 kPa (10.2 to 43.5 psi)
Maximum speed ... 3250 rpm

(4) Port

Displacement per revolution ... 16.5 cc (1 in^3)
Maximum operating pressure ... 20000 kPa (2901 psi)
Temperature range ... −25 to 95 °C (−13 to 203 °F)
Inlet pressure range ... 70 to 300 kPa (10.2 to 43.5 psi)
Maximum speed ... 3250 rpm

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i02156773

Gear Pump - Remove

SMCS - 5073-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Start By:

A. Release hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Tilt the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Cleanliness is an important factor. Before the removal procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, all hoses and all tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

1. Drain the hydraulic tank. Refer to Operation and Maintenance Manual, "Hydraulic System Oil - Change".

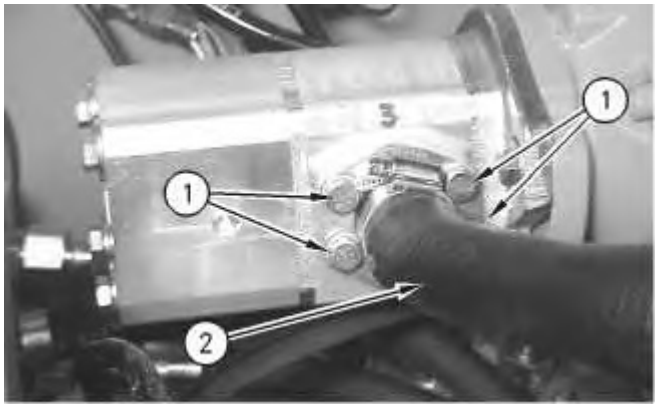


Illustration 1 g00770810

2. Remove bolts (1), the washers and half flanges. Move hose (2) to the side.

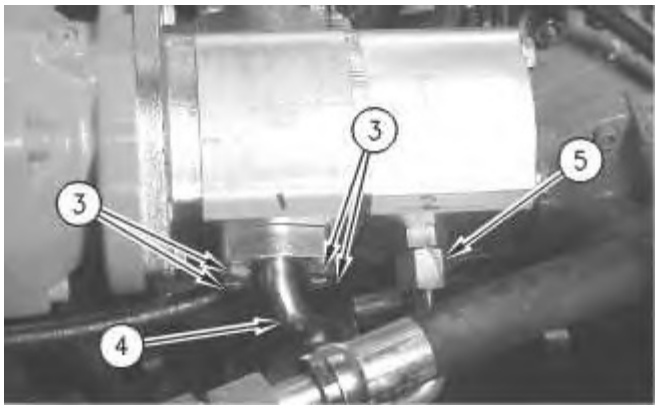


Illustration 2 g00770819

3. Remove bolts (3), the washers and half flanges. Move hose assembly (4) to the side.
4. Disconnect hose assembly (5) .

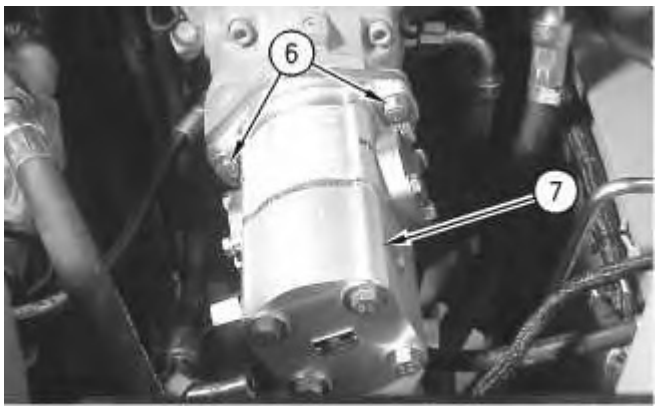


Illustration 3 g00770822

5. Remove bolts (6) and washers.
6. Remove gear pump (7) .



Illustration 4 g00770955

7. Remove O-ring seal (8) from the piston pump.

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i01990392

Gear Pump - Disassemble

SMCS - 5073-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the gear pump. Refer to Disassembly and Assembly, "Gear Pump - Remove".



Illustration 1 g01029217

1. Remove bolts (1), cover (2), and the O-ring seal.

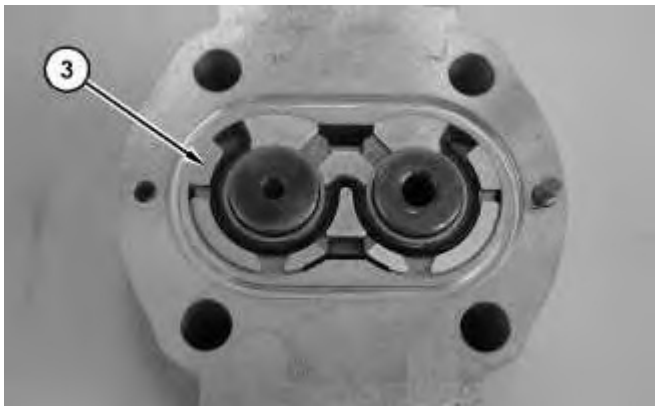


Illustration 2 g01029218

2. Remove bearing (3) and the seals.

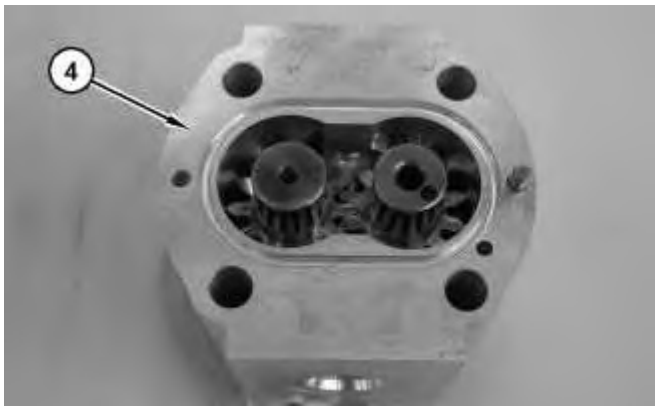


Illustration 3 g01029219

3. Remove housing (4) .

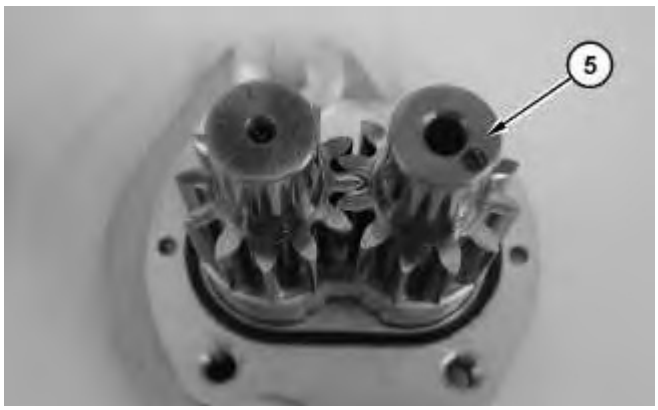


Illustration 4 g01029221

4. Remove gear (5) .



Illustration 5 g01029223

5. Remove gear (6) .

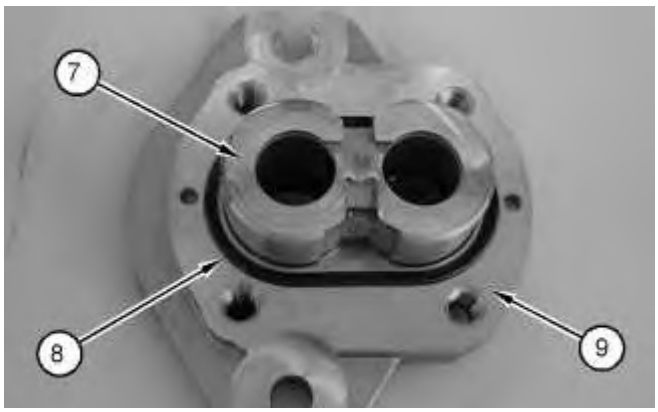


Illustration 6 g01029224

6. Remove bearing (7) and the seals.
7. Remove O-ring seal (8) .
8. Remove the seal and the retaining ring from cover (9) .

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i01990393

Gear Pump - Assemble

SMCS - 5073-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

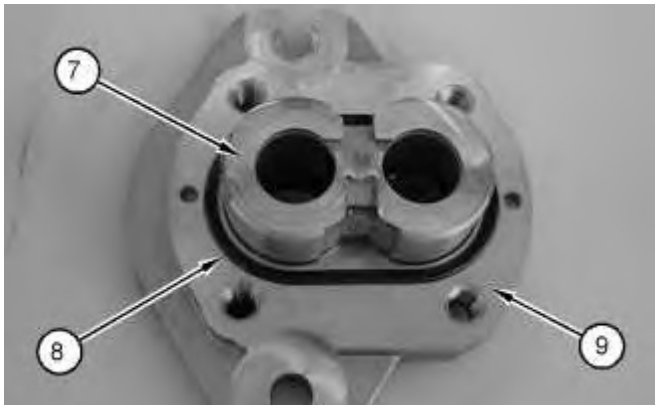


Illustration 1 g01029224

1. Install the seal and the retaining ring into cover (9) .
2. Position O-ring seal (8) onto cover (9) .
3. Position bearing (7) and the seals.



Illustration 2 g01029223

4. Install gear (6) .

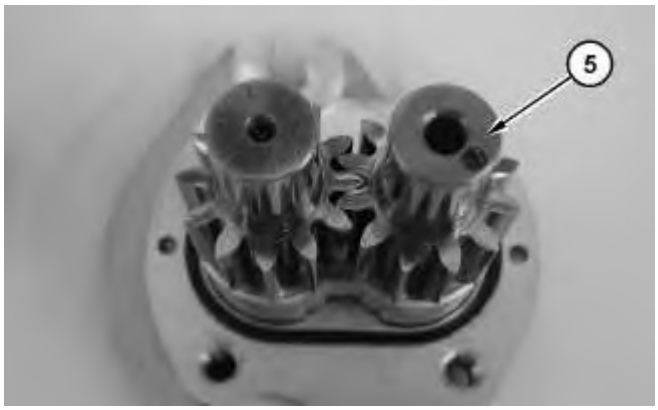


Illustration 3 g01029221

5. Install gear (5) .

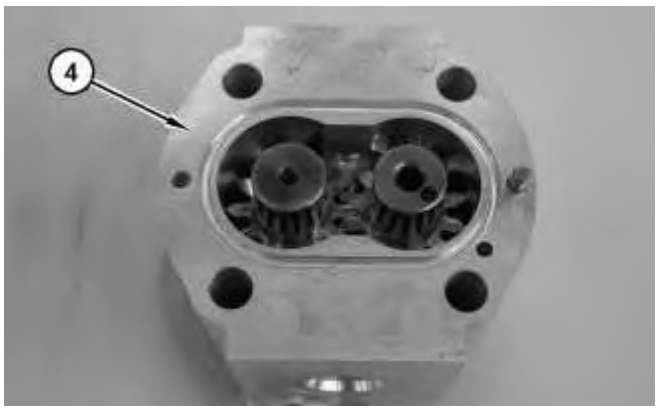


Illustration 4 g01029219

6. Install housing (4) .

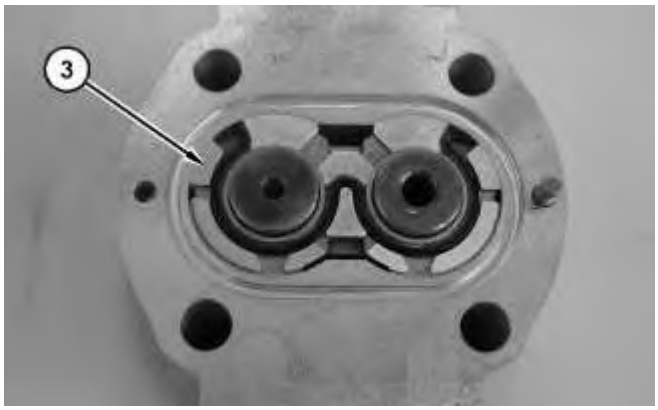


Illustration 5 g01029218

7. Install bearing (3) and the seals.



Illustration 6 g01029217

8. Install the O-ring seal, cover (2), and bolts (1). Tighten bolts (1) to a torque of 50 N·m (37 lb ft).

End By: Install the gear pump. Refer to Disassembly and Assembly, "Gear Pump - Install".

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i02156792

Gear Pump - Install

SMCS - 5073-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers

before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

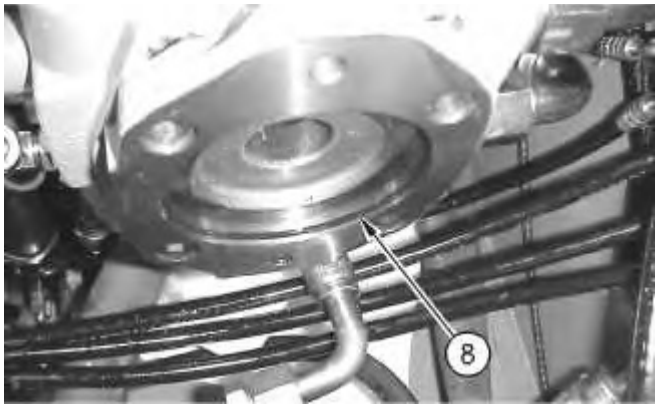


Illustration 1 g00592580

1. Install O-ring seal (8) into the piston pump.

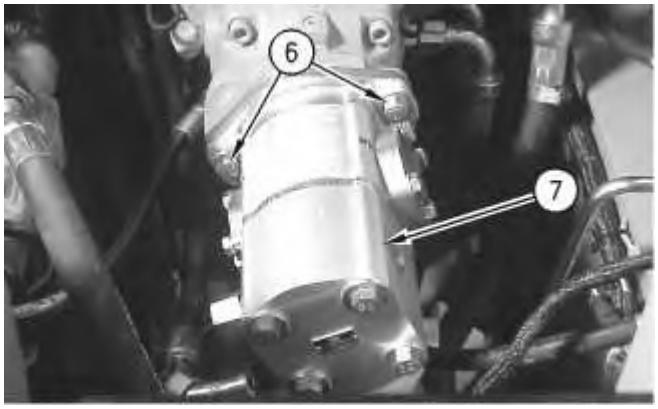


Illustration 2 g00770822

2. Place gear pump (7) into position. Make sure that the splines are aligned.
3. Install mounting bolts (6) and washers. Tighten bolts (6) to a torque of 100 ± 20 N·m (74 ± 15 lb ft).

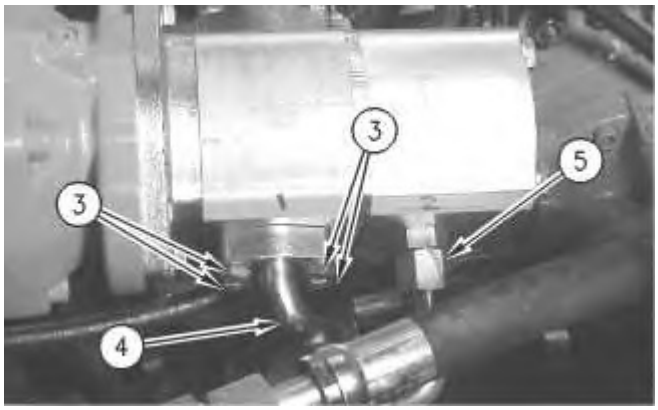


Illustration 3 g00770819

4. Place hose assembly (4) in position.

   Note: Check the O-ring seal on the face of hose assembly (4). If necessary, replace the O-ring seal.

5. Install bolts (3), the washers, and the half flanges. Tighten bolts (3) to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

6. Connect hose assembly (5) .

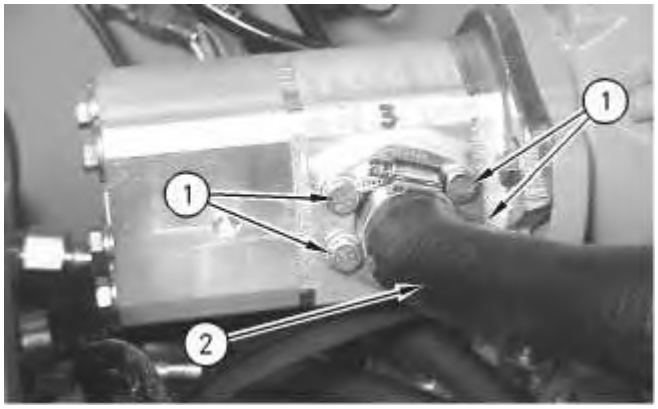


Illustration 4 g00770810

7. Put hose (2) into position.

8. Install four bolts (1), the washers, and the half flanges. Tighten the bolts to a torque of 30 ± 7 N·m (22 ± 5 lb ft).

9. Fill the hydraulic tank. Refer to Operation and Maintenance Manual, "Refill Capacities" and Operation and Maintenance Manual, "Lubricant Viscosities".

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02851359

Hydraulic Tank

SMCS - 5056

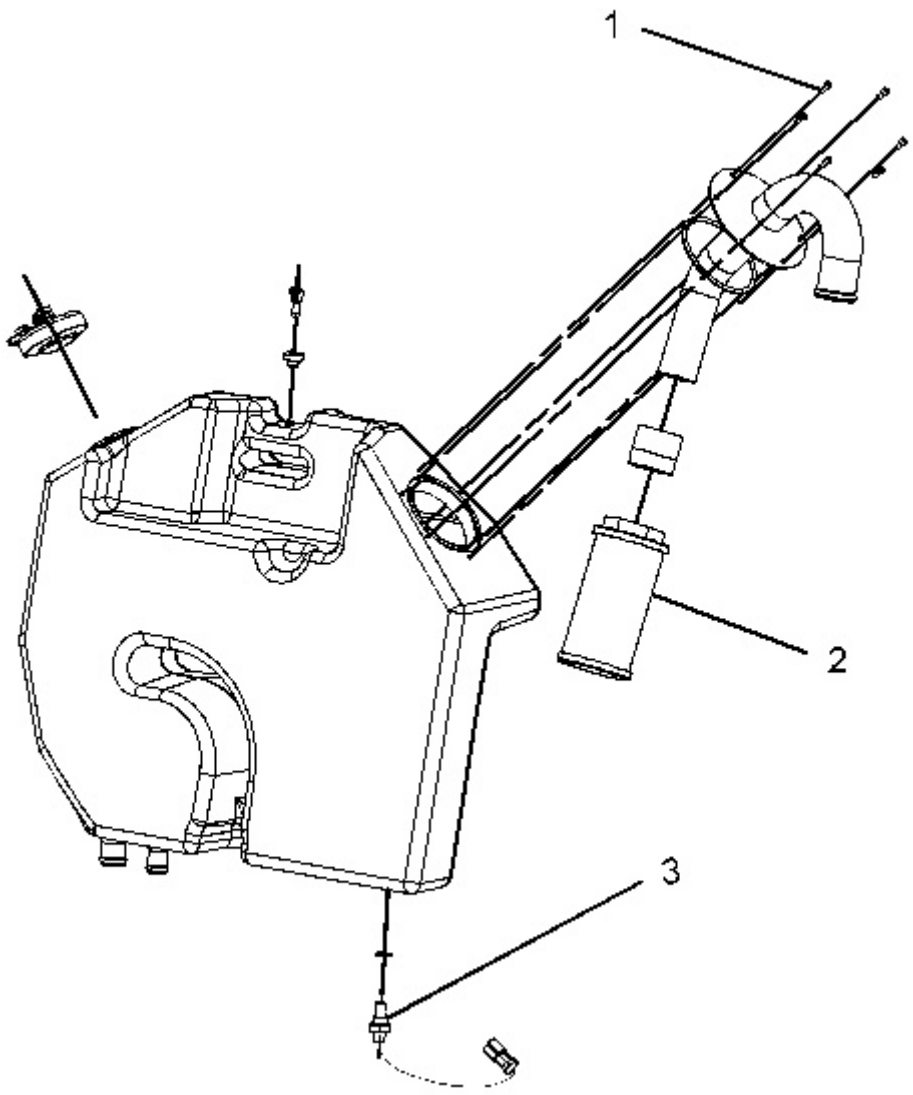


Illustration 1 g01420402

Front left view

Note: Apply **154-9731** Thread Lock Compound to the threads of the six bolts (1) .

(1) Torque for six bolts ... 8 ± 2 N·m (70 ± 18 lb in)

Note: Apply **5P-3413** Pipe Sealant to the threads of the suction screen (2) .

(2) Torque for the suction screen ... 18.5 ± 1.5 N·m (165 ± 13 lb in)

(3) Temperature switch

Contact position ... Normally open below the deactuation temperature.
Actuation temperature ... 102 ± 3 °C (216 ± 5 °F)
Minimum deactuation temperature ... 90 °C (194 °F)
Minimum voltage for actuation ... 8 VDC
Maximum voltage for actuation ... 28 VDC
Minimum resistive load ... 2.5 Milliamperes
Maximum resistive load ... 1 Ampere
Final installation torque ... 6.8 ± 1.4 N·m (60 ± 12 lb in)
Operating temperature ... -40 to 150 °C (-40 to 302 °F)

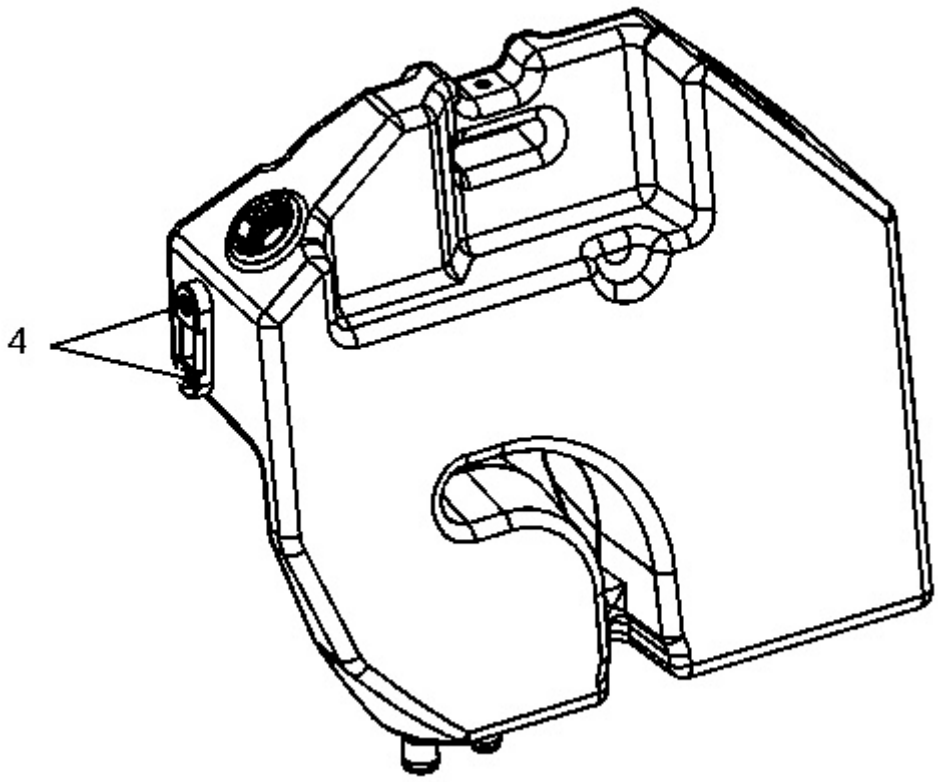


Illustration 2 g01432930

(4) Torque for two socket head screws for the sight gauge ... 9 ± 1 N·m (80 ± 9 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02851359

Hydraulic Tank

SMCS - 5056

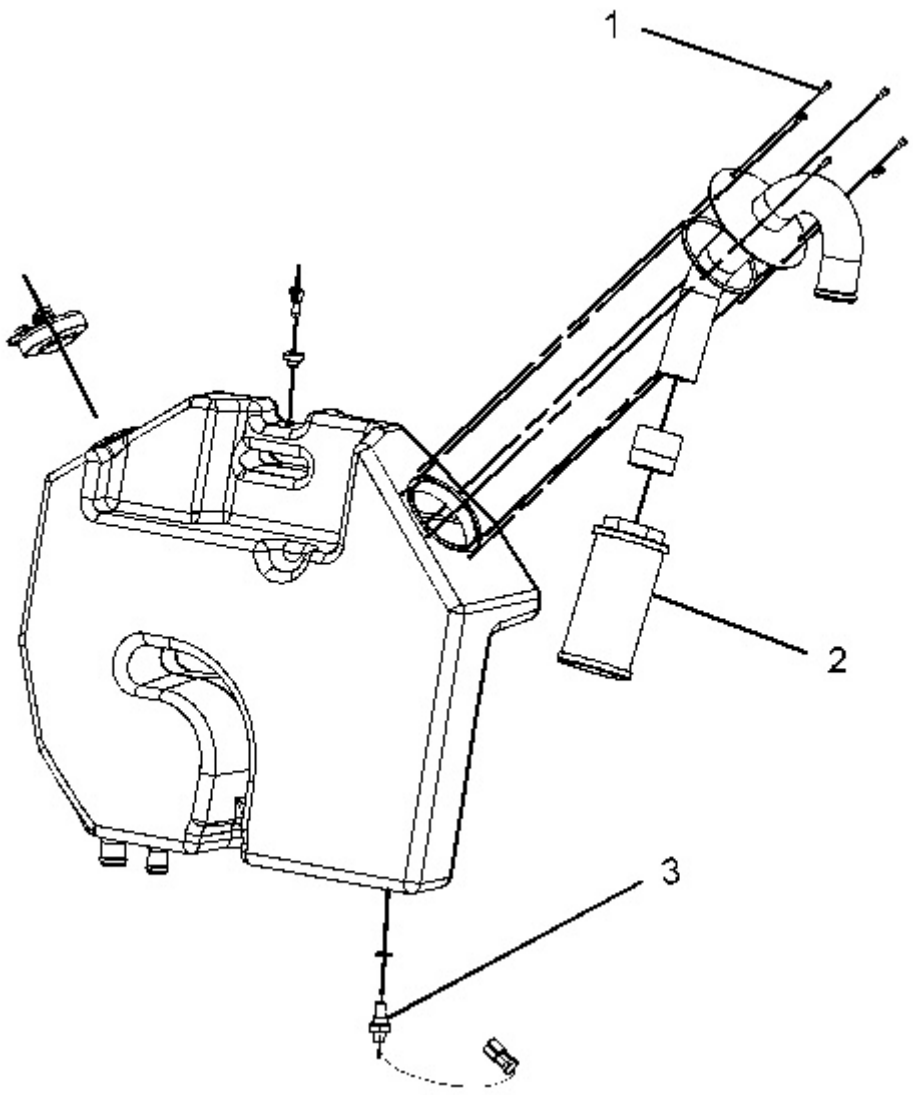


Illustration 1 g01420402

Front left view

Note: Apply **154-9731** Thread Lock Compound to the threads of the six bolts (1) .

(1) Torque for six bolts ... 8 ± 2 N·m (70 ± 18 lb in)

Note: Apply **5P-3413** Pipe Sealant to the threads of the suction screen (2) .

(2) Torque for the suction screen ... 18.5 ± 1.5 N·m (165 ± 13 lb in)

(3) Temperature switch

Contact position ... Normally open below the deactuation temperature.
Actuation temperature ... 102 ± 3 °C (216 ± 5 °F)
Minimum deactuation temperature ... 90 °C (194 °F)
Minimum voltage for actuation ... 8 VDC
Maximum voltage for actuation ... 28 VDC
Minimum resistive load ... 2.5 Milliamperes
Maximum resistive load ... 1 Ampere
Final installation torque ... 6.8 ± 1.4 N·m (60 ± 12 lb in)
Operating temperature ... -40 to 150 °C (-40 to 302 °F)

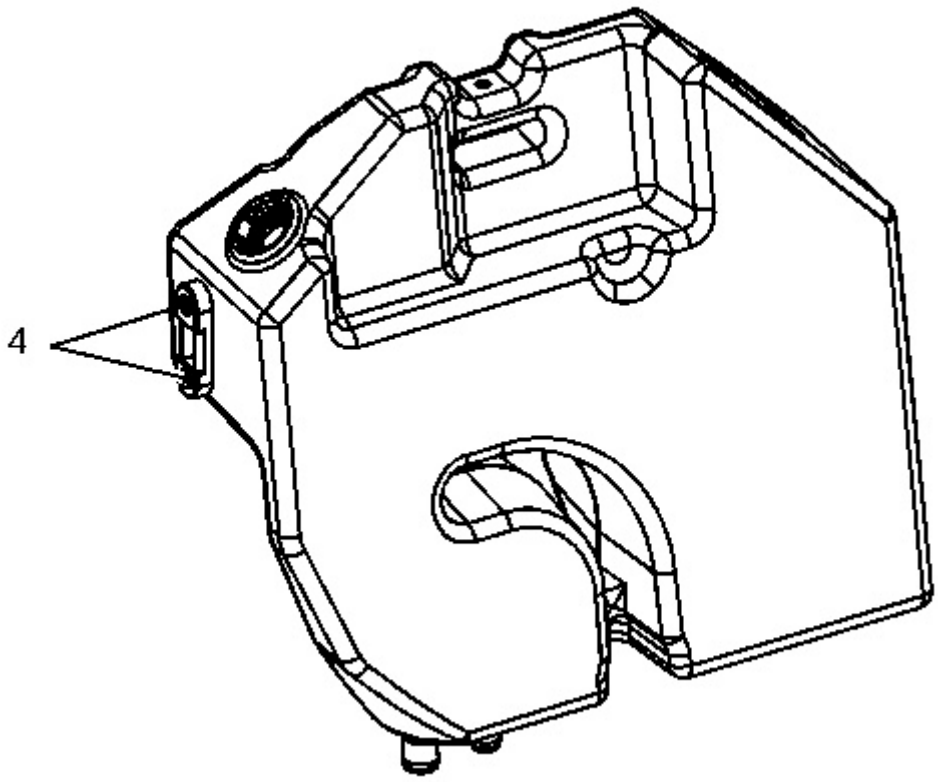


Illustration 2 g01432930

(4) Torque for two socket head screws for the sight gauge ... 9 ± 1 N·m (80 ± 9 lb in)

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i02005627

Hydraulic Tank - Remove

SMCS - 5056-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
ZZ	9U-7089	Tapered Cap/Plug	1
	9U-7088	Tapered Cap/Plug	1
	9U-7084	Tapered Cap/Plug	2
	9U-7081	Tapered Cap/Plug	1
	9U-7082	Tapered Cap/Plug	1
	9U-7069	Tapered Cap/Plug	1

Start By:

A. Tilt the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

Note: Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

1. Drain the hydraulic oil tank. Refer to Operation and Maintenance Manual, "Hydraulic Oil System - Change".

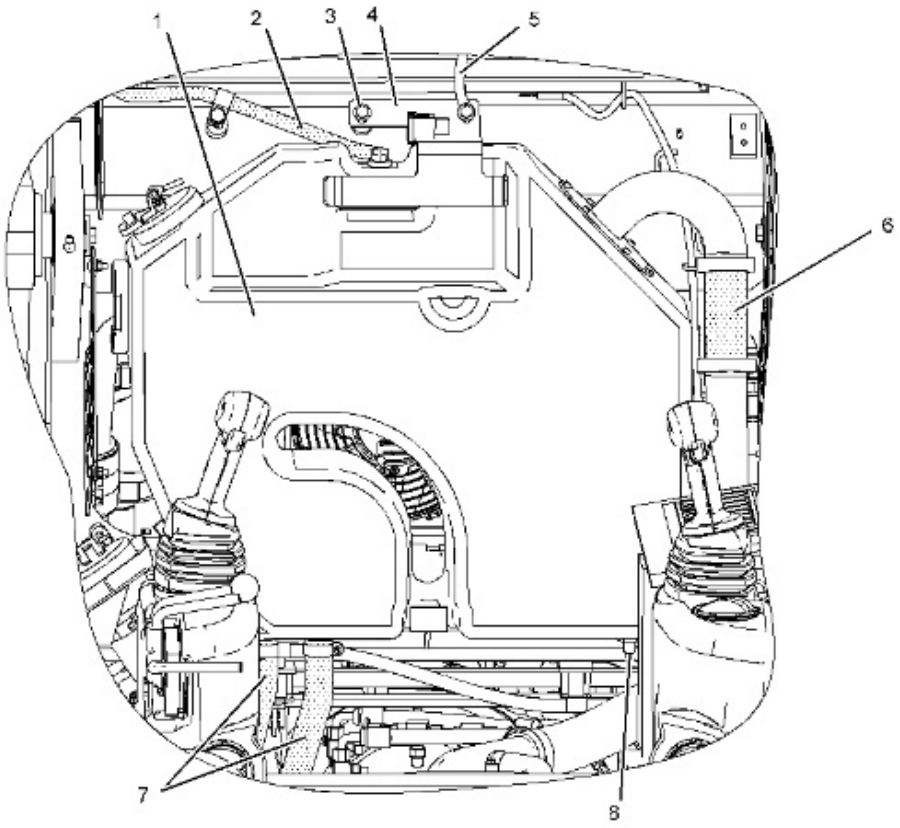


Illustration 1 g01037424

2. Disconnect harness assembly (8). Disconnect hoses (7). Loosen the clamp and disconnect hose (6). Disconnect hose (2). Remove bolts (3). Position ground strap (5) out of the way. Remove bracket (4) and remove hydraulic oil tank (1) .

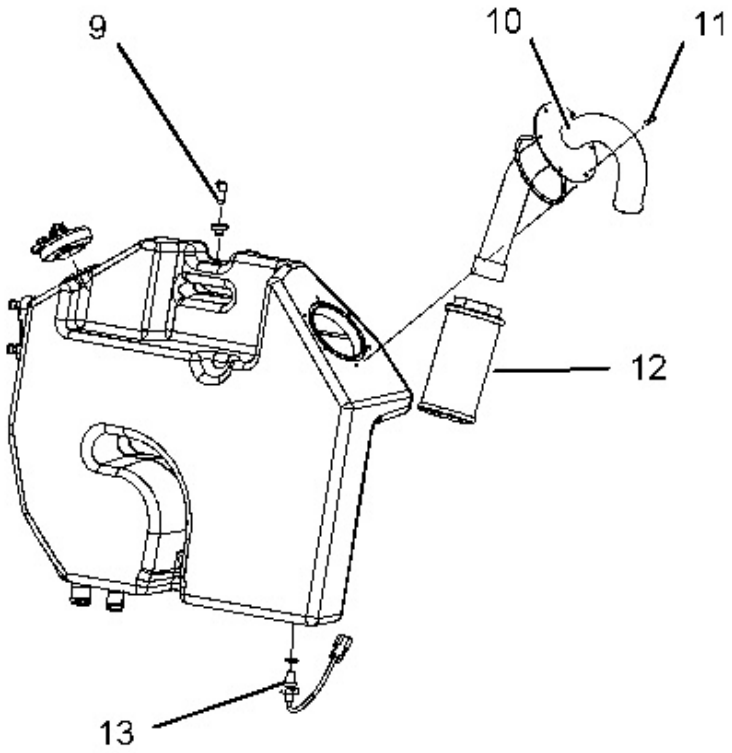


Illustration 2 g01037440

3. Remove elbow (9). Remove bolts (11) and remove tube assembly (10). Remove suction screen (12) and the O-ring seal. Remove sending unit (13) and the O-ring seal.

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i02005722

Hydraulic Tank - Install

SMCS - 5056-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	4C-9502	Gasket Sealant	1
B	155-0695	Thread Lock Compound	1

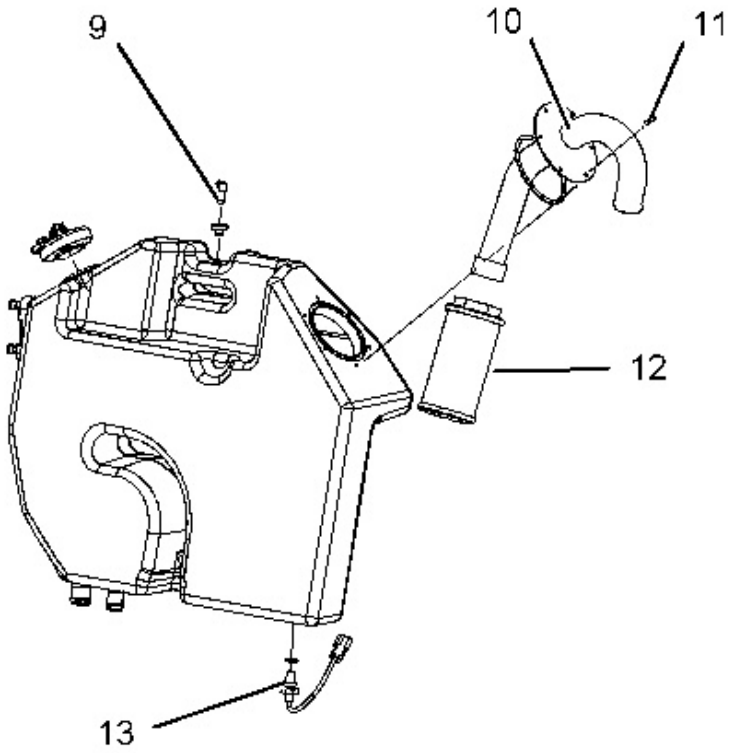


Illustration 1 g01037440

1. Check the condition of the O-ring seals. Replace the seals, if necessary. Install sending unit (13) and the O-ring seal. Install elbow (9). Apply Tooling (A) to the threads of suction screen (12). Install suction screen (12) and the O-ring seal. Install tube assembly (10). Apply Tooling (B) to the threads of bolts (11) and install bolts (11). Tighten bolts (11) to a torque of 8 ± 2 N·m (70 ± 18 lb in).

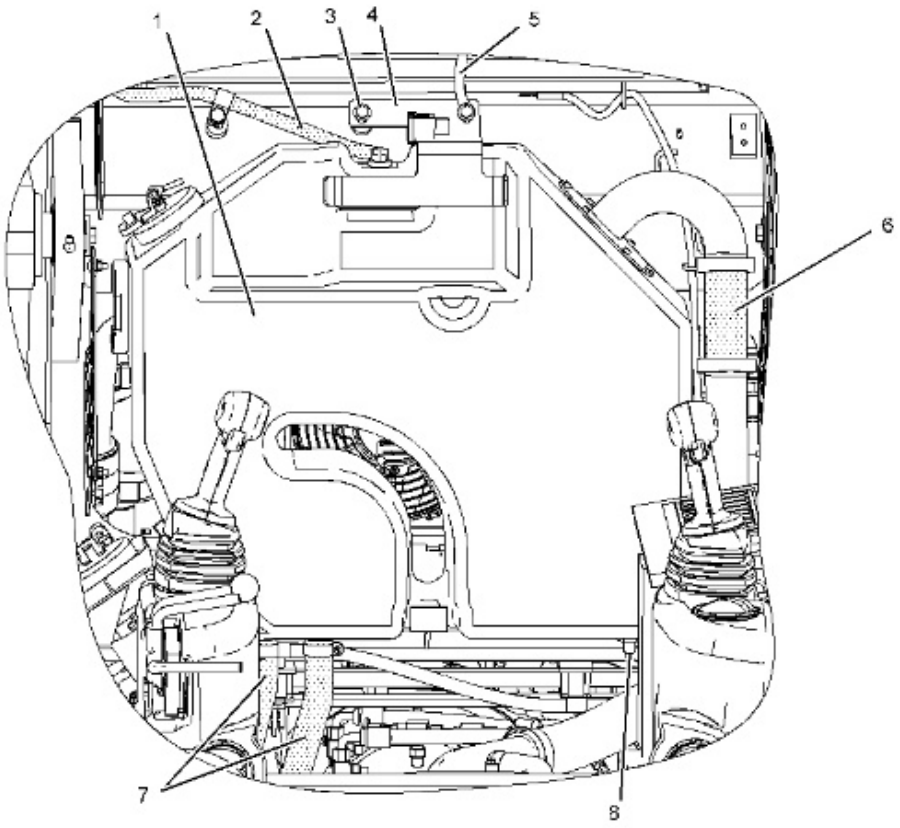


Illustration 2 g01037424

2. Install hydraulic oil tank (1) and install bracket (4). Reposition ground strap (5) and install bolts (3). Connect harness assembly (8). Connect hoses (7). Connect hose (6) and tighten the clamp. Connect hose (2) .

3. Fill the hydraulic oil tank. Refer to Operation and Maintenance Manual, "Hydraulic System Oil - Change".

4. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02946380

Control Valve (Work Tool)

SMCS - 5051

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

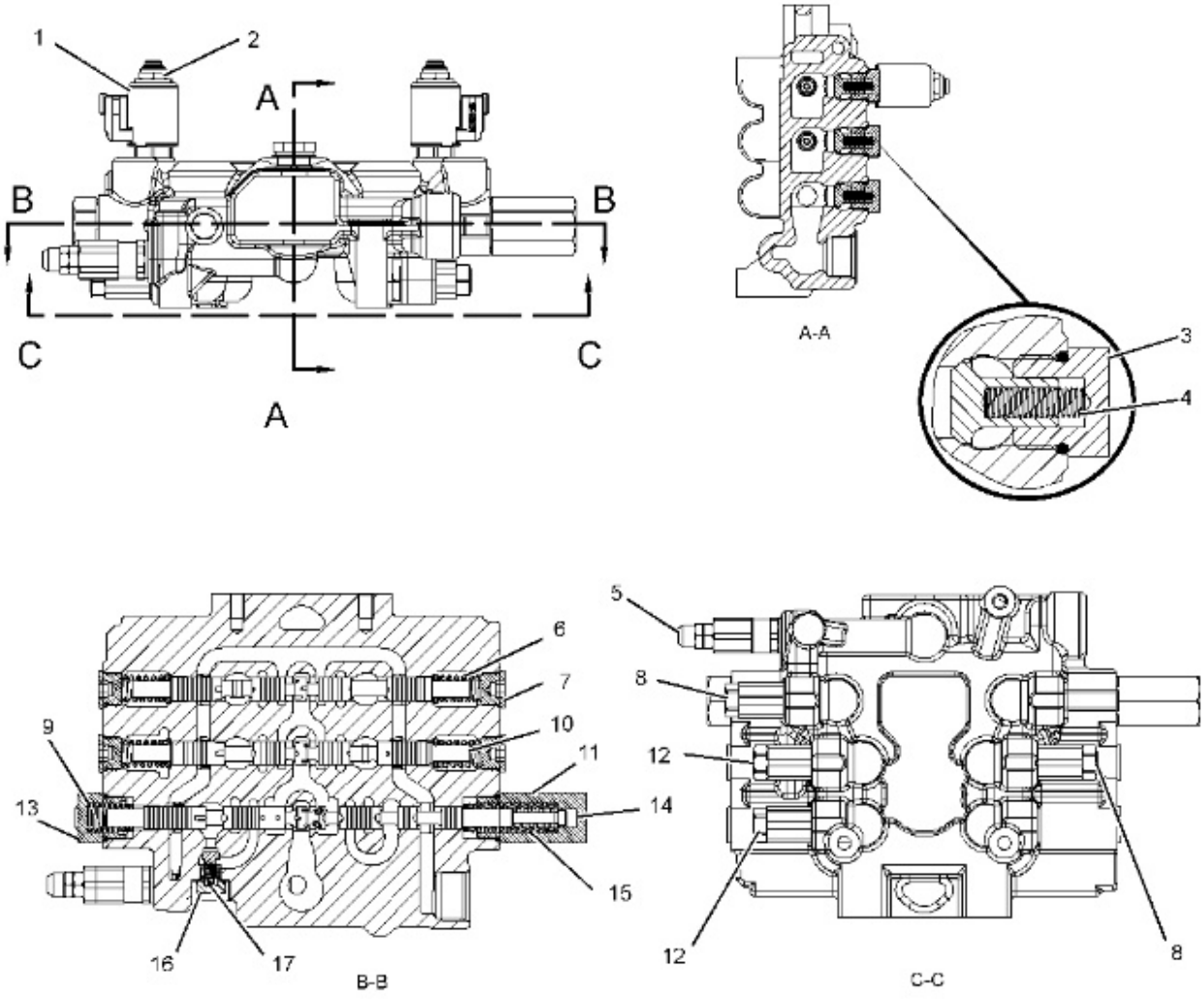


Illustration 1 g01460389

(1) **185-4254** Solenoid Valve Gp

Quantity ... 2
Operating voltage ... 12 VDC
Current at 120 °C (248 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)
Torque for installing the two solenoid valve groups ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the two nuts (2) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)

(3) Torque for the three plugs ... 65.3 ± 6.8 N·m (48 ± 5 lb ft)

(4) **003-3082** Spring

Quantity ... 3
Outside diameter ... 6.6 mm (0.26 inch)
Free length ... 35.0 mm (1.38 inch)

(5) **295-1799** Relief Valve Gp

The relief pressure setting for 80 L/min (21 US gpm) ... 23000 ± 172 kPa (3336 ± 25 psi)

Torque for the relief valve ... 45 ± 5 N·m (33 ± 4 lb ft)
Torque for the relief valve nut ... 24 ± 3 N·m (18 ± 2 lb ft)

(6) **204-1489** Spring

Quantity ... 4
Outside diameter ... 18.54 mm (0.730 inch)
Free length ... 32.43 mm (1.277 inch)

(7) Torque for the four plugs ... 65.3 ± 6.8 N·m (48 ± 5 lb ft)

(8) **216-6161** Relief Valve Gp

Quantity ... 2
The relief valve pressure setting for 3.79 L/min (1.0 US gpm) ... 27600 ± 345 kPa (4003 ± 50 psi)
Torque for the relief valve ... 44.9 ± 4.8 N·m (33 ± 4 lb ft)

(9) **204-1488** Spring

Outside diameter ... 19.30 mm (0.760 inch)
Free length ... 49.40 mm (1.945 inch)

(10) Torque for the spool end ... 9.5 ± 1.4 N·m (85 ± 12 lb in)

(11) Torque for the cap ... 122.4 ± 12.2 N·m (90 ± 9 lb ft)

(12) **216-6160** Relief Valve Gp

Quantity ... 2
The relief valve pressure setting for 3.79 L/min (1.0 US gpm) ... 24500 ± 345 kPa (3553 ± 50 psi)
Torque for the relief valve ... 44.9 ± 4.8 N·m (33 ± 4 lb ft)

(13) Torque for the cap ... 122.4 ± 12.2 N·m (90 ± 9 lb ft)

(14) Torque for the bolt ... 9.5 ± 1.4 N·m (85 ± 12 lb in)

(15) **204-1482** Spring

Outside diameter ... 19.38 mm (0.763 inch)
Free length ... 62.97 mm (2.479 inch)

(16) Torque for the plug ... 24.5 ± 2.7 N·m (18 ± 2 lb ft)

(17) **216-6157** Spring

Outside diameter ... 4.65 mm (0.183 inch)
Free length ... 23.32 mm (0.918 inch)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02946380

Control Valve (Work Tool)

SMCS - 5051

S/N - HEN6750-UP

S/N - SCP4600-UP

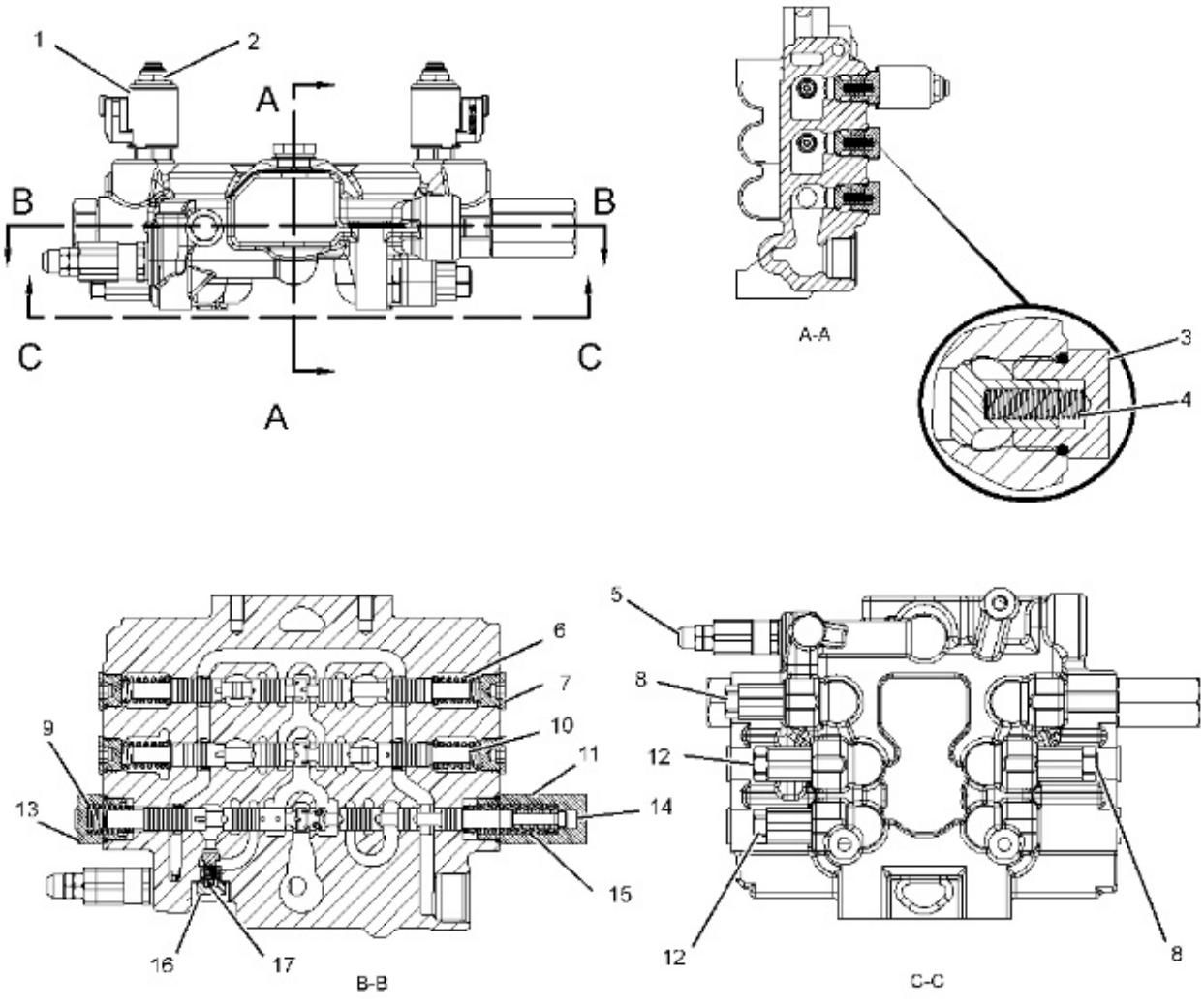


Illustration 1 g01460389

(1) **185-4254** Solenoid Valve Gp

Quantity ... 2
Operating voltage ... 12 VDC
Current at 120 °C (248 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)
Torque for installing the two solenoid valve groups ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the two nuts (2) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)

(3) Torque for the three plugs ... 65.3 ± 6.8 N·m (48 ± 5 lb ft)

(4) **003-3082** Spring

Quantity ... 3
Outside diameter ... 6.6 mm (0.26 inch)
Free length ... 35.0 mm (1.38 inch)

(5) **295-1799** Relief Valve Gp

The relief pressure setting for 80 L/min (21 US gpm) ... 23000 ± 172 kPa (3336 ± 25 psi)
Torque for the relief valve ... 45 ± 5 N·m (33 ± 4 lb ft)
Torque for the relief valve nut ... 24 ± 3 N·m (18 ± 2 lb ft)

(6) **204-1489** Spring

Quantity ... 4
Outside diameter ... 18.54 mm (0.730 inch)
Free length ... 32.43 mm (1.277 inch)

(7) Torque for the four plugs ... 65.3 ± 6.8 N·m (48 ± 5 lb ft)

(8) **216-6161** Relief Valve Gp

Quantity ... 2
The relief valve pressure setting for 3.79 L/min (1.0 US gpm) ... 27600 ± 345 kPa (4003 ± 50 psi)
Torque for the relief valve ... 44.9 ± 4.8 N·m (33 ± 4 lb ft)

(9) **204-1488** Spring

Outside diameter ... 19.30 mm (0.760 inch)
Free length ... 49.40 mm (1.945 inch)

(10) Torque for the spool end ... 9.5 ± 1.4 N·m (85 ± 12 lb in)

(11) Torque for the cap ... 122.4 ± 12.2 N·m (90 ± 9 lb ft)

(12) **216-6160** Relief Valve Gp

Quantity ... 2
The relief valve pressure setting for 3.79 L/min (1.0 US gpm) ... 24500 ± 345 kPa (3553 ± 50 psi)
Torque for the relief valve ... 44.9 ± 4.8 N·m (33 ± 4 lb ft)

(13) Torque for the cap ... 122.4 ± 12.2 N·m (90 ± 9 lb ft)

(14) Torque for the bolt ... 9.5 ± 1.4 N·m (85 ± 12 lb in)

(15) **204-1482** Spring

Outside diameter ... 19.38 mm (0.763 inch)
Free length ... 62.97 mm (2.479 inch)

(16) Torque for the plug ... 24.5 ± 2.7 N·m (18 ± 2 lb ft)

(17) **216-6157** Spring

Outside diameter ... 4.65 mm (0.183 inch)
Free length ... 23.32 mm (0.918 inch)

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i02077635

Control Valve (Work Tool) - Remove

SMCS - 5051-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
ZZ	6V-9832	Cap As	2
	6V-9511	Plug	2
	6V-9831	Cap As	4
	6V-9510	Face Seal Plug	4
	6V-9828	Cap As	4
	6V-9507	Face Seal Plug	4
	6V-9829	Cap As	4
	6V-9508	Face Seal Plug	4
	6V-9833	Cap As	1
	6V-9512	Face Seal Plug	1
	9U-7077	Tapered Cap/Plug	1

	9U-7080	Tapered Cap/Plug	1

Start By:

A. Engage the lift arm brace. Refer to Operation and Maintenance Manual, "Loader Lift Arm - Brace".
B. Release the pressure in the hydraulic system. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
C. Tilt the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

---

1. Drain the hydraulic oil tank. Refer to Operation and Maintenance Manual, "Hydraulic System Oil - Change". The capacity of the hydraulic oil tank is approximately 35 L (9.25 gal).

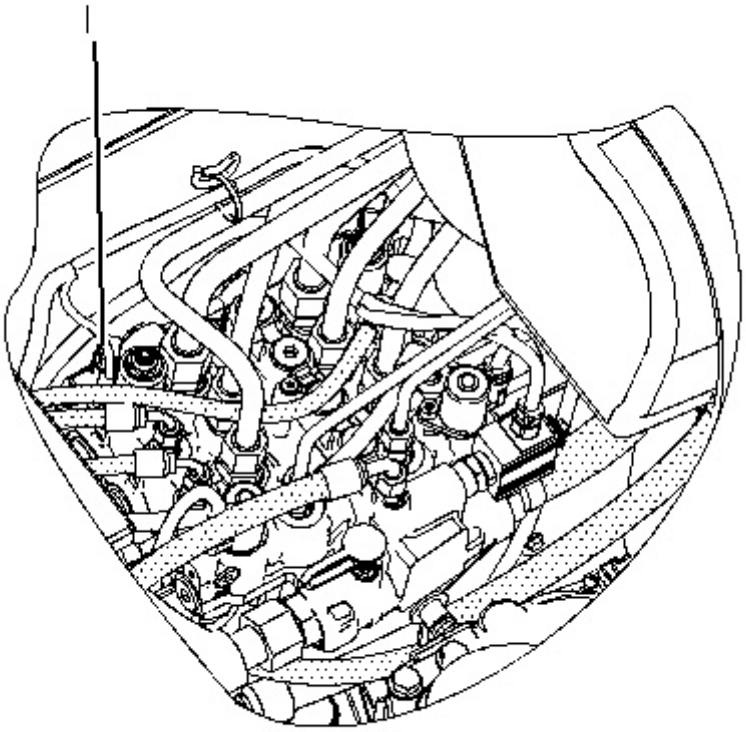


Illustration 1 g01039154

2. Disconnect five harness assemblies (1) from the control valve.

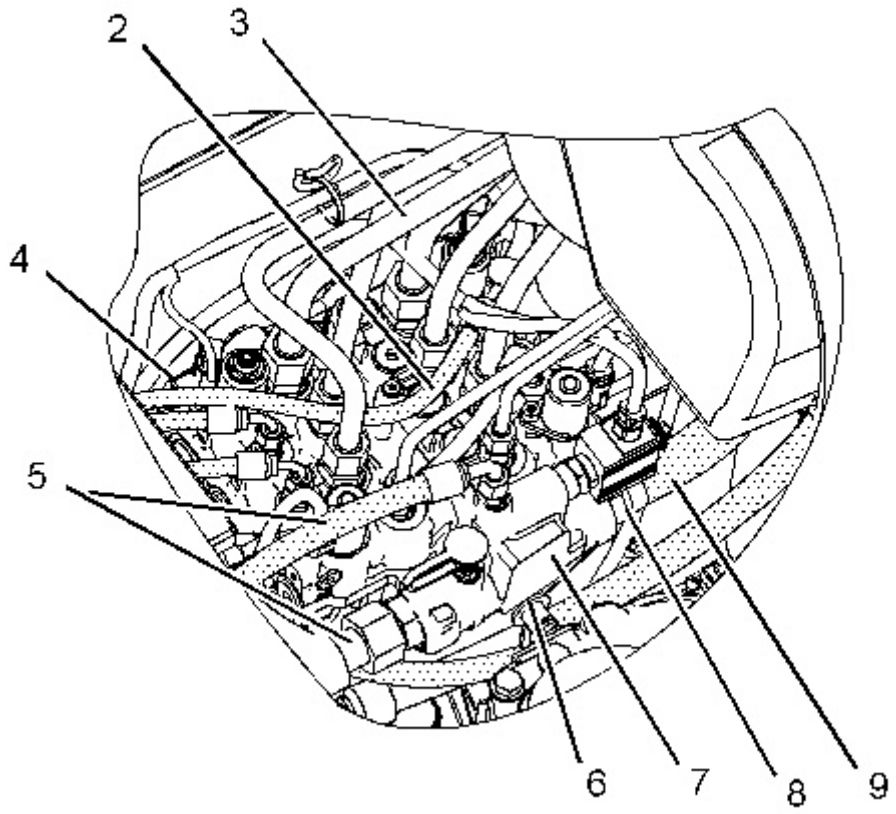


Illustration 2 g01039157

3. Disconnect four hose assemblies (2). Disconnect eight tube assemblies (3). Disconnect hose assemblies (5) and hose assembly (4) .

4. Loosen clamp (8). Disconnect hose (9). Remove bolt (6) (not shown) from control valve (7) .

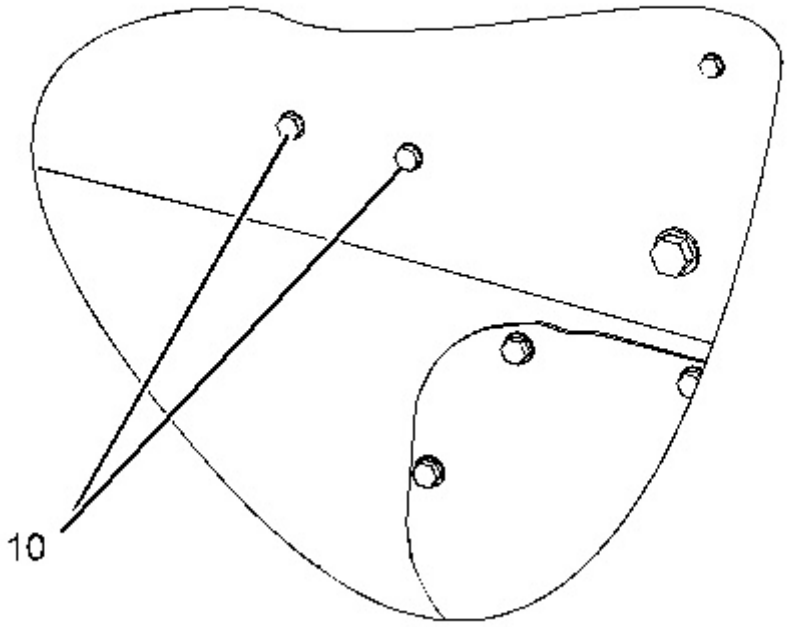


Illustration 3 g01062518

5. Remove bolts (10). Use two people or a suitable lifting device in order to remove the control valve. The weight of the control valve is approximately 36 kg (80 lb).

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02093099

Control Valve (Work Tool) - Disassemble

SMCS - 5051-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the Control Valve. Refer to Disassembly and Assembly, "Control Valve (Worktool) - Remove".

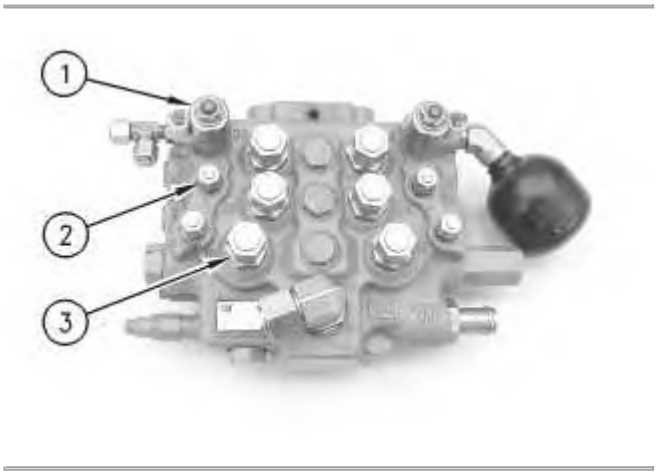


Illustration 1 g00902554

1. Remove solenoids (1). Remove fittings (2). Remove fittings (3) .



Illustration 2 g00902740

2. Remove O-ring seal (4). Remove O-ring seal (5). Remove O-ring seal (6) from solenoid (1) .



Illustration 3 g00902556

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

3. Remove the plug (7) and the O-ring seal .

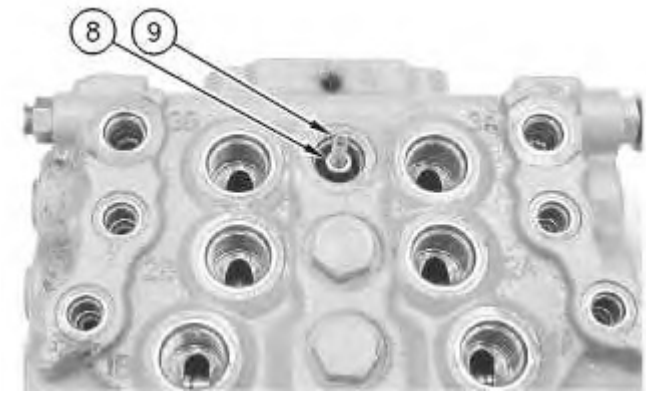


Illustration 4 g00902725

4. Remove spring (9). Remove check valve (8) .
5. Repeat Steps 3 through 4 for the remaining plugs.

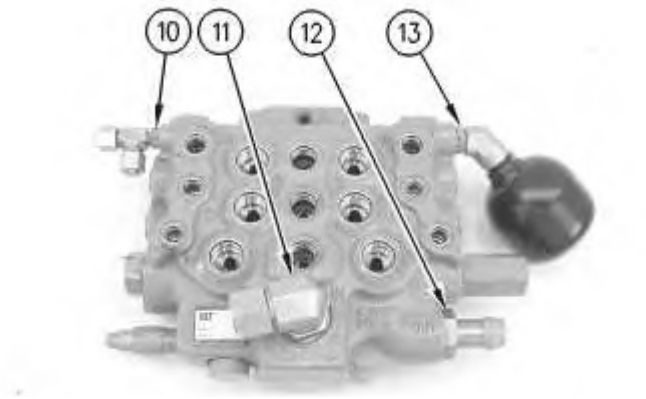


Illustration 5 g00902568

Note: Observe the orientation of the fittings and the accumulator.

6. Remove fitting (10). Remove fitting (11). Remove adapter (12). Remove fitting and the accumulator (13) .



Illustration 6 g00902570

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

7. Remove plug (14) and the O-ring seal .

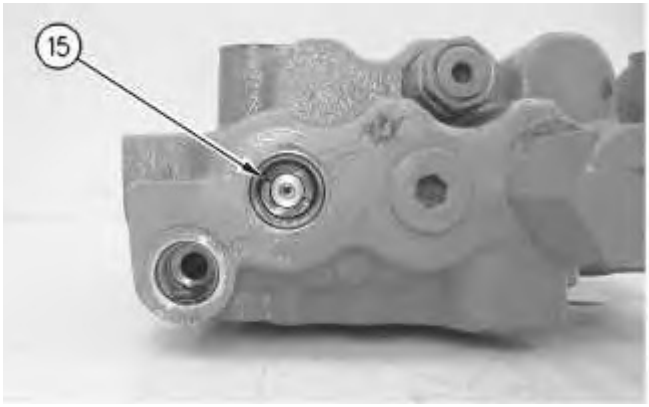


Illustration 7 g00902622

8. Remove spring (15) .
9. Repeat Steps 7 through 8 for the remaining plug.



Illustration 8 g00902652

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

10. Remove cap (16) and the O-ring seal.



Illustration 9 g01067199

11. Remove relief valves (17) .

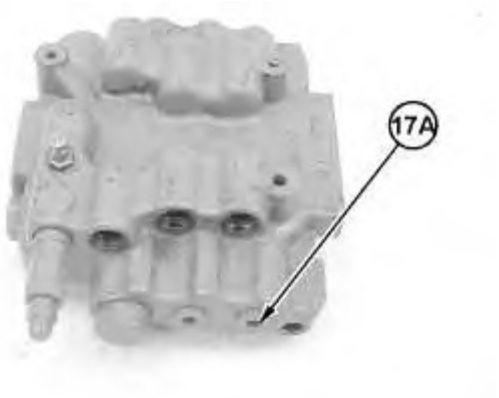


Illustration 10 g01067200

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

12. Remove plug (17A) and the O-ring seal .



Illustration 11 g00902889

13. Remove spring (18). Remove the screen and washer (19) .

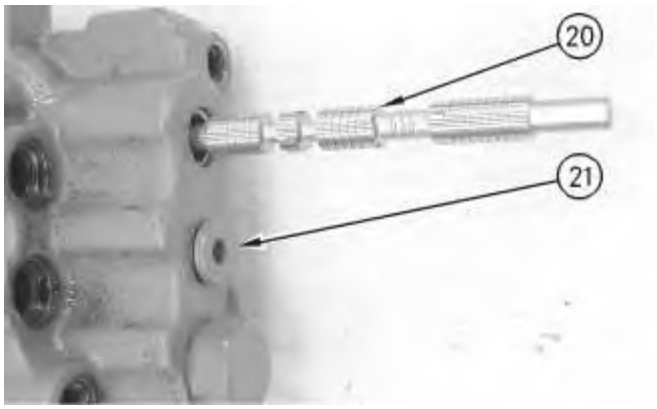


Illustration 12 g00902977

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

14. Remove spool (20). Remove the plug, the O-ring seal, and spring (21) .



Illustration 13 g00902978

15. Remove spool (22) .



Illustration 14 g00902979

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

16. Remove cap (23) and the O-ring seal .

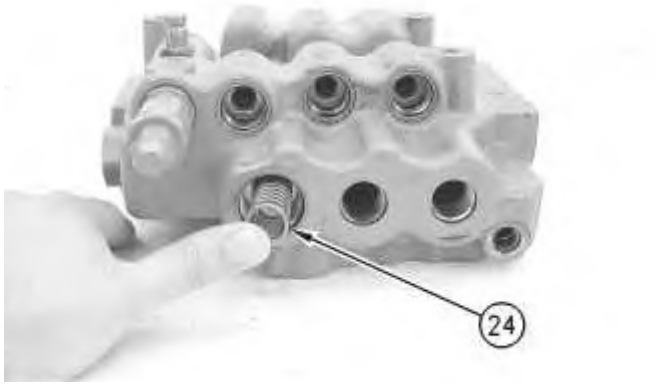


Illustration 15 g00902980

17. Remove spring (24) .

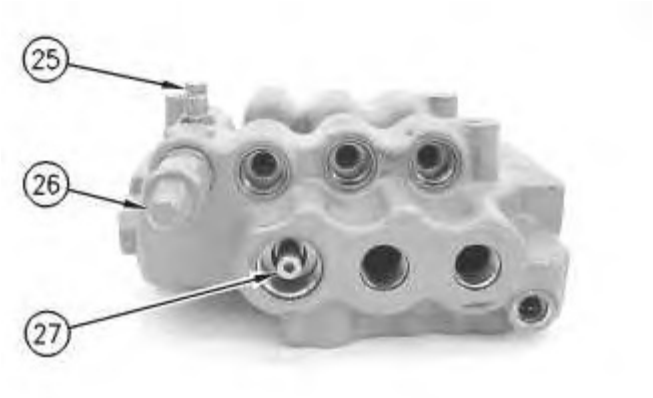


Illustration 16 g00902985

18. Remove fitting (25). Remove relief valve (26). Remove spool (27) .

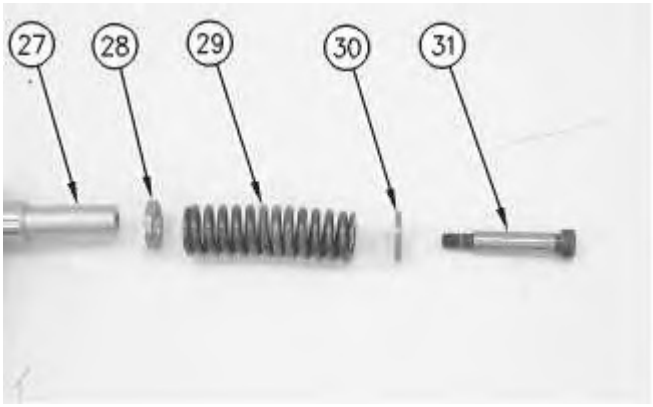


Illustration 17 g00902884

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

19. Apply heat to bolt (31). Remove bolt (31). Remove washer (30). Remove spring (29). Remove washer (28) .



Illustration 18 g00902987

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

20. Remove cap (32) and the O-ring seal .

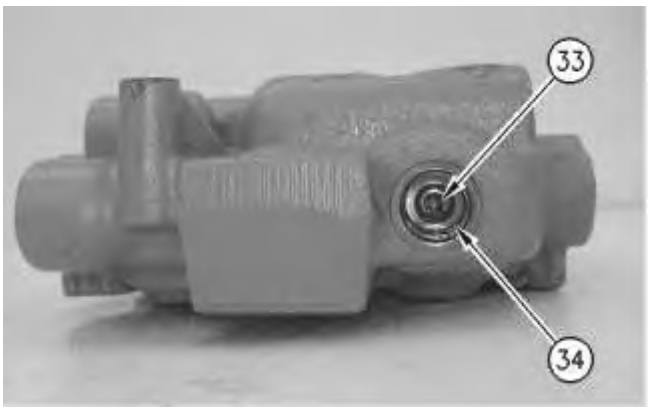


Illustration 19 g00902988

21. Remove spring (33). Remove check valve (34) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02077658

Control Valve (Work Tool) - Install

SMCS - 5051-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

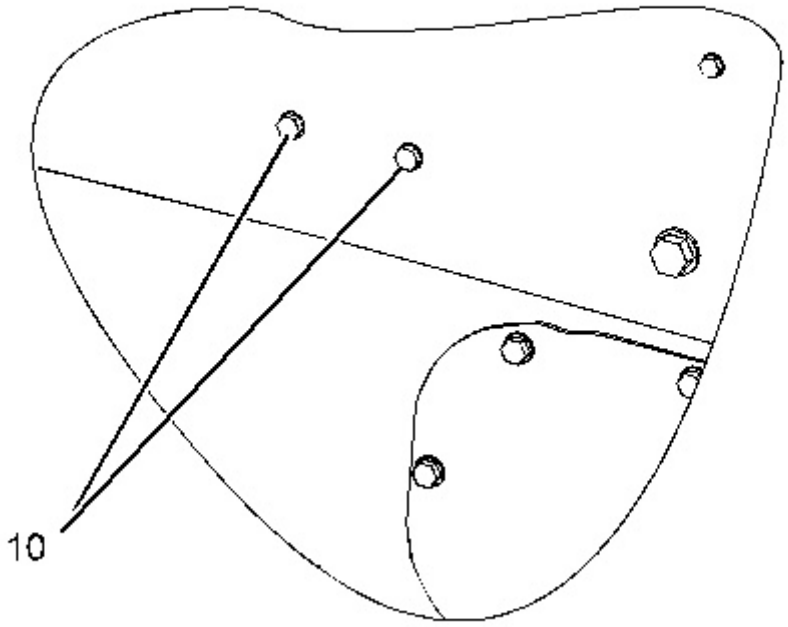


Illustration 1 g01062518

1. Use two people or a suitable lifting device in order to install the control valve. The weight of the control valve is approximately 36 kg (80 lb). Install bolts (10) .

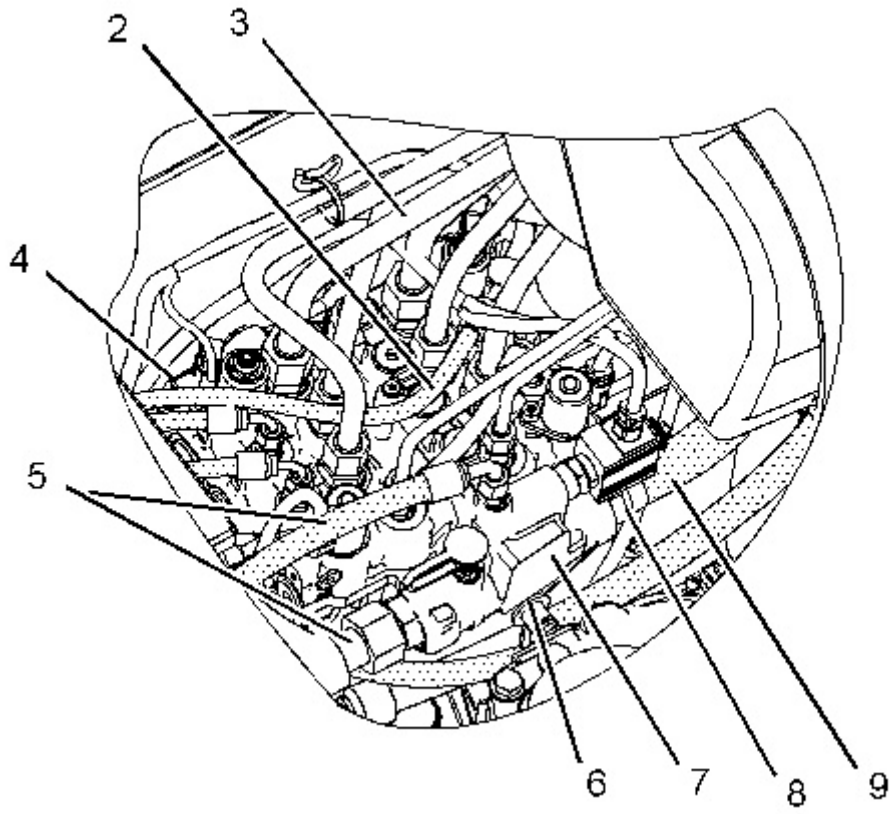


Illustration 2 g01039157

2. Connect hose assemblies (5) and hose assembly (4). Connect eight tube assemblies (3). Connect four hose assemblies (2). Install bolt (6) (not shown) into control valve (7). Connect hose (9). Tighten clamp (8) .

3. Connect four hose assemblies (2). Connect eight tube assemblies (3). Connect hose assemblies (5) and hose assembly (4) .

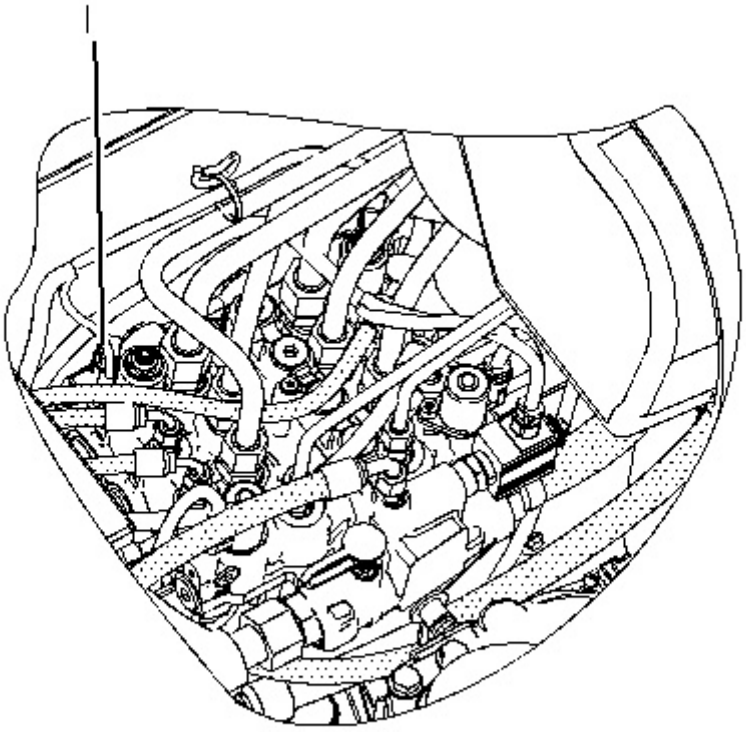


Illustration 3 g01039154

4. Connect five harness assemblies (1) for the control valve.
5. Fill the hydraulic oil tank. Refer to Operation and Maintenance Manual, "Hydraulic System Oil - Change". The capacity of the hydraulic oil tank is approximately 35 L (9.25 gal).
6. Remove the lift arm brace. Refer to Operation and Maintenance Manual, "Loader Lift Arm - Brace".

End By: Tilt the cab into the operating position. Refer to Disassembly and Assembly, "Cab - Tilt".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02152549

Diverter Valve - Remove

SMCS - 5066-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
ZZ	6V-9831	Cap As	4
	6V-9510	Face Seal Plug	4
	6V-9829	Cap As	2
	6V-9508	Face Seal Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Remove the air cleaner. Refer to Engine Supplement, "Air Cleaner - Remove and Install".

Note: The radiator and the hydraulic oil cooler have been removed for clarity.

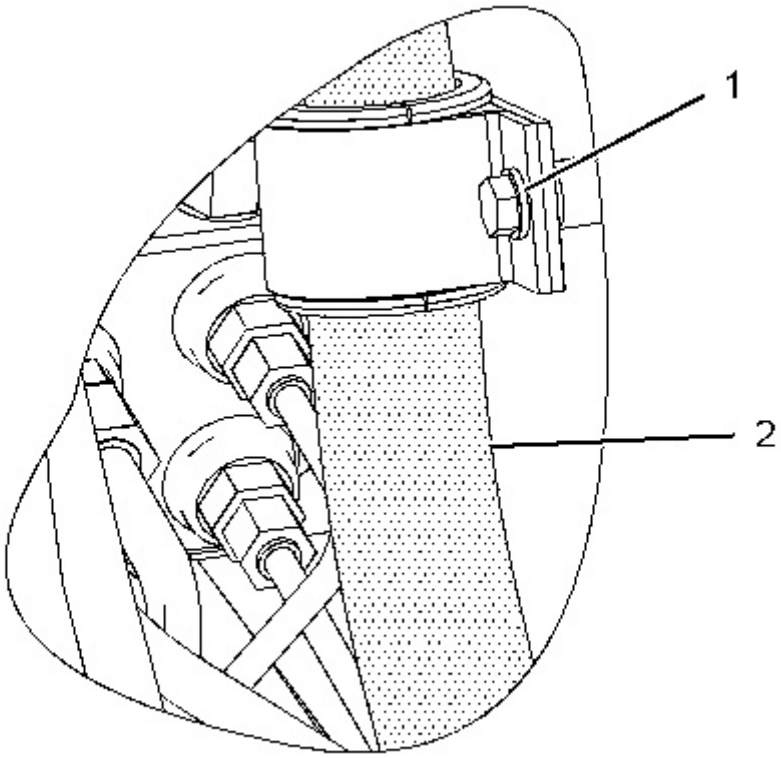


Illustration 1 g01038526

1. Remove bolt (1) and position hose (2) out of the way.

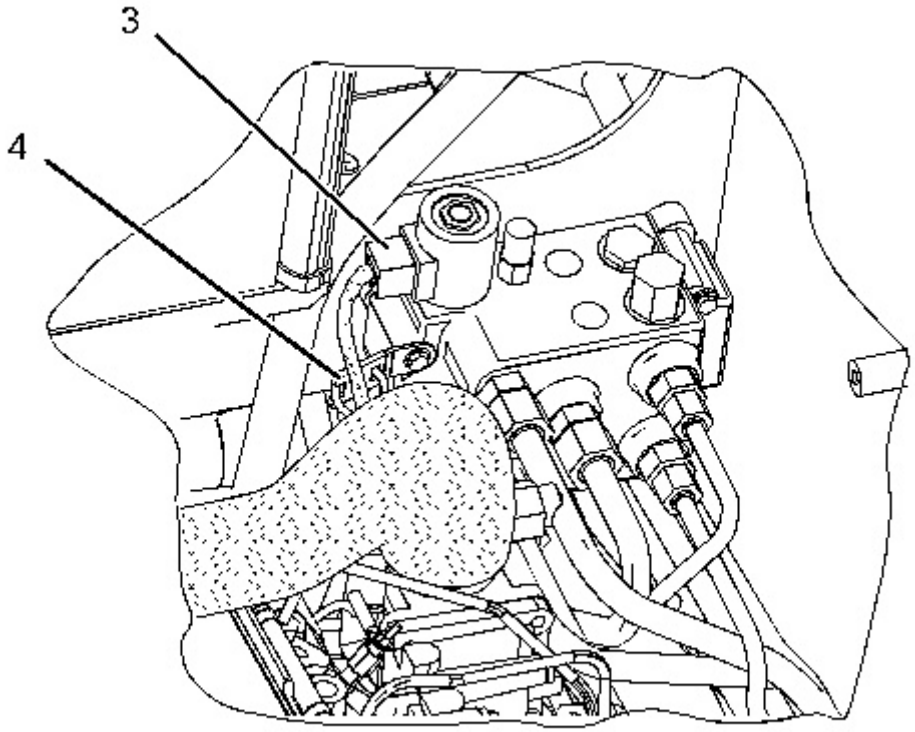


Illustration 2 g01091594

2. Disconnect harness assemblies (3) from the top and bottom of the valve. Remove cable strap (4) .

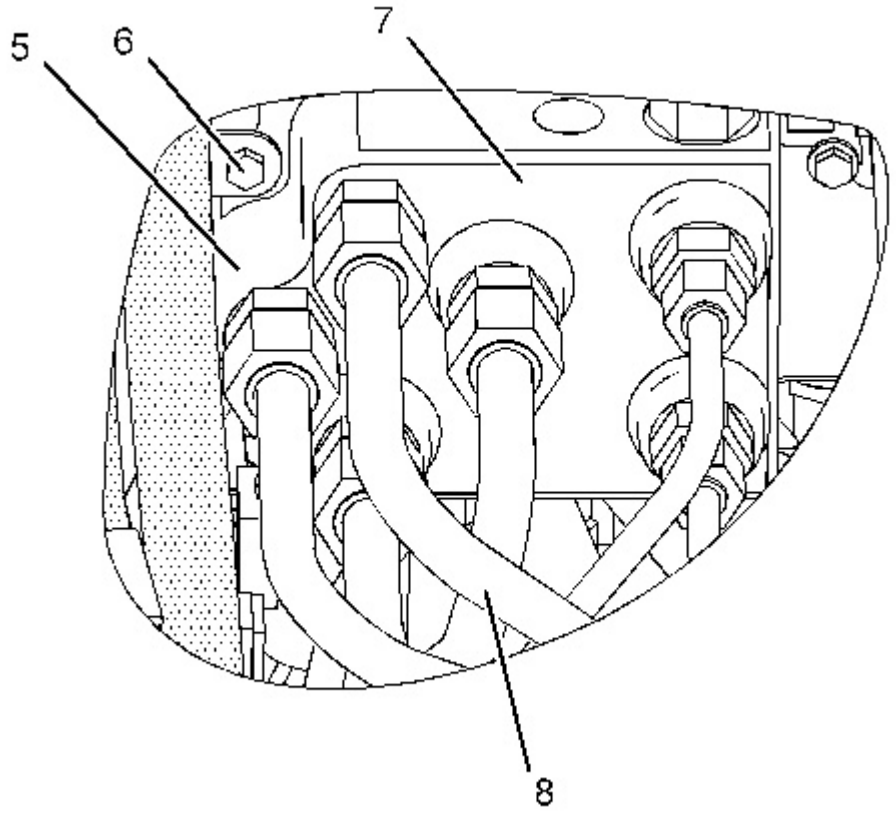


Illustration 3 g01038552

3. Disconnect tube assemblies (8). Remove bolts (6) and bracket (5). Remove diverter valve (7) .

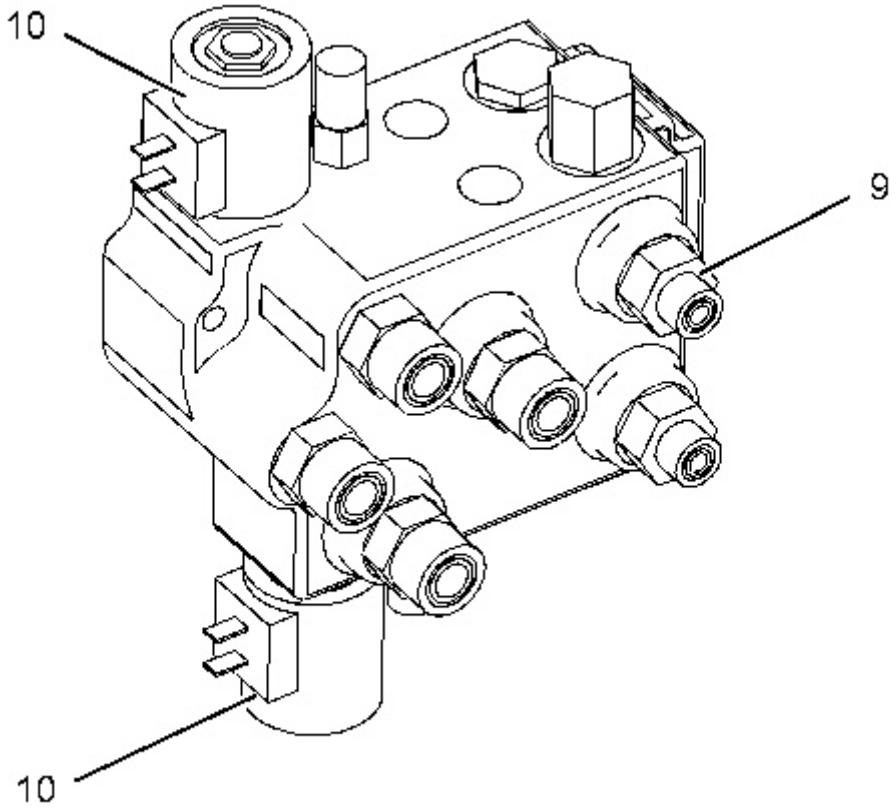


Illustration 4 g01038554

4. Remove solenoid coils (10) and fittings (9) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02153715

Diverter Valve - Install

SMCS - 5066-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

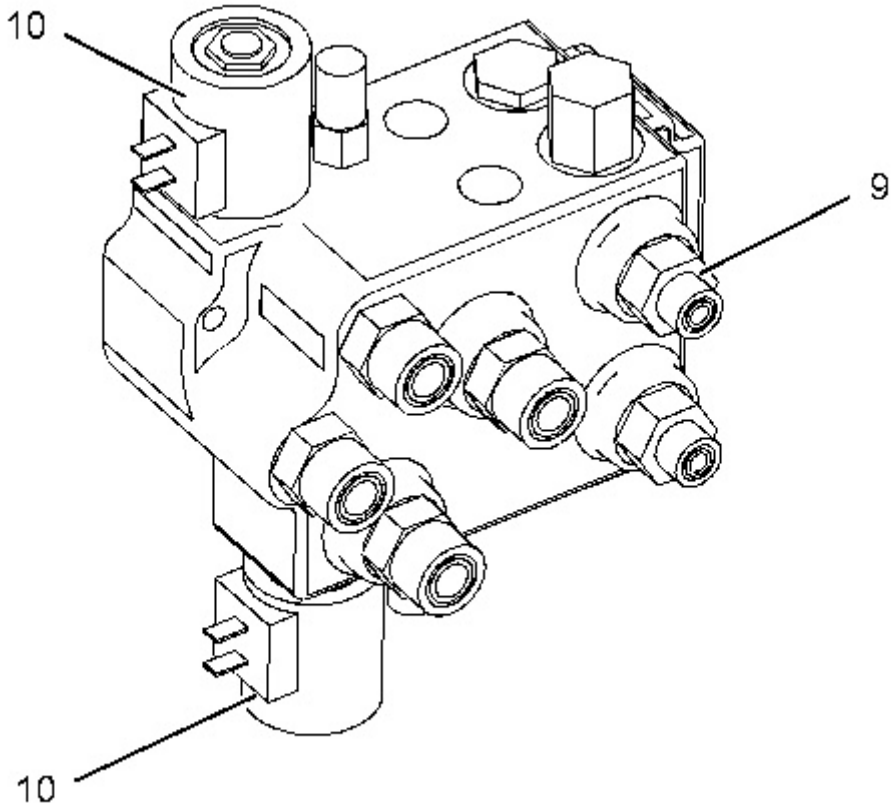


Illustration 1 g01038554

1. Install solenoid coils (10) and fittings (9). Tighten solenoid coils (10) to a torque of 41 ± 5 N·m (30 ± 4 lb ft). Tighten the nut on the solenoid coils to a torque of 5 ± 8 N·m (48 ± 7 lb in).

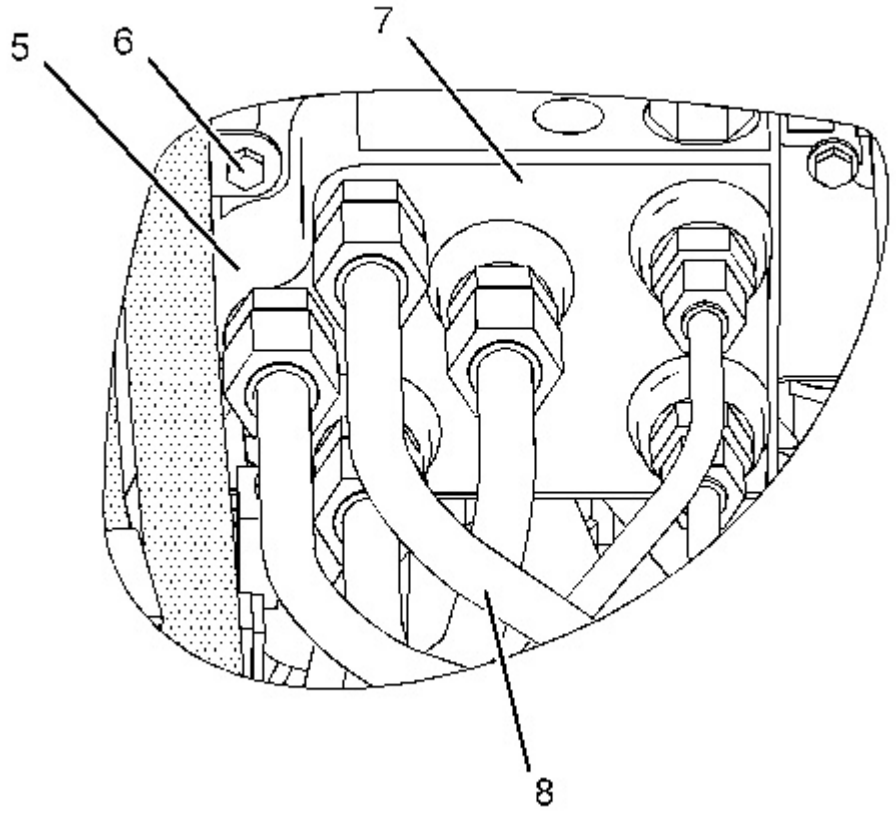


Illustration 2 g01038552

2. Install diverter valve (7). Install bracket (5) and bolts (6). Connect tube assemblies (8) .

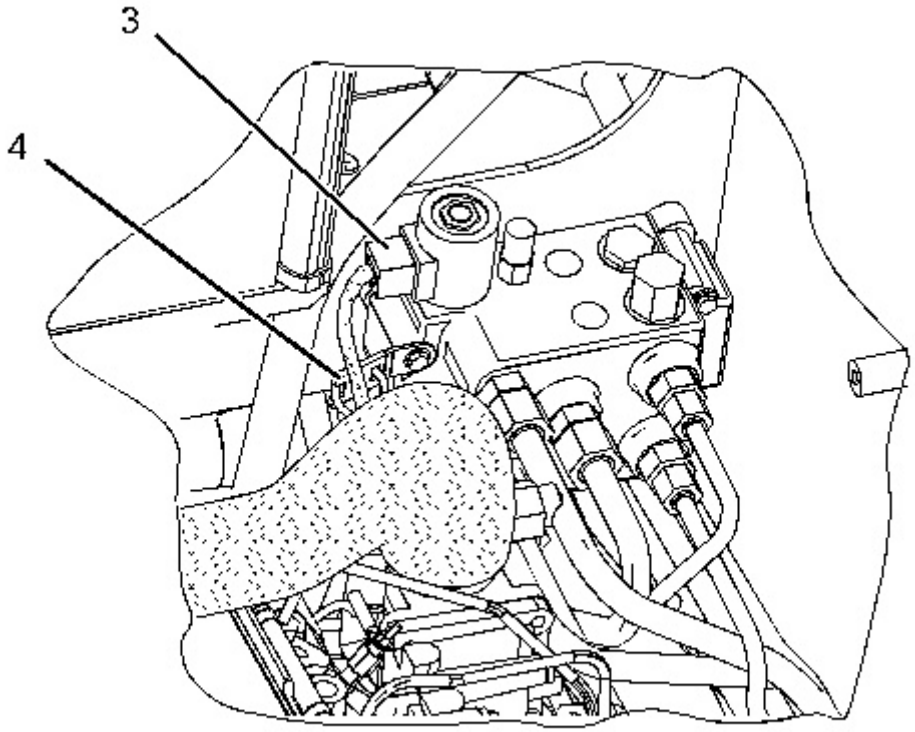


Illustration 3 g01091594

3. Connect harness assemblies (3) to the top and the bottom of the valve. Install cable strap (4) .

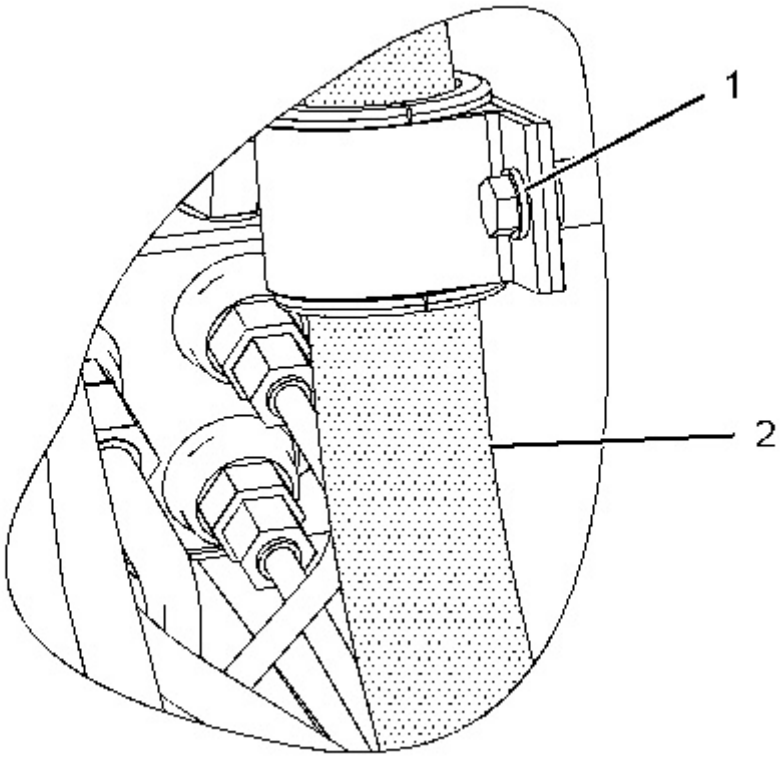


Illustration 4 g01038526

4. Move hose (2) into position and install bolt (1) .

End By: Install the air cleaner. Refer to Engine Supplement, "Air Cleaner - Remove and Install".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

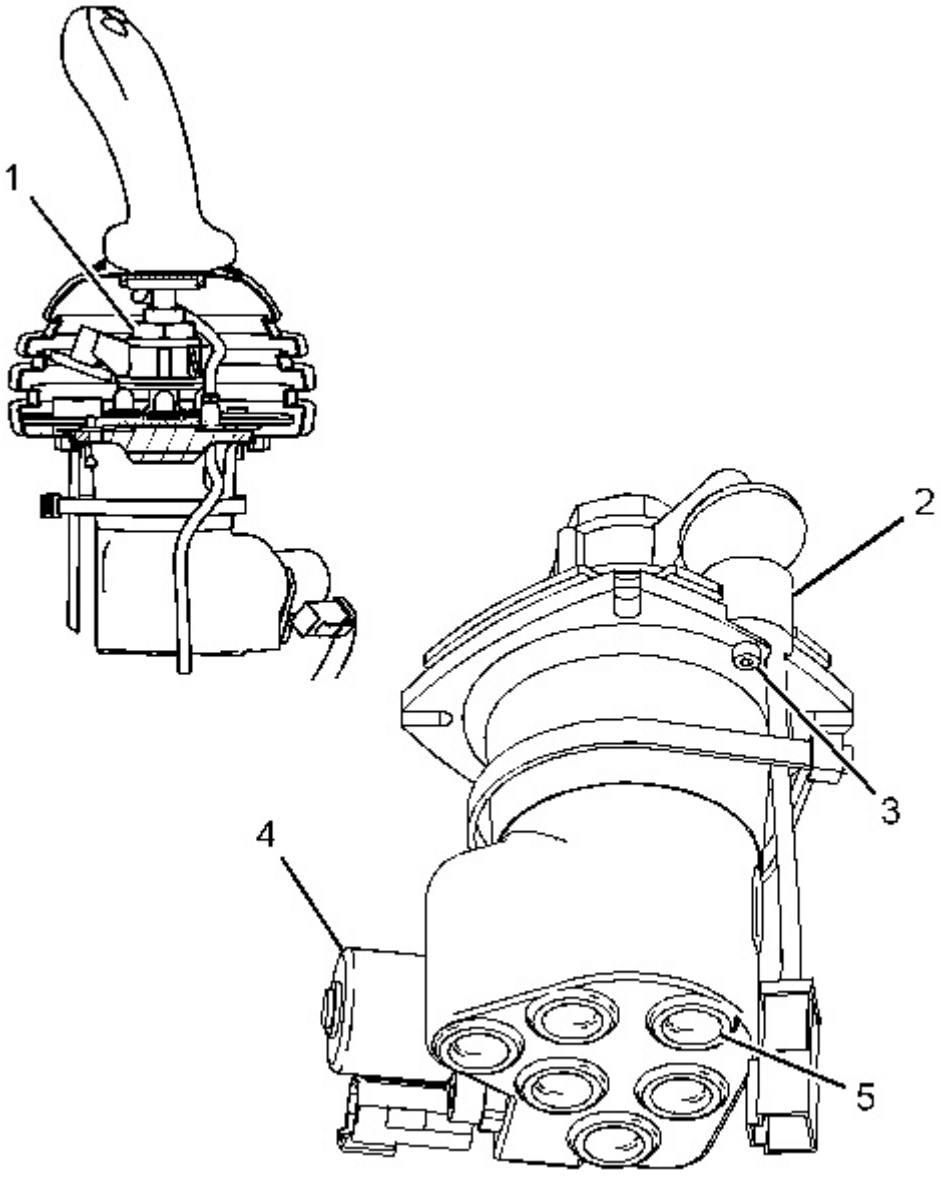


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

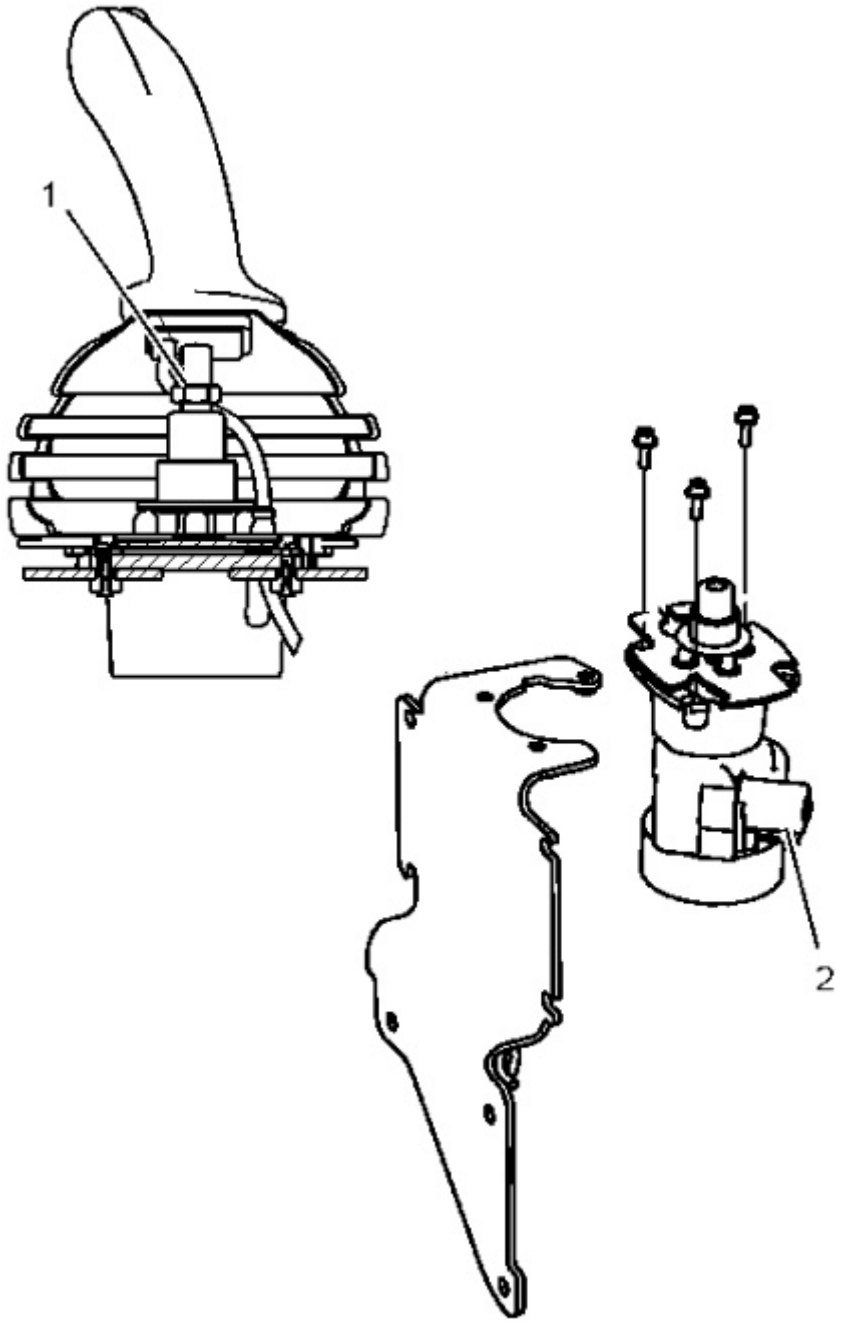


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

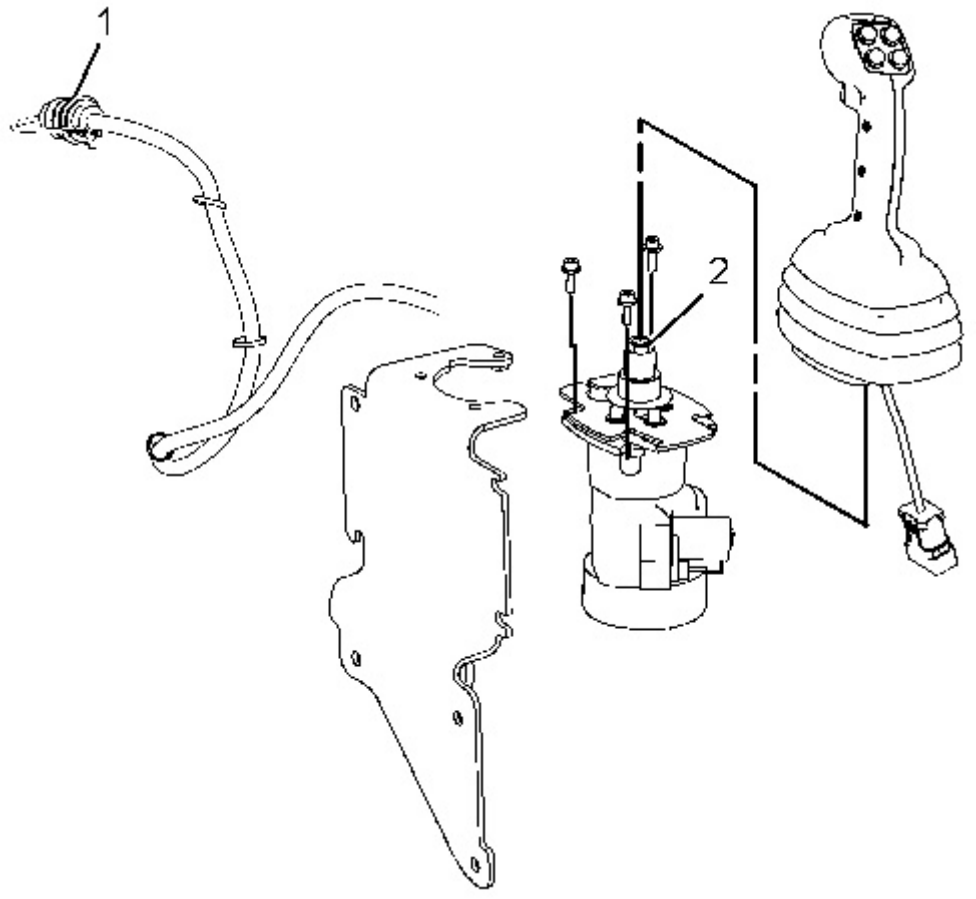


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

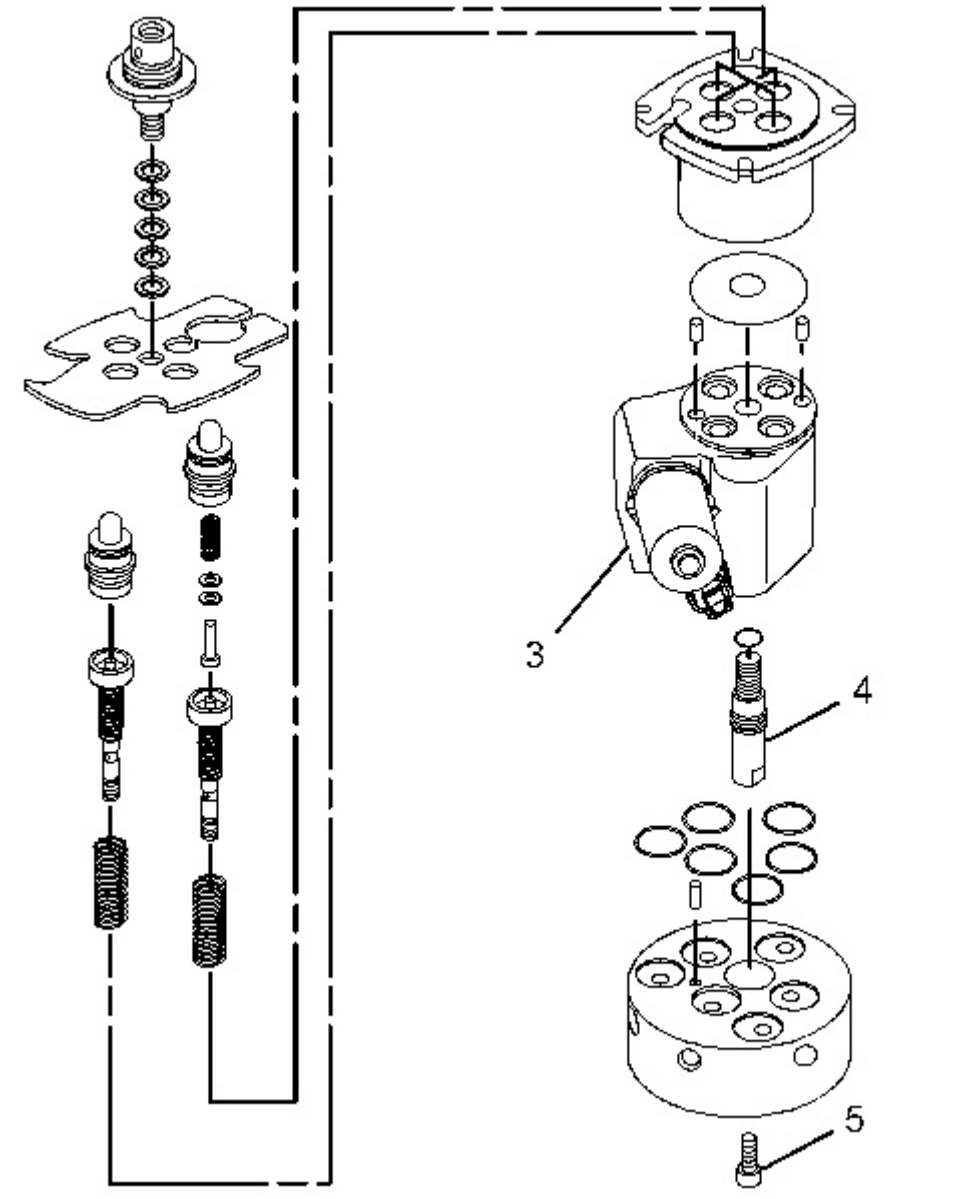


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC

Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

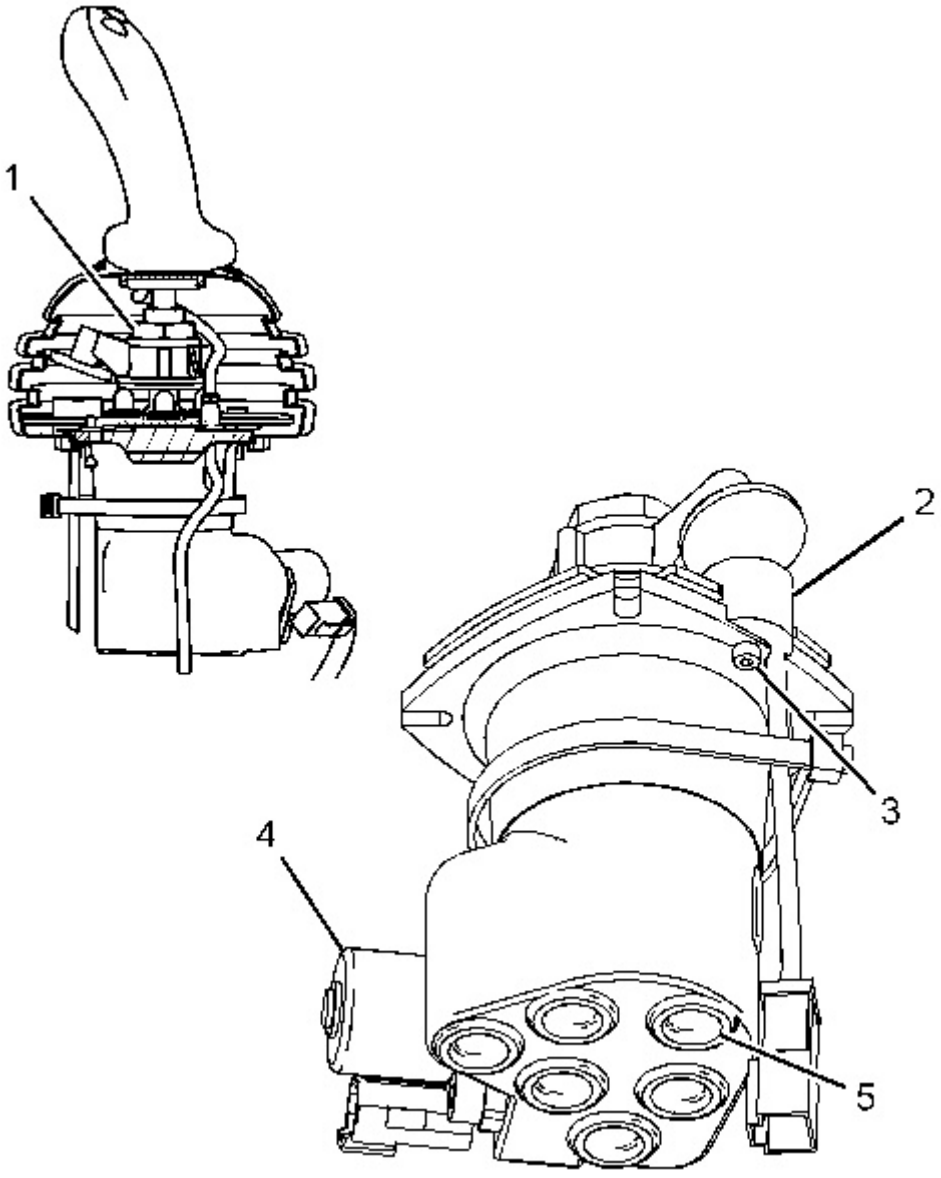


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

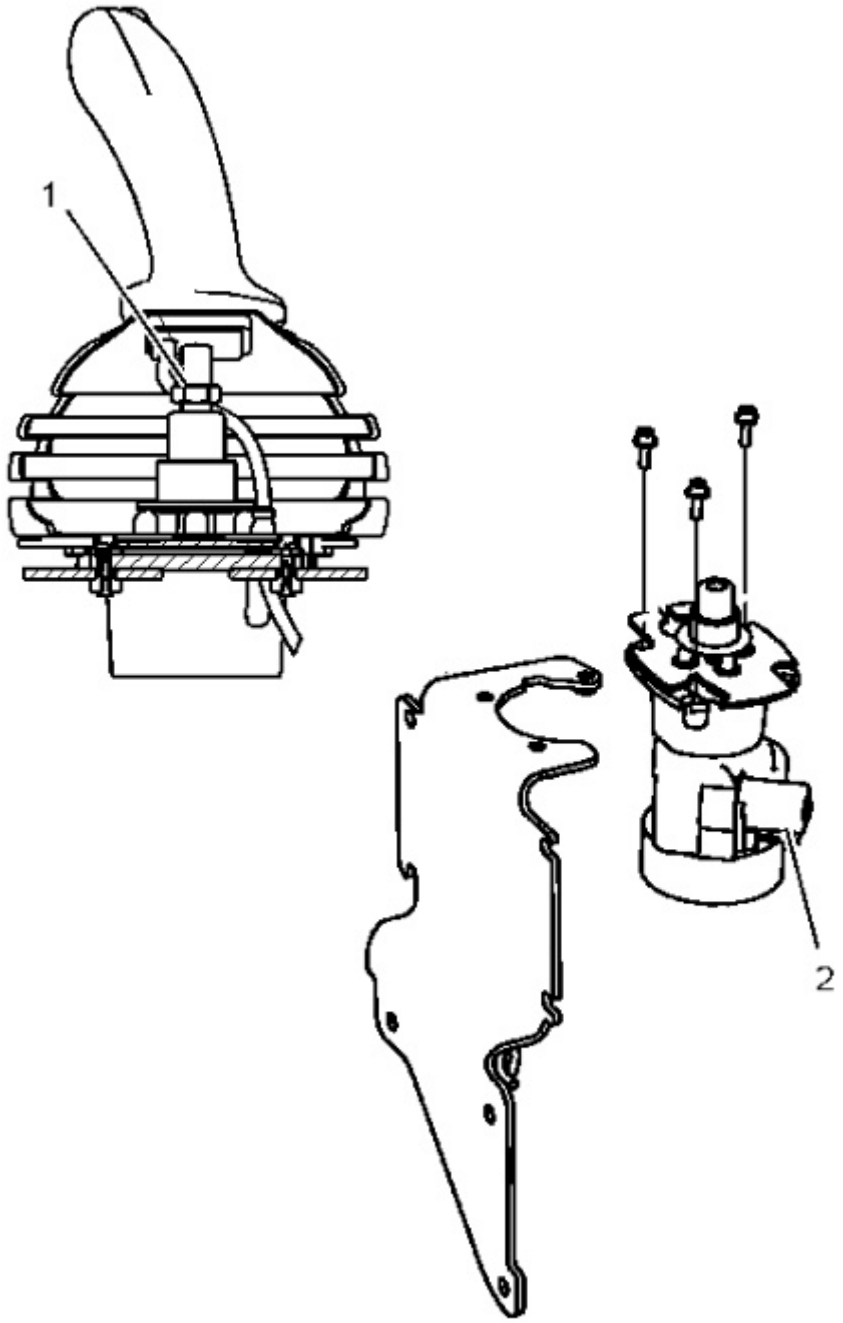


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN6750-UP

S/N - SCP4600-UP

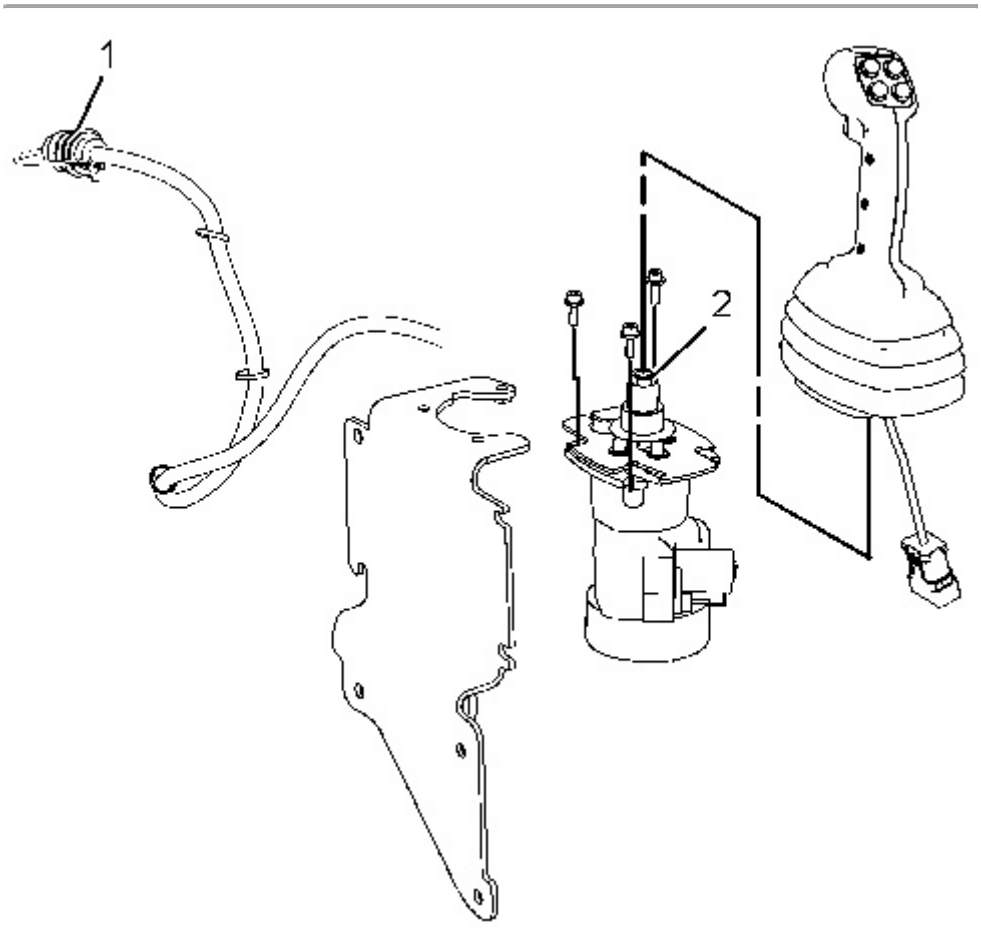


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

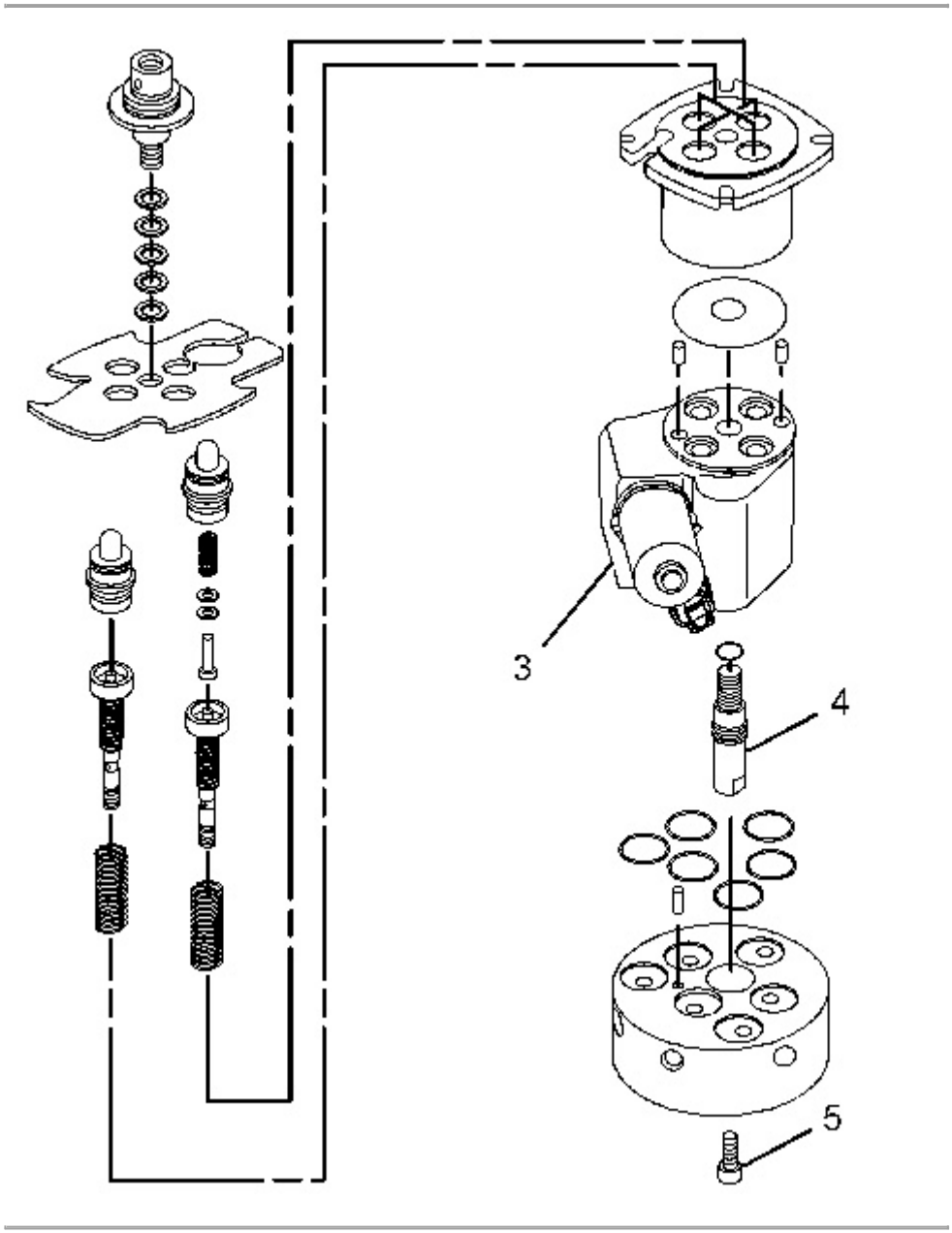


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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i02049704

Pilot Operated Hydraulic Control - Remove

SMCS - 5059-011; 5705-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	6V-9507	Face Seal Plug (9/16 - 18 THD)	5
	6V-9828	Cap As (9/16 - 18 THD)	5
	9U-7071	Tapered Cap/Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

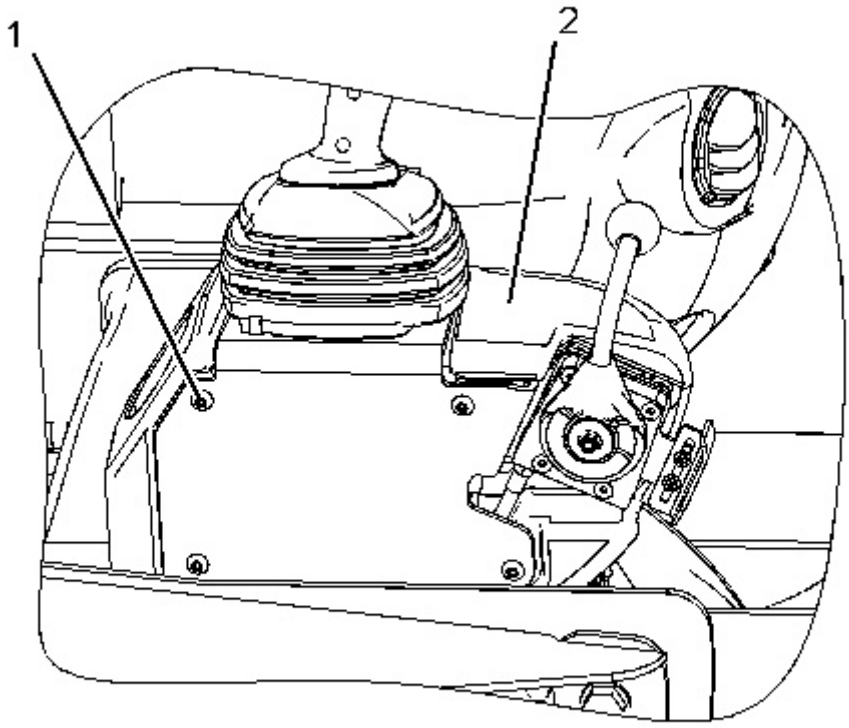


Illustration 1 g01051360

1. Remove screws (1) and remove console (2) .

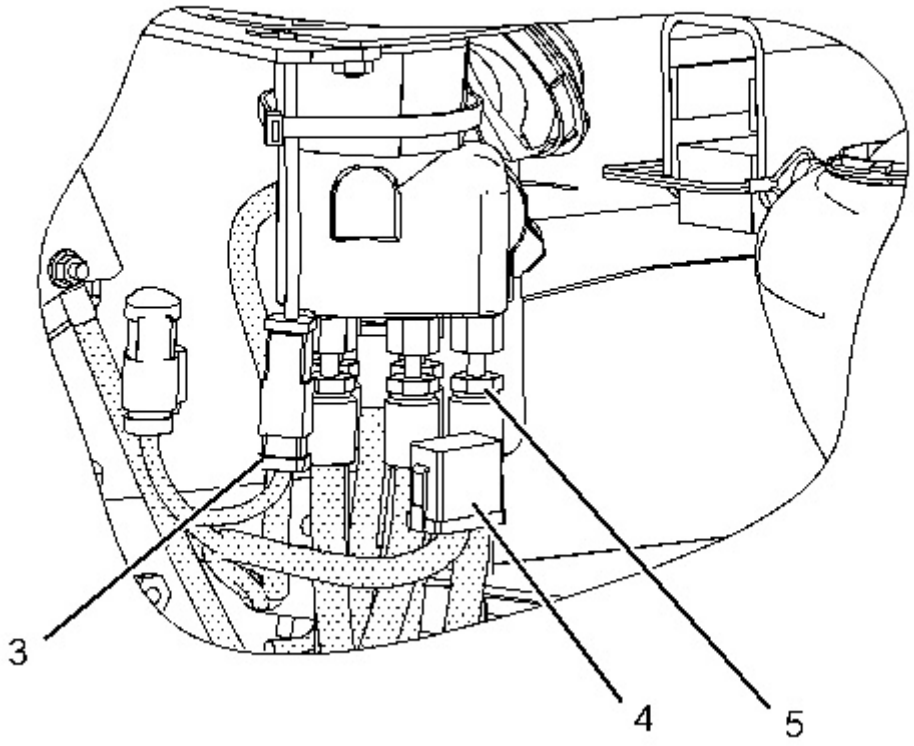


Illustration 2 g01051364

2. Disconnect harness assemblies (3) and (4). Disconnect hose assemblies (5) .

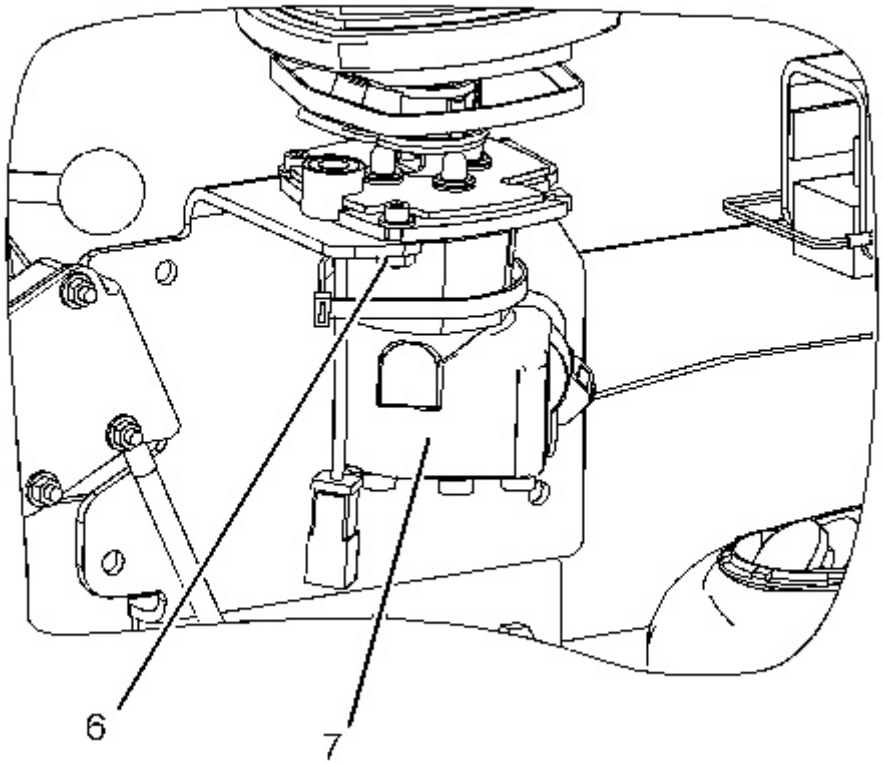


Illustration 3 g01051372

3. Remove bolts (6). Remove pilot operated hydraulic control (7) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117426

Pilot Operated Hydraulic Control - Disassemble

SMCS - 5059-015; 5705-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Remove".

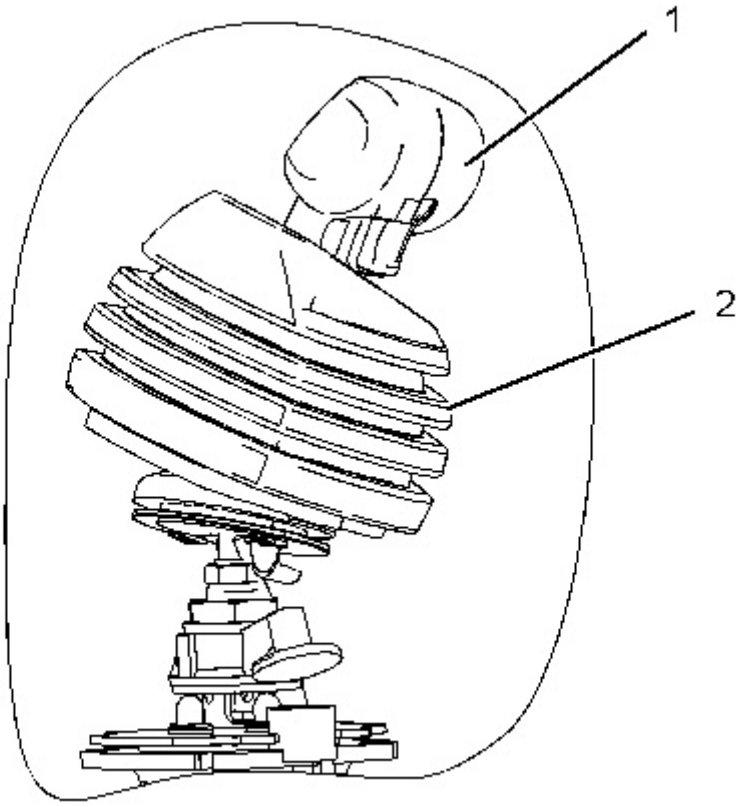


Illustration 1 g01078512

1. Lift rubber boot (2) from the joystick. Remove the screws on the side of joystick handle (1) and remove the joystick handle.

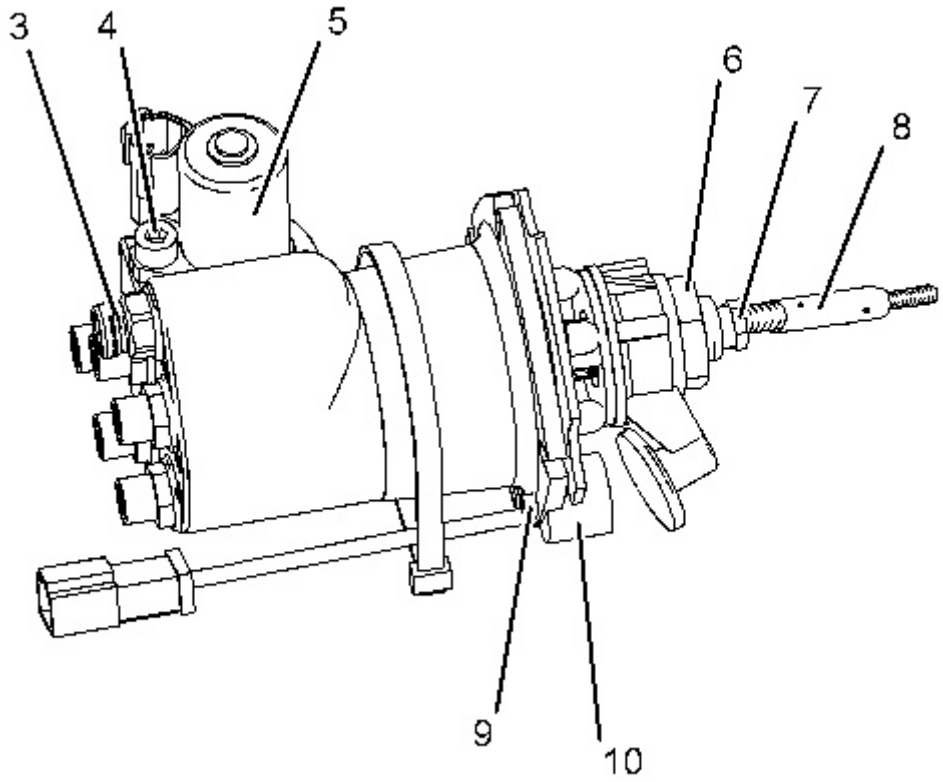


Illustration 2 g01078513

2. Remove fittings (3). Remove bolt (4) and solenoid (5). Remove bolt (9) and coil assembly (10). Note the orientation of nut (6), nut (7) and lever (8) for installation purposes. Loosen nut (7). Remove lever (8). Remove nut (6) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117461

Pilot Operated Hydraulic Control - Assemble

SMCS - 5059-016; 5705-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

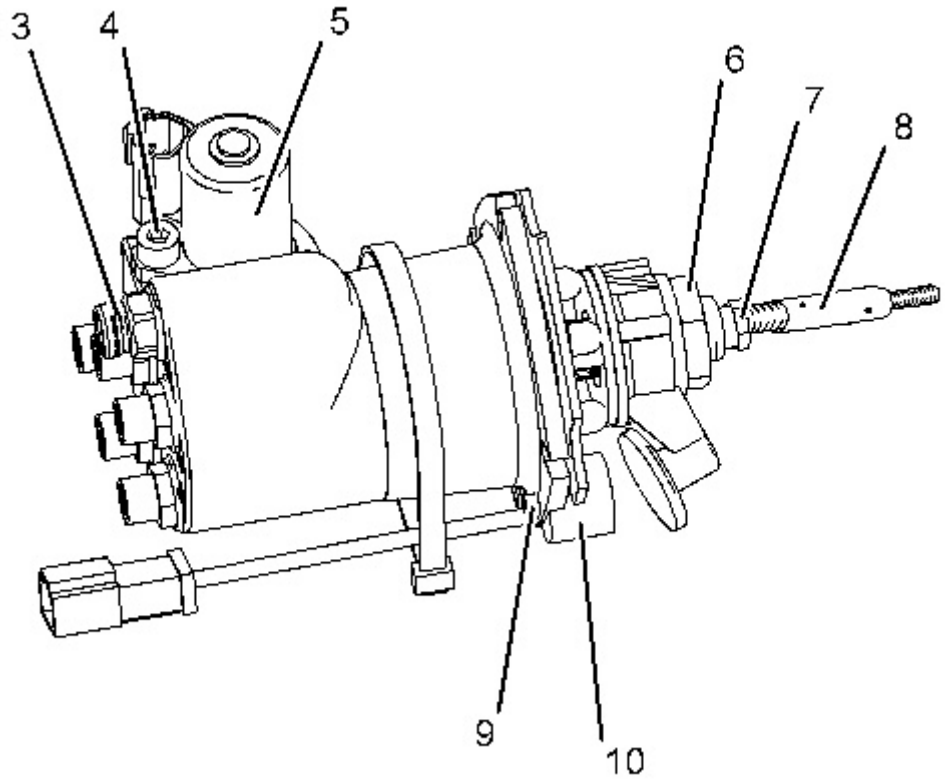


Illustration 1 g01078513

1. Install nut (6). Install lever (8). Tighten nut (7). Install fittings (3). Install solenoid (5) and bolt (4). Install coil assembly (10) and bolt (9).

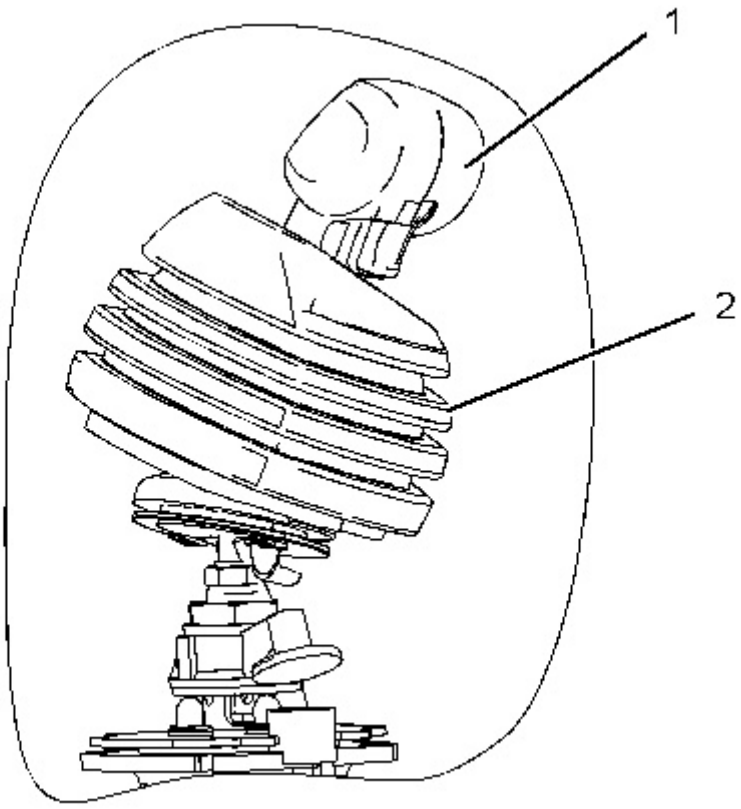


Illustration 2 g01078512

2. Install rubber boot (2) onto the joystick. Install the joystick handle (1). Install the screws on the side of joystick handle.

End By: Install the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Install".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02049737

Pilot Operated Hydraulic Control - Install

SMCS - 5059-012; 5705-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

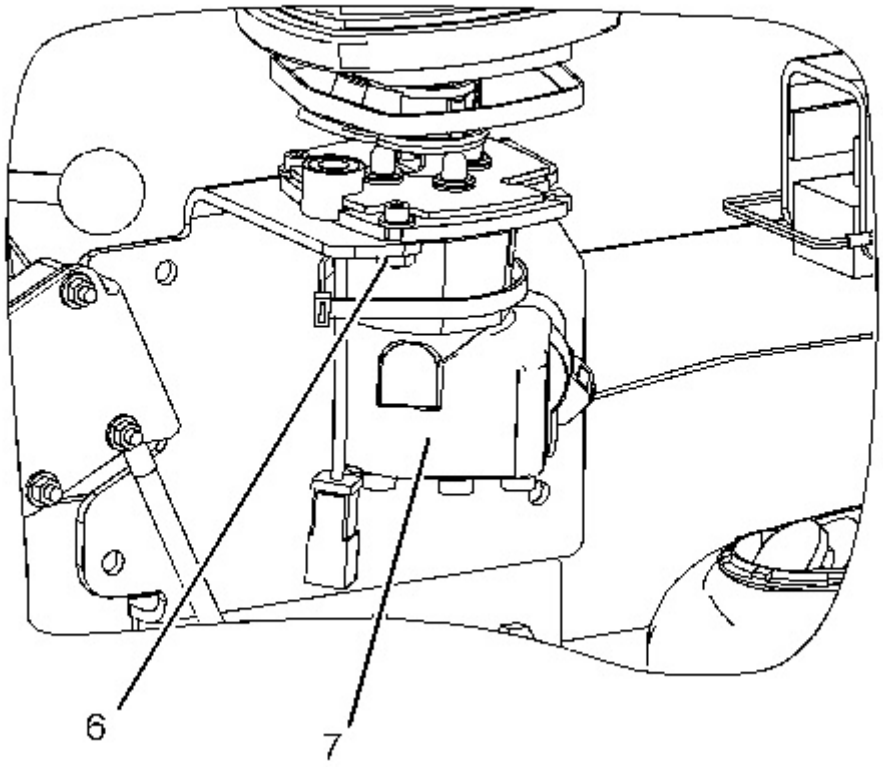


Illustration 1 g01051372

1. Install pilot operated hydraulic control (7). Install bolts (6) .

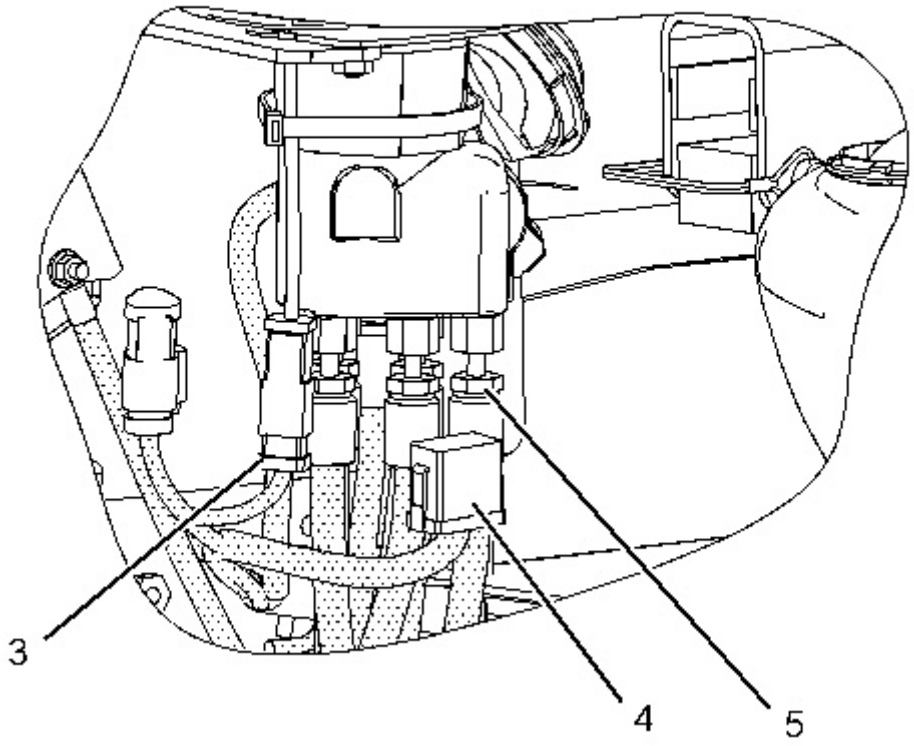


Illustration 2 g01051364

2. Connect harness assemblies (3) and (4). Connect hose assemblies (5) .

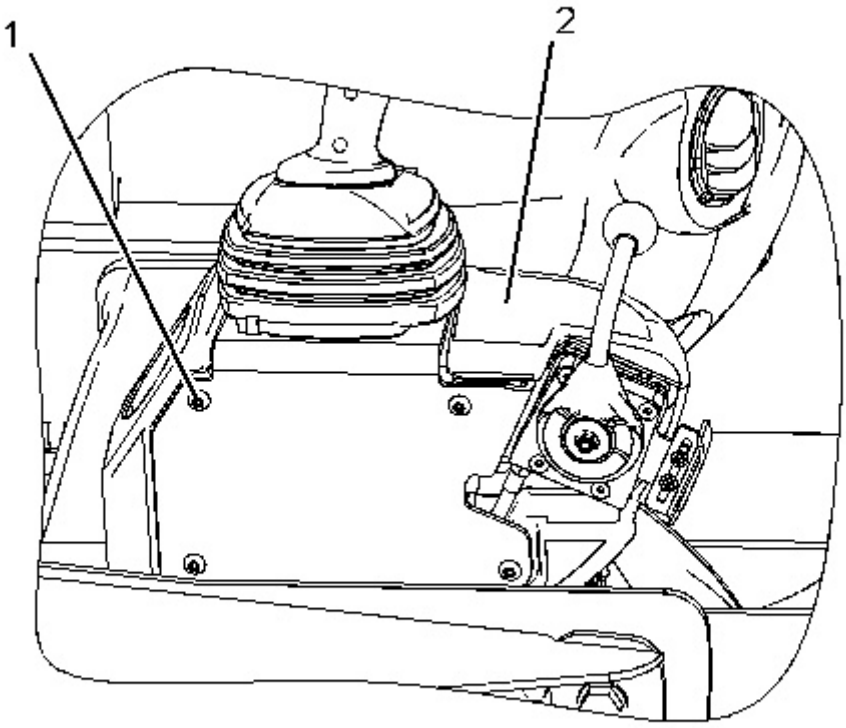


Illustration 3 g01051360

3. Install console (2). Remove screws (1). Tighten the screws (1) to a torque of 2.25 ± .25 N·m (20 ± 2 lb in).

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856143

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

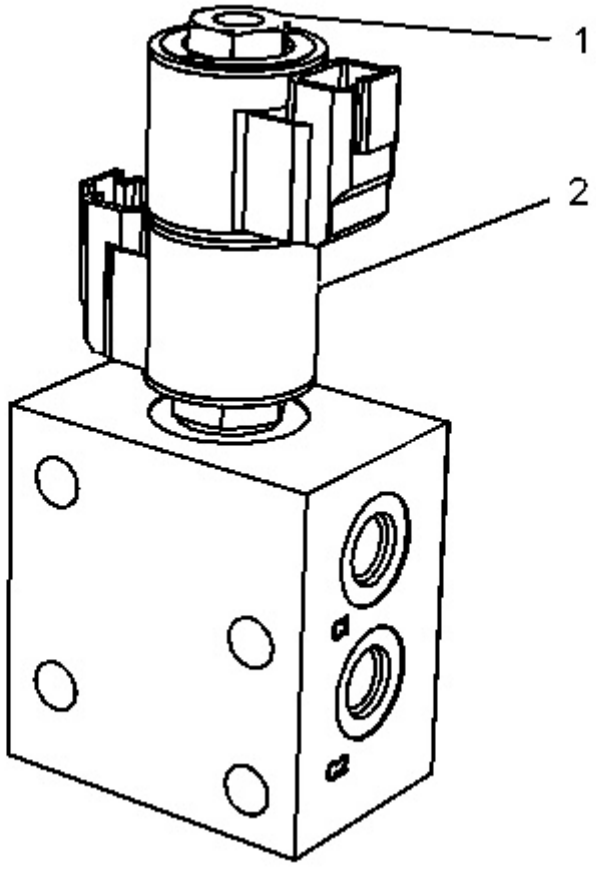


Illustration 1 g01422597

(2) **249-7160** Solenoid Valve Gp

Torque for the nut (1) ... 5.8 ± 1.0 N·m (50 ± 9 lb in)
Final installation torque ... 30 ± 3 N·m (265 ± 27 lb in)
Operating temperature range ... −40 to 105 °C (−40 to 221 °F)

Nominal voltage for operation ... 12 VDC
Maximum voltage for operation at 121 °C (250 °F) ... 14.5 VDC
Minimum current for valve actuation ... 0.92 Amperes
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 10.3 ± 0.6 Ohms
Minimum voltage for valve actuation with the coil at 40 °C (104 °F) ... 10.8 VDC
Maximum wattage for continuous duty ... 14 Watts

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856147

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

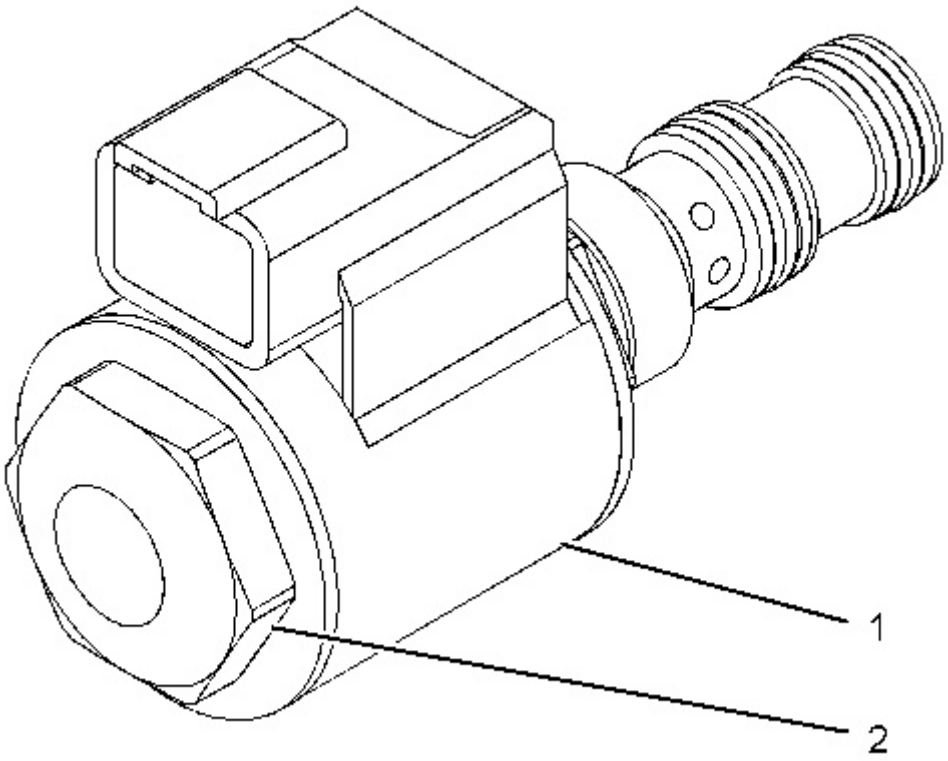


Illustration 1 g01422599

(1) **259-8194** Solenoid Valve Gp

Torque for the nut (2) ... 5.3 ± 1.5 N·m (45 ± 13 lb in)
Installation torque ... 24 ± 3 N·m (210 ± 27 lb in)
Operating voltage ... 12 VDC

Maximum voltage for valve actuation at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for valve actuation with the coil at 25 °C (77 °F) ... 10.2 VDC
Maximum wattage for continuous duty with the coil at a temperature of 25 °C (77 °F) ... 16.3 Watts
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 8.8 ± 0.5 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)

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i02856143

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

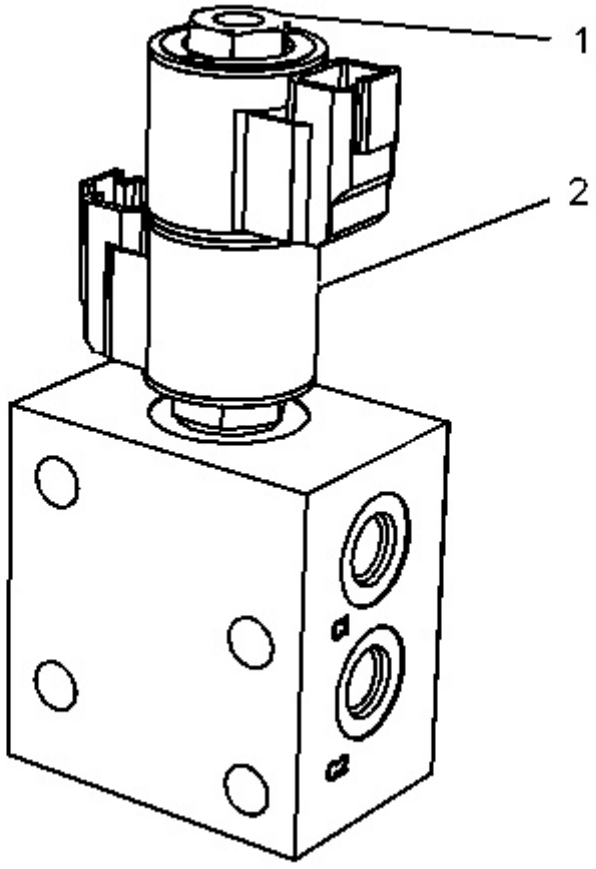


Illustration 1 g01422597

(2) **249-7160** Solenoid Valve Gp

Torque for the nut (1) ... 5.8 ± 1.0 N·m (50 ± 9 lb in)
Final installation torque ... 30 ± 3 N·m (265 ± 27 lb in)
Operating temperature range ... −40 to 105 °C (−40 to 221 °F)

Nominal voltage for operation ... 12 VDC
Maximum voltage for operation at 121 °C (250 °F) ... 14.5 VDC
Minimum current for valve actuation ... 0.92 Amperes
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 10.3 ± 0.6 Ohms
Minimum voltage for valve actuation with the coil at 40 °C (104 °F) ... 10.8 VDC
Maximum wattage for continuous duty ... 14 Watts

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856147

Control Manifold (Quick Coupler)

SMCS - 5264; 5479

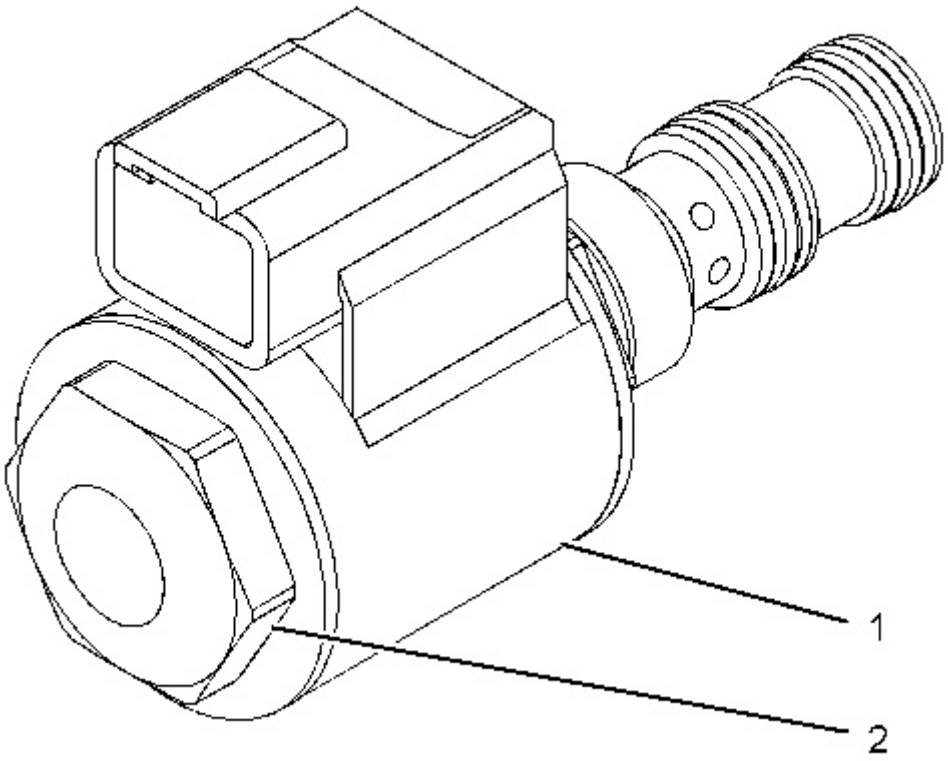


Illustration 1 g01422599

(1) **259-8194** Solenoid Valve Gp

Torque for the nut (2) ... 5.3 ± 1.5 N·m (45 ± 13 lb in)
Installation torque ... 24 ± 3 N·m (210 ± 27 lb in)
Operating voltage ... 12 VDC

Maximum voltage for valve actuation at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for valve actuation with the coil at 25 °C (77 °F) ... 10.2 VDC
Maximum wattage for continuous duty with the coil at a temperature of 25 °C (77 °F) ... 16.3 Watts
Resistance at 25 ± 5 °C (77 ± 9 °F) ... 8.8 ± 0.5 Ohms
Operating temperature range ... −40 to 120 °C (−40 to 248 °F)

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02161386

Lift Arms - Remove - Extended Reach Machines

SMCS - 6119-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	1P-1864	Retaining Ring Pliers As	1
B	1U-9200	Lever Puller Hoist	1
ZZ	6V-9508	Face Seal Plug	2
	6V-9829	Cap As	2
	6V-9510	Face Seal Plug	4
	6V-9831	Cap As	4

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

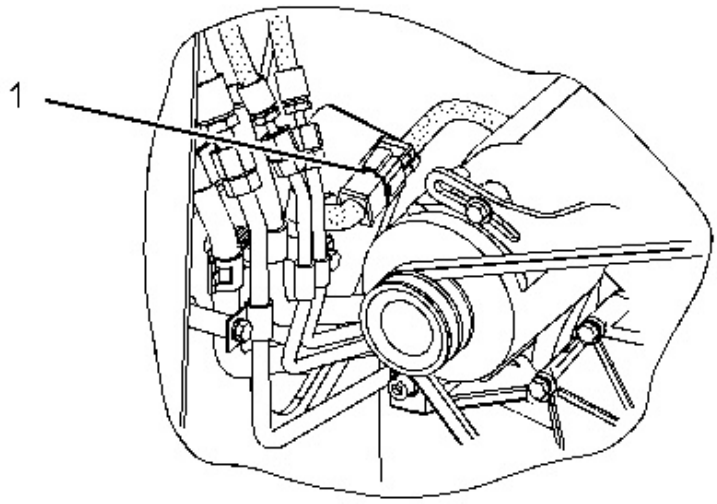


Illustration 1 g01051787

1. Disconnect harness assembly (1) .

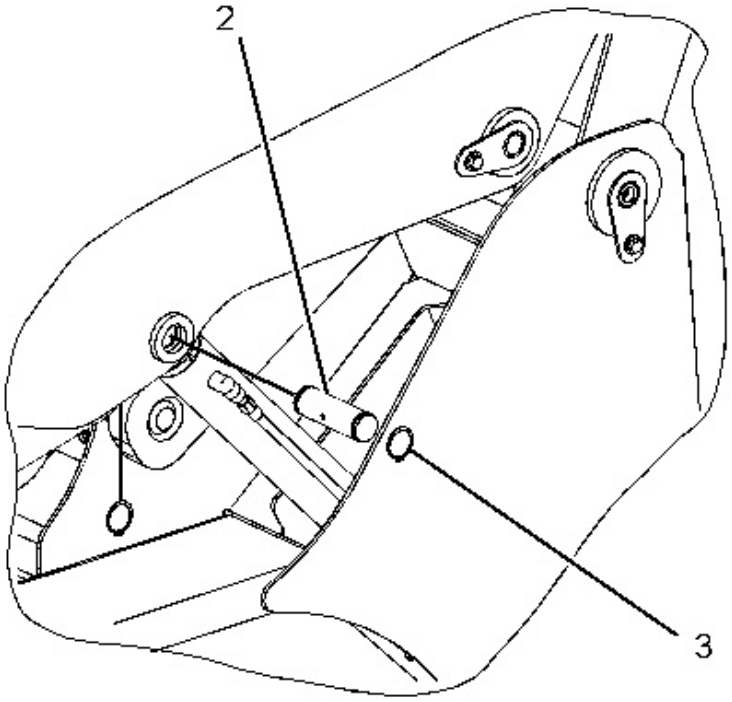


Illustration 2 g01051794

2. Use Tooling (A) in order to remove retaining ring (3). Remove pin assembly (2). Repeat this step for both sides of the machine.

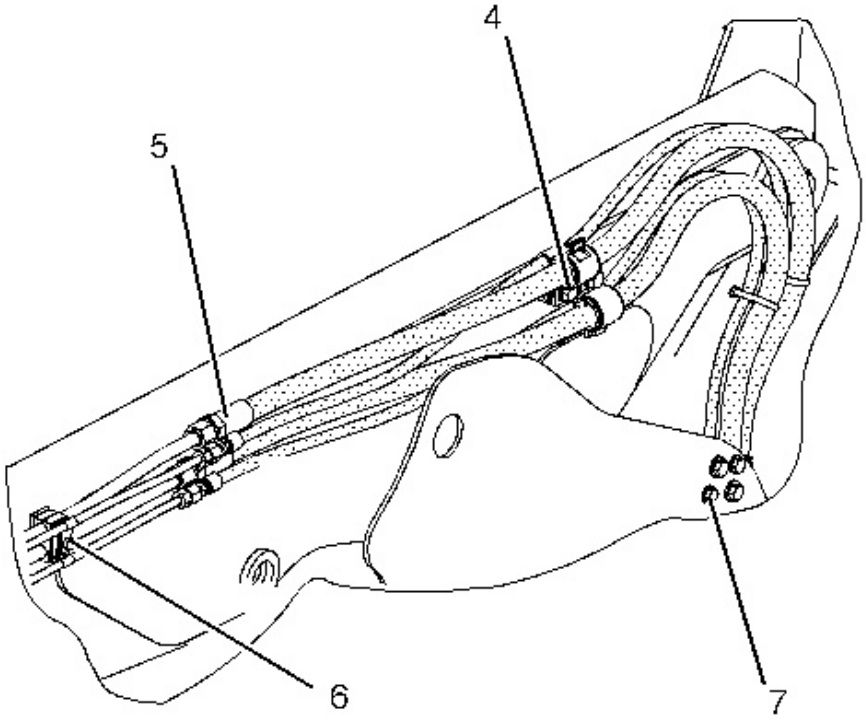


Illustration 3 g01051826

3. Remove bolts (4), (6) and (7). Disconnect hose assemblies (5).

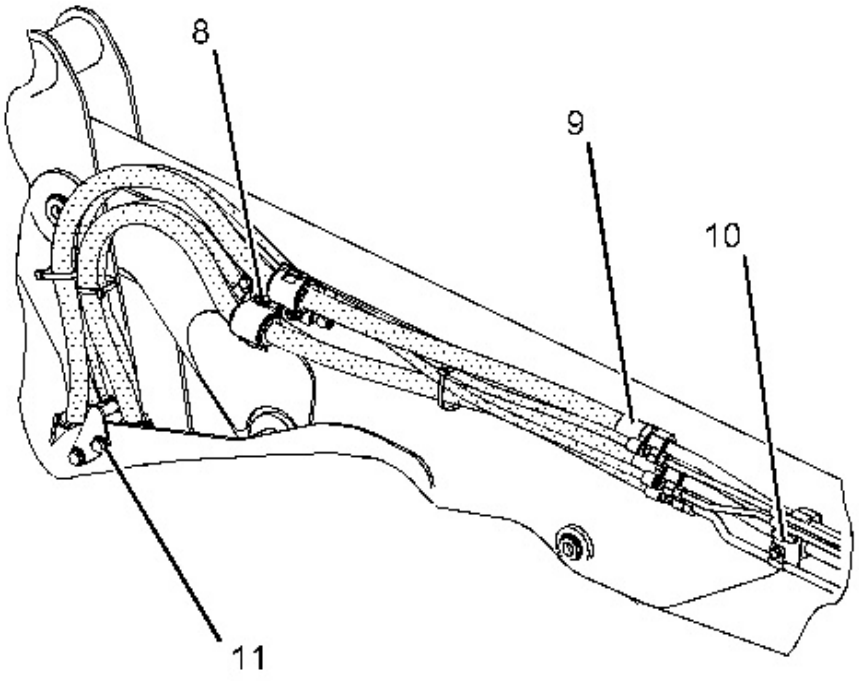


Illustration 4 g01051845

4. Remove bolts (8), (11) and (10). Disconnect hose assemblies (9) .

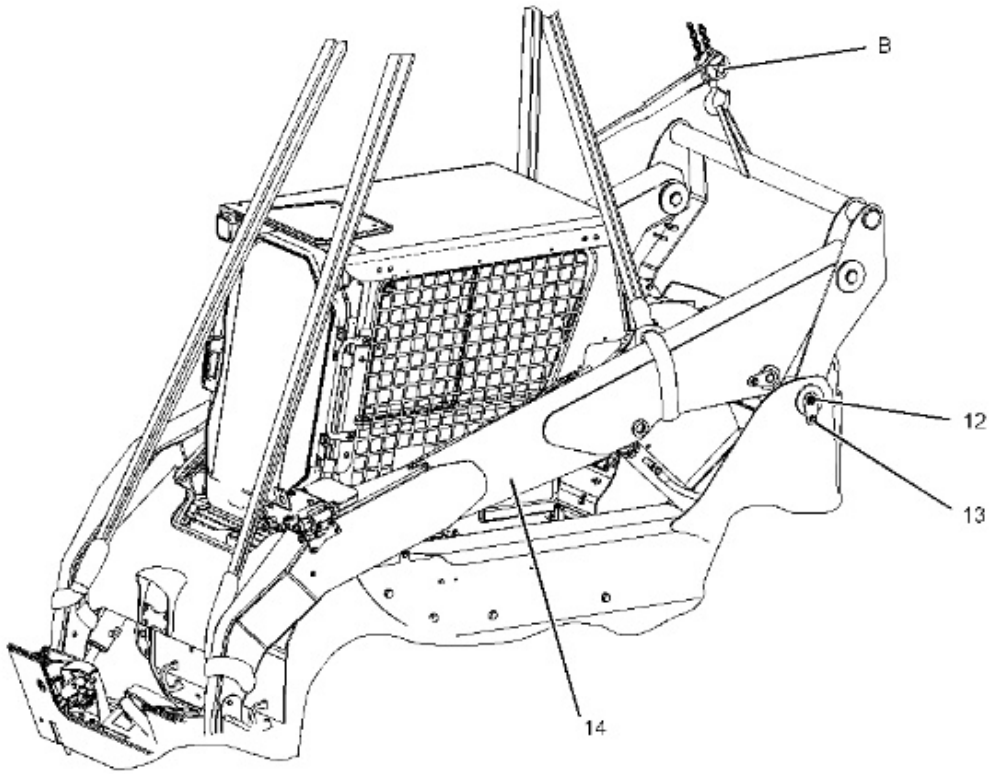


Illustration 5 g01051849

5. Attach Tooling (B) and a suitable lifting device to lift arms (14), as shown. The weight of the lift arms is approximately 368 kg (812 lb). Remove bolt (13) and remove pin assembly (12). Repeat this step for the other side of the lift arms.

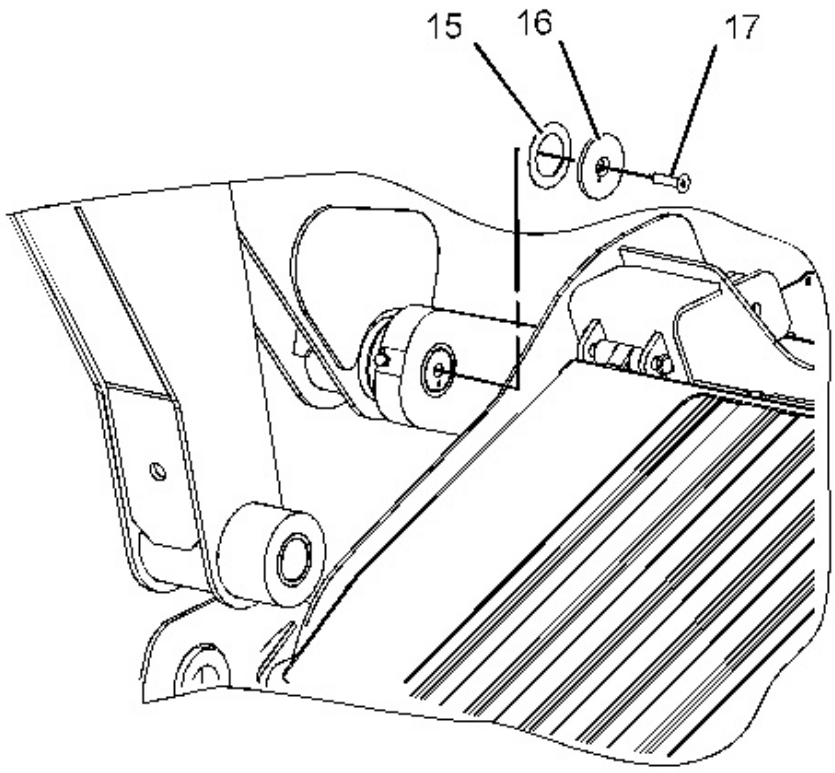


Illustration 6 g01051865

6. Raise the lift arms. Remove bolt (17), washer (16) and shim (15). Note the amount of shims for installation purposes.

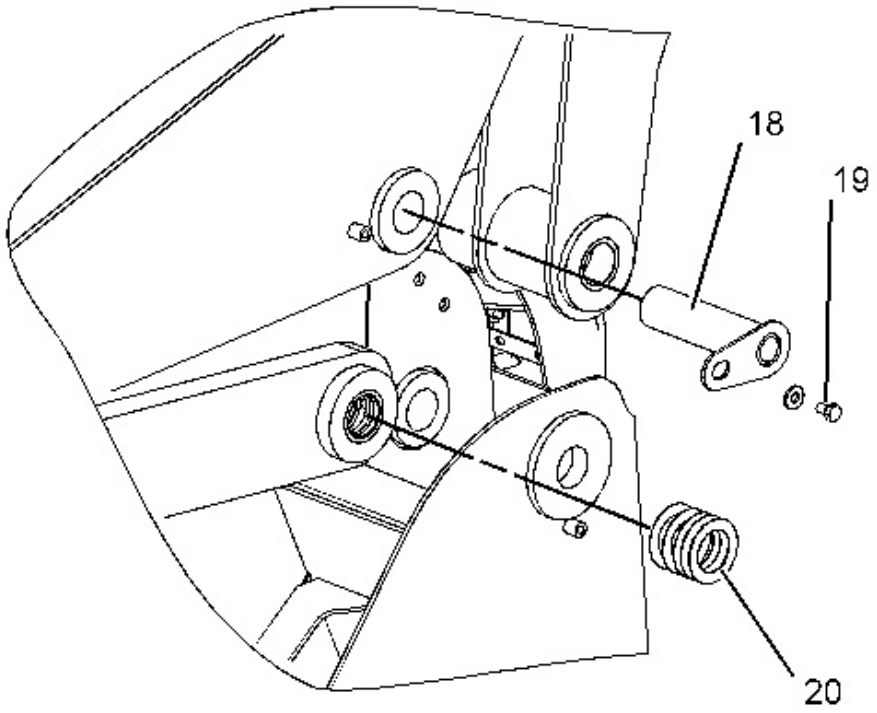


Illustration 7 g01051883

7. Remove bolt (19) and pin assembly (18) from the link assembly.
8. Repeat steps 6 and 7 for the other side of the lift arms. Remove the lift arms. Remove any shims (20) that may be present.

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i02155801

Lift Arms - Remove - Radial Arc Machines

SMCS - 6119-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	1P-2860	Retaining Ring Pliers	1
B	180-3032	Stands	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Remove the quick coupler. Refer to Disassembly and Assembly, "Quick Coupler - Remove and Install".
C. Remove the tilt cylinder. Refer to Disassembly and Assembly, "Tilt Cylinder - Remove and Install".

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

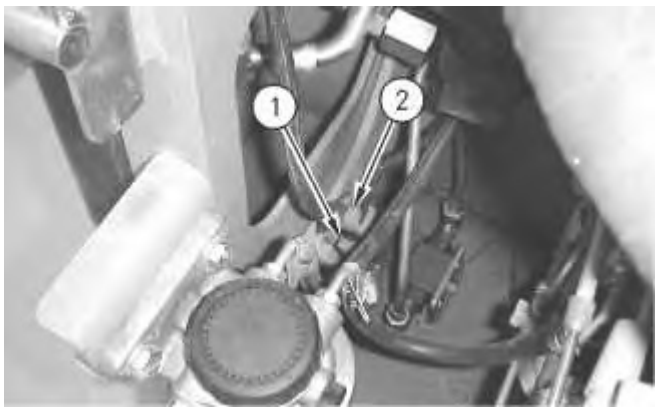


Illustration 1 g00881183

1. Remove cable strap (1) and disconnect harness assembly (2) .

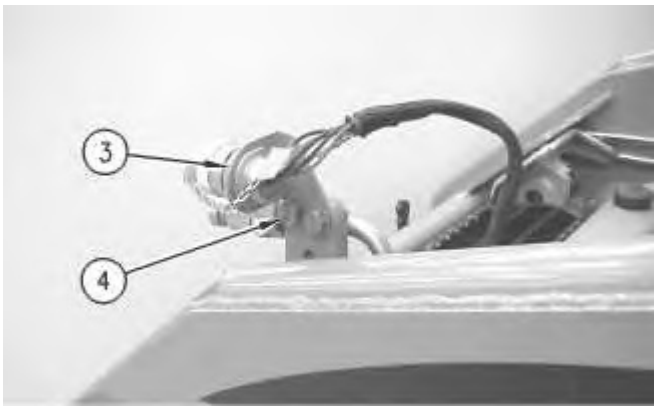


Illustration 2 g00881192

2. Remove bolts (4) and bracket (3), if equipped. Position the harness assembly out of the way.

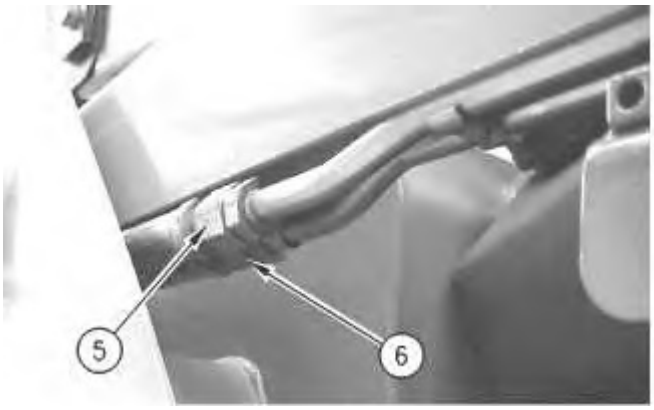


Illustration 3 g00589493

3. Disconnect hose assemblies (5) and (6) from both sides of the lift arm assembly.

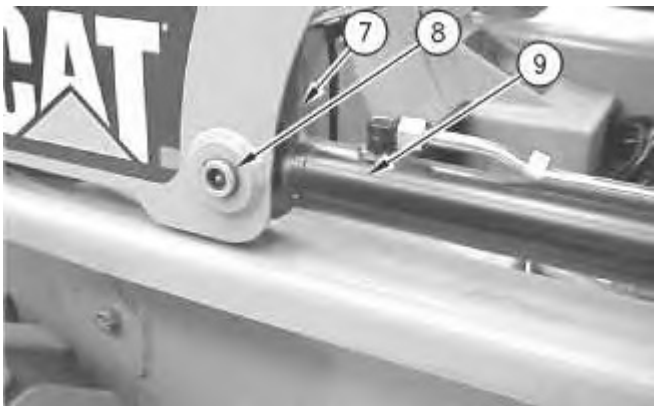


Illustration 4 g00881195

4. Use Tooling (A) to remove inside snap ring (7) and pin (8) in order to release left side lift cylinder (9) from the lift arm.



Illustration 5 g00589436

5. Remove retaining pin (10) and lower the lift arm brace onto the lift cylinder.

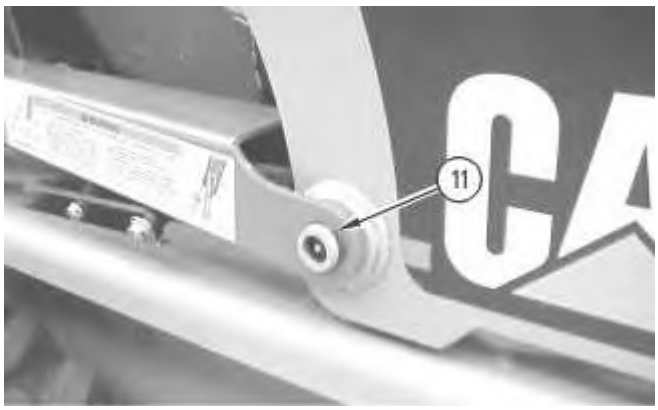


Illustration 6 g00589439

6. Use Tooling (A) to remove inside snap rings (11) .

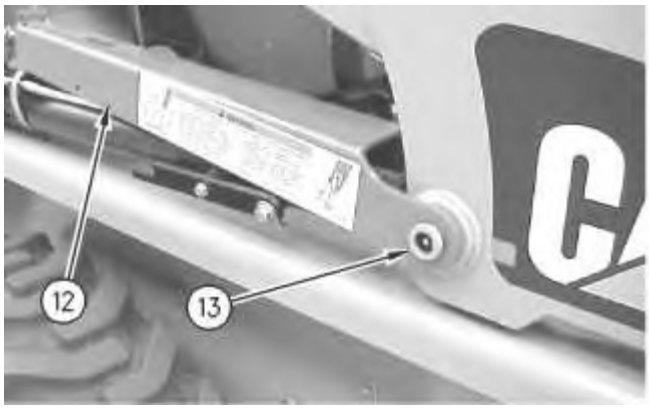


Illustration 7 g00881204

7. Remove pin (13) and lift arm brace (12) .

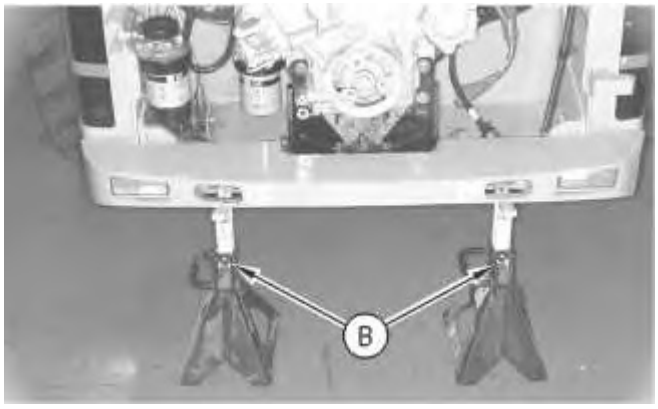


Illustration 8 g00563368

8. Use Tooling (B) to support the rear of the machine.



Illustration 9 g00563371

9. Attach a suitable lifting device to lift arm assembly (14). The weight of the lift arm assembly is approximately 238 kg (525 lb).

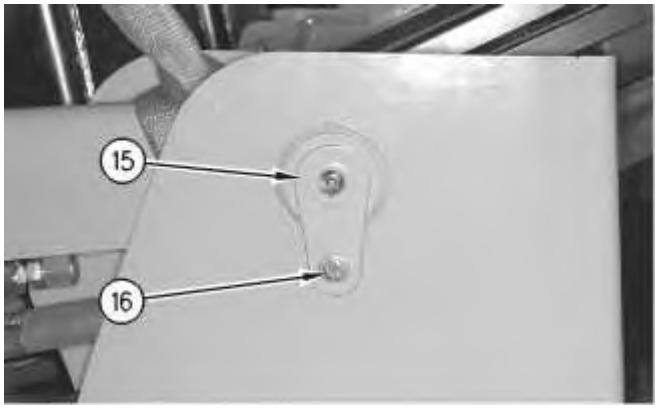


Illustration 10 g00881201

10. Remove bolt (16) and pin assembly (15) from both sides of the lift arm assembly. Remove the lift arm assembly.

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02161397

Lift Arms - Install - Extended Reach Machines

SMCS - 6119-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	1P-1864	Retaining Ring Pliers As	1
B	1U-9200	Lever Puller Hoist	1

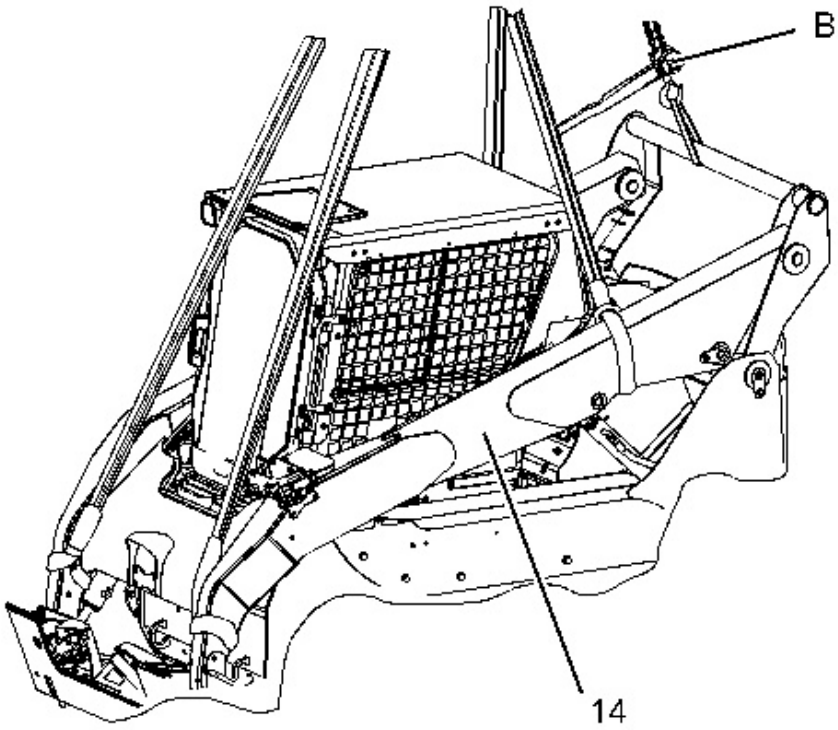


Illustration 1 g01051916

1. Attach Tooling (B) and a suitable lifting device to lift arms (14), as shown. The approximate weight of the lift arms is 368 kg (812 lb). Install the lift arms.

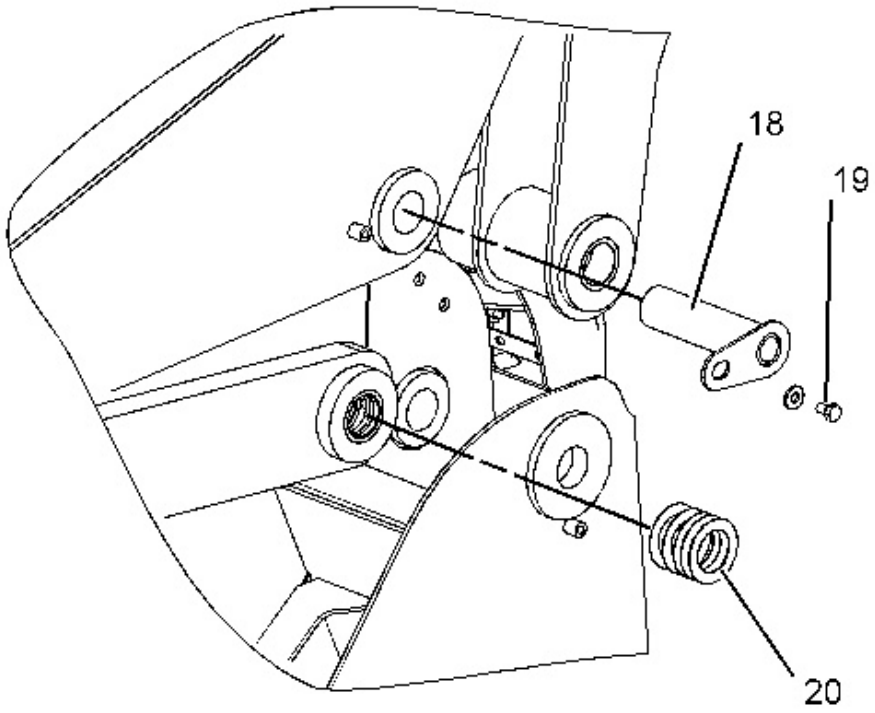


Illustration 2 g01051883

2. Install any shims (20) that may be present. Install bolt (19) and pin assembly (18) from the link assembly.

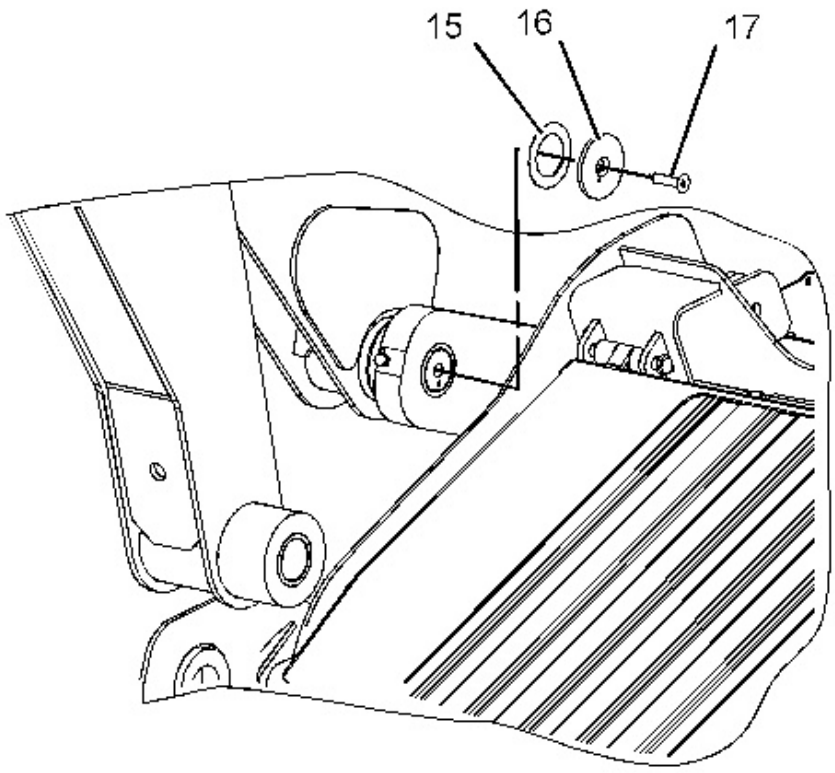


Illustration 3 g01051865

3. Raise the lift arms. Install bolt (17), washer (16) and shim (15) .

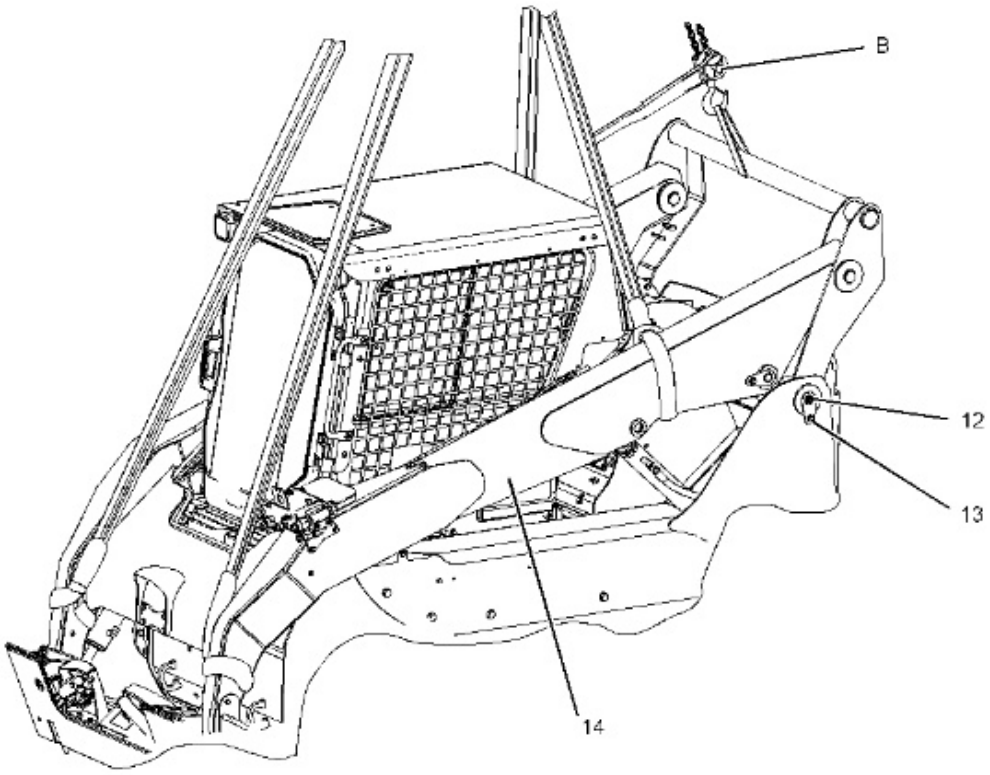


Illustration 4 g01051849

4. Install pin assembly (12) and install bolt (13). Repeat this step for the other side of the lift arms (14) .

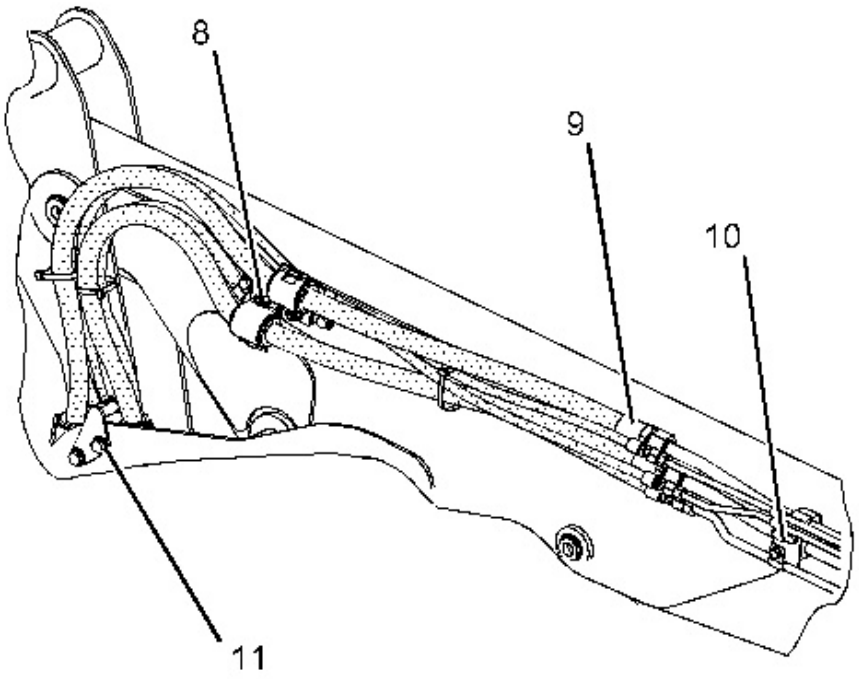


Illustration 5 g01051845

5. Connect hose assemblies (9). Install bolts (8), (11) and (10) .

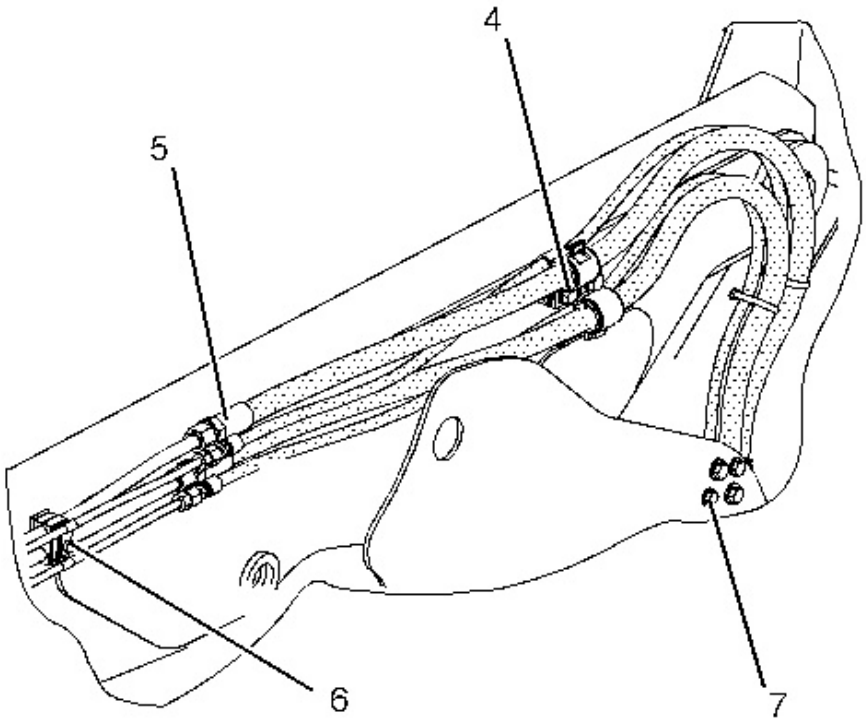


Illustration 6 g01051826

6. Connect hose assemblies (5). Install bolts (4), (6) and (7) .

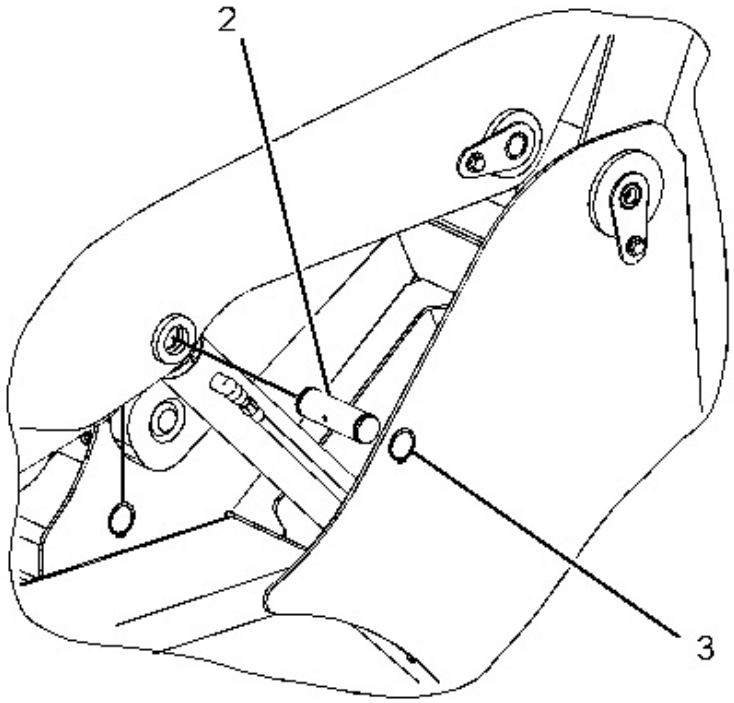


Illustration 7 g01051794

7. Install pin assembly (2). Use Tooling (A) in order to install retaining ring (3). Repeat this step for both sides of the machine.

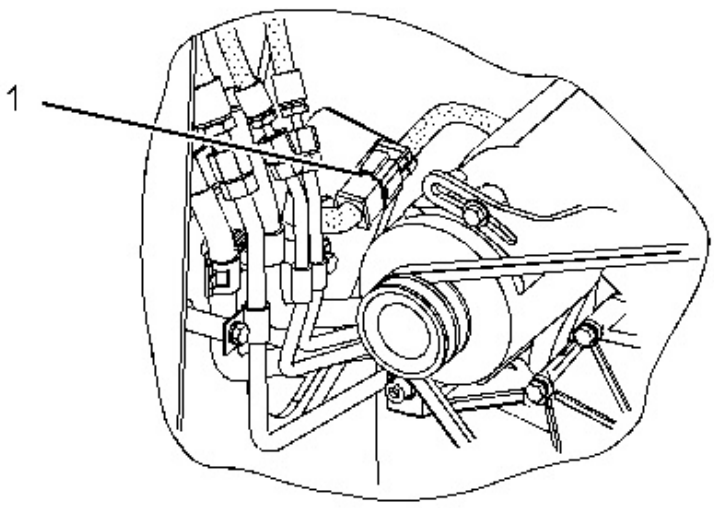


Illustration 8 g01051787

8. Connect harness assembly (1) .

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i02155905

Lift Arms - Install - Radial Arc Machines

SMCS - 6119-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

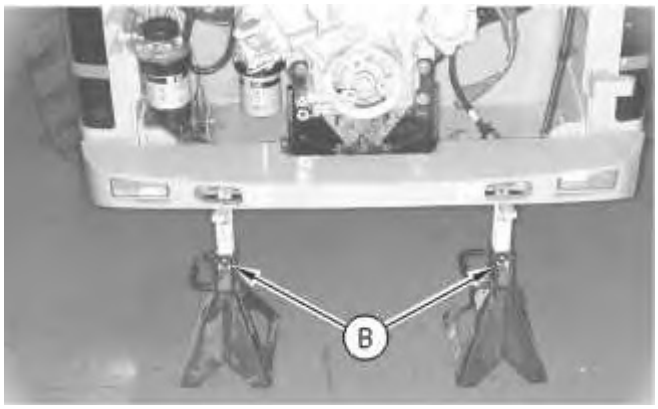


Illustration 1 g00563368

1. Use Tooling (B) to support the rear of the machine.



Illustration 2 g00563371

2. Use a hoist and lifting slings to position lift arm assembly (14). The weight of the lift arm assembly is approximately 238 kg (525 lb).

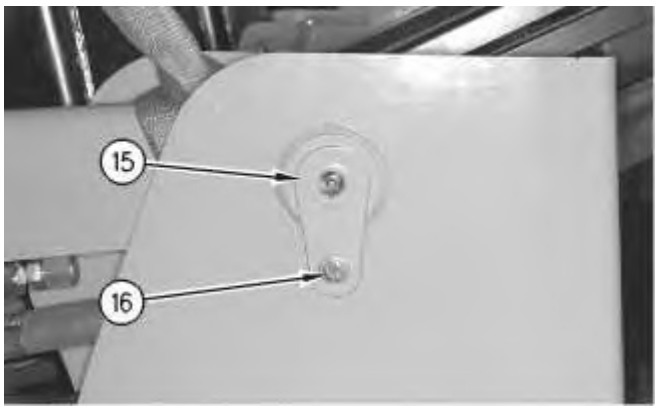


Illustration 3 g00881201

3. Install pin assembly (15) and bolt (16) to both sides of the lift arm assembly.

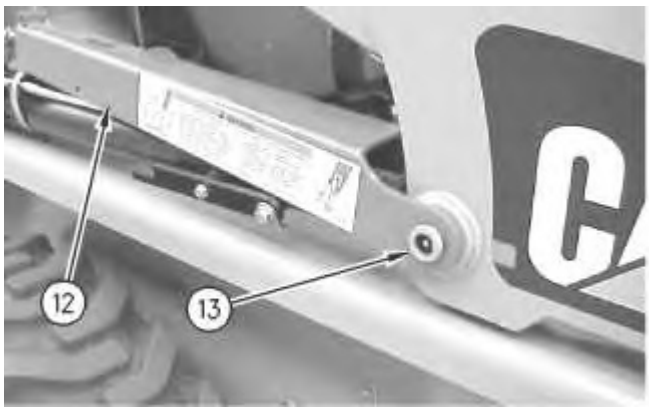


Illustration 4 g00881204

4. Position lift arm brace (12) and install pin (13) .

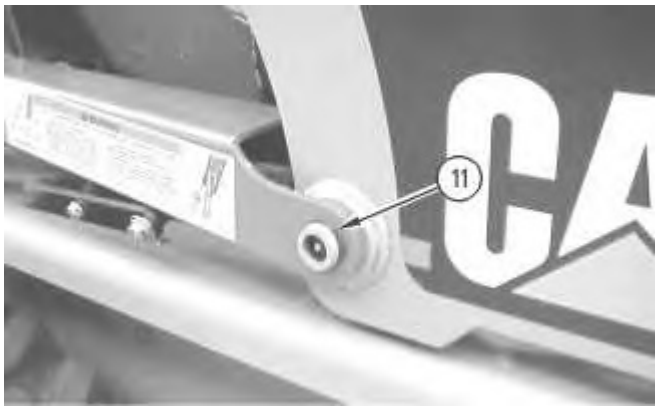


Illustration 5 g00589439

5. Use Tooling (A) to install inside snap rings (11) .

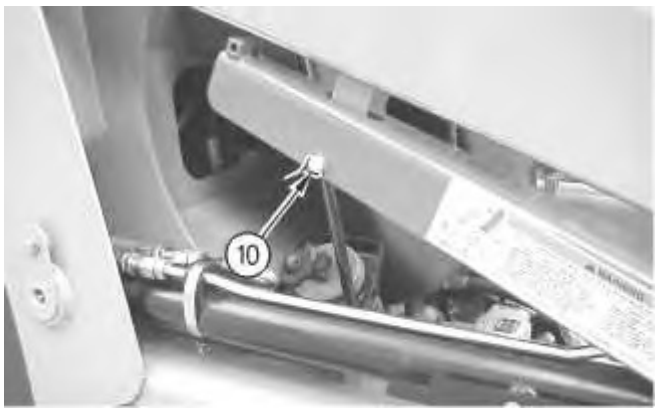


Illustration 6 g00589436

6. Install retaining pin (10) in the lift arm brace.

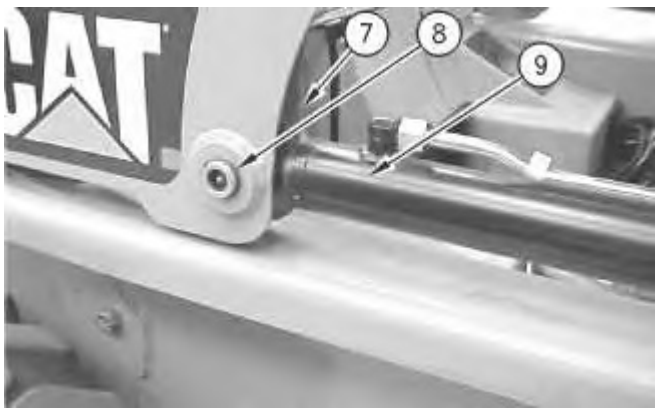


Illustration 7 g00881195

7. Use Tooling (A) to install pin (8) and inside snap ring (7) in lift cylinder (9) .

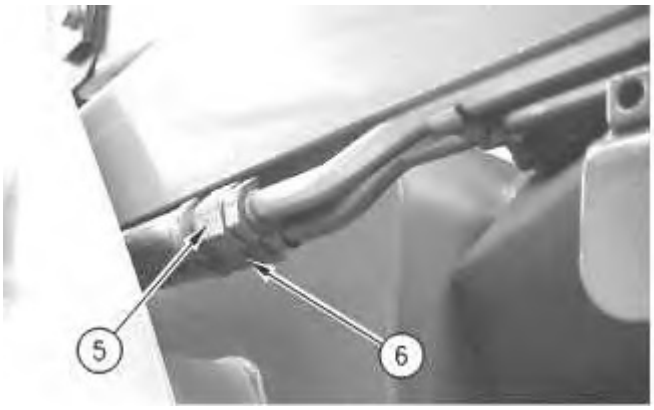


Illustration 8 g00589493

8. Connect hose assemblies (6) and (5) to both sides of the lift arm assembly.

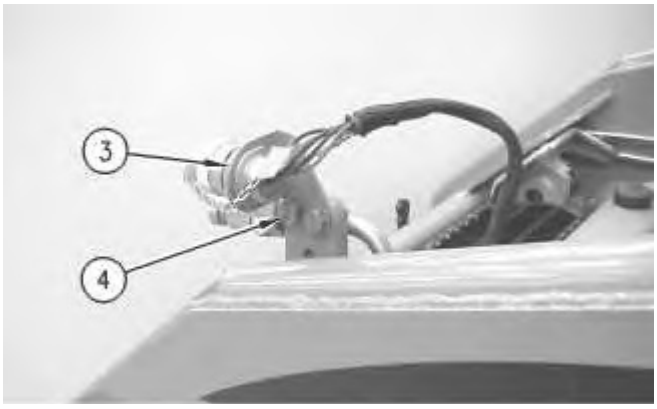


Illustration 9 g00881192

9. Position bracket (4) and install two bolts (3), if equipped.



Illustration 10 g00881183

10. Connect harness assembly (2) and tighten cable strap (1) .

End By:

a. Install the tilt cylinder. Refer to Disassembly and Assembly, "Tilt Cylinder - Remove and Install".
b. Install the quick coupler. Refer to Disassembly and Assembly, "Quick Coupler - Remove and Install".

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Systems Operation
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i02558237

Lubrication System

SMCS - 1300

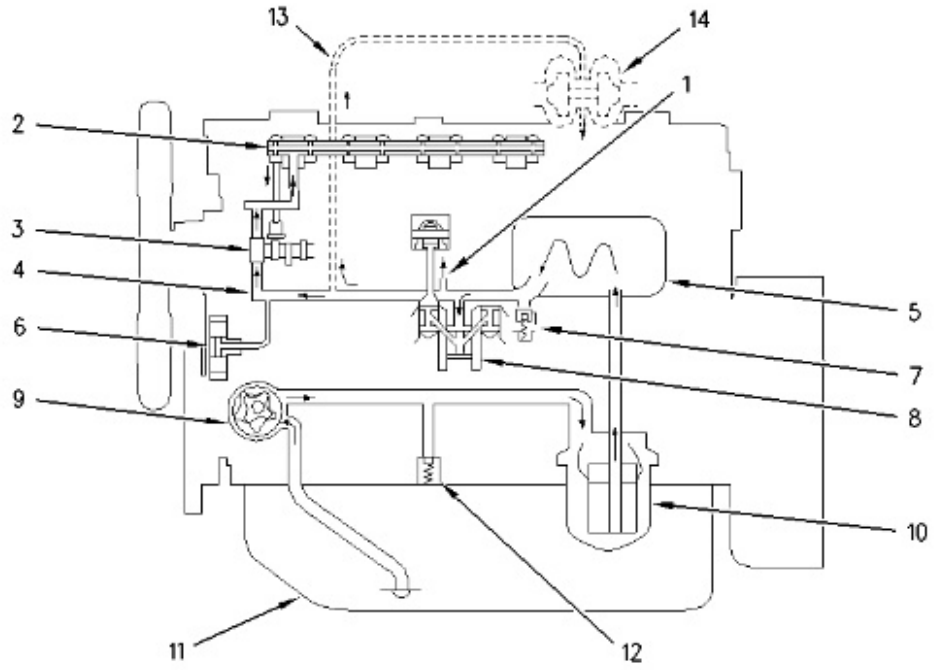


Illustration 1 g00987199

Flow diagram of the lubrication system

(1) Piston cooling jets

(2) Rocker arm shaft

(3) Camshaft

(4) Main oil gallery

(5) Engine oil cooler

(6) Idler gear

(7) Engine oil relief valve

(8) Crankshaft

(9) Engine oil pump

(10) Engine oil filter

(11) Engine oil pan

(12) Engine oil safety valve

(13) External line (supply)

(14) Turbocharger

Pressure for the lubrication system is supplied by an engine oil pump (9). The gerotor type pump has an inner rotor and an outer rotor. The axis of rotation of the rotors are off-center relative to each other.

The inner rotor has four lobes which mesh with the five lobes of the outer rotor. When the pump rotates, the distance increases between the lobes of the outer rotor and the lobes of the inner rotor in order to create suction. When the distance decreases between the lobes, pressure is created.

Lubricating oil from the engine oil pan (11) flows through a strainer and a pipe to the suction side of the engine oil pump. The lubricating oil flows from the outlet side of the pump through a passage to the engine oil filter (10) .

The oil then flows from the filter head through a pipe to the engine oil cooler (5). The plate type oil cooler is located on the left side of the cylinder block. From the engine oil cooler, the oil then flows to the main oil gallery (4) that is located along the left side of the cylinder block.

Lubricating oil from the main oil gallery flows through high pressure passages to the main bearings of the crankshaft (8). The oil then flows through the passages in the crankshaft to the connecting rod bearing journals.

The pistons and the cylinder bores are lubricated by the splash of oil from piston cooling jets (1), which are connected to the main oil gallery.

Lubricating oil from the main oil gallery flows through passages in the cylinder block to the journals of the camshaft (3). The oil then flows from the camshaft at a reduced pressure to the cylinder head. The oil flows into the rocker arm shaft (2) at a reduced pressure to the bearings of the rocker arm levers. The valve stems, the valve springs and the valve lifters are lubricated by the splash and the oil mist.

The hub of the idler gear (6) is lubricated by oil from the main oil gallery. The timing gears are lubricated by the splash from the oil.

Turbochargers (14) are lubricated by oil from a connection on the right hand side of the cylinder block. An external line (13) that is connected from the main oil gallery supplies oil to the top of the turbocharger. The oil then flows through the turbocharger. An external line that is connected to the bottom of the turbocharger returns the oil to the engine oil pan.

Engine oil relief valve (7) is installed in order to prevent damage to the lubricating system. The engine oil relief valve helps keep a constant oil pressure throughout the engine. If the main system relief valve fails to open, the high engine oil pressure can cause damage to engine components. In order to limit the possibility of engine damage due to a malfunctioning relief valve, the lubrication system contains a backup system for engine oil relief valve (7). Engine oil safety valve (12) is located inside engine oil pan (11) on the bottom of the cylinder block.

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Systems Operation
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02558237

Lubrication System

SMCS - 1300

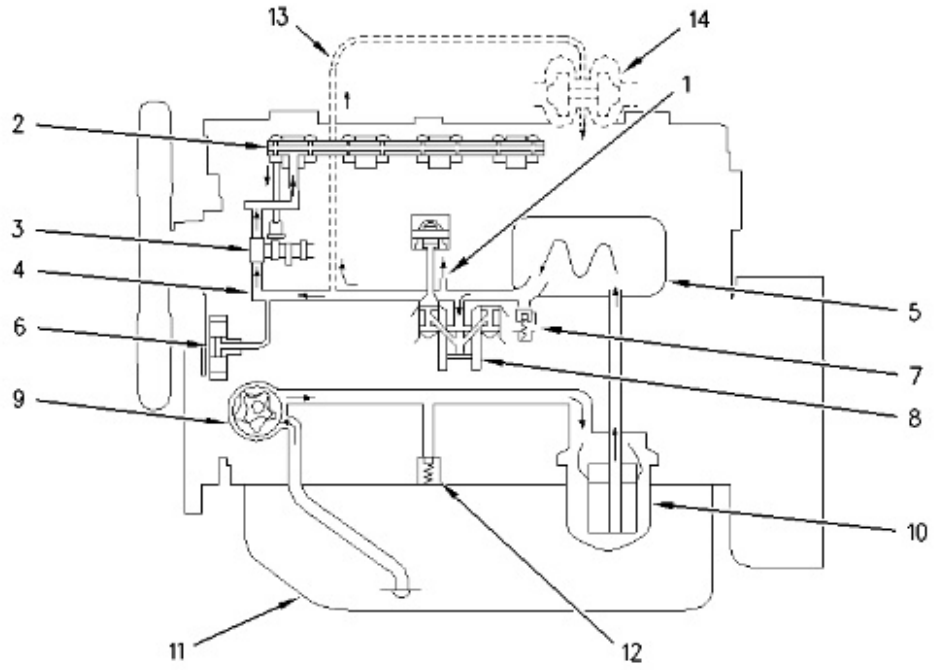


Illustration 1 g00987199

Flow diagram of the lubrication system

(1) Piston cooling jets

(2) Rocker arm shaft

(3) Camshaft

(4) Main oil gallery

(5) Engine oil cooler

(6) Idler gear

(7) Engine oil relief valve

(8) Crankshaft

(9) Engine oil pump

(10) Engine oil filter

(11) Engine oil pan

(12) Engine oil safety valve

(13) External line (supply)

(14) Turbocharger

Pressure for the lubrication system is supplied by an engine oil pump (9). The gerotor type pump has an inner rotor and an outer rotor. The axis of rotation of the rotors are off-center relative to each other.

The inner rotor has four lobes which mesh with the five lobes of the outer rotor. When the pump rotates, the distance increases between the lobes of the outer rotor and the lobes of the inner rotor in order to create suction. When the distance decreases between the lobes, pressure is created.

Lubricating oil from the engine oil pan (11) flows through a strainer and a pipe to the suction side of the engine oil pump. The lubricating oil flows from the outlet side of the pump through a passage to the engine oil filter (10) .

The oil then flows from the filter head through a pipe to the engine oil cooler (5). The plate type oil cooler is located on the left side of the cylinder block. From the engine oil cooler, the oil then flows to the main oil gallery (4) that is located along the left side of the cylinder block.

Lubricating oil from the main oil gallery flows through high pressure passages to the main bearings of the crankshaft (8). The oil then flows through the passages in the crankshaft to the connecting rod bearing journals.

The pistons and the cylinder bores are lubricated by the splash of oil from piston cooling jets (1), which are connected to the main oil gallery.

Lubricating oil from the main oil gallery flows through passages in the cylinder block to the journals of the camshaft (3). The oil then flows from the camshaft at a reduced pressure to the cylinder head. The oil flows into the rocker arm shaft (2) at a reduced pressure to the bearings of the rocker arm levers. The valve stems, the valve springs and the valve lifters are lubricated by the splash and the oil mist.

The hub of the idler gear (6) is lubricated by oil from the main oil gallery. The timing gears are lubricated by the splash from the oil.

Turbochargers (14) are lubricated by oil from a connection on the right hand side of the cylinder block. An external line (13) that is connected from the main oil gallery supplies oil to the top of the turbocharger. The oil then flows through the turbocharger. An external line that is connected to the bottom of the turbocharger returns the oil to the engine oil pan.

Engine oil relief valve (7) is installed in order to prevent damage to the lubricating system. The engine oil relief valve helps keep a constant oil pressure throughout the engine. If the main system relief valve fails to open, the high engine oil pressure can cause damage to engine components. In order to limit the possibility of engine damage due to a malfunctioning relief valve, the lubrication system contains a backup system for engine oil relief valve (7). Engine oil safety valve (12) is located inside engine oil pan (11) on the bottom of the cylinder block.

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i04643912

Engine Crankcase Pressure (Blowby) - Test

SMCS - 1215; 1317

Table 1

Tools Needed		
Part Number	**Part Name**	**Quantity**
348-5430	Multi-Tool Gp	1
285-0900	Blowby Tool Group	1
NETG5049	Software License	1

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than a normal amount of blowby fumes rising from the crankcase breather. The breather can then become restricted in a short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.



Illustration 1 g02709261

348-5430 Multi-Tool Gp

The **348-5430** Multi-Tool Gp , or the **285-0900** Blowby Tool Group is used to check the amount of blowby. Refer to Tool Operating Manual, NEHS1087, " **348-5430** Multi-Tool Gp " for the test procedure for checking the blowby.

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i03864816

Engine Oil Pressure - Test

SMCS - 1304-081

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
1U-5470	Engine Pressure Group	1

An oil pressure gauge that has a defect can indicate low oil pressure.

The **1U-5470** Engine Pressure Group can be used to check engine oil pressure.

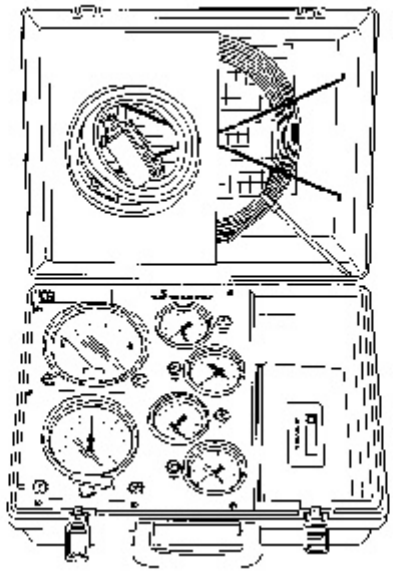


Illustration 1 g00296486

1U-5470 Engine Pressure Group

The **1U-5470** Engine Pressure Group has a gauge that measures the oil pressure in the engine. Refer to Special Instruction, SEHS8907 for more information on using the **1U-5470** Engine Pressure Group . The information is included in the tool group.

1. Ensure that the engine is filled to the correct oil level.
2. Connect the **1U-5470** Engine Pressure Group to a pressure tap location for engine oil.
3. Operate the engine. Allow the engine to obtain normal operating temperature.
4. Keep the oil temperature constant with the engine at the rated rpm. Read the pressure gauge.
5. Refer to Table 2 in order to determine if the engine oil pressure is in tolerance.

Table 2

Oil Pressure [1]	
Oil Pressure at 1500 rpm	300 to 500 kPa (44 to 73 psi)
Oil Pressure at Idle	100 kPa (15 psi)

[1] The oil temperature must be 60 ° to 88 °C (140 ° to 158 °F).

Find the cause of the problem and correct the problem if the results of the test do not fall within the pressure range in Table 2. Engine failure or a reduction in engine life can be the result if engine operation is continued with oil pressure outside this range.

Note: A record of engine oil pressure at regular intervals can be used as an indication of possible problems of the engine. A record of engine oil pressure at regular intervals can also be used as an indication of possible damage to the engine. The engine should be inspected and the problem should be corrected if there is a sudden increase or a sudden decrease of 70 kPa (10 psi) in oil pressure.

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i01897292

Engine Oil Pump - Inspect

SMCS - 1304-040

If any part of the oil pump is worn enough in order to affect the performance of the pump, the oil pump must be replaced.

Perform the following procedures in order to inspect the oil pump. Refer to Specifications, "Engine Oil Pump" for clearances.

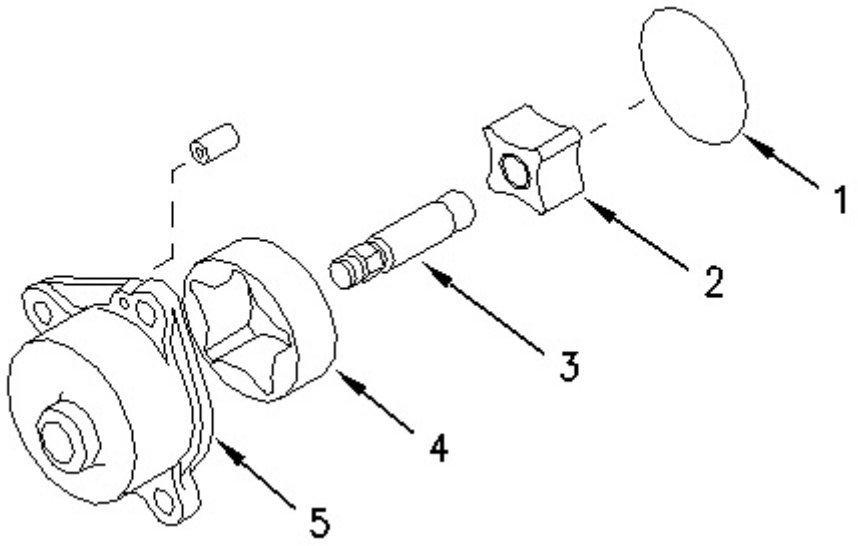


Illustration 1 g00987624

Exploded view of the oil pump

(1) O-ring

(2) Inner rotor

(3) Shaft

(4) Outer rotor

(5) Body

1. Remove the oil pump from the engine.
2. Remove all of the parts. Clean all of the parts. Look for cracks in the metal or other damage.

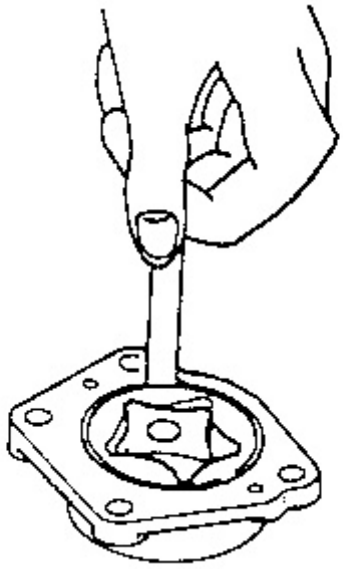


Illustration 2 g00987626

Clearance of outer rotor to body

3. Install the outer rotor. Measure the clearance of the outer rotor to the body.

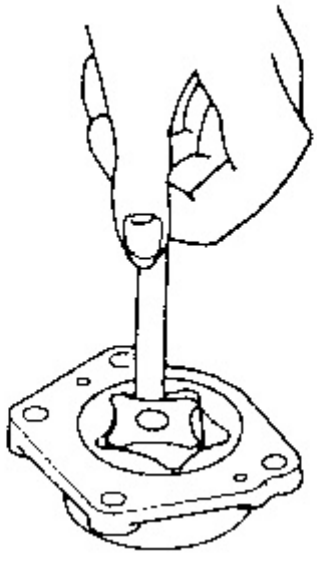


Illustration 3 g00987627

Clearance of inner rotor to outer rotor

4. Install the inner rotor. Measure the clearance of the inner rotor to the outer rotor.

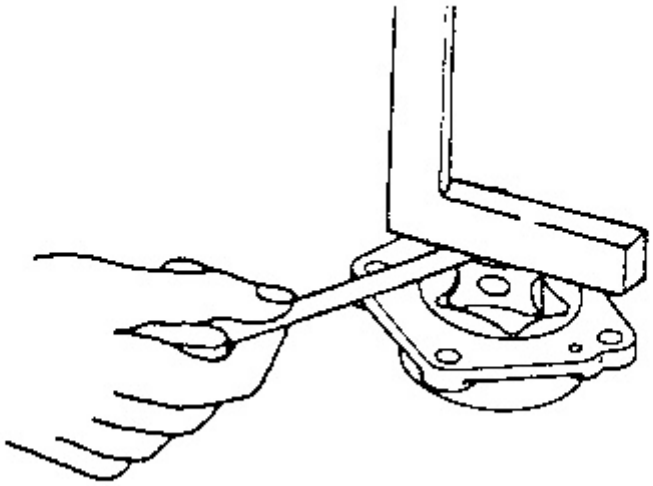


Illustration 4 g00987628

End play of rotors

5. Measure the end play of the rotors with a straight edge and a feeler gauge.
6. Clean the top face of the oil pump. Replace the O-ring and install the oil pump on the engine.

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Testing and Adjusting
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7578-05 **Publication Date -01/07/2007** **Date Updated -27/07/2007**

i03993149

Excessive Engine Oil Consumption - Inspect

SMCS - 1348-040

Engine Oil Leaks on the Outside of the Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the gasket for the engine oil pan and all lubrication system connections. Look for any engine oil that may be leaking from the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure in the crankcase. A dirty crankcase breather will cause the gaskets and the seals to leak.

Engine Oil Leaks into the Combustion Area of the Cylinders

Engine oil that is leaking into the combustion area of the cylinders can be the cause of blue smoke. There are several possible ways for engine oil to leak into the combustion area of the cylinders:

- Leaks between worn valve guides and valve stems
- Worn components or damaged components (pistons, piston rings, or dirty return holes for the engine oil)
- Incorrect installation of the compression ring and/or the intermediate ring
- Leaks past the seal rings in the turbocharger shaft
- Overfilling of the crankcase
- Wrong oil level gauge or guide tube
- Sustained operation at light loads

Excessive consumption of engine oil can also result if engine oil with the wrong viscosity is used. Engine oil with a thin viscosity can be caused by increased engine temperature.

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i01462628

Increased Engine Oil Temperature - Inspect

SMCS - 1348-040

Look for a restriction in the oil passages of the oil cooler. The oil temperature may be higher than normal when the engine is operating. In such a case, the oil cooler may have a restriction. A restriction in the oil cooler will not cause low oil pressure in the engine.

Determine if the oil cooler bypass valve is held in the open position. This condition will allow the oil to pass through the valve instead of the oil cooler. The oil temperature will increase.

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i04643912

Engine Crankcase Pressure (Blowby) - Test

SMCS - 1215; 1317

Table 1

Tools Needed		
Part Number	**Part Name**	**Quantity**
348-5430	Multi-Tool Gp	1
285-0900	Blowby Tool Group	1
NETG5049	Software License	1

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than a normal amount of blowby fumes rising from the crankcase breather. The breather can then become restricted in a short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.



Illustration 1 g02709261

348-5430 Multi-Tool Gp

The **348-5430** Multi-Tool Gp , or the **285-0900** Blowby Tool Group is used to check the amount of blowby. Refer to Tool Operating Manual, NEHS1087, " **348-5430** Multi-Tool Gp " for the test procedure for checking the blowby.

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i03864816

Engine Oil Pressure - Test

SMCS - 1304-081

Table 1

Required Tools		
Part Number	**Part Description**	**Qty**
1U-5470	Engine Pressure Group	1

An oil pressure gauge that has a defect can indicate low oil pressure.

The **1U-5470** Engine Pressure Group can be used to check engine oil pressure.

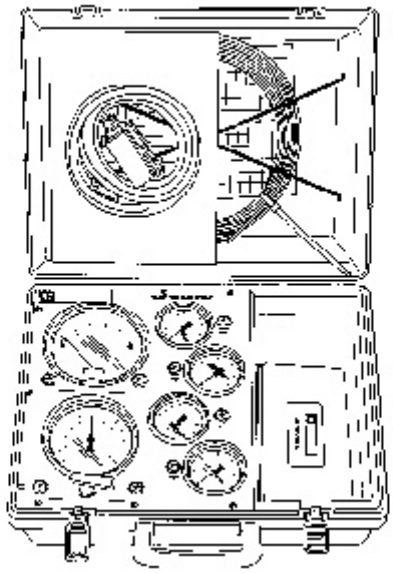


Illustration 1 g00296486

1U-5470 Engine Pressure Group

The **1U-5470** Engine Pressure Group has a gauge that measures the oil pressure in the engine. Refer to Special Instruction, SEHS8907 for more information on using the **1U-5470** Engine Pressure Group . The information is included in the tool group.

1. Ensure that the engine is filled to the correct oil level.
2. Connect the **1U-5470** Engine Pressure Group to a pressure tap location for engine oil.
3. Operate the engine. Allow the engine to obtain normal operating temperature.
4. Keep the oil temperature constant with the engine at the rated rpm. Read the pressure gauge.
5. Refer to Table 2 in order to determine if the engine oil pressure is in tolerance.

Table 2

Oil Pressure [1]	
Oil Pressure at 1500 rpm	300 to 500 kPa (44 to 73 psi)
Oil Pressure at Idle	100 kPa (15 psi)

[1] The oil temperature must be 60 ° to 88 °C (140 ° to 158 °F).

Find the cause of the problem and correct the problem if the results of the test do not fall within the pressure range in Table 2. Engine failure or a reduction in engine life can be the result if engine operation is continued with oil pressure outside this range.

Note: A record of engine oil pressure at regular intervals can be used as an indication of possible problems of the engine. A record of engine oil pressure at regular intervals can also be used as an indication of possible damage to the engine. The engine should be inspected and the problem should be corrected if there is a sudden increase or a sudden decrease of 70 kPa (10 psi) in oil pressure.

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i01897292

Engine Oil Pump - Inspect

SMCS - 1304-040

If any part of the oil pump is worn enough in order to affect the performance of the pump, the oil pump must be replaced.

Perform the following procedures in order to inspect the oil pump. Refer to Specifications, "Engine Oil Pump" for clearances.

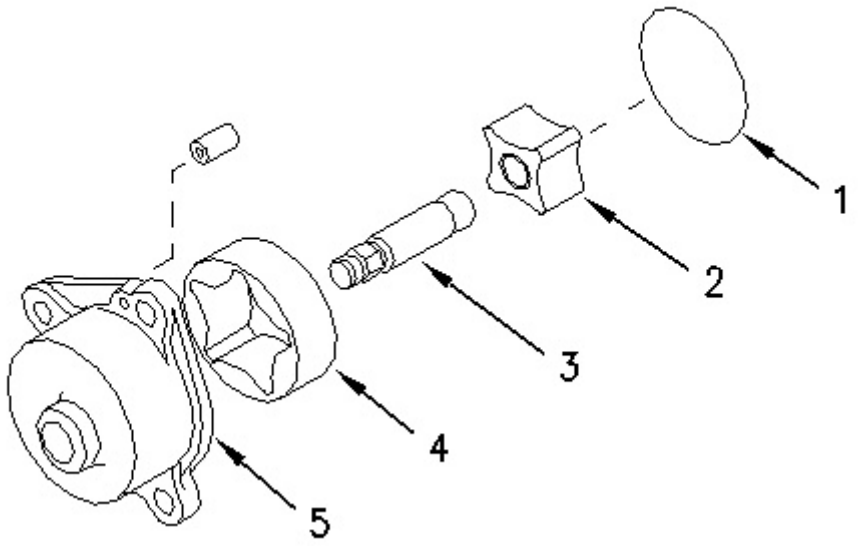


Illustration 1 g00987624

Exploded view of the oil pump

(1) O-ring

(2) Inner rotor

(3) Shaft

(4) Outer rotor

(5) Body

1. Remove the oil pump from the engine.
2. Remove all of the parts. Clean all of the parts. Look for cracks in the metal or other damage.

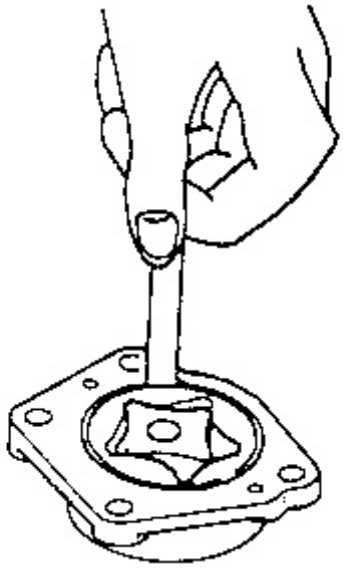


Illustration 2 g00987626

Clearance of outer rotor to body

3. Install the outer rotor. Measure the clearance of the outer rotor to the body.

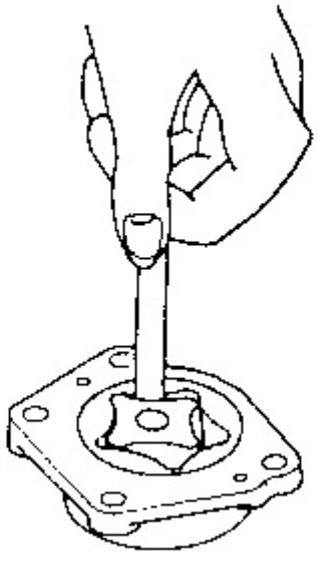


Illustration 3 g00987627

Clearance of inner rotor to outer rotor

4. Install the inner rotor. Measure the clearance of the inner rotor to the outer rotor.

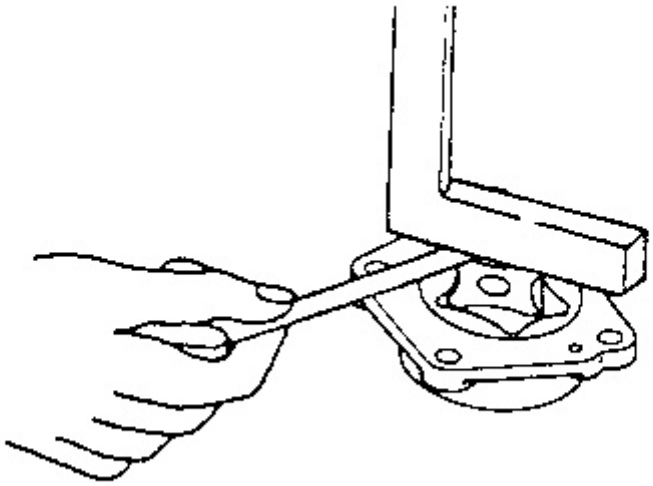


Illustration 4 g00987628

End play of rotors

5. Measure the end play of the rotors with a straight edge and a feeler gauge.
6. Clean the top face of the oil pump. Replace the O-ring and install the oil pump on the engine.

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Testing and Adjusting
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6940-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i03993149

Excessive Engine Oil Consumption - Inspect

SMCS - 1348-040

Engine Oil Leaks on the Outside of the Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the gasket for the engine oil pan and all lubrication system connections. Look for any engine oil that may be leaking from the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure in the crankcase. A dirty crankcase breather will cause the gaskets and the seals to leak.

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Engine oil that is leaking into the combustion area of the cylinders can be the cause of blue smoke. There are several possible ways for engine oil to leak into the combustion area of the cylinders:

- Leaks between worn valve guides and valve stems
- Worn components or damaged components (pistons, piston rings, or dirty return holes for the engine oil)
- Incorrect installation of the compression ring and/or the intermediate ring
- Leaks past the seal rings in the turbocharger shaft
- Overfilling of the crankcase
- Wrong oil level gauge or guide tube
- Sustained operation at light loads

Excessive consumption of engine oil can also result if engine oil with the wrong viscosity is used. Engine oil with a thin viscosity can be caused by increased engine temperature.

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i01462628

Increased Engine Oil Temperature - Inspect

SMCS - 1348-040

Look for a restriction in the oil passages of the oil cooler. The oil temperature may be higher than normal when the engine is operating. In such a case, the oil cooler may have a restriction. A restriction in the oil cooler will not cause low oil pressure in the engine.

Determine if the oil cooler bypass valve is held in the open position. This condition will allow the oil to pass through the valve instead of the oil cooler. The oil temperature will increase.

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i03898085

Disconnecting Snap To Connect Fittings

SMCS - 7554-X6

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disconnection Procedure

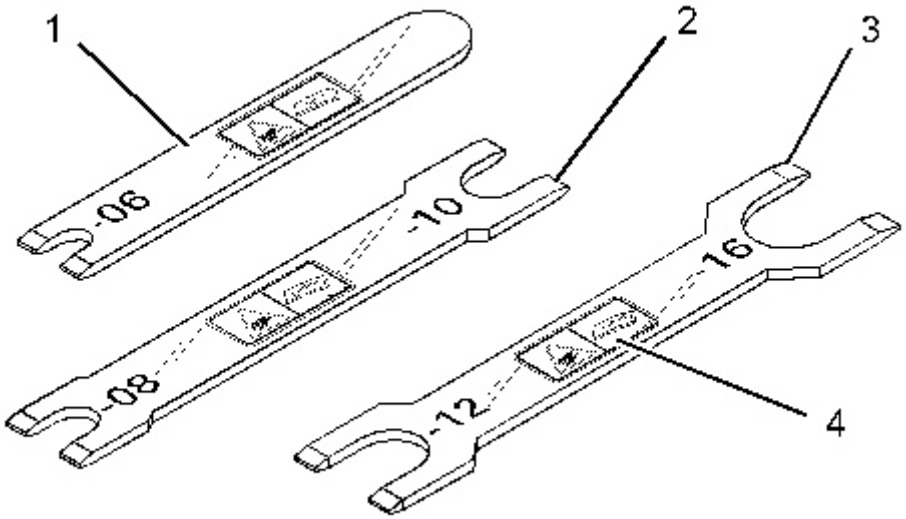


Illustration 1 g02145423

Table 1

304-1165 Tool Kit			
Item	**Part No.**	**description**	**Fitting Size**
1	304-1166	STC Wrench	-06
2	304-1167	STC Wrench	-08 and -10
3	304-1168	STC Wrench	-12 and -16
4	341-2603	Warning Film	-
-	304-2721	Tool Pouch	-

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

NOTICE

Using the incorrect size snap to connect (STC) wrench can cause slippage, resulting in personal injury. Always verify that the STC wrench size matches the size fitting to be disconnected.

1. Lower all work tools and attachments to the ground.
2. Release the system pressure. Refer to Disassembly and Assembly, "System Pressure - Release".
3. Clean the connection that is to be disassembled. Clean the surrounding area in order to ensure that the connection is free of all dirt, dust, and grit.
4. Pressure can be trapped in circuits after the engine has stopped. Personal injury or death can result if all pressures are not released. Ensure that the pressure is zero in the line that is being disconnected.

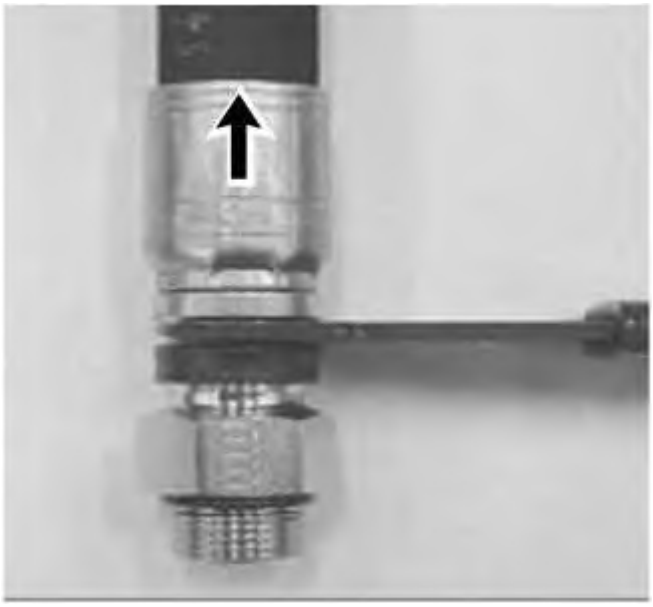


Illustration 2 g02141795

5. Select the designated release tool for the size of the connection. Using the wrong tool may result in damage to the coupling, or cause slippage, resulting in unsafe conditions.

   Note: Prying on the connection may result in damage to the release sleeve, requiring hose replacement.

6. Insert the release tool behind the release sleeve, so that the release tool is perpendicular to the connection. Fully insert the release tool in order to cause the release sleeve to move and separate the retaining ring. The coupling may now be separated.

7. Pull on the hose in the direction parallel to the axis of connection while keeping the release tool engaged. Pulling the hose at an angle may result in extra force required to disconnect the connection.

8. Cover both ends of the connection with recommended plugs or caps in order to avoid contamination.

Connection Procedure

1. Clean the connection that is to be assembled. Ensure that the connection is free of all dirt, dust, and grit.



Illustration 3 g02141956

Note: If the release sleeve is damaged during the connection or disconnection of the STC connection, the male portion must be replaced with new parts.

Note: Do not use the rubber sleeve as leverage to push the male half into the female half of the STC connection.

2. Align the STC fitting on the hose assembly with the STC connector. Push the hose fitting into the mating connector until you feel a definite snap and a solid stop.
3. Pull straight back on the connection. An improperly made connection will disconnect.

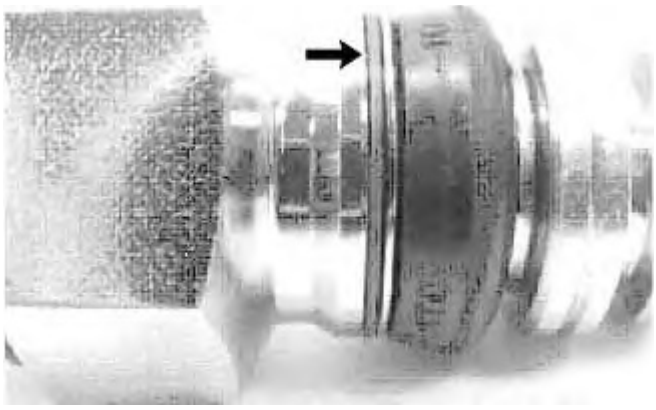


Illustration 4 g02141958

Red ring, on an improper connection.

4. Check for a visible red ring. An improper assembly shows the red ring.

Note: For more information on the operation and the maintenance of Snap to Connect wrenches, refer to Tool Operating Manual, NEHS1083.

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Disassembly and Assembly
3044C Engine for Caterpillar Built Machines
Media Number -SENR9823-00 **Publication Date -01/06/2006** **Date Updated -29/06/2006**

i02001086

Crankcase Breather - Remove and Install

SMCS - 1317-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

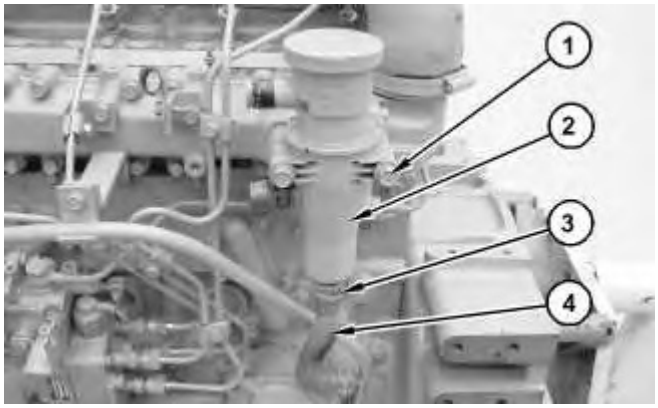


Illustration 1 g01035452

1. Loosen clamp (3) and disconnect hose (4). Remove bolts (1). Remove crankcase breather (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

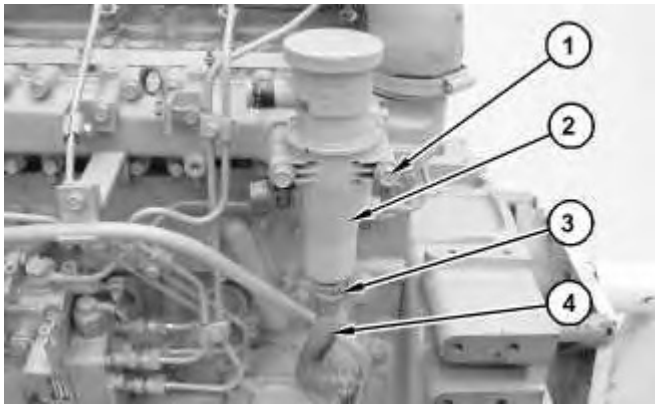


Illustration 2 g01035452

1. Position crankcase breather (2) and install bolts (1). Connect hose (4) and tighten clamp (3) .

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i02001086

Crankcase Breather - Remove and Install

SMCS - 1317-010

Removal Procedure

NOTICE

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Contaminants may cause rapid wear and shortened component life.

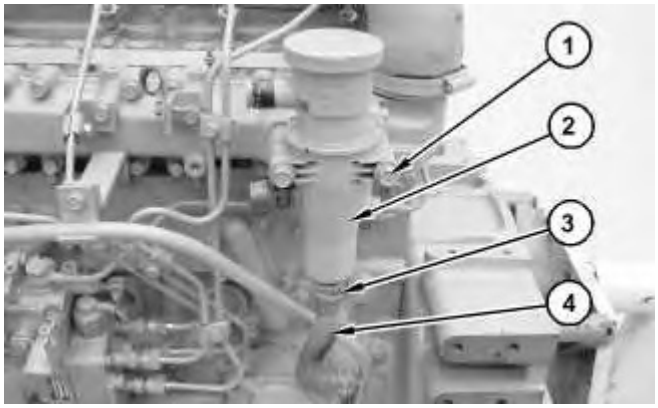


Illustration 1 g01035452

1. Loosen clamp (3) and disconnect hose (4). Remove bolts (1). Remove crankcase breather (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

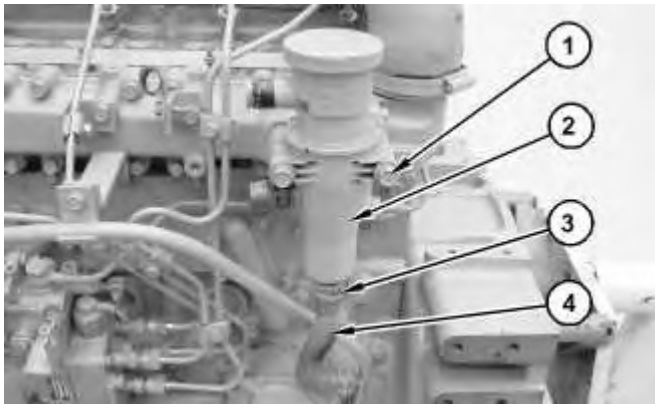


Illustration 2 g01035452

1. Position crankcase breather (2) and install bolts (1). Connect hose (4) and tighten clamp (3) .

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Disassembly and Assembly
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6941-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i02639284

Crankcase Breather - Remove and Install - Turbocharged Engines

SMCS - 1317-010

Removal Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

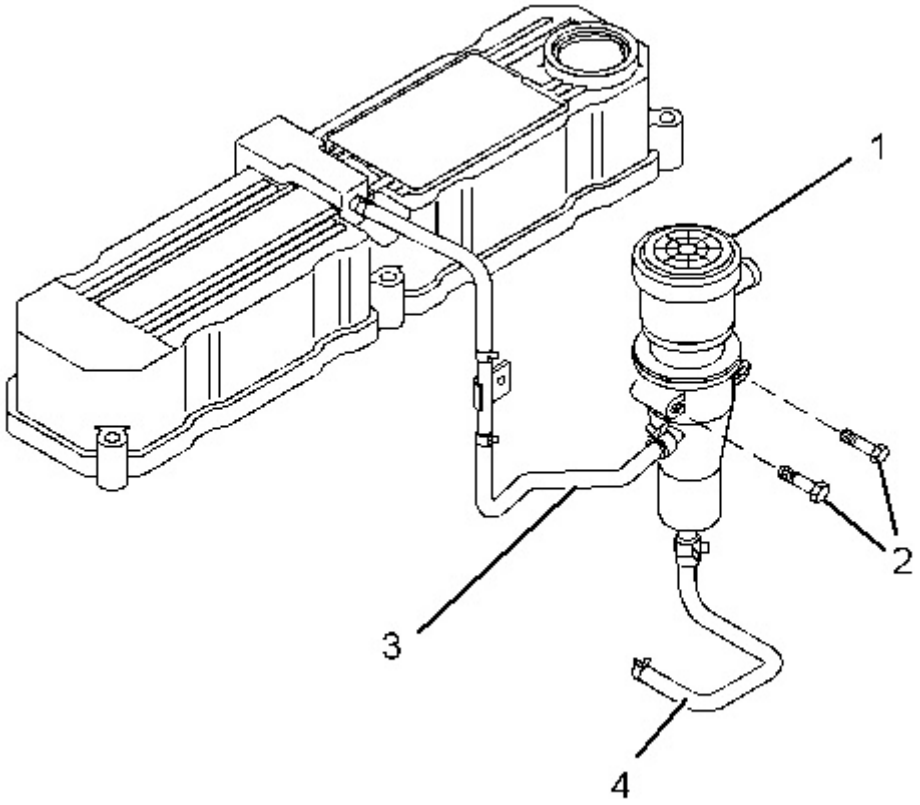


Illustration 1 g01344989

Typical example

1. Loosen the hose clamp and disconnect hose (3) from crankcase breather (1) .
2. Loosen the hose clamp and disconnect hose (4) from crankcase breather (1) .
3. Remove bolts (2) and remove crankcase breather (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

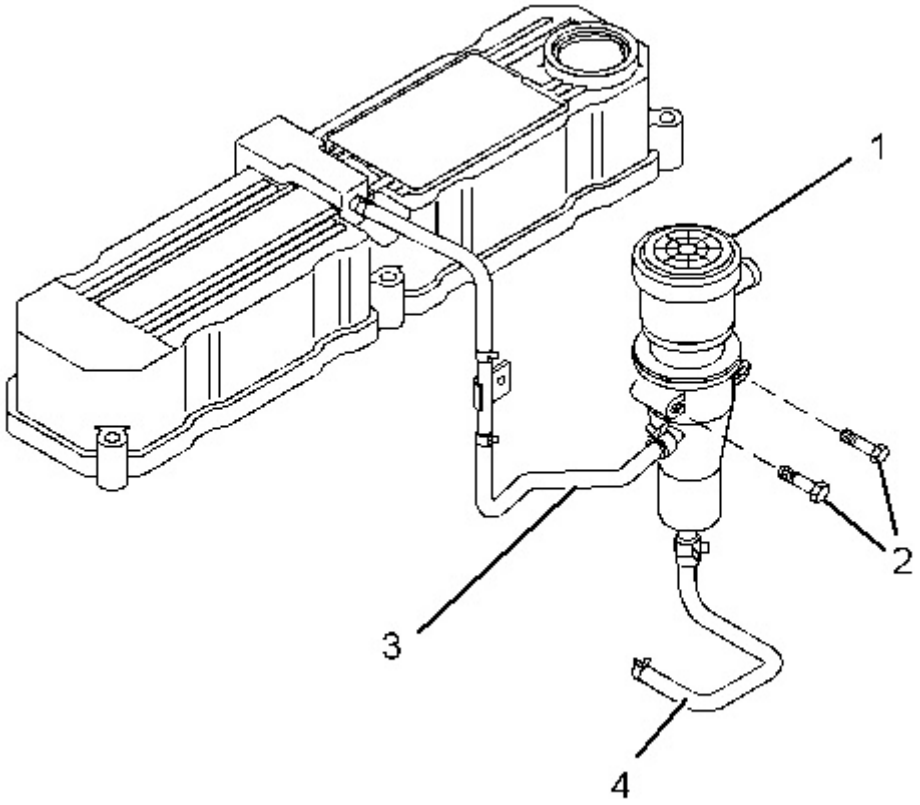


Illustration 2 g01344989

Typical example

1. Connect hose (4) to crankcase breather (1) and tighten the hose clamp.
2. Position crankcase breather (1) and install bolts (2). Tighten the bolts to a torque of 18 N·m (13 lb ft).
3. Connect hose (3) to crankcase breather (1) and tighten the hose clamp.

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Specifications
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Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i05265757

Engine Oil Bypass Valve

SMCS - 1306-BV

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

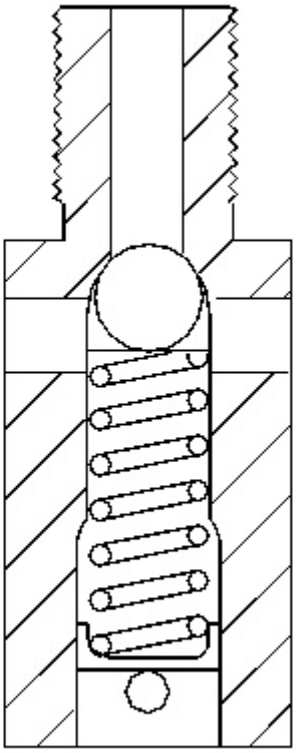


Illustration 1 g00987878

Typical example

Engine oil bypass valve

Tighten the engine oil bypass valve to the following torque. ... 64 to 74 N·m (47 to 55 lb ft)

Opening pressure of engine oil bypass valve ... 1.1 MPa (160 psi)

Note: One engine oil bypass valve is mounted on the inside of the engine oil pan along the left side oil pan rail.

Note: There may be a second engine oil bypass valve located within the engine oil filter assembly.

Differential opening pressure of engine oil bypass valve within the engine oil filter assembly ... 80 to 120 kPa (11.6 to 17.4 psi)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05265757

Engine Oil Bypass Valve

SMCS - 1306-BV

S/N - -

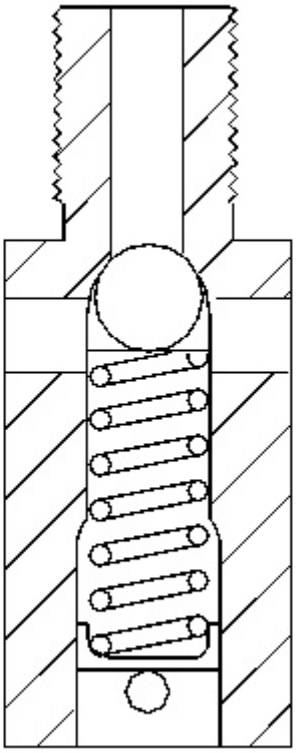


Illustration 1 g00987878

Typical example

Engine oil bypass valve

Tighten the engine oil bypass valve to the following torque. ... 64 to 74 N·m (47 to 55 lb ft)

Opening pressure of engine oil bypass valve ... 1.1 MPa (160 psi)

Note: One engine oil bypass valve is mounted on the inside of the engine oil pan along the left side oil pan rail.

Note: There may be a second engine oil bypass valve located within the engine oil filter assembly.

Differential opening pressure of engine oil bypass valve within the engine oil filter assembly ... 80 to 120 kPa (11.6 to 17.4 psi)

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i02001319

Engine Oil Filter Base - Remove and Install

SMCS - 1306-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

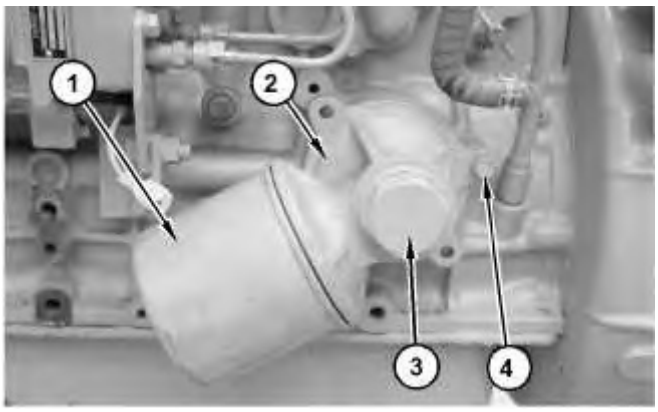


Illustration 1 g01035650

1. Use Tooling (A) to remove engine oil filter (1). Remove bolts (3) and (4). Remove engine oil filter base (2) .

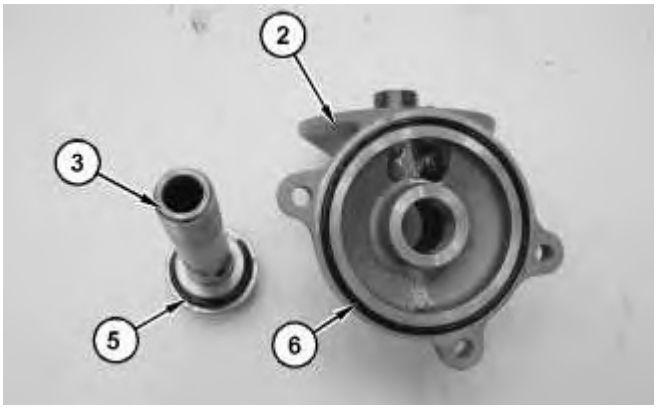


Illustration 2 g01035651

2. Remove O-ring seal (5) from bolt (3). Remove O-ring seal (6) from engine oil filter base (2) .

Installation Procedure

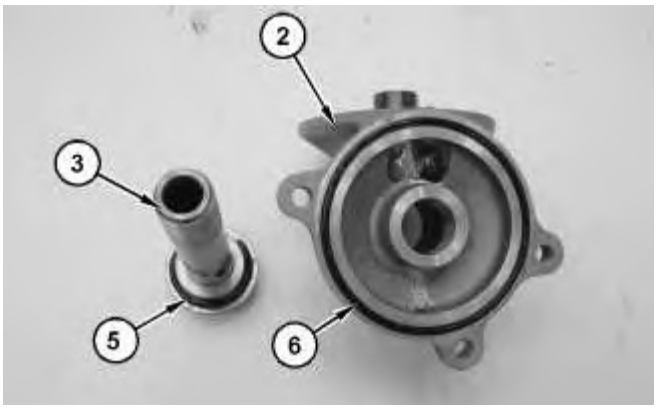


Illustration 3 g01035651

1. Install O-ring seal (6) on engine oil filter base (2). Install O-ring seal (5) on bolt (3) .

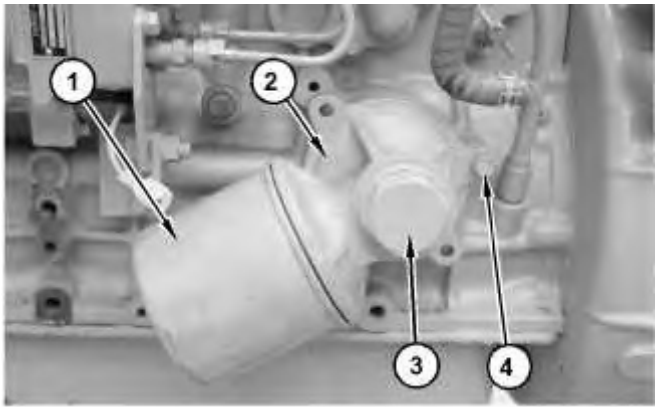


Illustration 4 g01035650

2. Position engine oil filter base (2). Install bolts (3) and (4). Install engine oil filter (1) .

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i02001319

Engine Oil Filter Base - Remove and Install

SMCS - 1306-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

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Dispose of all fluids according to local regulations and mandates.

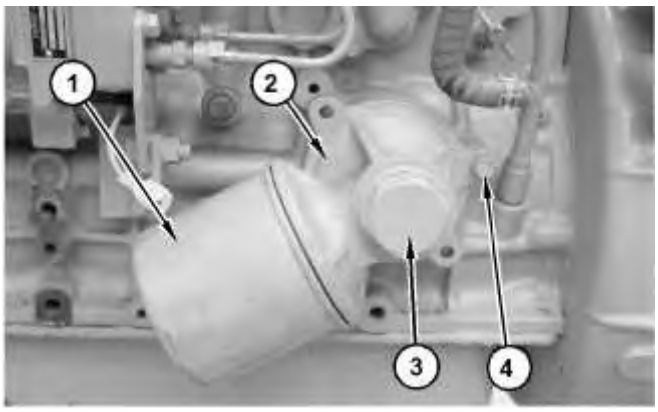


Illustration 1 g01035650

1. Use Tooling (A) to remove engine oil filter (1). Remove bolts (3) and (4). Remove engine oil filter base (2) .

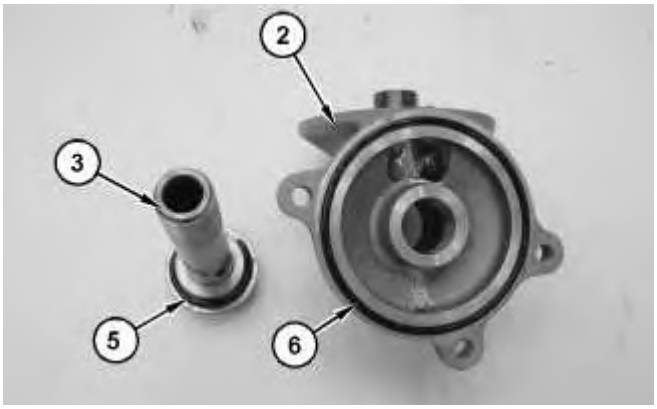


Illustration 2 g01035651

2. Remove O-ring seal (5) from bolt (3). Remove O-ring seal (6) from engine oil filter base (2) .

Installation Procedure

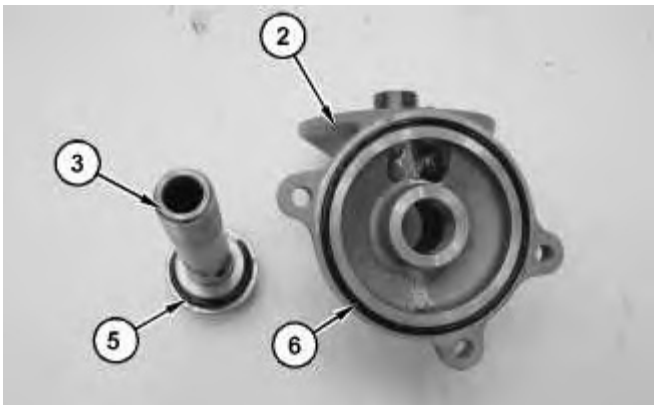


Illustration 3 g01035651

1. Install O-ring seal (6) on engine oil filter base (2). Install O-ring seal (5) on bolt (3) .

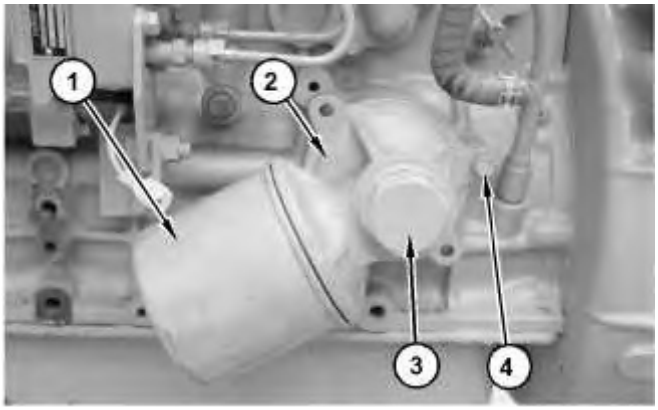


Illustration 4 g01035650

2. Position engine oil filter base (2). Install bolts (3) and (4). Install engine oil filter (1) .

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i02638783

Engine Oil Filter Base - Remove and Install

SMCS - 1306-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

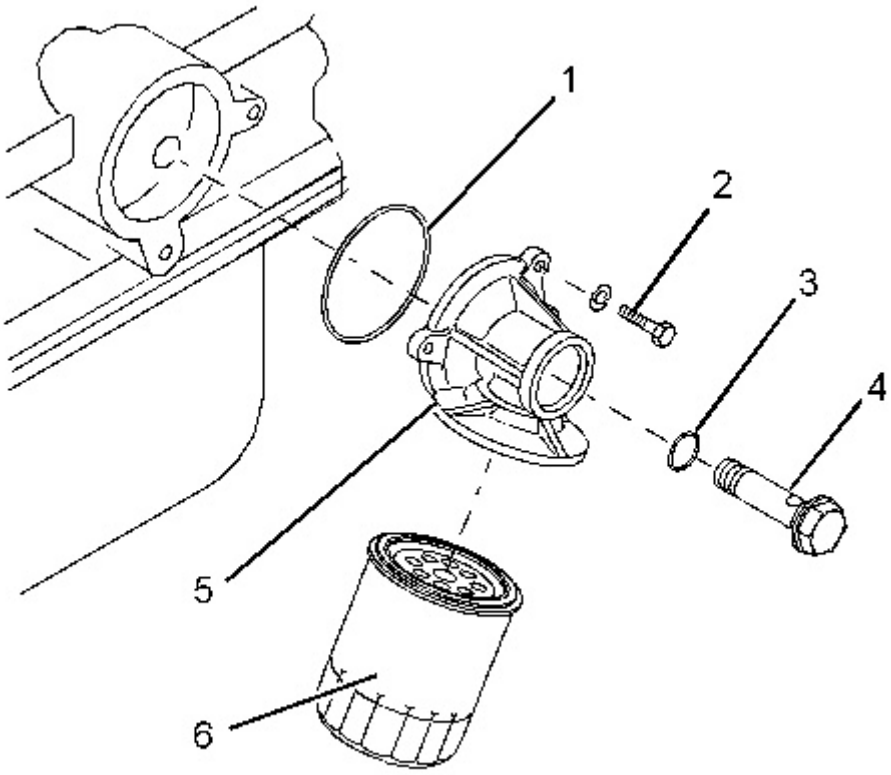


Illustration 1 g01333853

Typical example

1. Use Tooling (A) to remove engine oil filter (6) from engine oil filter base (5). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".
2. Mark the orientation of engine oil filter base (5) for installation. Remove bolt (2) .

   Note: The engine oil filter base can be oriented in different positions.
3. Remove bolt (4) and remove engine oil filter base (5) from the cylinder block. Plug the oil galleries in the cylinder block with suitable plugs.
4. Remove O-ring seal (1) from engine oil filter base (5) .
5. Remove O-ring seal (3) from bolt (4) .

Installation Procedure

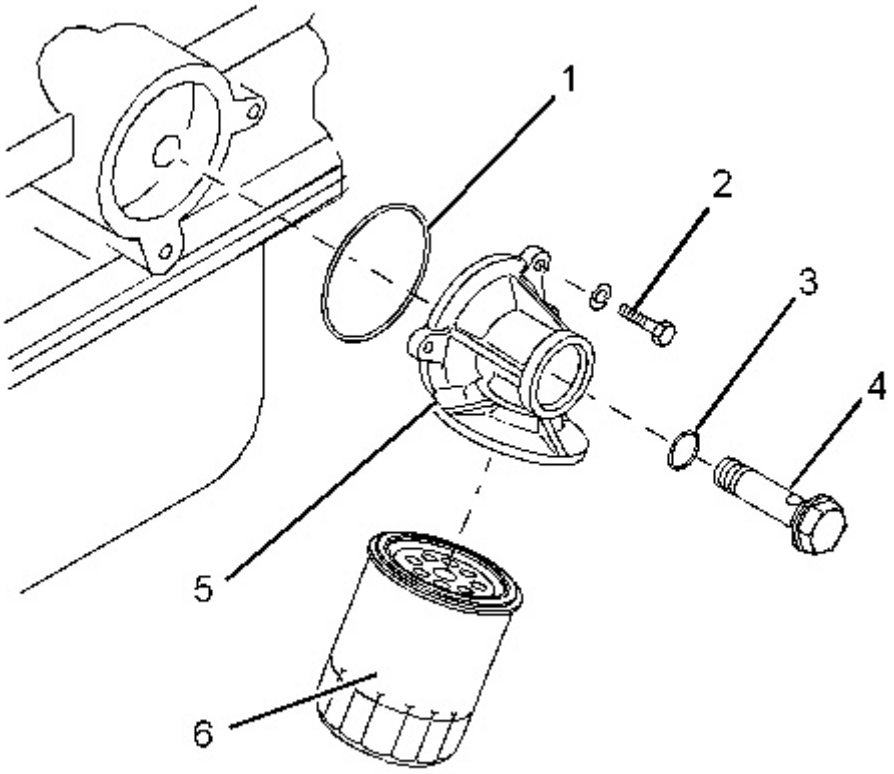


Illustration 2 g01333853

Typical example

1. Ensure that the engine oil filter base is clean and free from damage. Clean the mating surfaces of the cylinder block.
2. Install a new O-ring seal (1) to engine oil filter base (5). Install a new O-ring seal (3) to bolt (4) .
3. Position engine oil filter base (5) against the cylinder block. Install bolt (4) finger tight.
4. Ensure the correct orientation of engine oil filter base (5). Install bolt (2) finger tight.

   Note: The engine oil filter base can be oriented in different positions.
5. Tighten bolt (4) to a torque of 50 N·m (37 lb ft). Tighten bolt (2) to a torque of 11 N·m (97 lb in).
6. Install a new engine oil filter (6). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the correct procedure.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01893227

Engine Oil Relief Valve

SMCS - 1315

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - TPE1-UP

S/N - ZSA1-UP

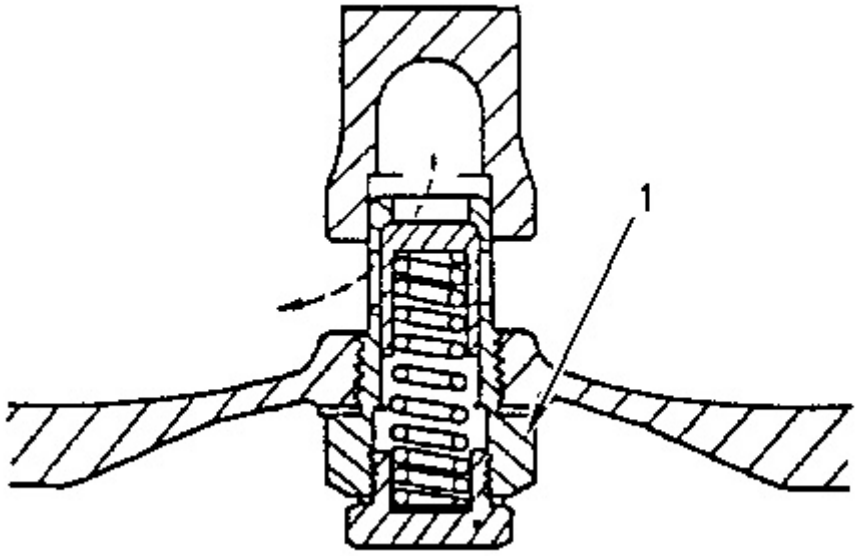


Illustration 1 g00987876

(1) Tighten the engine oil relief valve to the following torque. ... 44 to 54 N·m (33 to 40 lb ft)

Opening pressure of engine oil relief valve ... 350 ± 50 kPa (50 ± 7 psi)

Note: The engine oil relief valve is located on the left side of the cylinder block.

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01893227

Engine Oil Relief Valve

SMCS - 1315

S/N - -

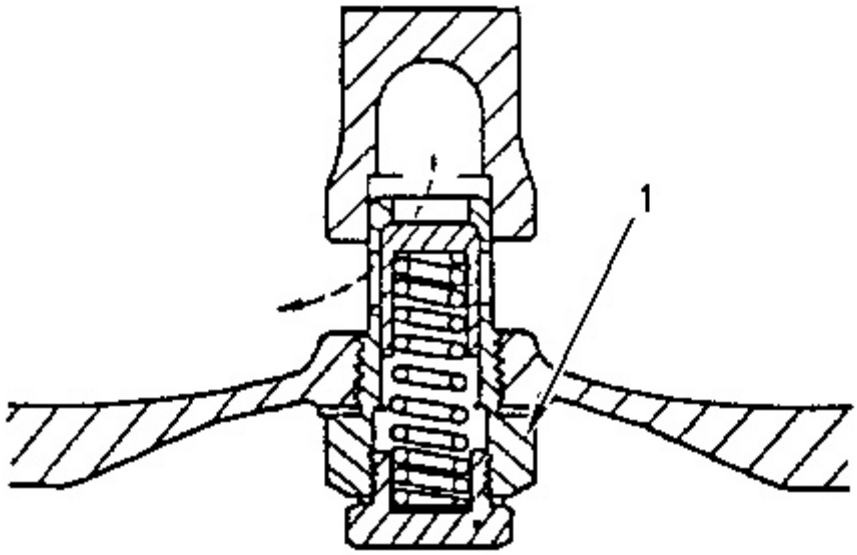


Illustration 1 g00987876

(1) Tighten the engine oil relief valve to the following torque. ... 44 to 54 N·m (33 to 40 lb ft)

Opening pressure of engine oil relief valve ... 350 ± 50 kPa (50 ± 7 psi)

Note: The engine oil relief valve is located on the left side of the cylinder block.

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i01996283

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01033271

1. Remove engine oil filter (1) with Tooling (A) .

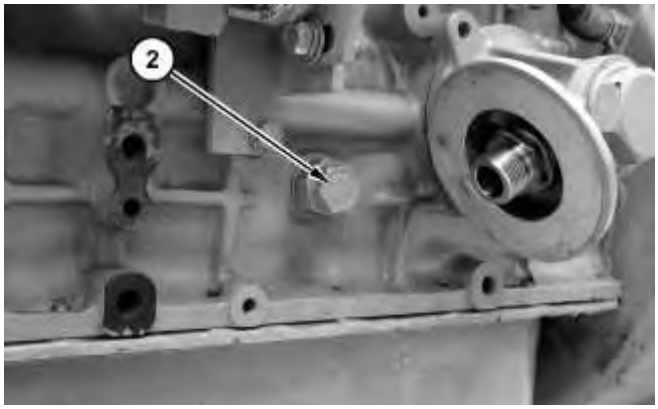


Illustration 2 g01033273

2. Remove engine oil relief valve (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

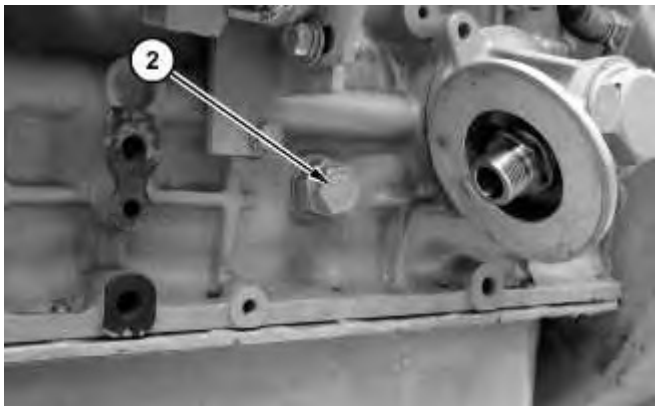


Illustration 3 g01033273

1. Install engine oil relief valve (2) and tighten to a torque of 44 to 54 N·m (33 to 40 lb ft).



Illustration 4 g01033271

2. Install engine oil filter (1) .

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i01996283

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01033271

1. Remove engine oil filter (1) with Tooling (A) .

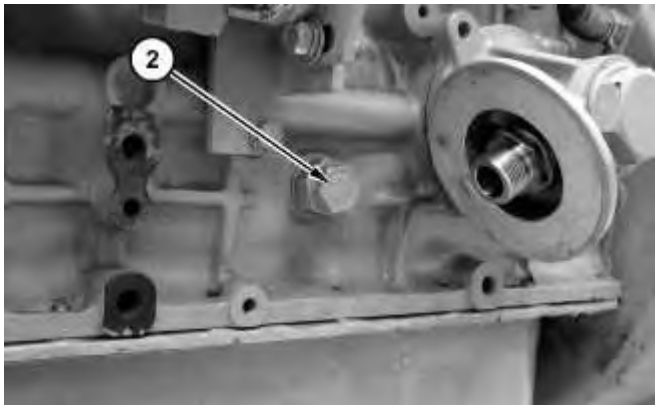


Illustration 2 g01033273

2. Remove engine oil relief valve (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

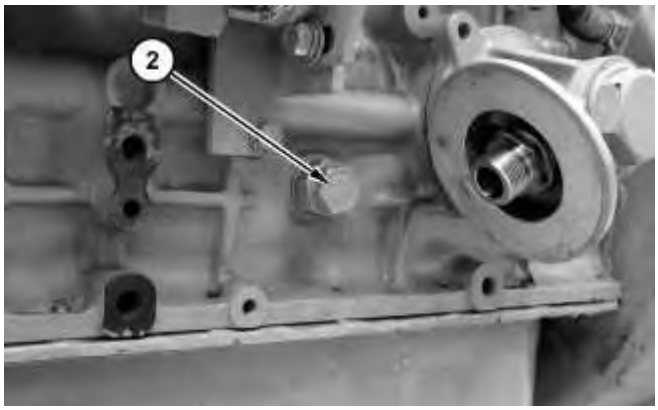


Illustration 3 g01033273

1. Install engine oil relief valve (2) and tighten to a torque of 44 to 54 N·m (33 to 40 lb ft).



Illustration 4 g01033271

2. Install engine oil filter (1) .

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i02638813

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

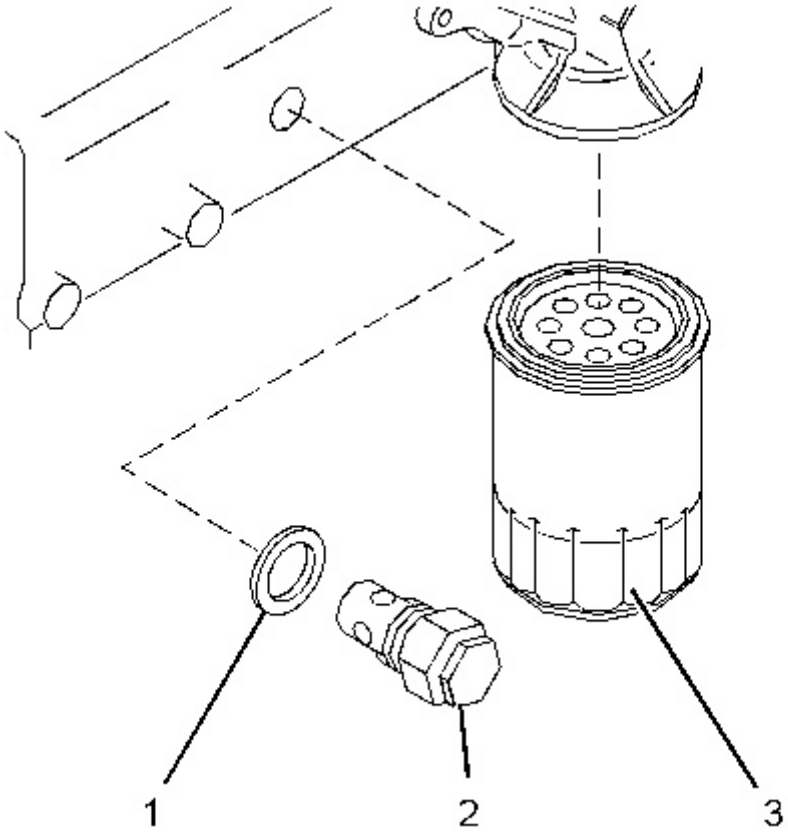


Illustration 1 g01334417

Typical example

1. If necessary, use Tooling (A) in order to remove engine oil filter (3). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".
2. Remove engine oil relief valve (2) .
3. Remove sealing washer (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

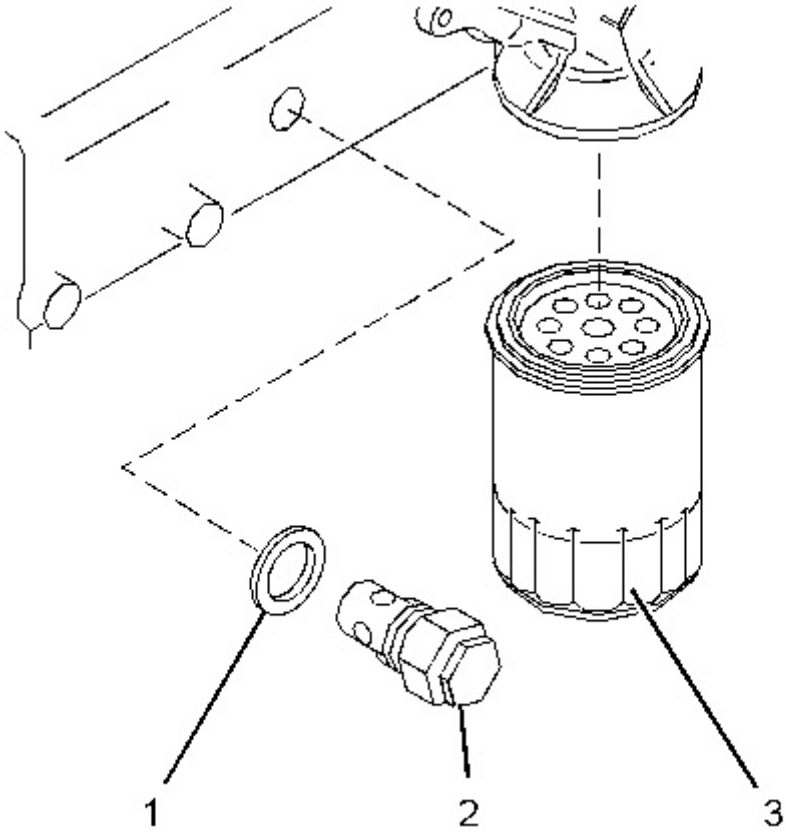


Illustration 2 g01334417

Typical example

1. Install a new sealing washer (1) to engine oil relief valve (2) .
2. Install engine oil relief valve (2) to the cylinder block. Tighten the engine oil relief valve to a torque of 49 N·m (36 lb ft).
3. If necessary, install a new engine oil filter (3). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the correct procedure.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i01893227

Engine Oil Relief Valve

SMCS - 1315

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

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S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

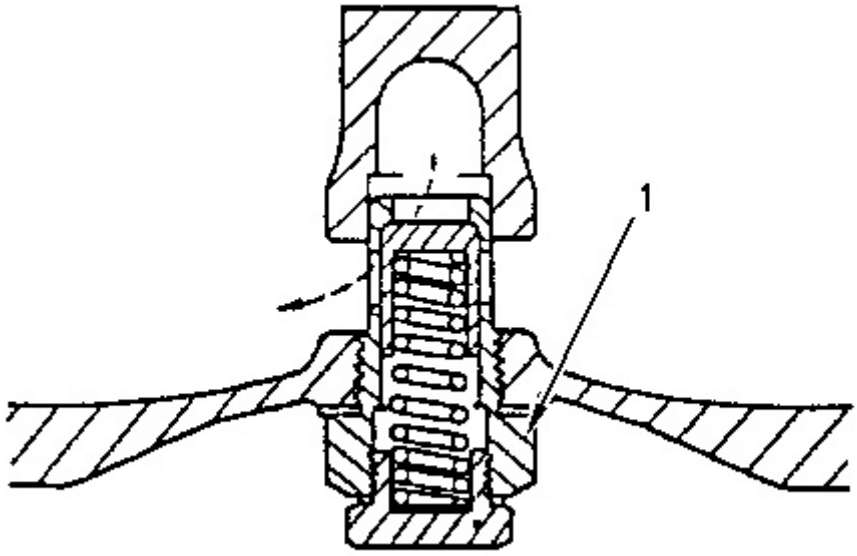


Illustration 1 g00987876

(1) Tighten the engine oil relief valve to the following torque. ... 44 to 54 N·m (33 to 40 lb ft)

Opening pressure of engine oil relief valve ... 350 ± 50 kPa (50 ± 7 psi)

Note: The engine oil relief valve is located on the left side of the cylinder block.

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i02509538

Engine Oil Pump

SMCS - 1304

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - TAR1-UP

S/N - TPE1-UP

S/N - ZSA1-UP

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8H-8581	Feeler Gauge	1

Type ... Gear-driven differential rotor

Number of lobes

Inner rotor ... 4
Outer rotor ... 5

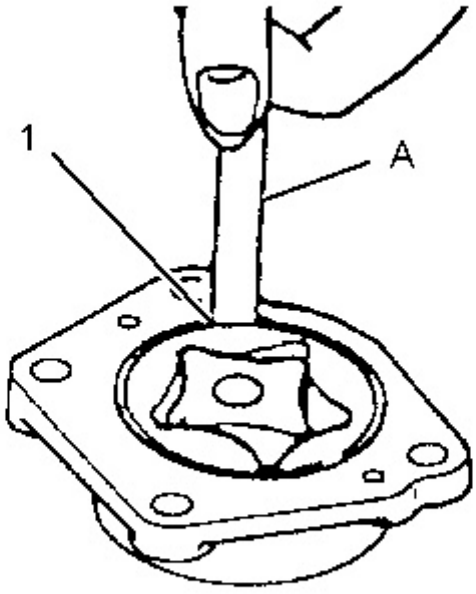


Illustration 1 g01256721

(1) Clearance between the outer rotor and the body

Standard ... 0.20 to 0.30 mm (0.0079 to 0.0118 inch)
Service limit ... 0.50 mm (0.0197 inch)

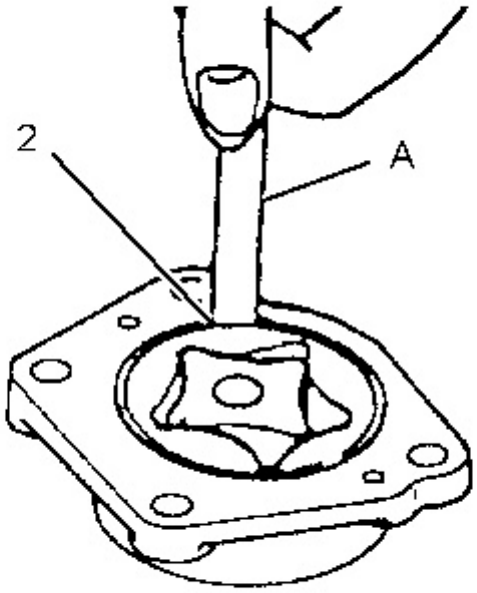


Illustration 2 g01256242

(2) Clearance between the outer rotor and the inner rotor

Standard ... 0.13 to 0.15 mm (0.0051 to 0.0059 inch)
Service limit ... 0.20 mm (0.0079 inch)

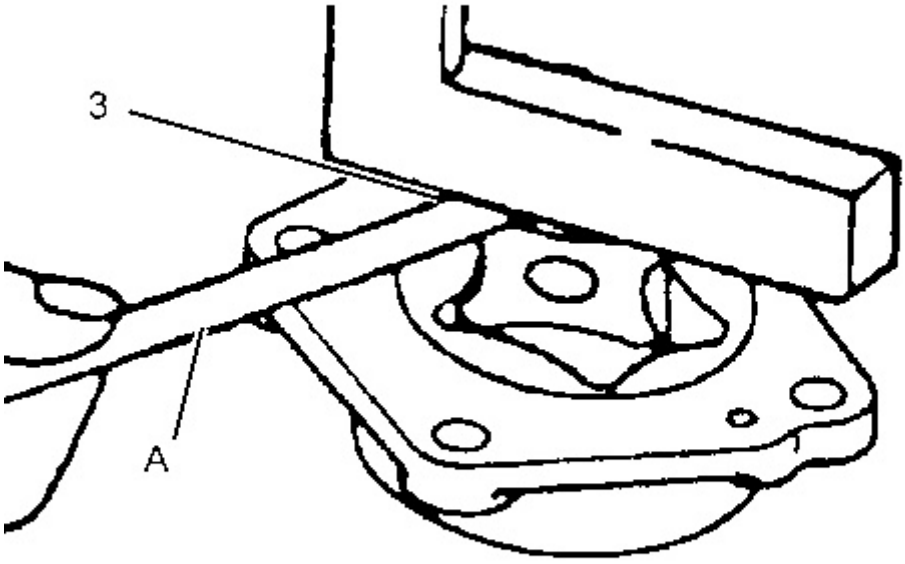


Illustration 3 g01256243

(3) Clearance between the rotors and the body

Standard ... 0.04 to 0.09 mm (0.0016 to 0.0035 inch)
Service limit ... 0.15 mm (0.0059 inch)

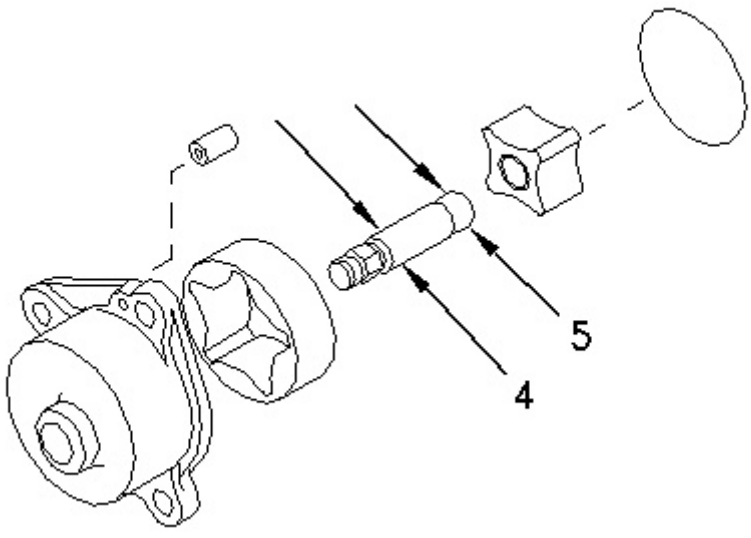


Illustration 4 g00996150

(4) Diameter of main shaft (near body) ... 15.985 to 16.000 mm (0.6293 to 0.6299 inch)

Clearance between the main shaft and the body

Standard ... 0.032 to 0.074 mm (0.0013 to 0.0029 inch)
Service limit ... 0.15 mm (0.0059 inch)

(5) Diameter of main shaft (near bushing) ... 13.957 to 13.975 mm (0.5495 to 0.5502 inch)

Clearance between the main shaft and the bushing

Standard ... 0.025 to 0.111 mm (0.0010 to 0.0044 inch)
Service limit ... 0.200 mm (0.0079 inch)

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Specifications
3044C Industrial Engine and Engines for Caterpillar Built Machines
Media Number -RENR7577-06 **Publication Date -01/07/2007** **Date Updated -01/08/2007**

i05265757

Engine Oil Bypass Valve

SMCS - 1306-BV

S/N - 3441-UP

S/N - CYC1-UP

S/N - DWS1-UP

S/N - GCP1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JWF1-UP

S/N - LBA1-UP

S/N - MAS1-UP

S/N - MDH1-UP

S/N - MER1-UP

S/N - MJF1-UP

S/N - MST1-UP

S/N - MXF1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

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S/N - TPE1-UP

S/N - ZSA1-UP

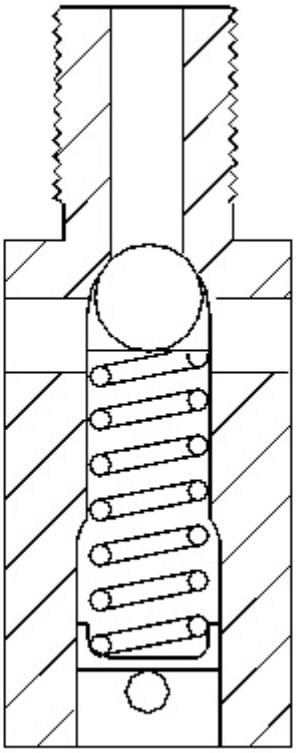


Illustration 1 g00987878

Typical example

Engine oil bypass valve

Tighten the engine oil bypass valve to the following torque. ... 64 to 74 N·m (47 to 55 lb ft)

Opening pressure of engine oil bypass valve ... 1.1 MPa (160 psi)

Note: One engine oil bypass valve is mounted on the inside of the engine oil pan along the left side oil pan rail.

Note: There may be a second engine oil bypass valve located within the engine oil filter assembly.

Differential opening pressure of engine oil bypass valve within the engine oil filter assembly ... 80 to 120 kPa (11.6 to 17.4 psi)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i01893227

Engine Oil Relief Valve

SMCS - 1315

S/N - -

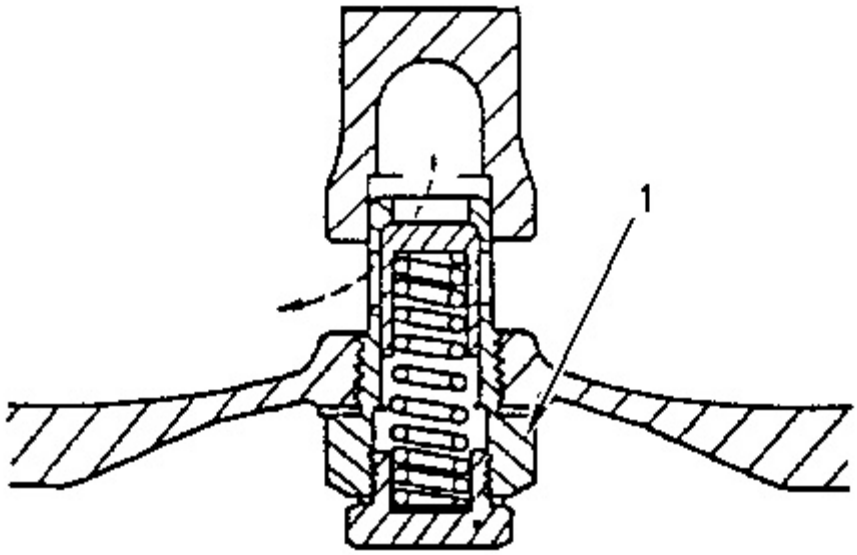


Illustration 1 g00987876

(1) Tighten the engine oil relief valve to the following torque. ... 44 to 54 N·m (33 to 40 lb ft)

Opening pressure of engine oil relief valve ... 350 ± 50 kPa (50 ± 7 psi)

Note: The engine oil relief valve is located on the left side of the cylinder block.

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i02509538

Engine Oil Pump

SMCS - 1304

S/N - -

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	8H-8581	Feeler Gauge	1

Type ... Gear-driven differential rotor

Number of lobes

Inner rotor ... 4
Outer rotor ... 5

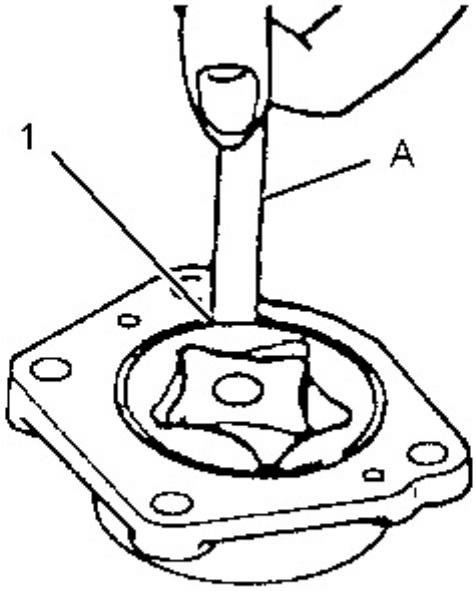


Illustration 1 g01256721

(1) Clearance between the outer rotor and the body

Standard ... 0.20 to 0.30 mm (0.0079 to 0.0118 inch)
Service limit ... 0.50 mm (0.0197 inch)

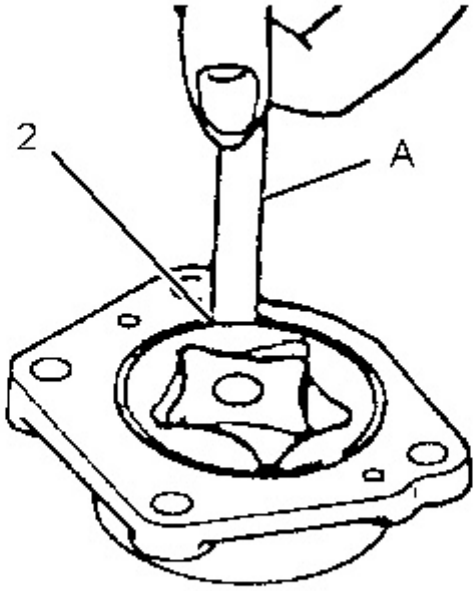


Illustration 2 g01256242

(2) Clearance between the outer rotor and the inner rotor

Standard ... 0.13 to 0.15 mm (0.0051 to 0.0059 inch)
Service limit ... 0.20 mm (0.0079 inch)

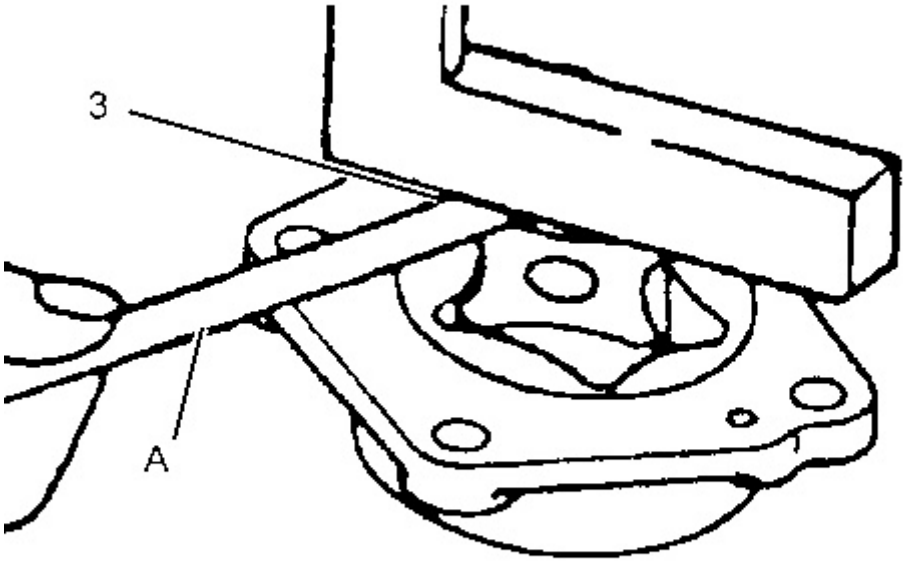


Illustration 3 g01256243

(3) Clearance between the rotors and the body

Standard ... 0.04 to 0.09 mm (0.0016 to 0.0035 inch)
Service limit ... 0.15 mm (0.0059 inch)

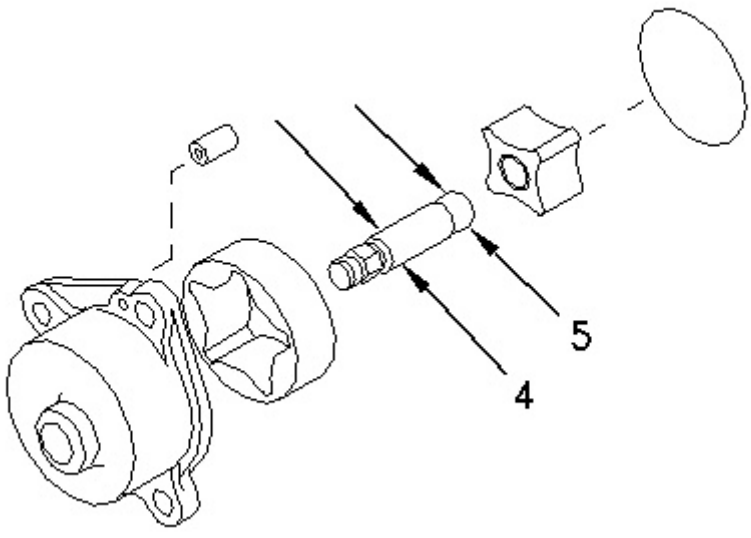


Illustration 4 g00996150

(4) Diameter of main shaft (near body) ... 15.985 to 16.000 mm (0.6293 to 0.6299 inch)

Clearance between the main shaft and the body

Standard ... 0.032 to 0.074 mm (0.0013 to 0.0029 inch)
Service limit ... 0.15 mm (0.0059 inch)

(5) Diameter of main shaft (near bushing) ... 13.957 to 13.975 mm (0.5495 to 0.5502 inch)

Clearance between the main shaft and the bushing

Standard ... 0.025 to 0.111 mm (0.0010 to 0.0044 inch)
Service limit ... 0.200 mm (0.0079 inch)

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Specifications
C3.4 Engines for Caterpillar Built Machines
Media Number -KENR6939-04 **Publication Date -01/03/2012** **Date Updated -01/03/2012**

i05265757

Engine Oil Bypass Valve

SMCS - 1306-BV

S/N - -

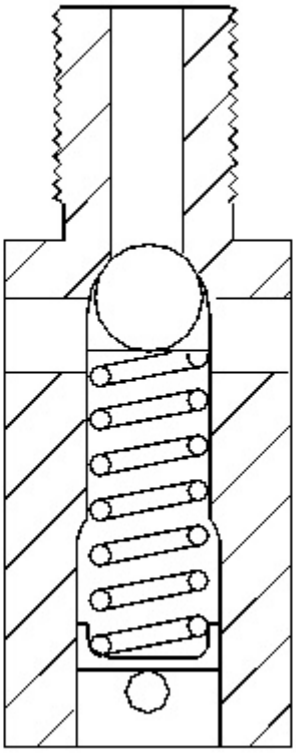


Illustration 1 g00987878

Typical example

Engine oil bypass valve

Tighten the engine oil bypass valve to the following torque. ... 64 to 74 N·m (47 to 55 lb ft)

Opening pressure of engine oil bypass valve ... 1.1 MPa (160 psi)

Note: One engine oil bypass valve is mounted on the inside of the engine oil pan along the left side oil pan rail.

Note: There may be a second engine oil bypass valve located within the engine oil filter assembly.

Differential opening pressure of engine oil bypass valve within the engine oil filter assembly ... 80 to 120 kPa (11.6 to 17.4 psi)

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i01996283

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01033271

1. Remove engine oil filter (1) with Tooling (A) .

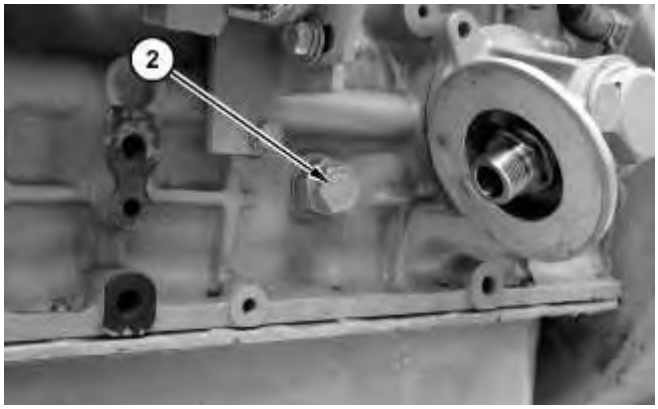


Illustration 2 g01033273

2. Remove engine oil relief valve (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

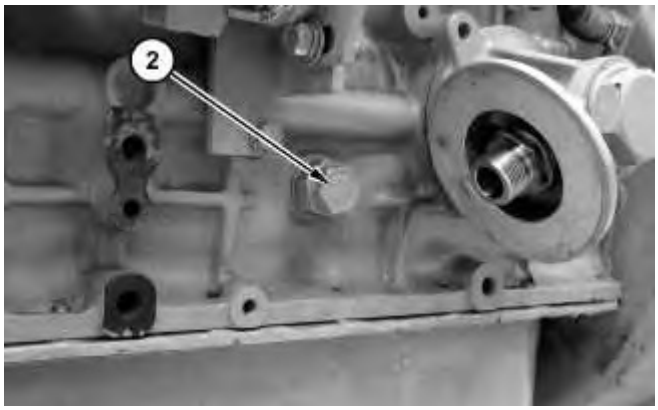


Illustration 3 g01033273

1. Install engine oil relief valve (2) and tighten to a torque of 44 to 54 N·m (33 to 40 lb ft).



Illustration 4 g01033271

2. Install engine oil filter (1) .

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i01999670

Engine Oil Bypass Valve - Remove and Install

SMCS - 1306-010-BV

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

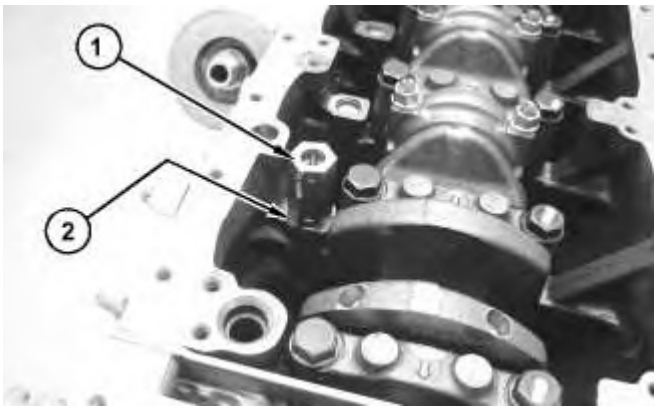


Illustration 1 g01034580

1. Remove engine oil bypass valve (1) and gasket (2) .

Note: Check the valve and the valve seat for an abnormal contact pattern. Inspect the spring for weakness or damage. Replace the engine oil bypass valve, if necessary.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

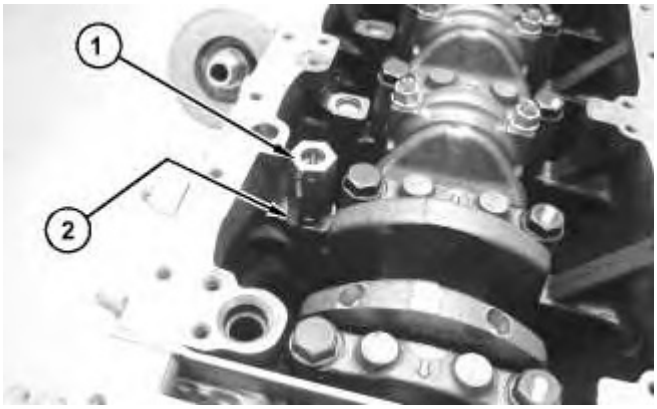


Illustration 2 g01034580

1. Install engine oil bypass valve (1) and gasket (2) .
2. Tighten the cap of engine oil bypass valve (1) to a torque of 64 to 74 N·m (47 to 55 lb ft).

End By: Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i01998907

Engine Oil Pump - Remove

SMCS - 1304-011

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

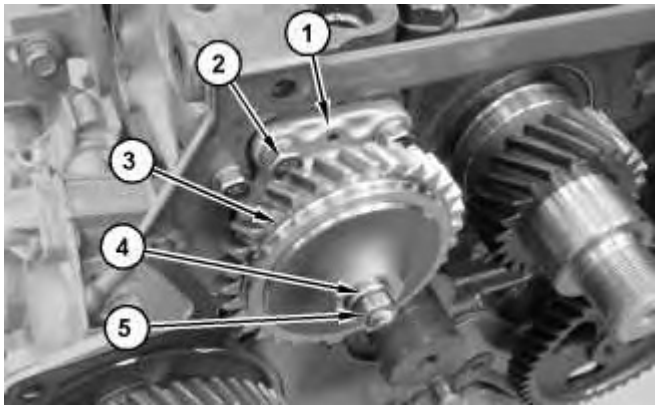


Illustration 1 g01034191

2. Remove nut (5) and washer (4). Remove oil pump gear (3) .
3. Remove the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".
4. Remove bolts (2). Remove engine oil pump (1) and the O-ring seal.
5. Check the condition of the bushing in the cylinder block for the engine oil pump. If the bushing is damaged or worn, replace the bushing.

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i01998973

Engine Oil Pump - Install

SMCS - 1304-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. If necessary, install a new bushing in the cylinder block for the engine oil pump.
2. Check the condition of the O-ring seal. Replace the O-ring seal, if necessary.

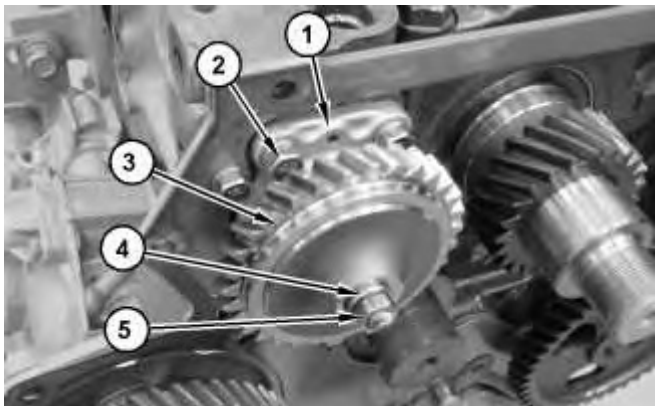


Illustration 1 g01034191

3. Position engine oil pump (1) on the cylinder block. Install bolts (2) .

4. Install the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".

   Note: Ensure that the timing marks on the timing gears are in alignment.

5. Position oil pump gear (3). Install washer (4) and nut (5) and tighten to a torque of 28 to 38 N·m (21 to 28 lb ft).

6. Inspect the timing gear backlash and end play. Refer to Testing and Adjusting, "Gear Group - Inspect".

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i01996283

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.



Illustration 1 g01033271

1. Remove engine oil filter (1) with Tooling (A) .

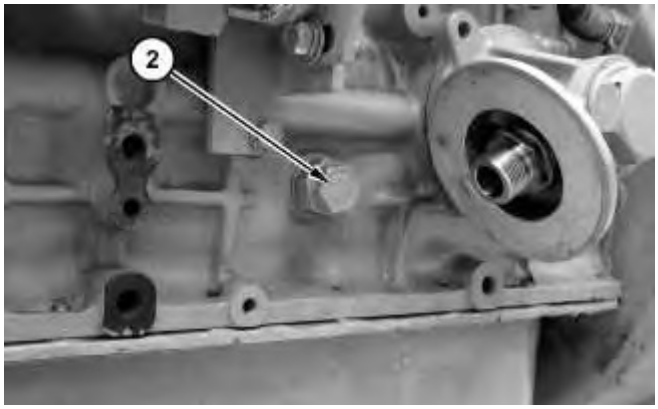


Illustration 2 g01033273

2. Remove engine oil relief valve (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

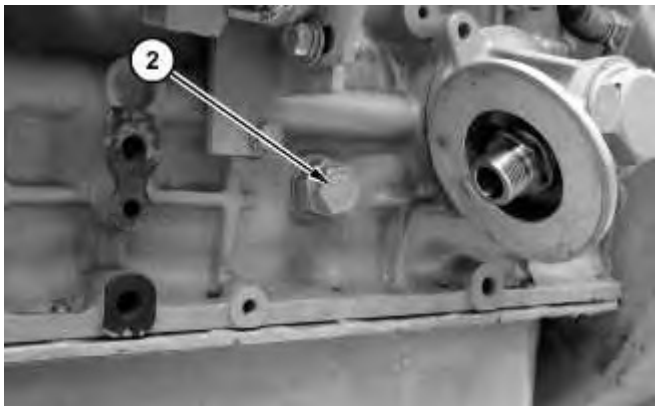


Illustration 3 g01033273

1. Install engine oil relief valve (2) and tighten to a torque of 44 to 54 N·m (33 to 40 lb ft).



Illustration 4 g01033271

2. Install engine oil filter (1) .

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i01999670

Engine Oil Bypass Valve - Remove and Install

SMCS - 1306-010-BV

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

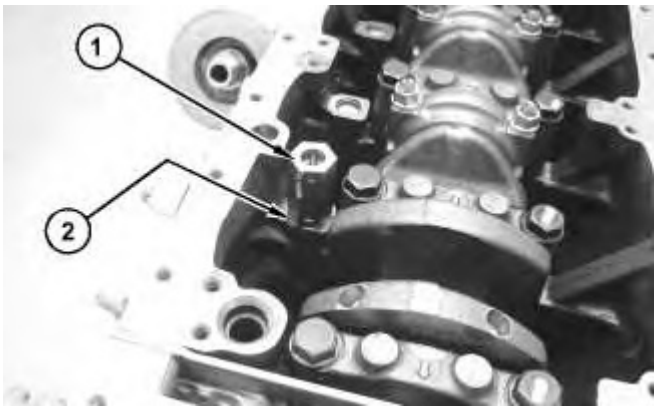


Illustration 1 g01034580

1. Remove engine oil bypass valve (1) and gasket (2) .

Note: Check the valve and the valve seat for an abnormal contact pattern. Inspect the spring for weakness or damage. Replace the engine oil bypass valve, if necessary.

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

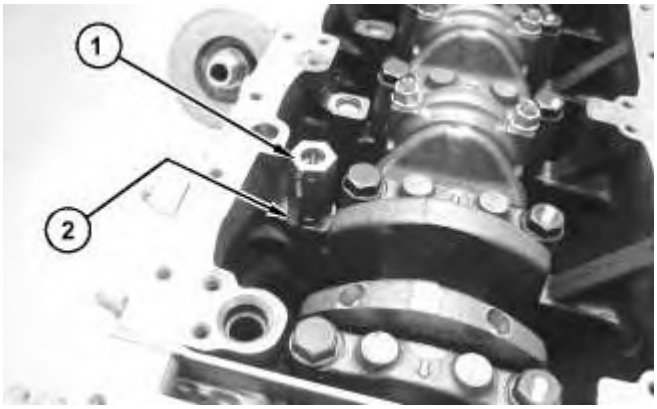


Illustration 2 g01034580

1. Install engine oil bypass valve (1) and gasket (2) .
2. Tighten the cap of engine oil bypass valve (1) to a torque of 64 to 74 N·m (47 to 55 lb ft).

End By: Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i01998907

Engine Oil Pump - Remove

SMCS - 1304-011

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Ensure that the No. 1 cylinder is at the top center compression stroke. Refer to Testing and Adjusting, "Finding Top Center Position for No. 1 Piston".

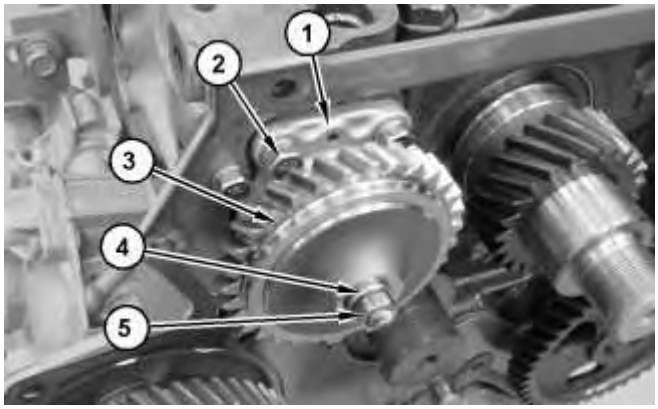


Illustration 1 g01034191

2. Remove nut (5) and washer (4). Remove oil pump gear (3) .
3. Remove the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".
4. Remove bolts (2). Remove engine oil pump (1) and the O-ring seal.
5. Check the condition of the bushing in the cylinder block for the engine oil pump. If the bushing is damaged or worn, replace the bushing.

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i01998973

Engine Oil Pump - Install

SMCS - 1304-012

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. If necessary, install a new bushing in the cylinder block for the engine oil pump.
2. Check the condition of the O-ring seal. Replace the O-ring seal, if necessary.

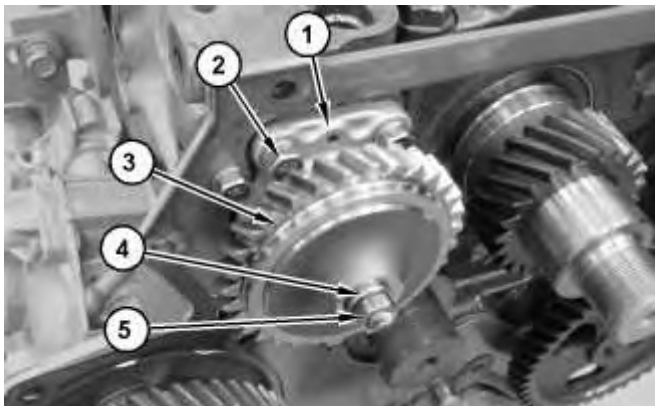


Illustration 1 g01034191

3. Position engine oil pump (1) on the cylinder block. Install bolts (2) .

4. Install the idler gear. Refer to Disassembly and Assembly, "Idler Gear - Remove and Install".

   Note: Ensure that the timing marks on the timing gears are in alignment.

5. Position oil pump gear (3). Install washer (4) and nut (5) and tighten to a torque of 28 to 38 N·m (21 to 28 lb ft).

6. Inspect the timing gear backlash and end play. Refer to Testing and Adjusting, "Gear Group - Inspect".

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Install".

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i02638813

Engine Oil Relief Valve - Remove and Install

SMCS - 1315-010

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	185-3630	Strap Wrench As	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

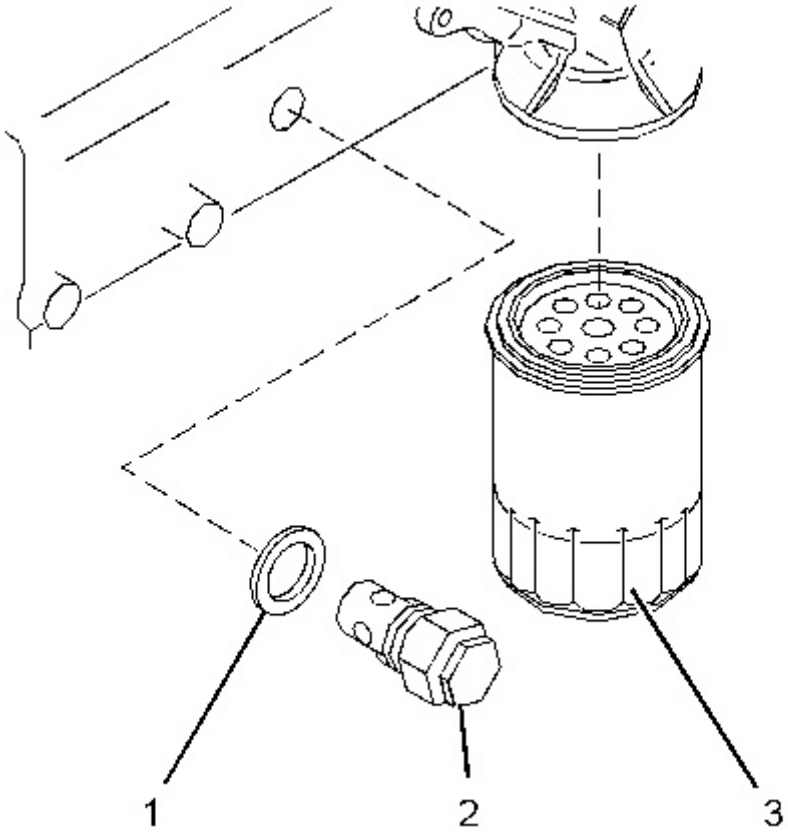


Illustration 1 g01334417

Typical example

1. If necessary, use Tooling (A) in order to remove engine oil filter (3). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change".
2. Remove engine oil relief valve (2) .
3. Remove sealing washer (1) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

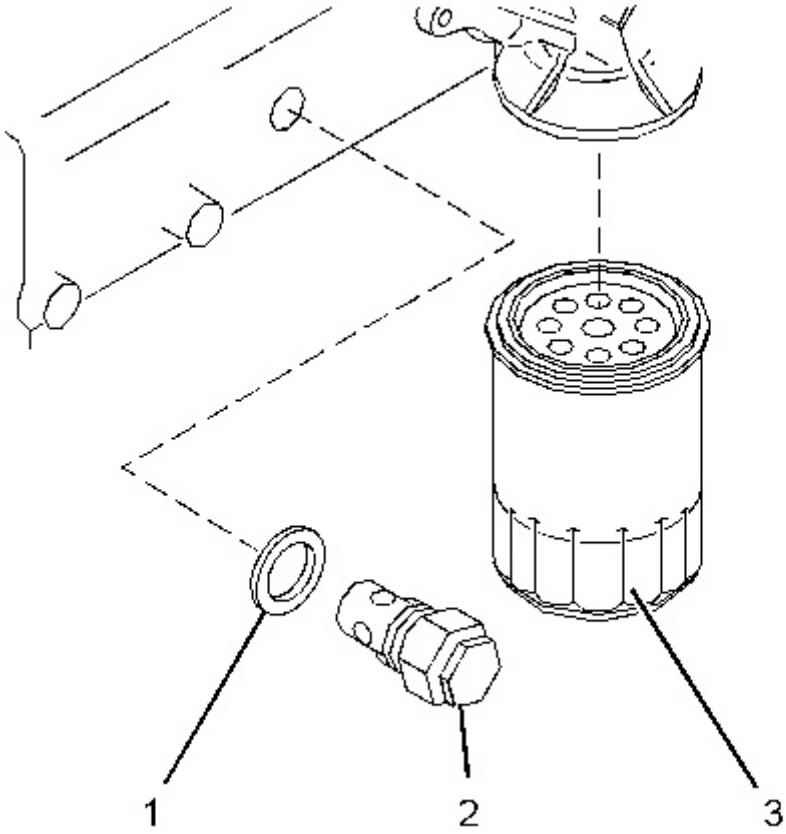


Illustration 2 g01334417

Typical example

1. Install a new sealing washer (1) to engine oil relief valve (2) .
2. Install engine oil relief valve (2) to the cylinder block. Tighten the engine oil relief valve to a torque of 49 N·m (36 lb ft).
3. If necessary, install a new engine oil filter (3). Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for the correct procedure.

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i02638817

Engine Oil Bypass Valve - Remove and Install

SMCS - 1306-010-BV

Removal Procedure

Start By:

A. Remove the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

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1. If the engine is equipped with a balancer, remove the balancer. Refer to Disassembly and Assembly, "Balancer - Remove".

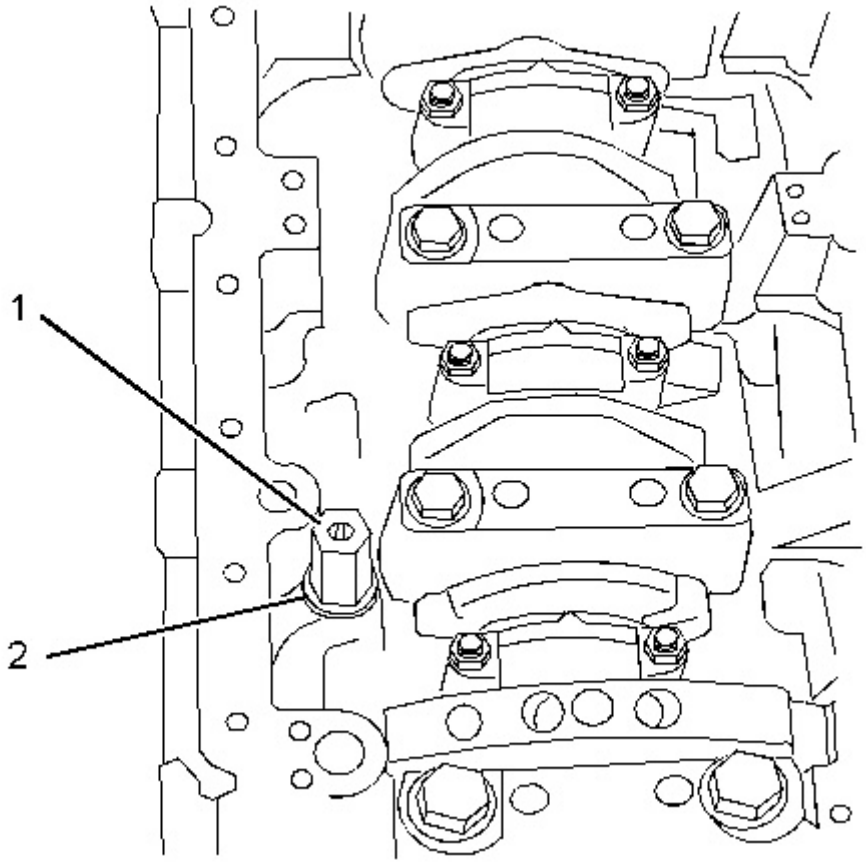


Illustration 1 g01334433

Typical example

2. Remove engine oil bypass valve (1) .
3. Remove sealing washer (2) .

Installation Procedure

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Inspect the components of the engine oil bypass valve for wear or damage. Check the valve and the valve seat for an abnormal contact pattern. Check the spring for weakness or damage. If necessary, replace the engine oil bypass valve.

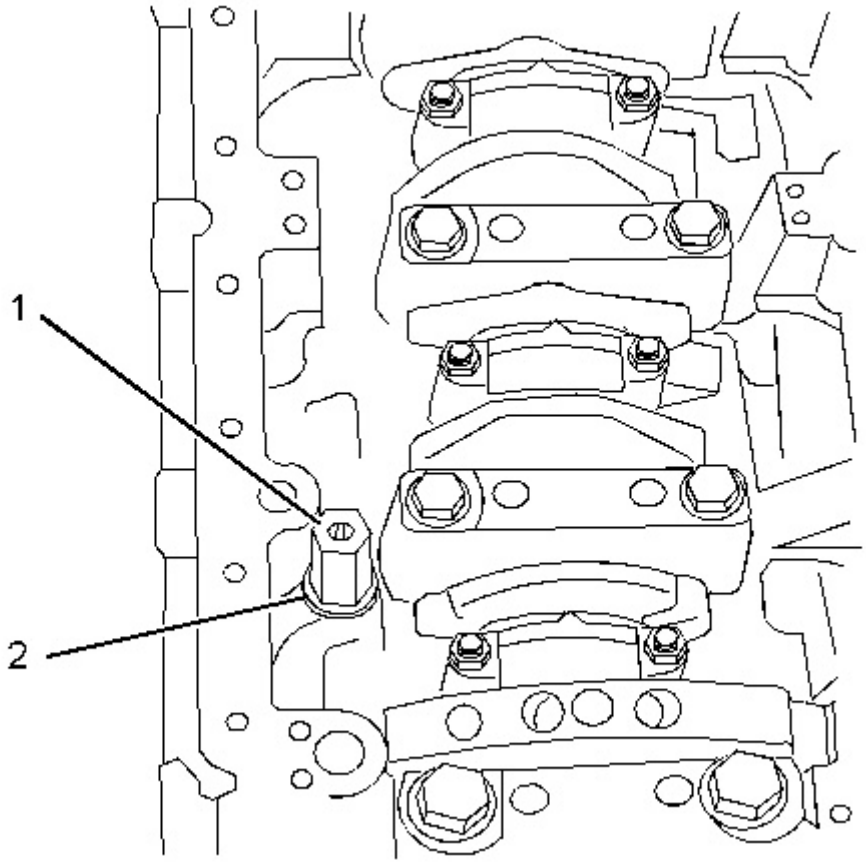


Illustration 2 g01334433

Typical example

2. Install a new sealing washer (2) to engine oil bypass valve (1) .
3. Install engine oil bypass valve (1) to the cylinder block. Tighten the engine oil bypass valve to a torque of 69 N·m (51 lb ft).
4. If the engine is equipped with a balancer, install the balancer. Refer to Disassembly and Assembly, "Balancer - Install".

End By: Install the engine oil pan. Refer to Disassembly and Assembly, "Engine Oil Pan - Remove and Install".

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i02638819

Engine Oil Pump - Remove

SMCS - 1304-011

Removal Procedure

Start By:

A. Remove the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

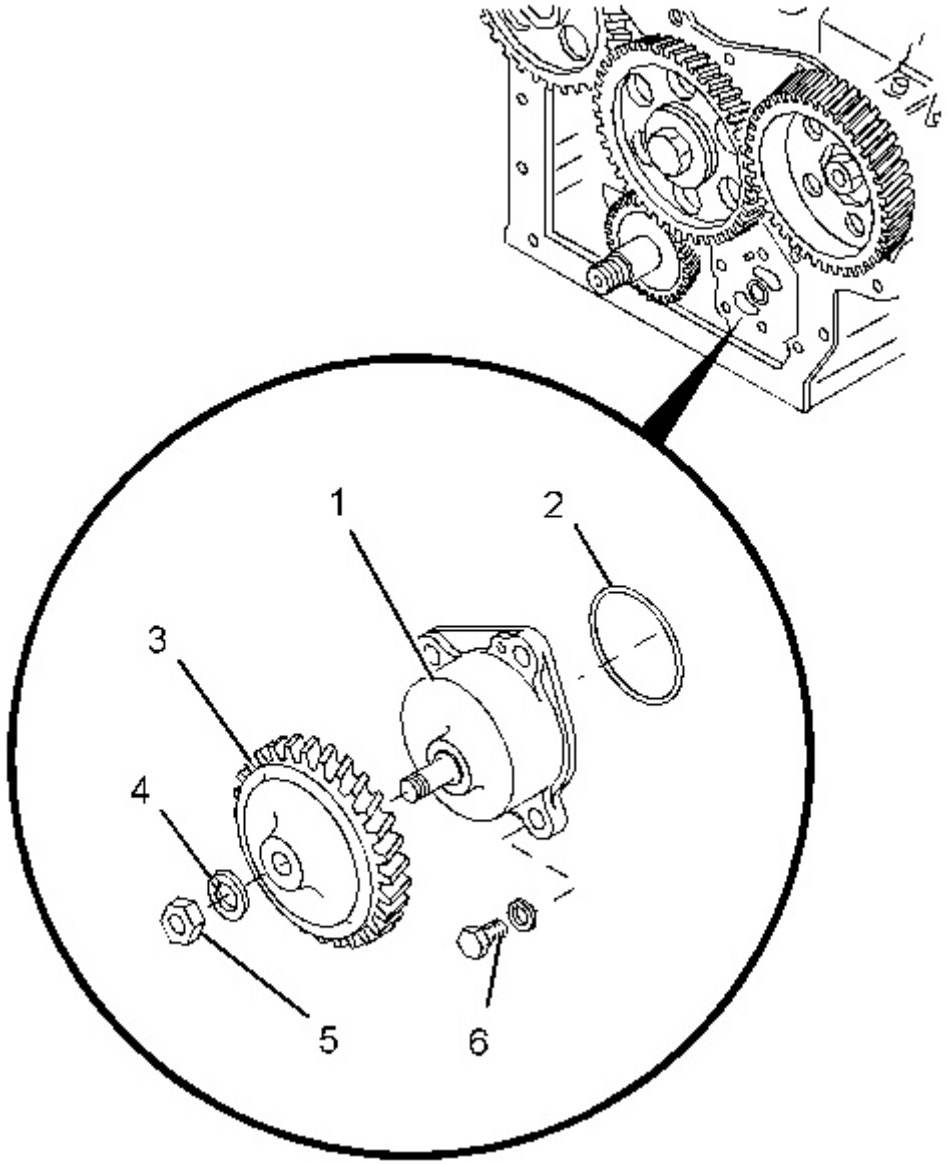


Illustration 1 g01334537

1. Remove nut (5) and washer (4) .
2. Remove gear (3) from the shaft of engine oil pump (1) .
3. Remove bolts (6) and remove engine oil pump (1) from the cylinder block.
4. Remove O-ring seal (2) .

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i02638821

Engine Oil Pump - Install

SMCS - 1304-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	9U-7324	Indicator Bracket	1
	7H-1942	Dial Indicator	1
	3S-3268	Indicator Contact Point	1
	7H-1940	Universal Attachment	1

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

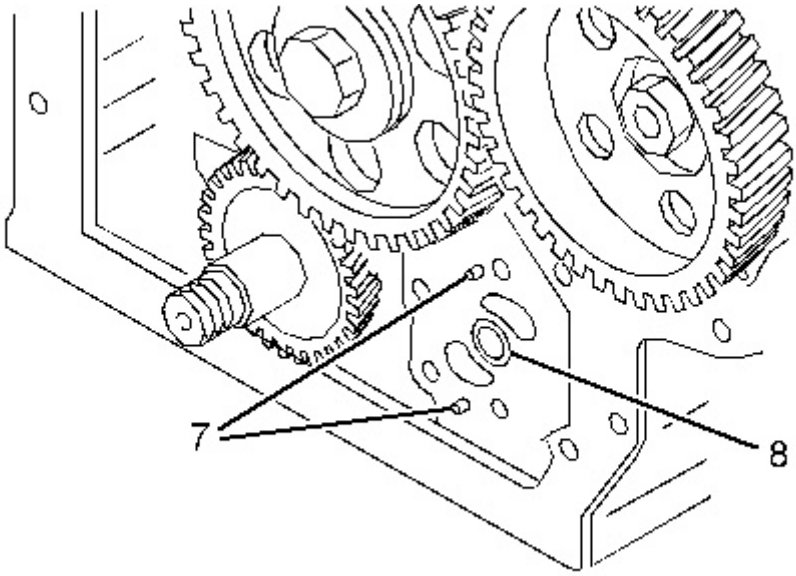


Illustration 1 g01334869

1. Ensure that bushing (8) is free from wear or damage. Refer to Specifications, "Engine Oil Pump" for more information. If necessary, replace the bushing.

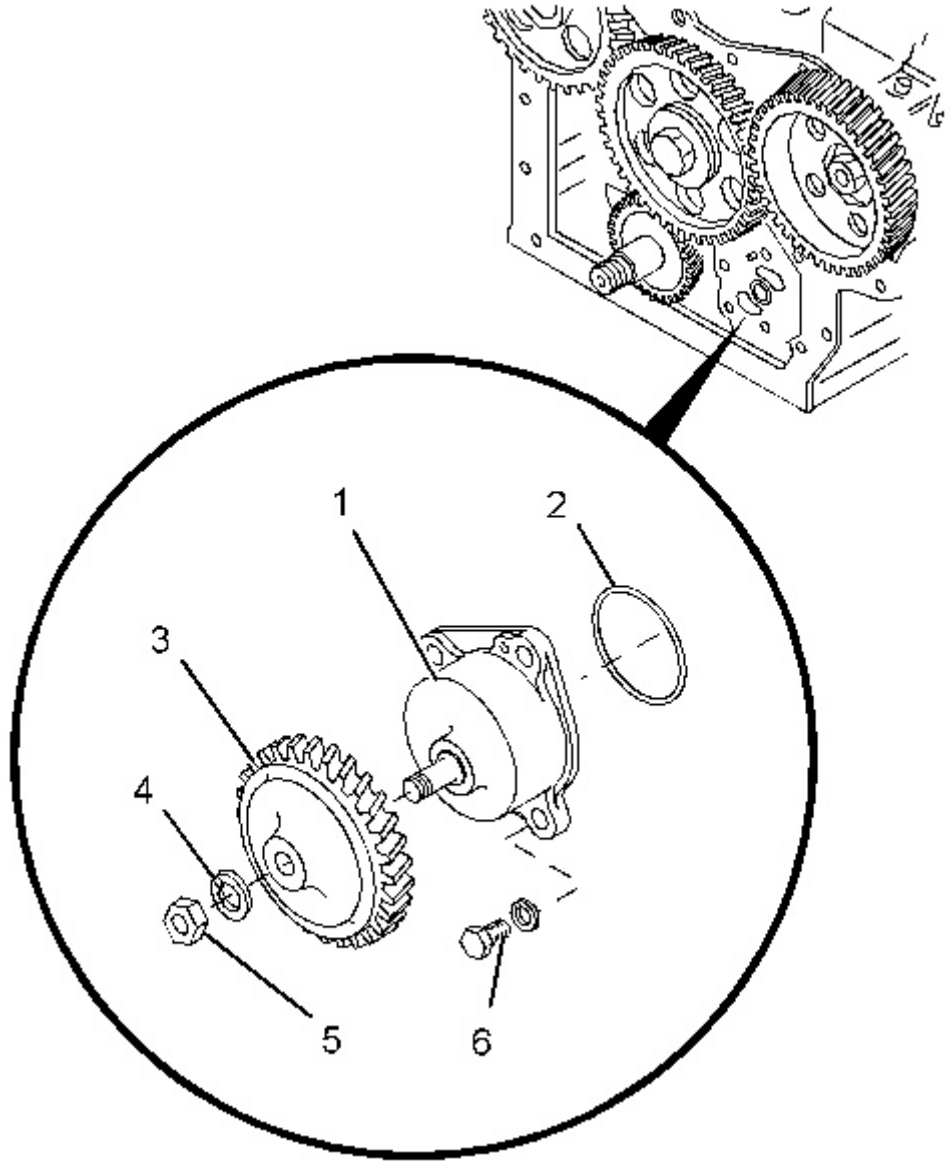


Illustration 2 g01334537

2. Ensure that engine oil pump (1) is clean and free from wear or damage. Refer to Specifications, "Engine Oil Pump" for more information. If necessary, replace the engine oil pump.

3. Install a new O-ring seal (2) to engine oil pump (1). Lubricate the rotors of the engine oil pump with clean engine oil.

4. Align engine oil pump (1) with dowels (7). Install the engine oil pump to the cylinder block.

5. Install bolts (6). Tighten the bolts to a torque of 11 N·m (97 lb in).

6. Position oil pump gear (3) onto the shaft of engine oil pump (1). Ensure that the oil pump gear is aligned with the flat on the shaft. Install washer (4) and nut (5). Tighten the nut to a torque of 33 N·m (24 lb ft).

7. Use Tooling (A) to check the backlash between oil pump gear (3) and the idler gear. Ensure that the backlash is within specified values. Refer to Specifications, "Gear Group (Front)" for further information.

End By: Install the front housing. Refer to Disassembly and Assembly, "Housing (Front) - Remove and Install".

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Systems Operation
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03861420

Service Intervals

SMCS - 7000; 7309; 7320

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Note: Before performing any maintenance, refer to Troubleshooting, SENR5664, "Machine Preparation for Troubleshooting" for the correct lockout procedure.

Regular maintenance must be performed in order to maximize the performance of the air conditioning system. Regular maintenance must be performed in order to minimize the downtime of the machine. Failure to inspect these systems will cause poor performance and premature failure. Inspect and maintain the Heater and the Air conditioner system per the chart below. For additional information on the component and system maintenance instructions, refer to Service Manual, SENR5664, "testing and adjusting".

Table 1

Component or System	Clean/Inspect	Replace
Dryer with Quick Disconnect		Every 2000 hours
Dryer with Tube O-Ring Connect		Every 4000 hours
Recirculation Filter	Weekly	Monthly
Condenser Coil	as needed	
Fresh Air Filter	Each shift	Weekly
Heating and A/C Maintenance checklist	Seasonal	

- Perform regular maintenance on the refrigerant service units in accordance to the instructions from the manufacturer. Change the oil that is in the vacuum pumps according to the instructions from the manufacturer.
- Check the scale that is used for charging for accuracy after every 30 days. Check after every 30 uses according to the instructions from the manufacturer.

Heating and A/C Maintenance Checklist

Table 2

Filters	
Operation	**Check if OK**
Check the cleanliness of the Fresh Air Filter.	
Check the cleanliness of the Recirculation Filter.	

Table 3

Coils	
Operation	**Check if OK**
Check the condenser coil for damage or debris.	
Check the evaporator coil for damage or debris.	
Check the heater coil for damage or debris.	

Table 4

Blowers and Fans	
Operation	**Check if OK**
Check the remote condenser fans in order to make sure that the fans operate when the air conditioning system is running.	
Make sure that the blower fans for the cab operate on all speed settings.	

Table 5

Condensate Drain Lines	
Operation	**Check if OK**
Make sure that the drain lines are clean and that the drain lines allow condensate flow.	
Make sure that the drain valves are present and correctly located.	

Table 6

Dryer	
Operation	**Check if OK**
If the dryer has quick disconnects, make sure that the dryer has been replaced within the last 2000 hours. Replace according to the maintenance chart	
If the dryer has tube connections that are an O-ring, make sure that the dryer has been replaced within the last 4000 hours. Replace according to the maintenance chart	

Table 7

Compressor	
Operation	**Check if OK**

Check the cleanliness of the wire connections for the compressor and make sure that the connections are free of damage.	
Make sure that the dust caps are securely installed on the service ports.	
Make sure that the clutch engages when the A/C switch is on and the thermostat is set to maximum cooling.	

Table 8

Compressor Drive Belt	
Operation	**Check if OK**
Check for wear and damage on the compressor drive belt.	
Make sure that the auto tension pulleys are functioning correctly.	
Make sure that the drive belt is aligned within 1/3 of a degree.	

Table 9

Hoses and Connections	
Operation	**Check if OK**
Check for wear and damage on the refrigerant lines	
Check for leaks on the refrigerant lines	
Check for wear and damage on the heater lines	
Check for leaks on the heater lines	
Make sure that the heater valves are open for use in the winter.	

Table 10

Performance	
Operation	**Check if OK**
Make sure that a performance check on the air conditioning indicates a system that is functioning properly. Refer to testing and adjusting, SENR5664, "Performance Checks for the Air Conditioning System".	
Make sure that a performance check on the heater system indicates that the system is properly functioning. Refer to testing and adjusting, SENR5664, "Performance Checks for the Air Conditioning System".	

Air Filters-Clean

The cab air filters are designed to provide clean air to the evaporator and the heater coils. The cab air filters are also designed to keep the cab pressurized. If the filters are not properly maintained, the coils will be coated with dirt. Dirty coils will result in loss of heating and cooling. Dirty coils could also result in failure of the compressor. Refer to testing and adjusting, SENR5664, "Coil Cleaning".

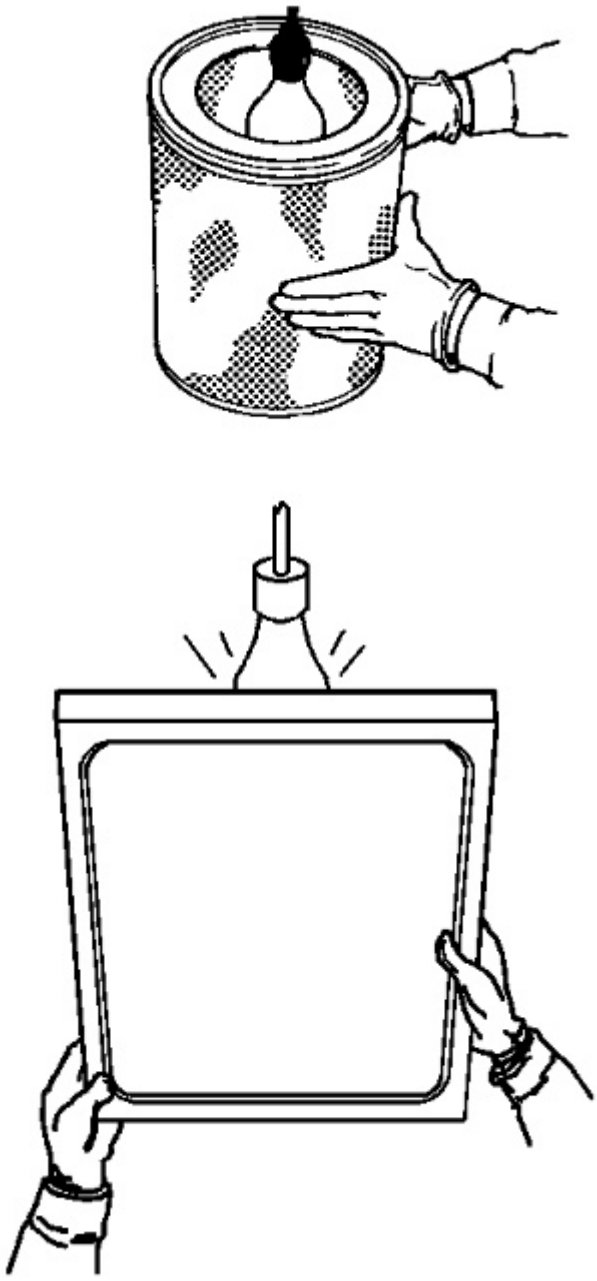


Illustration 1 g01517100

Cab air filters should be inspected regularly. Any inspection variance depends on the environmental conditions. Fresh air filters should be checked after every shift (8 to 10 hours). Fresh air filters should be changed after every week (40 to 50 hours). Recirculation filters should be checked after every week (40 to 50 hours). Recirculation filters should be changed after every

month (160 to 200 hours). Inspect the filter for holes. Look through the filter toward a bright light. Check for damaged gaskets or dented metal parts. Do not use damaged filters. For extreme dust conditions, the filters should be inspected daily, and the filters should be cleaned whenever is necessary.

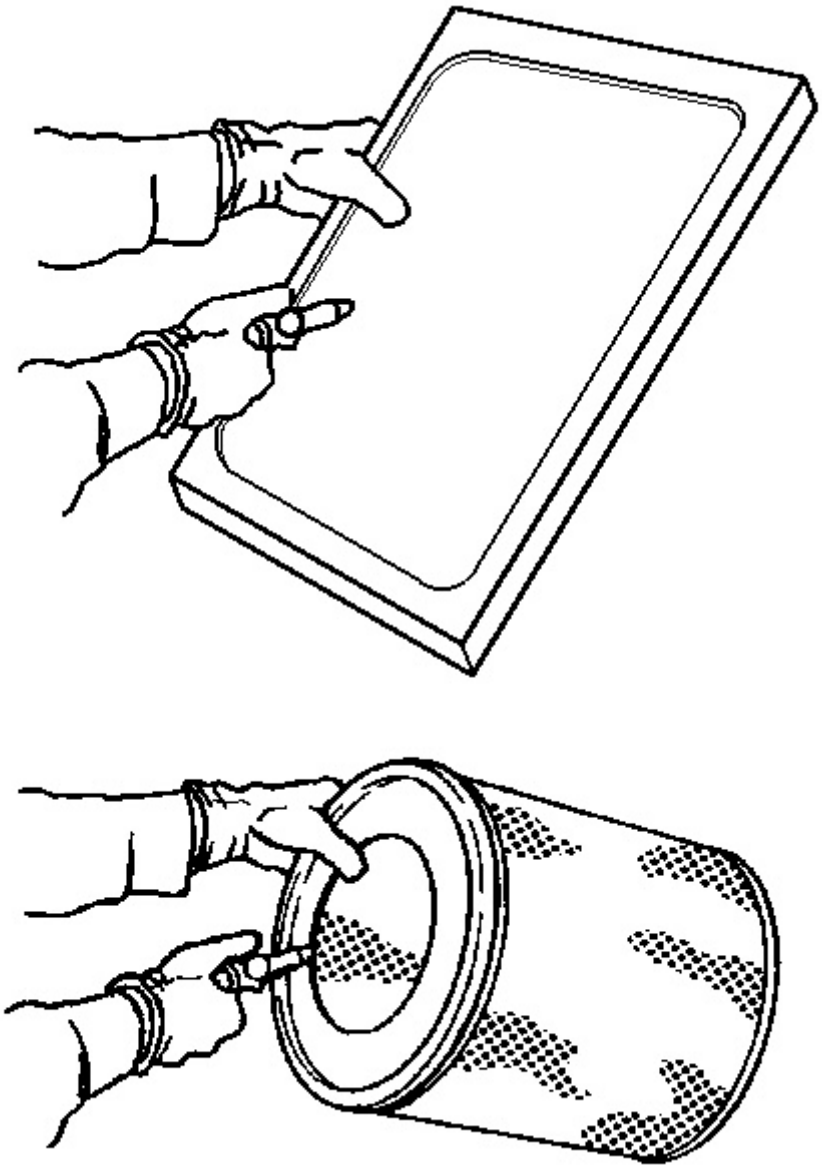


Illustration 2 g01517101

Remove loose dirt with compressed air. Do not exceed 690 kPa (100 psi) from an air nozzle that is 3.18 mm (0.125 inch)diameter. Keep the air nozzle at least 51 mm (2 inch) from the filter.

The filters that are made of foam can be blown out with low-pressure air. The filters that are made of foam can also be gently washed with a mild detergent. After washing the filters, dry the filters with low-pressure air.

If the carbon is still active, the carbon impregnated filters may be blown out with low-pressure air. Do not wash the carbon impregnated filters.

Standard filters or high efficiency filters may be blown out with low-pressure air. Do not wash the standard filters or the high efficiency filters.

Coil Cleaning

NOTICE

Do not use steam to clean the coils, under any circumstance. The heat from the steam will induce thermal stresses on the construction of the components of the coil. The stress can weaken the overall construction and permanently damaging the coil.

NOTICE

Do not use any other objects in order to straighten the fins, such as a screwdriver or a knife. These objects can damage the coil.

In order for an HVAC coil to function properly, air must be able to flow freely across the fins without any major obstructions. Because the coils need to stay clean, cleaning the coil is important in order for the coils to provide sufficient air flow. Some job applications may cause the coils to become dirty quickly, and dirty coils requires frequent cleaning. There are different methods that are utilized for proper cleaning. The different methods that are used depend on the type of coil that is used.

Condenser coils typically have a thicker, more durable fin structure that is designed to withstand the conditions of the environment. Due to the construction of the condenser coils, condenser coils can be washed with a low-pressure power washer. Power wash in order to remove any dirt from the coil and any debris from the coil. The coils should be cleaned from a safe distance. However, if the nozzle is too close to the coil the water still can damage the fins.

The evaporator and heater coils typically reside within an enclosed area. In order to protect the evaporator and the heater coils from the environment and outside dirt and debris. Therefore, the construction is not strong enough to withstand washing with direct pressure. In order to clean the coils, use a low-pressure air nozzle that is like the one that is used in cleaning the filter. Carefully use the low-pressure air nozzle in order to blow out any dirt and debris that is present on the coils.

During normal operation and routine cleaning, the fins may possibly get bent. The bent fins could cause blockages in the air flow, which will reduce overall system performance. Straighten the fins by using the **208-1350** Radiator Tool Gp . Start at one side of the coil and work toward the other side. Be careful not to rip or tear the fins during straightening, as this straightening will cause an unwanted reduction in performance.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03607159

Heating and Air Conditioning Service Publications

SMCS - 7000; 7320

Table 1

Publication Number	Products	Title of Publication
Data Sheets		
PEHJ0092	All Products	"Cat Cabin Air Filters"
PEHJ0148	All Products	"Cat Air Conditioning Kits"
Information Release Memo		
PELJ0374	All Products	"Air Conditioning Kits for Caterpillar Equipment"
PELM0992	Integrated Toolcarrier Wheel Loader Motor Grader Track-Type Tractor	"CAT Field Installed Air Conditioning Kits (R134a)"
Special Instructions		
REHS1692	D10R, D11R	"Procedure to Replace the Water Valve for the Climate Control System"
REHS1715	Articulated Trucks	"Procedure to Replace the Control Assembly and Water Valve Assembly in the Air Conditioner Group"
REHS1716	Wheel Tractor-Scrapers	"Procedure to Replace the Water Valve for the Climate Control System"
REHS1717	Wheel Dozer Wheel Loader	"Installation Procedure for the New Water Valve for the Climate Control System"
REHS1798	Multi Terrain Loader	"Installing the 233-5870 Installation Arrangement (Air Conditioner Conversion)(Kit)"

REHS1799	Multi Terrain Loader	"Installing the 233-5873 Installation Arrangement (Air Conditioner, Heater)(Kit)"
REHS1801	Skid Steer Loader	"Installing the 218-6747 Installation Arrangement (Air Conditioner, Heater)(Kit)"
REHS1802	Skid Steer Loader	"Installing the 218-6749 Installation Arrangement (Air Conditioner Conversion)(Kit)"
REHS2488	All Products	"Refrigerant Compressor Functional Test for All Caterpillar Machines"
REHS3093	Large Track-Type Tractor	"Improving the Cab Environment for the Operator of Track-Type Tractors"
REHS3678	All Products	"Refrigerant Dryer Functional Test"
REHS4025	Wheel Loader Integrated Toolcarriers	"Replacement of the Blower Assembly on Certain Wheel Loaders"
REHS4100	D10T, D9T, D8T	"Improvement to the Case of the Air Cleaner"
REHS4138	Integrated Toolcarriers Wheel Loader Excavator Industrial Tractor Track Feller Buncher Wheel Feller Buncher	"Assembly Instructions for Installing The Air Mix Door"
REHS4499	All Products	"Testing the Refrigerant Compressor Protection Module"
SEHS9088	Earthmoving Compactor Excavator Motor Grader Track-Type Loader Track-Type Tractor Wheel Loader Wheel Tractor-Scraper	"Installation Instructions for the 174-1508 Electric Motor"
SEHS9098	Track-Type Loader Articulated Truck Excavator Track-Type Tractor Wheel Loader	"Instructions for the Installation of the 174-1508 Electric Motor"

	Wheel Tractor-Scraper	
SEHS9734	All Products	"Retrofitting Caterpillar R-12 Air Conditioning Systems to R134a Refrigerant"
SMHS7059	D7G, D8K, D9H	"Installation of 9P4752, 9P4753, and 9P4754 Air Conditioner Arrangements"
Specifications, Systems Operation, Testing and Adjusting, Disassembly and Assembly		
SENR3334	All Products	"Air Conditioning and Heating R-12 All Caterpillar Machines"
SENR5664	All Products	"Air Conditioning and Heating R-134a for All Caterpillar Products"
Service Magazine		
SEPD0306	Challenger	"Improvements to Challenger Agricultural Tractors Air Conditioning Available"
SEPD0353	Wheel Loader Soil Compactor Landfill Compactor	"New Heating Ventilation and Air Conditioning (HVAC) Electronic Control Troubleshooting Procedure Available"
SEPD0418	D5M, D6M Track-Type Tractor	"New, Air Conditioner Tubes Increase Service Life of Condenser Coil"
SEPD0473	All Products	"Air Conditioner Service Tips"
SEPD0559	All Products	"Material for Sound Suppression in the Cab is Available"
SEPD0559	All Products	"Part Numbers for Electric Motors that are Used in HVAC Have Changed"
SEPD0653	Off-Highway Truck	"New Components Improve the Air Conditioning System on Certain Off-Highway Truck/Tractor"
SEPD0665	Combine Excavator Track Feller Buncher Integrated Toolcarrier Paving Compactor Road Reclaimer	"Checking the Motor Rotation after Replacing the Blower Motor Can Increase Service Life"
SEPD0723	Off-Highway Truck Wheel Loader	"The Fan Drive Groups Have Changed"
SEPD0730	Off-Highway Truck	"New Mounting Brackets for the Air Conditioner Compressor are Now Available"

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02093443

Pilot Valve (Joystick)

SMCS - 5059; 5705

There are two pilot valves on the machine. The two pilot valves get hydraulic oil from separate circuits. Hydraulic oil for both circuits comes from the gear pump.

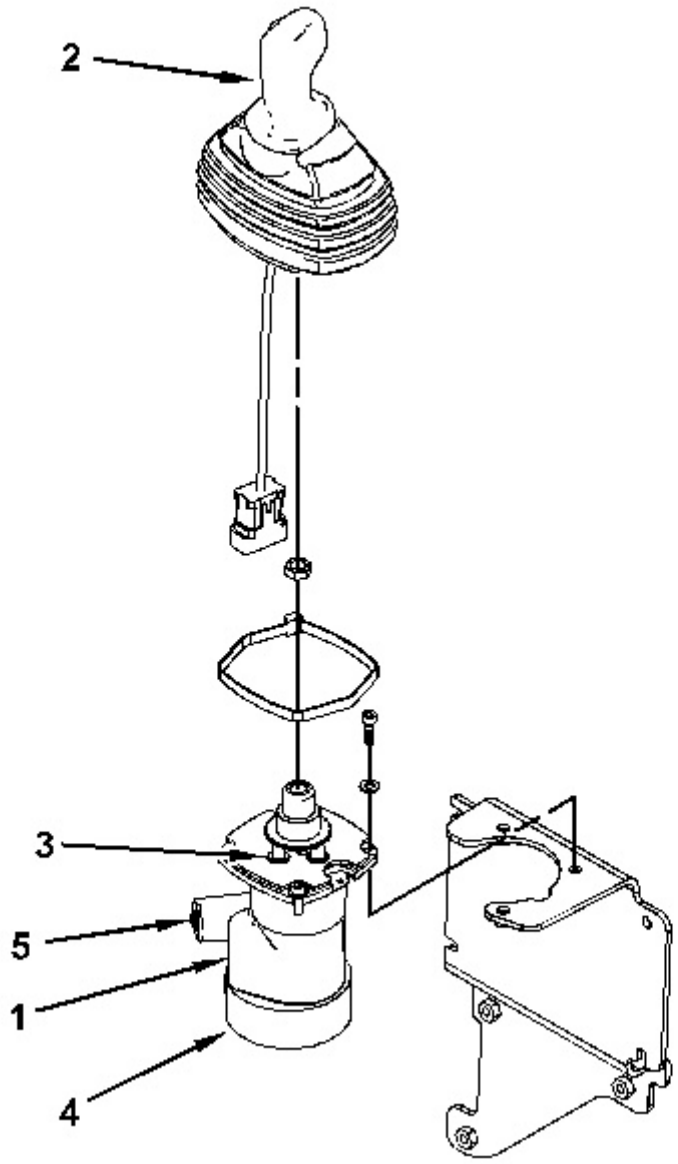


Illustration 1 g01056035

(1) Pilot valve

(2) Control lever

(3) Plungers

(4) Resolver block

(5) Solenoid valve (hydrostatic)

The first pilot valve (1) controls the motion of the machine. The control lever (2) is moved to a desired position. The plungers (3) for the pilot valve are moved by the control lever. The plungers direct the oil flow to the resolver block (4). The resolver block directs the hydraulic oil to the actuator pistons for the piston pump (hydrostatic). The solenoid valve (hydrostatic) (5) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

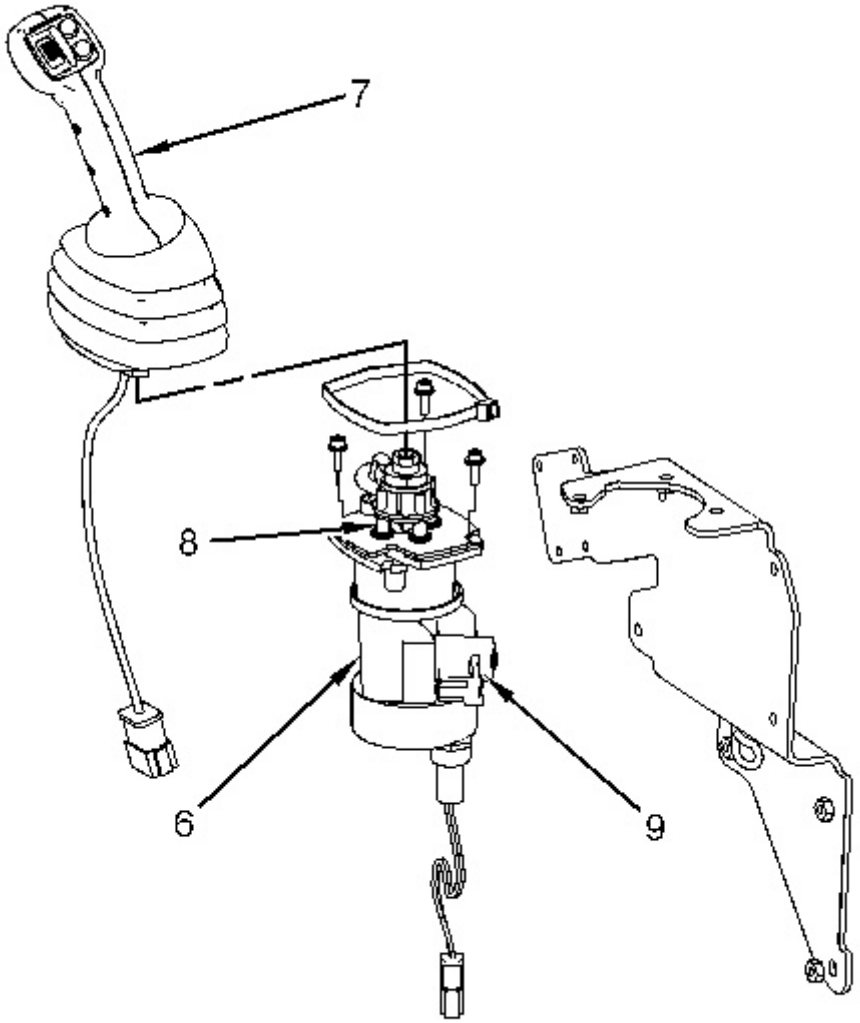


Illustration 2 g01056040

(6) Pilot valve

(7) Control lever

(8) Plungers

(9) Solenoid valve (work tool)

The second pilot valve (6) controls the motion of the work tool. The control lever (7) is moved to a desired position. The plungers (8) for the pilot valve direct the pilot hydraulic oil to the respective spool in the control valve (work tool). The work tool reacts accordingly. The solenoid valve (work tool) (9) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

The control levers on both pilot valves are spring centered. When the levers are released from any position except for the FLOAT position, the levers will return to the NEUTRAL position. The FLOAT position has a detent that keeps the pilot valve for the work tool in the FLOAT position until you move the lever. Then, the pilot valve will return to the NEUTRAL position.

Refer to the Operation and Maintenance Manual, "Operator Controls - Joystick Controls" for more information on the pilot operated hydraulic controls.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01992332

Switches

SMCS - 1435; 7332

Switches provide information to the control. Switches are two state devices. The two states are listed below.

Closed - The switch connects a circuit to the control input.

Open - The switch opens a circuit to the control input.

Switch (Seat)

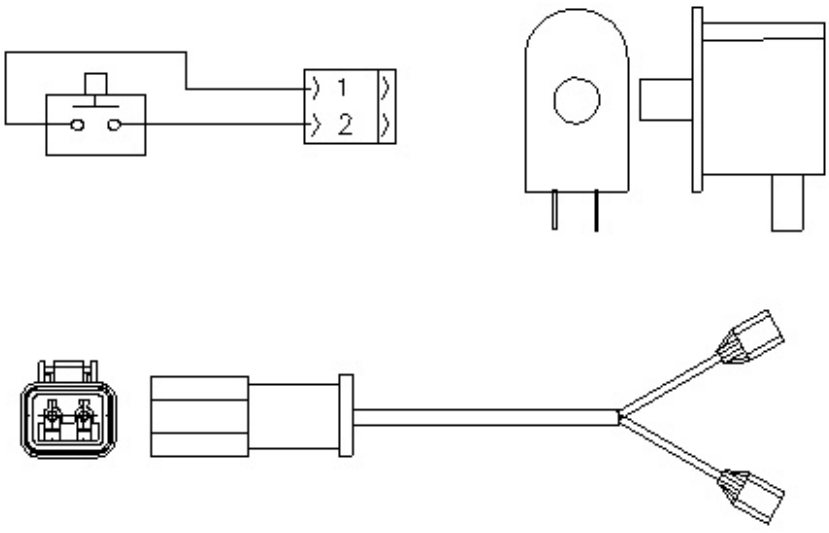


Illustration 1 g00777378

Switch (seat)



Illustration 2 g00777422

Location of the seat switch

The switch is located within the operator seat. The connector for the switch is located beneath the seat.

The switch tells the auxiliary hydraulic ECM and the interlock ECM that the operator is in the seat. The switch is a momentary, normally open switch. When the seat is occupied the switch is closed.

The seat switch is in series with the armrest switch. When the switches are activated, a ground will be placed on pin 68 of the auxiliary hydraulic ECM. If the armrest switch is down, and the seat becomes unoccupied, the ECM will wait for 5 seconds before any action is taken.

The auxiliary hydraulic ECM monitors the status of the switch. If incorrect inputs are encountered, the ECM will log a diagnostic code.

Switch (Armrest)

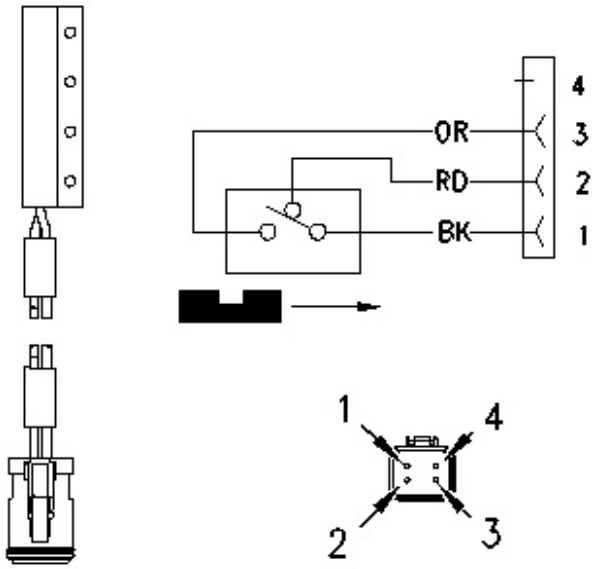


Illustration 3 g00532778

Switch (armrest)



Illustration 4 g01032480

Location of the armrest switch

The switch is located on the right side of the armrest at the pivot point.

The switch tells the auxiliary hydraulic ECM and the interlock ECM the position of the armrest. The switch is a proximity switch with contacts that are normally open and normally closed. When the armrest is lowered, the normally closed contacts open and the normally open contacts close.

The normally open contacts are in series with the seat switch. The seat switch and the armrest switch create a circuit. When both switches are closed, a grounded input is placed on pin 68 of the auxiliary hydraulic ECM.

The armrest switch will also place an open input on pin 70 of the auxiliary hydraulic ECM. When this occurs the operator is in the seat and the armrest is lowered.

Switch (Parking Brake)

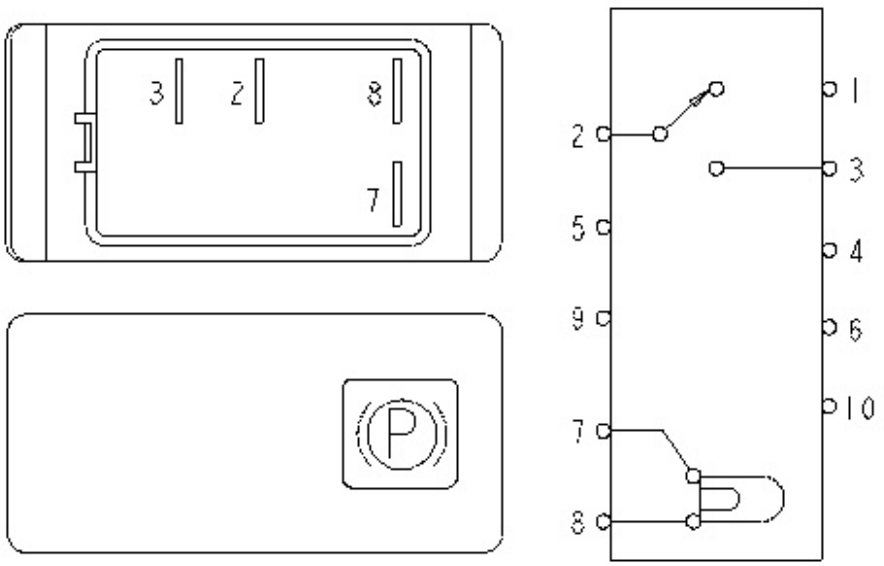


Illustration 5 g00539375

Switch (parking brake)



Illustration 6 g01031999

Location of the parking brake switch

The switch is located on the left headliner to the left of the key start switch.

The switch tells the auxiliary hydraulic ECM and the interlock ECM that the operator wants to release the parking brake and the operator wants to enable the auxiliary hydraulics.

The parking brake switch is a momentary, normally open switch. When the switch is pressed the circuit closes. This places a grounded input on pin 45 of the auxiliary hydraulic ECM.

If the switch is grounded for more than 30 seconds the switch is considered to be stuck in the closed position. The ECM will disable the auxiliary hydraulics and a diagnostic code will be logged.

Switch (Hydraulic Lockout) and Switch (Interlock Override)

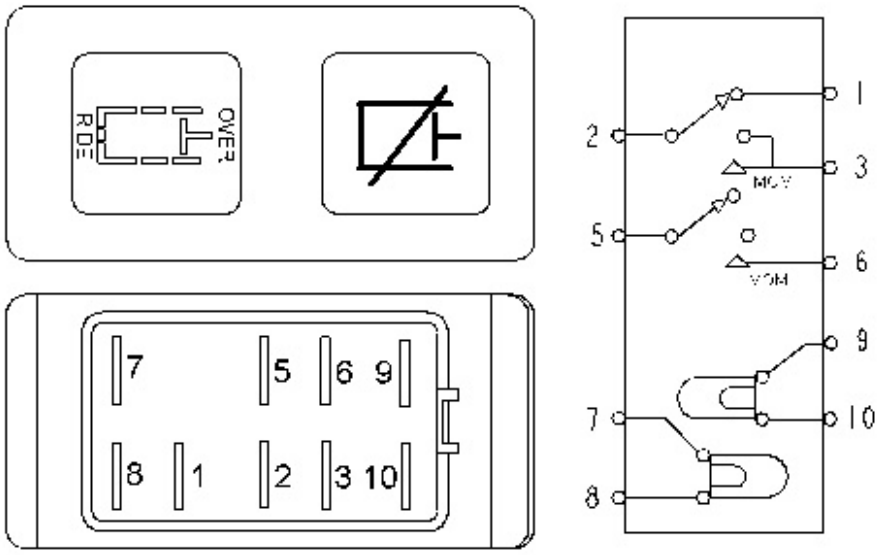


Illustration 7 g01032711

Switch (hydraulic lockout) and interlock override



Illustration 8 g01032621

Location of the switch for the hydraulic lockout and interlock override

The switch is located on the right headliner.

Depress the top of the switch in order to activate the hydraulic lockout.

The switch tells the auxiliary hydraulic ECM that the operator wants to disable the auxiliary hydraulic circuit and the high flow control. The switch also tells the interlock ECM that the operator wants to disable the work tool.

The switch is a normally closed rocker switch. When the switch is actuated the circuit is open. When the switch is actuated, an open is placed on pin 47 of the auxiliary hydraulic ECM. The work tool will be disabled.

The auxiliary hydraulic ECM monitors the status of the switch. No diagnostics are associated with the switch.

Note: A jumper wire is used on machines without this switch. The jumper wire is a **165-0312** Wire Assembly. This jumper wire is fastened to the harness that must be connected in order to allow both the primary work tool and the auxiliary work tool to operate.

The interlock override switch is located on the right overhead control panel. The interlock override and the hydraulic lockout share the same switch on the machine. See illustration 8.

Depress the bottom of the switch in order to activate the interlock override.

The switch tells the ECM that the operator wants to be able to raise the armrest in order to exit the seat while the continuous flow function is active.

The switch is a momentary, normally open rocker switch. Pressing the switch puts a ground on the pin 64 of the ECM.

The auxiliary hydraulic ECM monitors the status of the switch. If the input is grounded for 30 seconds or more, the ECM will interpret the signal as a stuck switch and the ECM will produce a diagnostic code.

Switch (Auxiliary Hydraulics)

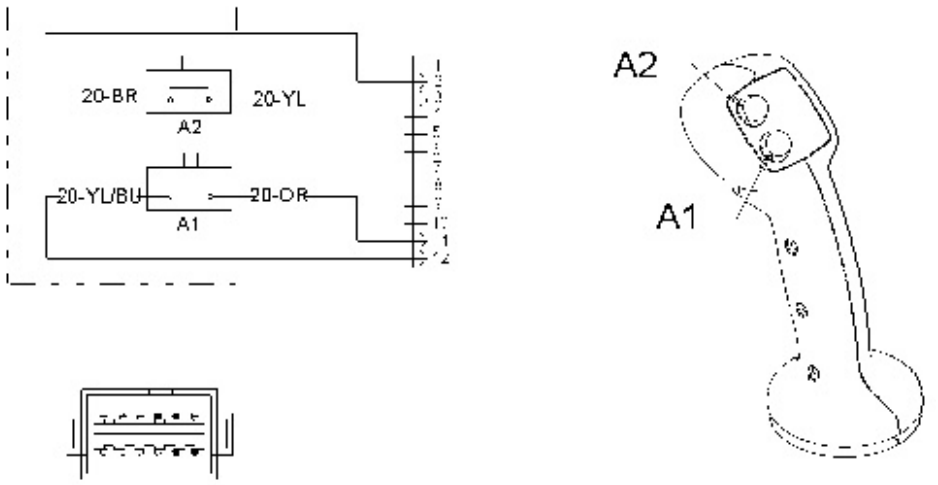


Illustration 9 g01033727

Switch (auxiliary hydraulics)

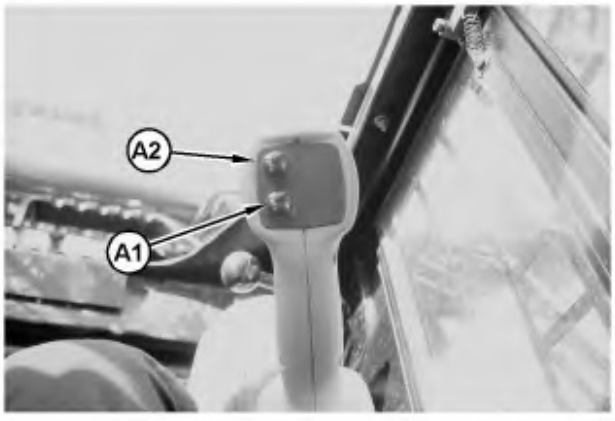


Illustration 10 g01033512

Location of the A1 switch and A2 switch

The switches are located on the right joystick. The A1 switch is the lower push button and the A2 switch is the upper push button.

The switches tell the ECM that the operator wants to energize the auxiliary hydraulic solenoid (A1) or the auxiliary hydraulic solenoid (A2).

The switches are momentary, normally open switches. When the switch (A1) is actuated a ground is placed on pin 62 of the ECM. When the switch (A2) is actuated a ground is placed on pin 53 of the ECM.

The ECM monitors the status of the switches. When both switches are grounded at the same time the ECM will indicate a diagnostic code.

Switch (Continuous Flow)

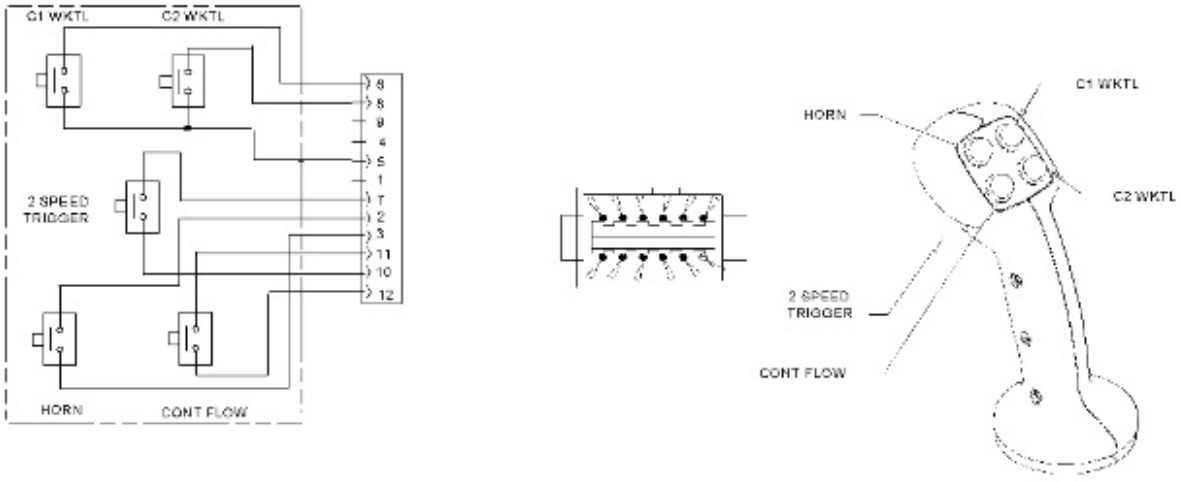


Illustration 11 g01035819

Schematic of the continuous flow switch



Illustration 12 g01033276

Location of the continuous flow switch

The continuous flow switch is mounted in the left hand joystick.

The continuous flow switch tells the auxiliary hydraulic ECM that the operator wants to supply a flow of hydraulic oil to the auxiliary circuit without the need to continuously hold the auxiliary hydraulic control.

Push down on either of the auxiliary hydraulic switches (A1 and A2). Push on the bottom of the continuous flow switch and then release the continuous flow switch. Immediately release the auxiliary hydraulic control after you release the continuous flow control. If the auxiliary hydraulic control is not released within one second of releasing the continuous flow control, the continuous flow function will not be activated. Push on either the auxiliary hydraulic control or the continuous flow switch in order to stop the flow to the auxiliary circuit.

The switch is a momentary, normally open push-button switch. When the switch is closed the circuit puts a ground on the pin 7 of the ECM.

The ECM monitors the status of the switch. If the input is grounded for 30 seconds or more the ECM will interpret the signal as a stuck switch and the ECM will produce a diagnostic code.

Switch (Auxiliary Pressure Release)

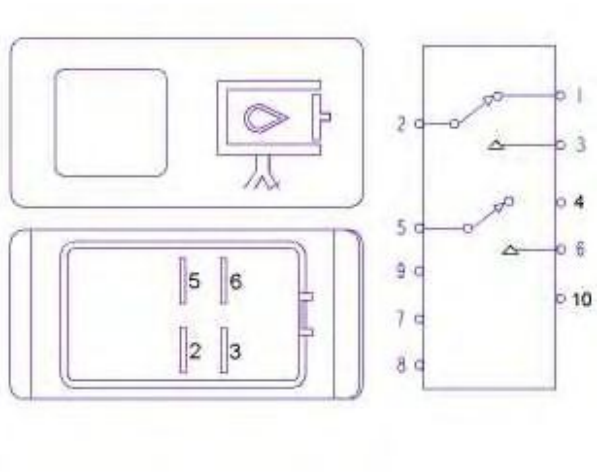


Illustration 13 g01033594

Switch (Auxiliary Pressure Release)



Illustration 14 g01033280

Activating the switch relieves the pressure on the auxiliary hydraulic lines. This feature will be used with tools that require an auxiliary hydraulic connection. When the Auxiliary Pressure Release switch is pushed, with the machine off, the ECM will activate the auxiliary solenoids releasing pressure back to tank.

For normal operation, turn the machine off, press and hold the Auxiliary Pressure Release switch, this will cause the Auxiliary Hydraulic Control ECM to power up and provide a switch to ground input to pin 19 of the ECM. The ECM will energize Auxiliary solenoid A1 and then energize Auxiliary solenoid A2, for 2 seconds each.

The auxiliary pressure release switch is a momentary normally open switch.

Switch (Auxiliary Hydraulic Mode Select)

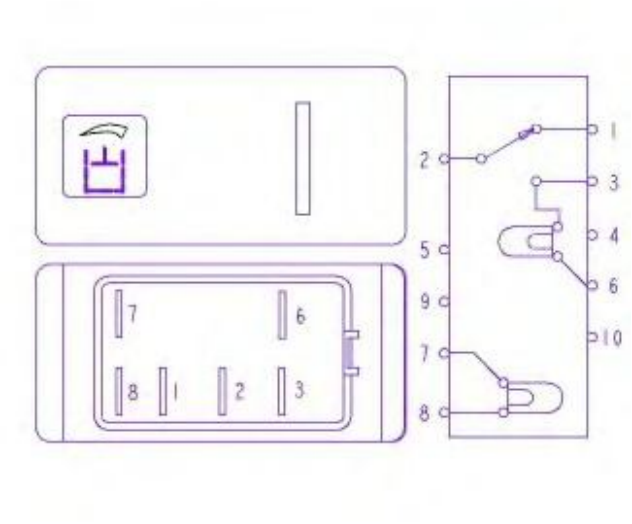


Illustration 15 g01033810

Switch (Auxiliary hydraulic mode select)



Illustration 16 g01033816

Location of the Switch (Auxiliary hydraulic mode select)

The switch is located in the left headliner to the left of the key start switch.

The switch tells the ECM that the operator wants either the high flow option or the standard flow option.

The switch is a two-position rocker switch. Pressing the switch in the left position (high flow mode) puts a ground on the pin 31 of the ECM. Pressing the switch in the right position (auxiliary mode) puts a ground on the pin 9 of the ECM.

The auxiliary hydraulic ECM monitors the status of the switch. If the inputs are both open or both grounded the ECM will produce a diagnostic code.

Switch (Two Speed)

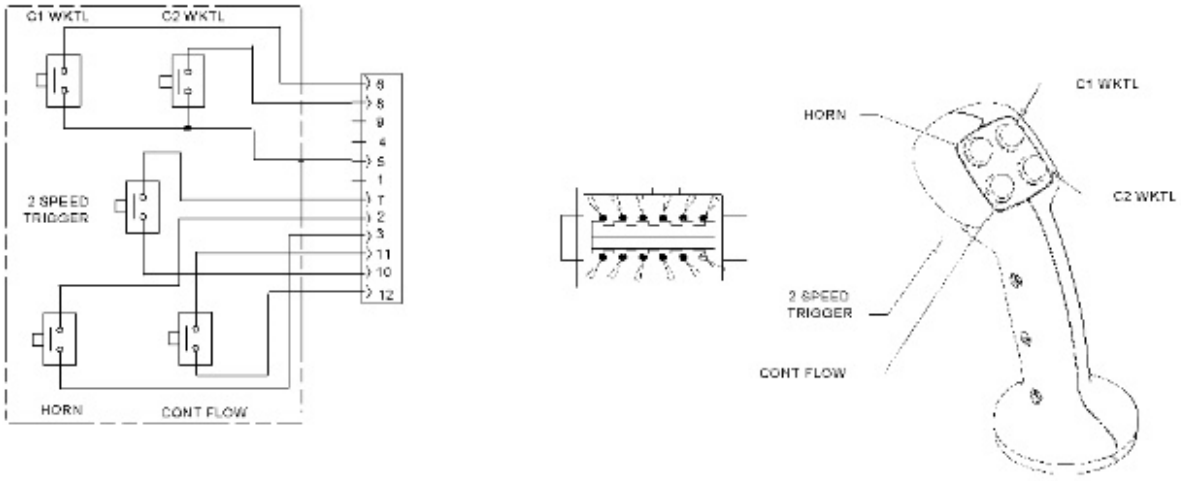


Illustration 17 g01035819

Schematic of the two speed switch



Illustration 18 g01033923

Location of the two speed switch

The switch is located on the front side of the left joystick. The two speed switch is a push button switch.

The switch tells the ECM that the operator wants to energize the two speed function.

The switch is a momentary, normally open switch. When the switch is actuated a ground is placed on pin 29 of the ECM.

The ECM monitors the status of the switch. When the switch is grounded for more than 30 seconds, a diagnostic code will be set.

Pressure Switch (High Flow)

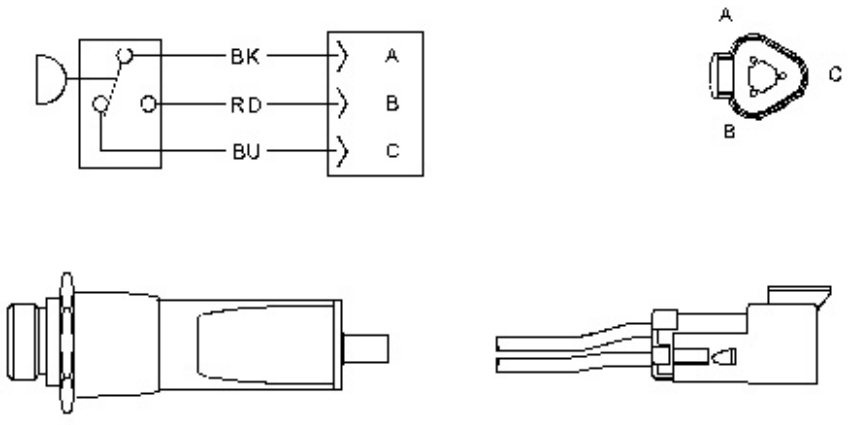


Illustration 19 g01035903

Switch (High flow pressure)

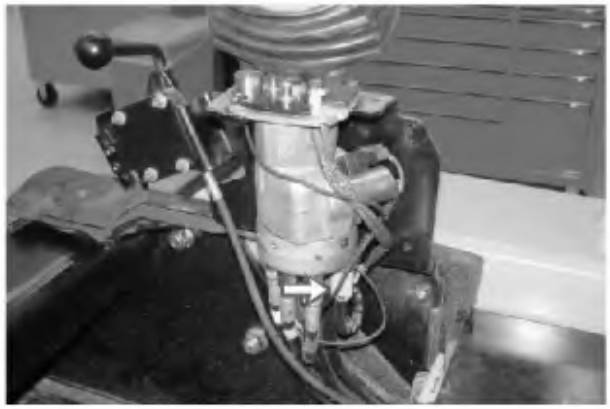


Illustration 20 g01035904

Location of the high flow pressure switch

The high flow pressure switch is located below the right joystick. The switch signals the ECM on pin 62 when a lift or tilt function is requested.

The ECM also reads pin 66 C+ or C- activation. If pin 66 is grounded or both pins 62 and 66 are grounded or there is no input into either pins 62 or 66, then the ECM will turn off the control solenoid (pin 24).

Note: This switch is only on machines with the XPS high flow system.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995775

Indicators

SMCS - 6700-IND

The indicators show the status of certain functions of the auxiliary hydraulic ECM.

Indicator (Hydraulic Lockout) and Indicator (Interlock Override)

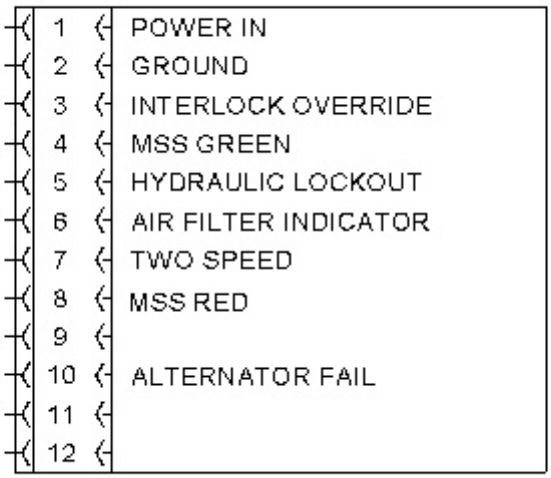


Illustration 1 g01033111

Indicator (hydraulic lockout) and interlock override connect to contact 3 and contact 5



Illustration 2 g01033983

Location of the Indicator for the hydraulic lockout and interlock override

(1) Hydraulic Lockout

(2) Interlock Override

The indicator for each function is located in the warning indicator module in the right headliner.

The indicator for the hydraulic lockout shows the operator that the hydraulic lockout is enabled. If the hydraulic lockout is enabled, the hydraulics are locked out and the indicator is illuminated. The normally open set of contacts in the lockout switch and the door switch activate the indicator.

The interlock override indicator shows the operator when the interlock override function is enabled. The auxiliary hydraulic ECM sends a signal to the indicator when the interlock override function is enabled.

Indicator (Two Speed)

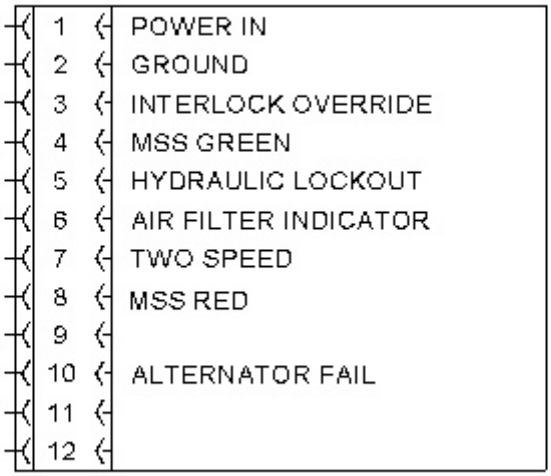


Illustration 3 g01033111

Indicator for two speed function connects to contact 7



Illustration 4 g01033112

Location of the indicator for the two speed function

The indicator is located in the right headliner.

The indicator for the two speed shows the operator when the two speed function is enabled. The auxiliary hydraulic ECM controls the signal to the indicator.

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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01995788

Sensors

SMCS - 6700-NS

Position Sensor (Auxiliary Hydraulic Control)

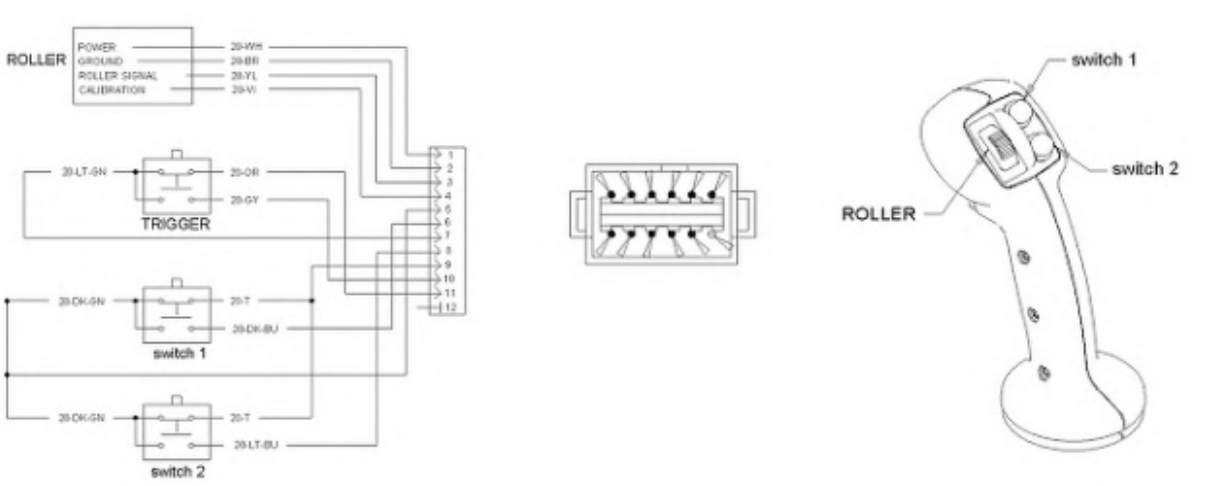


Illustration 1 g01034219

Auxiliary control for the auxiliary hydraulics

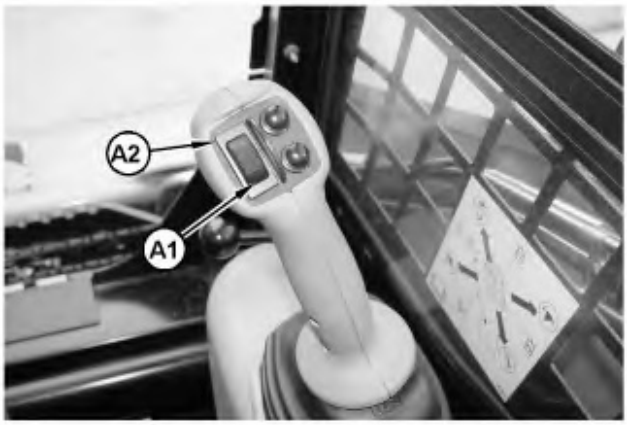


Illustration 2 g01034147

Location of the auxiliary control

The auxiliary hydraulic control is the thumb wheel on the work tool control that can be pressed upward or downward. The auxiliary hydraulic control tells the auxiliary hydraulic ECM that the operator wants to activate the auxiliary hydraulics. The auxiliary hydraulic control will allow the operator to control the amount of hydraulic oil flow that is sent to the auxiliary hydraulics.

The auxiliary hydraulic control sends a proportional signal to the auxiliary hydraulic ECM. The signal is a pulse width modulated signal (PWM) that is generated at a frequency between 500 Hz ± 80 Hz. When the auxiliary hydraulic control is in the neutral position, a duty cycle of 50% ±3% is seen by the ECM. When the auxiliary hydraulic control is pressed up or down, the duty cycle will vary from 50% to a minimum of 20% in the A2 position and from 50% to a maximum of 80% in the A1 position.

The auxiliary hydraulic ECM receives the proportional signal on pin 53 of the ECM. The auxiliary hydraulic ECM will then send a proportional signal to the corresponding modulated valve (auxiliary) (A1 or A2).

The auxiliary hydraulic ECM monitors the auxiliary control for duty cycles that are erratic, out of range or an abnormal frequency. A diagnostic code will then be set and the auxiliary hydraulics will not function.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01991368

Switches

SMCS - 1435; 7332

Switches provide information to the Electronic Control Module (ECM). Switches are two state devices. The two states are listed below.

Closed - The switch connects a circuit to the ECM input.

Open - The switch opens a circuit to the ECM input.

Switch (Seat)

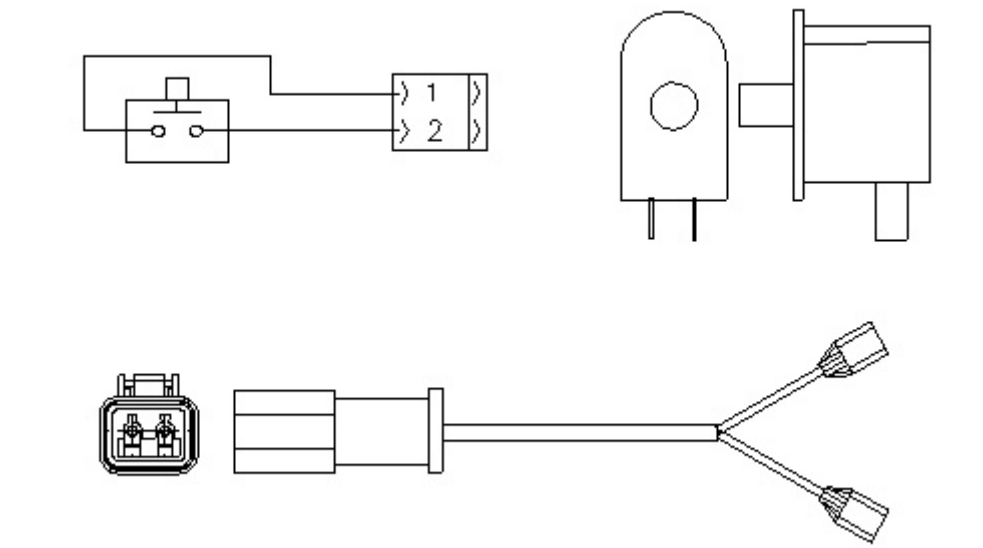


Illustration 1 g00777378

Switch (seat)



Illustration 2 g00777422

Location of the seat switch

The switch is located within the operator seat. The connector for the switch is located beneath the seat.

The switch tells the interlock ECM that the operator is in the seat. The switch is a momentary, normally open switch. When the seat is occupied the switch is closed.

The seat switch is in series with the armrest switch. When the switches are activated, a ground will be placed on pin 58 of the ECM. If the armrest switch is down, and the seat becomes unoccupied, the ECM will wait for 5 seconds before any action is taken.

The interlock ECM monitors the status of the switch. If incorrect inputs are encountered, the ECM will flash the armrest indicator.

Note: If the machine is equipped with auxiliary hydraulics, the switch is also seen by the auxiliary hydraulic ECM.

Switch (Armrest)

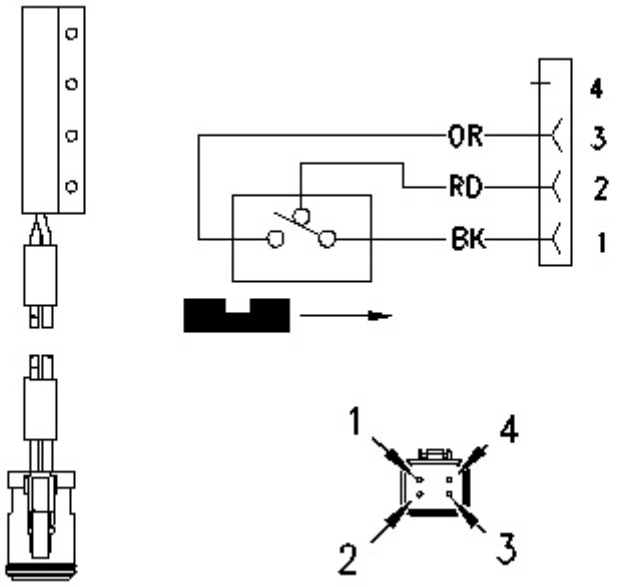


Illustration 3 g00532778

Switch (armrest)



Illustration 4 g01032480

Location of the armrest switch

The switch is located on the right side of the armrest at the pivot point.

The switch tells the interlock ECM the position of the armrest. The switch is a proximity switch with contacts that are normally open and normally closed. When the armrest is lowered, the normally closed contacts open and the normally open contacts close.

The normally open contacts are in series with the seat switch. The seat switch and the armrest switch create a circuit. When both switches are closed a grounded input is placed on pin 58 of the ECM. The armrest switch will also place an open input on pin 47 of the ECM. When this occurs the operator is in the seat and the armrest is lowered.

When both pins are grounded at the same time, the ECM will flash the armrest indicator, which indicates a fault in the circuit.

Note: If the machine is equipped with auxiliary hydraulics, the switch is also seen by the auxiliary hydraulic ECM.

Switch (Parking Brake)

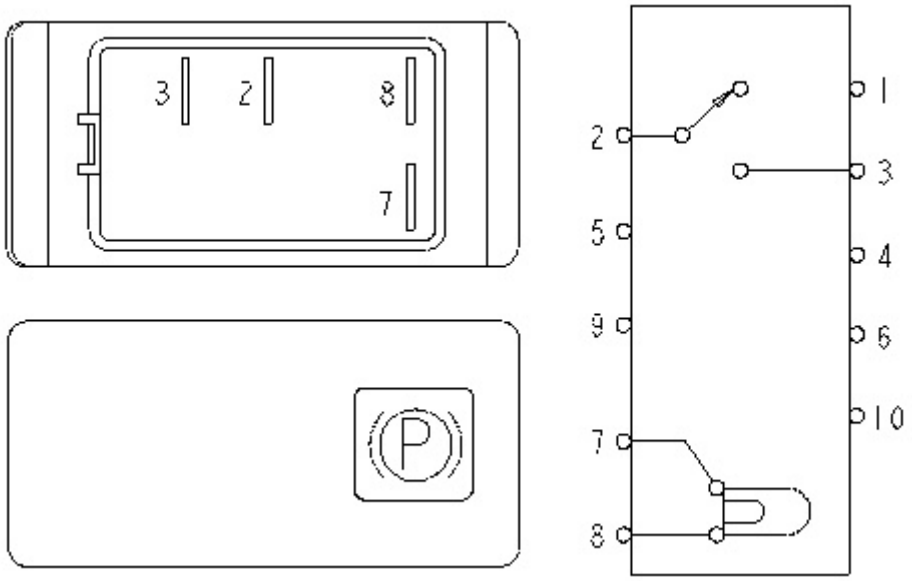


Illustration 5 g00539375

Switch (parking brake)



Illustration 6 g00777435

Location of the parking brake switch

The switch is located on the left headliner to the left of the key start switch.

The switch tells the interlock ECM that the operator wants the parking brake to be applied or released.

The switch is a momentary, normally open rocker switch. When the switch is pressed the circuit closes. This places a grounded input on pin 42 of the ECM.

If the switch is grounded for more than 30 seconds the switch is considered to be stuck in the closed position. The ECM will then flash the parking brake indicator, which indicates a fault.

Note: If the machine is equipped with auxiliary hydraulics, the switch is also seen by the auxiliary hydraulic ECM.

Switch (Door)



Illustration 7 g01035209

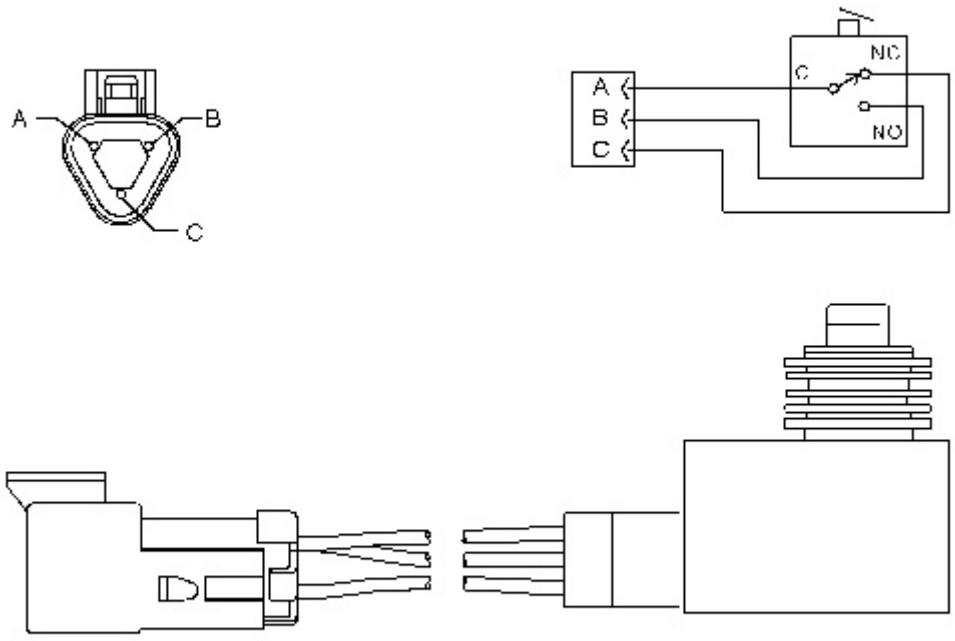


Illustration 8 g01035210

The switch is located on the bottom left of the door.

The switch tells the ECM to disable the hydraulics.

The switch is a 2 position limit switch. When the switch is not actuated, the normally closed contacts complete the circuit to the hydraulic lockout indicator. When the switch is actuated, the normally open contacts complete the circuit from the hydraulic lockout switch to pin 60 of the ECM.

There are no diagnostics that are associated with the switch.

Switch (Hydraulic Lockout)

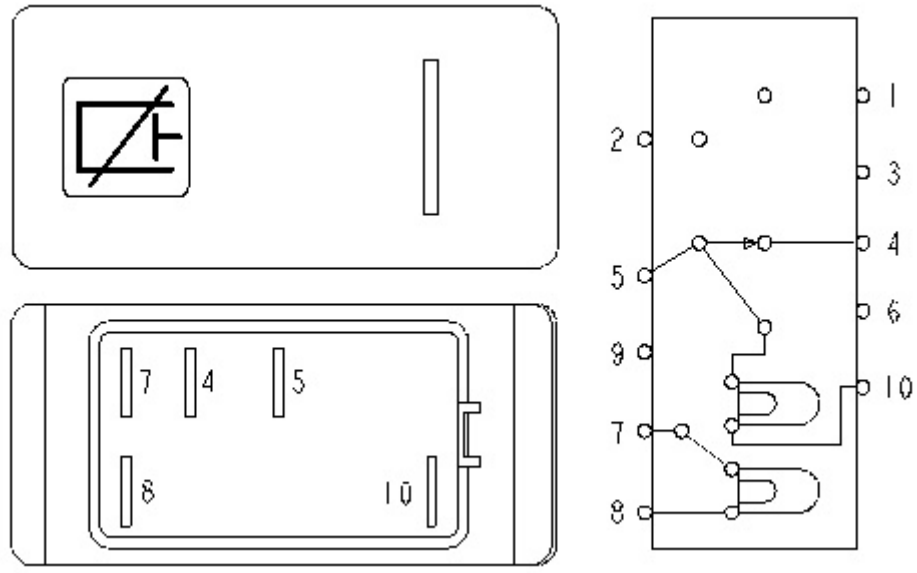


Illustration 9 g00539377

Switch (hydraulic lockout) and Interlock Override



Illustration 10 g00777449

Location of the lockout switch

The switch is located on the right headliner.

The switch tells the ECM that the operator wants to disable the 3 position hydraulics.

The switch is a normally closed rocker switch. When the switch is actuated an open is placed on pin 60 of the ECM and the work tool is locked out.

There are no diagnostics that are associated with the switch.

Note: A jumper wire is used on machines without this switch. The jumper wire is a **165-0312** Wire Assembly. This jumper wire is fastened to the harness that must be connected in order to allow both the primary work tool and the auxiliary work tool to operate.

Note: If the machine is equipped with auxiliary hydraulics, the switch is also seen by the auxiliary hydraulic ECM.

Switch (Key Start Switch)

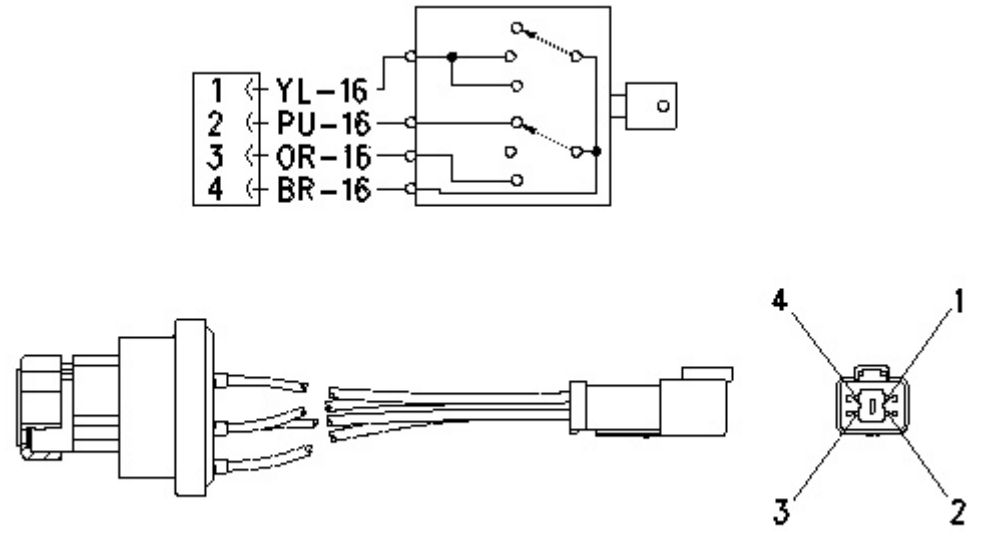


Illustration 11 g00497430

Switch (key start switch)



Illustration 12 g00779591

Location of the key start switch

The switch is located in the left headliner.

The switch is a rotary key switch. The START position is a momentary position.

The switch tells the ECM that the operator wants to start the engine. The switch is a rotary switch. When the switch is in the START position the circuit is closed. This applies a +battery voltage to pin 62 of the ECM. If the seat switch and the armrest switch are actuated, the ECM will turn on the output for the start relay.

Note: On machines that are equipped with the machine security system (MSS), the output for the start relay goes to the MSS. The MSS will then send an output to the start relay.

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Systems Operation
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System

Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995086

Indicators

SMCS - 7450

The indicators show the status of certain functions of the interlock ECM.

Indicator (Parking Brake)

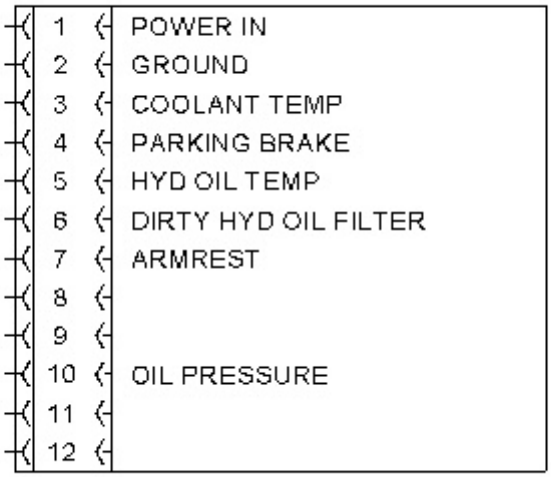


Illustration 1 g01032580

Indicator (parking brake)



Illustration 2 g00779665

Location of the parking brake indicator

This parking brake indicator is located in the warning indicator module in the left headliner.

The indicator shows the operator whether the parking brake is engaged or released. The indicator also shows when the hydrostatic system is enabled. If the parking brake is engaged, the indicator will be illuminated.

The parking brake indicator will flash once per second if there is a fault in either of the following circuits:

- parking brake
- hydrostatic pilot solenoid
- solenoid return wire

Indicator (Armrest)

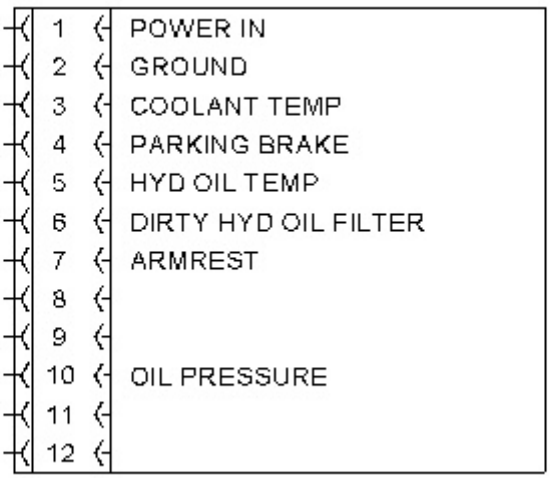


Illustration 3 g01032580

Indicator (Armrest)



Illustration 4 g00779664

Location of the armrest indicator

The armrest indicator is located in the warning indicator module in the left headliner.

The indicator shows the operator whether the seat is occupied and the armrest is down. If either of these conditions are not met the armrest indicator is illuminated.

The armrest indicator will flash once per second if there is a fault in either of the following circuits:

- switch (armrest)
- switch (seat)
- solenoid valve (work tool pilot)
- solenoid return wire

Indicator (Hydraulic Lockout) and Indicator (Interlock Override)

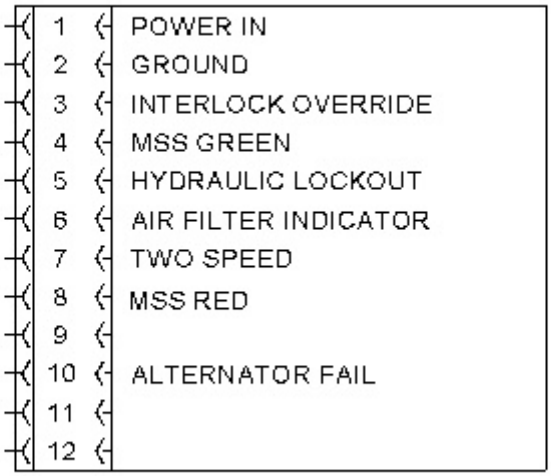


Illustration 5 g01033111

Indicator (hydraulic lockout) and interlock override connect to contact 3 and contact 5



Illustration 6 g01033983

Location of the Indicator for the hydraulic lockout and interlock override

(1) Hydraulic Lockout

(2) Interlock Override

The indicator for each function is located in the warning indicator module in the right headliner.

The indicator for the hydraulic lockout shows the operator that the hydraulic lockout is enabled. If the hydraulic lockout is enabled, the work tools are locked out and the indicator is illuminated. The normally open set of contacts in the switch activate the indicator.

The indicator for the interlock override shows the operator that the override is enabled. If the interlock override is enabled, the auxiliary hydraulics will function with the armrest in the raised position and the indicator is illuminated. The normally open set of contacts in the switch activate the indicator.

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Systems Operation
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03007150

General Information

SMCS - 7309

The purpose of this service manual is to describe the operation, testing and adjusting procedures, and disassembly and assembly procedures of Caterpillar operator station heating and air conditioning systems.

These systems are designed to provide thermal comfort to machine operators in various conditions.

Both systems are closed loop systems that work by exchanging heat between the system fluid and the air that is supplied to the operator station. The fluid in the air conditioning system is refrigerant, and the fluid in the heating system is engine coolant.

In the air conditioning system, heat is transferred from the hot cab air to the cold refrigerant in the evaporator. The refrigerant is then transported to the condenser. Heat is deposited outside the condenser.

In the heating system, heat is transferred from the hot engine coolant to the cold cab air in the heater coil. The engine coolant is then transported to the engine. When the coolant is back in the engine, the coolant is heated again.

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Systems Operation
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02983732

Identifying the Refrigerant

SMCS - 1809

Before servicing the air conditioning system, the type of refrigerant that is used must be determined so that the correct service manual can be selected.

A tag that is placed in the cab or near the compressor can identify the refrigerant. The machine can have factory installed tag (1), or the machine can have tag (2) that is installed by the dealer.



Illustration 1 g01507259

(1) Factory installed identification tag

(2) Retrofit tag that is installed by the dealer

One may also identify the type of refrigerant that is used in the air conditioning system by examining the charging ports. Systems with R-134a will use ports that are quick disconnect (4)

while systems with the older R-12 will use threaded ports (3). These ports are usually found in the block fittings that attach to the compressor.

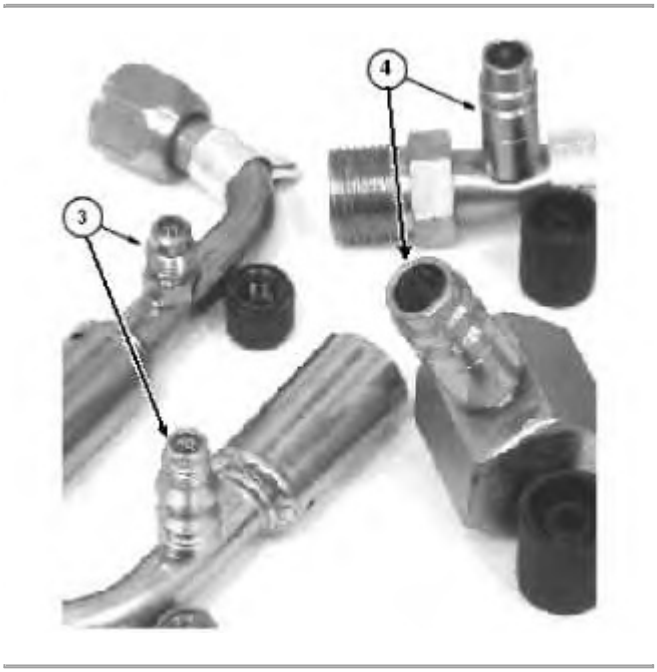


Illustration 2 g01507261

(3) R-12 charging port

(4) R-134a charging port

If the system contains R-12 and needs to be serviced, refer to Service Manual, SENR3334, "Air Conditioning and Heater R-12".

If the system contains R-12 and needs to be retrofitted for use with R-134a, refer to Special Instruction, SEHS9734, "Retrofitting Caterpillar R-12 Air Conditioning System to R-134a Refrigerant".

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02979466

Identifying the Air Conditioning System

SMCS - 1808; 7320-ZJ; 7322

The R-134a air conditioning system can be identified as an orifice tube system or an expansion valve system.



Illustration 1 g01507394

(1) In-line dryer

One identifies the orifice tube system by locating either an in-line dryer (1) or an accumulator (2) in the system. The orifice tube is located within the in-line dryer or within the evaporator inlet tube and the orifice tube cannot be seen.

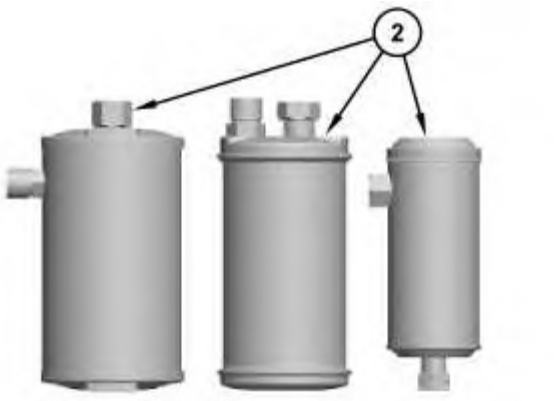


Illustration 2 g01507395

(2) Accumulators

The following components are the six components of the orifice tube system:

- Compressor
- Condenser coil
- Dryer
- Orifice tube
- Evaporator Coil
- Accumulator

The expansion valve system can be identified by locating a Thermostatic Expansion Valve (TXV) in the system. The two main types of TXV's are block (3) and 90° expansion valves (4). Expansion valve systems also contain a receiver-dryer (5).

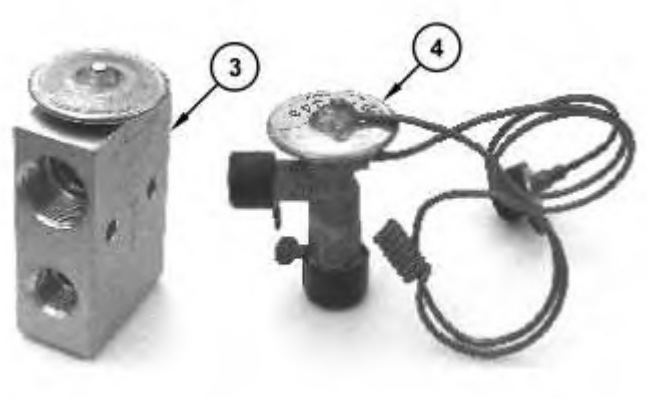


Illustration 3 g01507433

(3) Block expansion valve

(4) 90° expansion valve

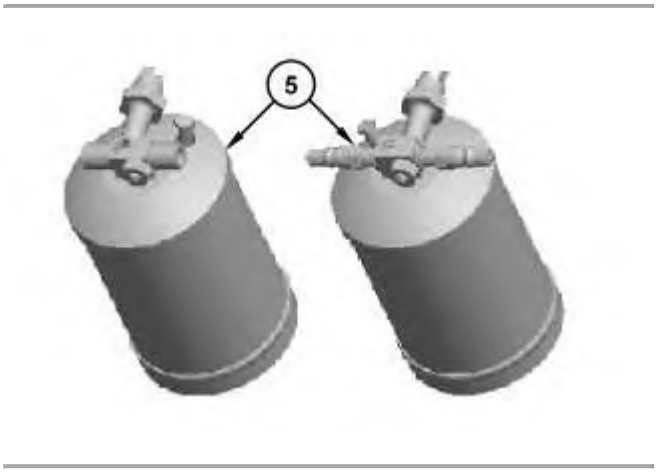


Illustration 4 g01507435

(5) Receiver-dryers

The following components are the five components of the expansion valve system:

- Compressor
- Condenser coil
- Receiver-dryer
- Expansion valve
- Evaporator coil

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i02980711

Identifying the Heating System

SMCS - 7304; 7309

Identifying the Heating System

The heating system can be identified as either a water valve control system or a blend door control system. The control system for the water valve regulates the amount of hot engine coolant that is circulated through the heater coil. The control system for the blend door regulates the amount of air that is routed through the heater coil. Both the water valve and the blend door can be regulated through either a mechanical cable or through an electronic actuator.

Heating System with Water Valve Control

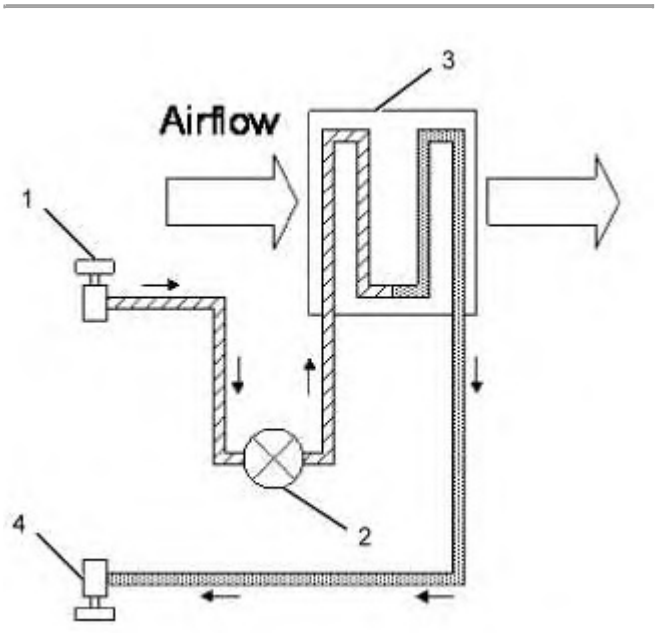


Illustration 1 g01510721

(1) Outlet valve for the engine cooling system

(2) Heater control valve

(3) Heater coil

(4) Return valve for the engine cooling system

The hot coolant from the engine circulates through the heating system. This coolant flows from the outlet valve for engine cooling system (1), through heater control valve (2), through heater coil (3), and back to the return valve for the engine cooling system (4). The temperature control knob, which is located on the control panel within the cab, regulates the flow of coolant.

With the temperature control knob in the maximum cold position, heater control valve (2) is closed. This prevents the flow of coolant into heater coil (3). When the control knob is moved away from the maximum cold position toward the maximum heating position, the heater control valve begins to open. As the control valve opens, coolant begins to flow from the outlet valve for engine cooling system (1) through the heater control valve and into the heater coil. As the hot coolant flows through the heater coil, the temperature of the air that is flowing through the coil increases.

The temperature of the air that is flowing out of heater coil (3) and into the cab is controlled by the amount of coolant that circulates through the heater coil. The coolant transfers the heat into the air stream. By increasing the amount of coolant that is circulating through the heater coil, the temperature of the air that is flowing out of the coil also increases. The coolant leaves the heater coil at a reduced temperature and flows back into the return valve for the engine cooling system (4) .

Heating System with Blend Door Control

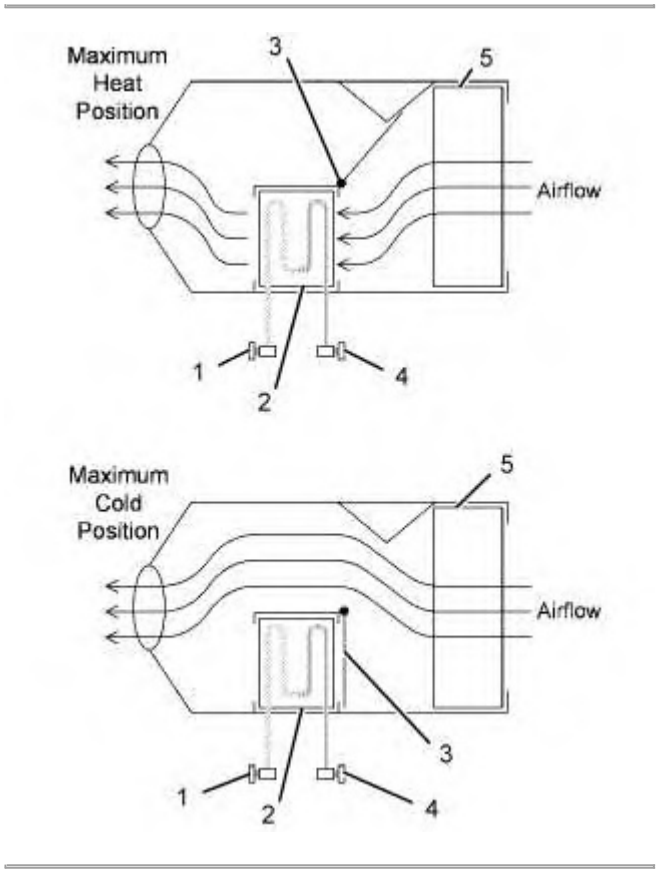


Illustration 2 g01508235

(1) Outlet valve for the engine cooling system

(2) Heater coil

(3) Blend door

(4) Return valve for the engine cooling system

(5) Evaporator coil

The hot coolant from the engine circulates through the heating system. This coolant flows from the outlet valve for the engine cooling system (1), through heater control valve (2), through heater coil (3), and back to the return valve for the engine cooling system (4). The temperature control knob, which is located on the control panel within the cab, regulates the flow of coolant.

The air from outside of the unit is pulled through evaporator coil (5). This is through a series of ducts and filters. The incoming air is directed through the use of a blend door (3) ., The air can be directed in order to flow through heater coil (2), or the air can be directed in order to bypass the heater coil. With the temperature control knob in the maximum cold position, blend door (3) is closed. This prevents the air from flowing through heater coil (2). This air flows directly from evaporator coil (5) to the cab.

When the control knob is moved away from the maximum cold toward the maximum heat position, blend door (3) begins to open. As the blend door opens, air begins to flow through heater coil (2) and mixes with the colder air that is flowing through evaporator coil (5). This mixture of air is delivered to the cab through the air ducts. As the amount of air that is flowing through the heater coil increases, the overall temperature of the air that is flowing into the cab also increases.

Heater Coil

The heater coil is a device that is similar to a radiator. The heater coil heats the cab of the machine. The heater coil is exposed to the air which passes across the evaporator coil. The heater transfers the heat from the hot engine coolant into the air that is traveling across the engine. The heat transfer will heat up the air that is flowing to the cab, which also reduces the temperature of the coolant that is flowing back to the engine cylinder.

Water Valve

The water valve is a device that is used to regulate the flow of engine coolant to the heater coil and the flow of engine coolant from the heater coil. The water valve is a necessary component in the control system for the water valve. The water valve can be used in a blend door controlled system. In the blend door system, the water valve would allow coolant to flow through the coil, or the water valve would block coolant flow completely.

Depending on the type of system that is being used, the water valve can be connected to a mechanical cable, or the water valve can be connected to an electronic actuator. The mechanical cable is connected between the control knob in the cab and the valve. The control knob opens the valve and the control knob closes the valve. The electronic actuator is connected to the water valve and wired to the control panel.

Blend Door

The blend door is a device that is used to control the temperature of the cab air. The blend door controls the temperature by regulating the amount of air that is allowed to pass through the heater coil and mixing the air with the cool air from the evaporator coil. As the blend door gradually opens, the hot coolant that is flowing through the heater coil transfers heat to the cooler air that is flowing across the heater coil. This warmer air mixes with the cool air that is flowing across the evaporator in order to regulate the air temperature that is entering the ducts in the cab.

The blend door is typically plastic with insulation on both sides in order to prevent any unnecessary heat transfer when the system is set to the maximum heat position or the maximum cold position. The blend door is controlled by an electronic actuator, which is wired into the control panel within the cab.

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i02979504

Refrigerant Expansion Valve System

SMCS - 7320

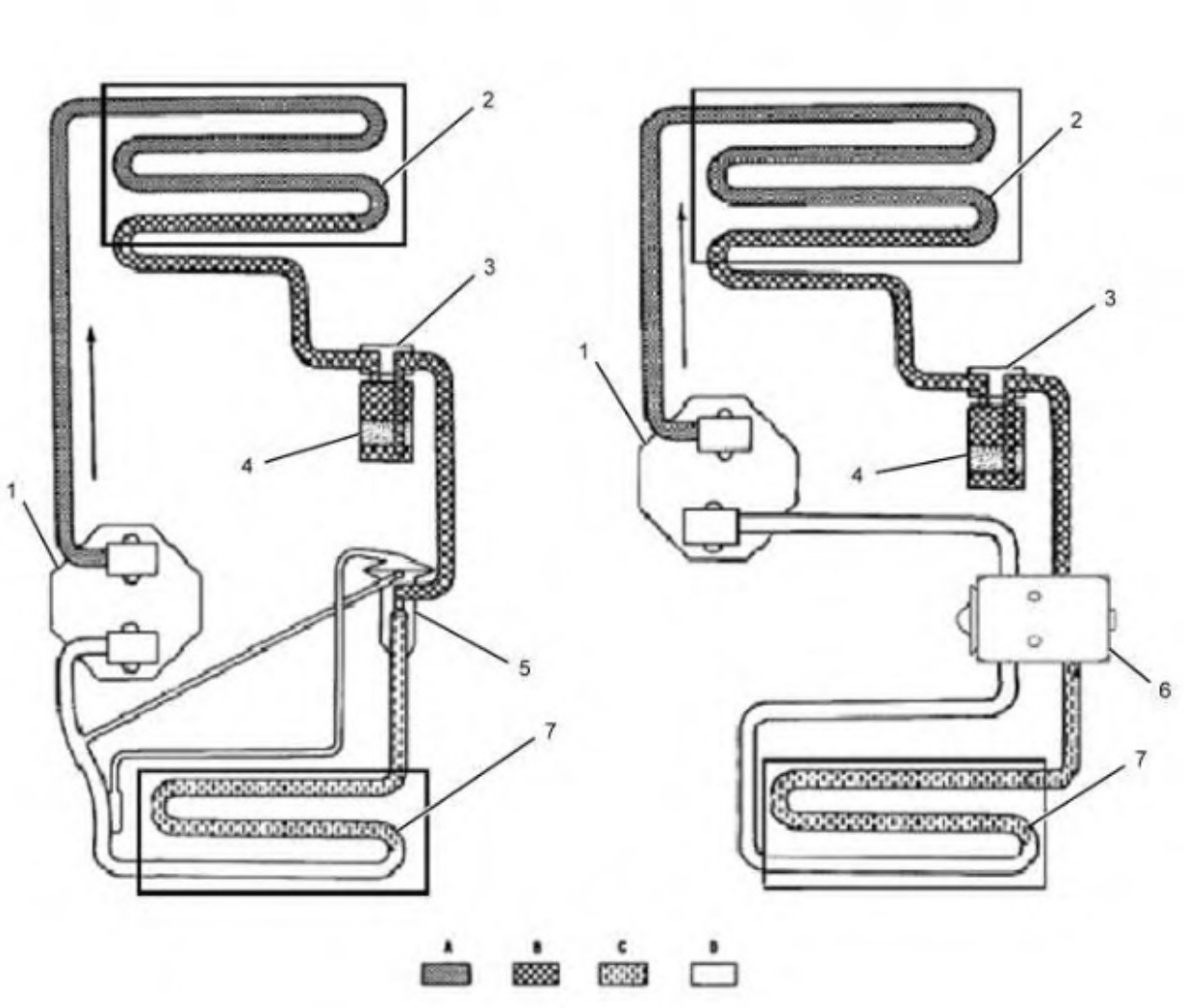


Illustration 1 g01507473

(1) Compressor

(2) Condenser

(3) Receiver-dryer

(4) Desiccant

(5) 90° expansion valve

(6) Block expansion valve

(7) Evaporator

(A) High temperature high pressure refrigerant vapor

(B) High temperature and high pressure refrigerant liquid

(C) Low temperature, low pressure refrigerant liquid vapor mixture

(D) Low temperature low pressure refrigerant vapor

The air conditioner refrigerant begins to flow in the air conditioning system at the refrigerant compressor (1). The compressor is designed to change the air conditioner refrigerant from a vapor that has low pressure into a vapor that has high pressure. Also, the compressor changes the refrigerant from a vapor with low temperature to a vapor with high temperature. The increase in pressure causes the increase in temperature.

The refrigerant is sent through the condenser coil (2). In the condenser coil, heat is transferred from the refrigerant to the outside air. This changes the refrigerant to a high temperature and high pressure liquid.

From the condenser coil, the refrigerant moves to the receiver-dryer (3). In the receiver-dryer, moisture is removed from the refrigerant by the desiccant (4).

The refrigerant moves from the receiver-dryer to either the 90° expansion valve (5) or the block expansion valve (6). In the expansion valve, the refrigerant is changed from a high pressure and a high temperature liquid to a low pressure and a low temperature mixture of liquid and vapor.

The low pressure and low temperature refrigerant moves to the evaporator coil (7). While the refrigerant is in the evaporator coil, the refrigerant absorbs heat from the cab. This changes the refrigerant to a low pressure and low temperature vapor.

The refrigerant returns to the compressor as a low pressure and low temperature vapor. This marks the end of the cycle. The cycle is repeated continuously.

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i03028705

Refrigerant Orifice Tube System

SMCS - 7320-QT

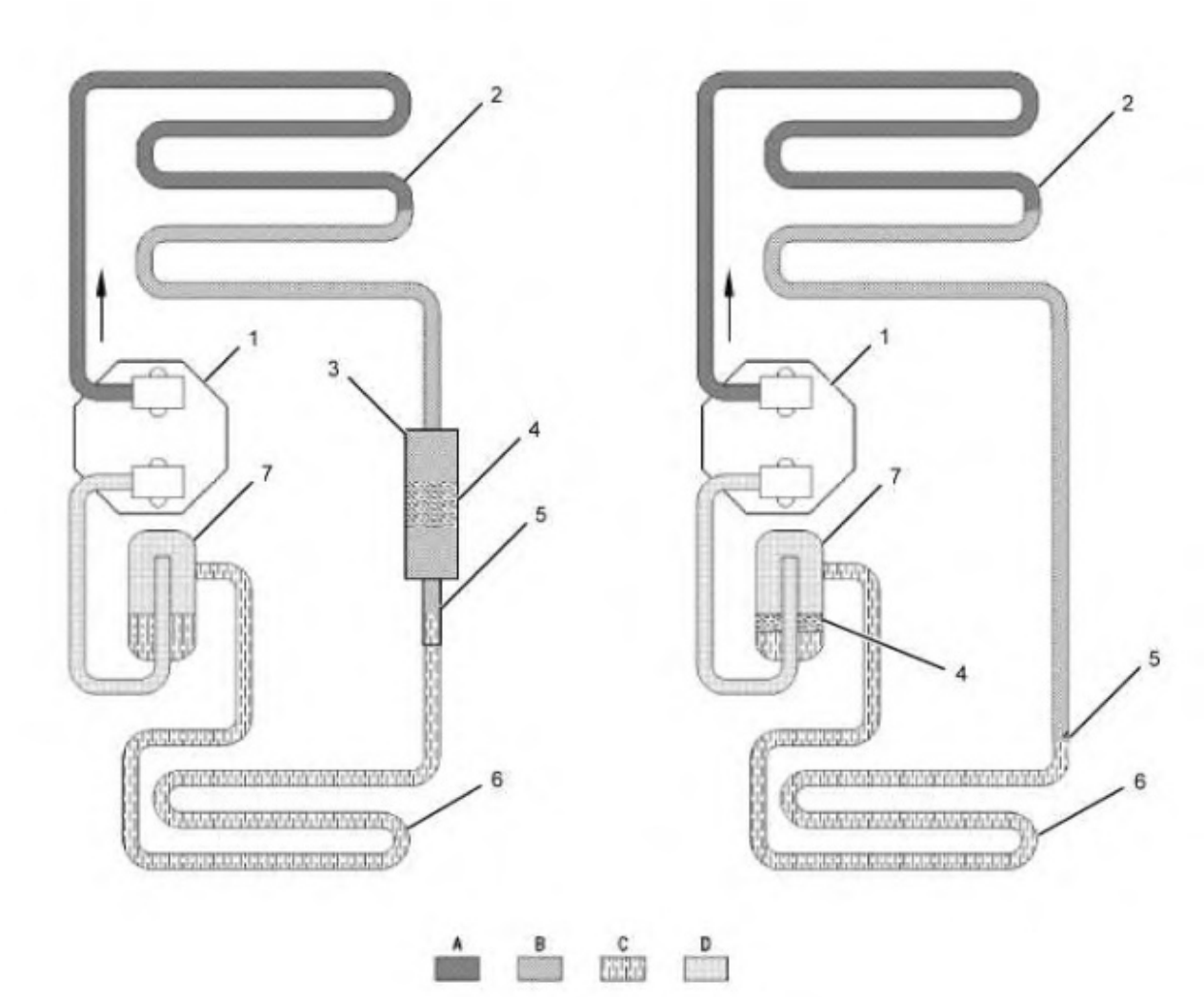


Illustration 1 g01507889

(1) Compressor

(2) Condenser

(3) In-line dryer

(4) Desiccant

(5) Orifice Tube

(6) Evaporator

(7) Accumulator

(A) High temperature high pressure refrigerant vapor

(B) High temperature, high pressure refrigerant liquid

(C) Low temperature, low pressure refrigerant liquid vapor mixture

(D) Low temperature low pressure refrigerant vapor

The air conditioner refrigerant begins to flow in the air conditioning system at refrigerant compressor (1). The compressor is designed to change the air conditioner refrigerant from a vapor that has low pressure into a vapor that has high pressure. Also, the compressor changes the refrigerant from a vapor with low temperature to a vapor with high temperature. The increase in pressure causes the increase in temperature.

The refrigerant is sent through condenser coil (2). In the condenser coil, heat is transferred from the refrigerant to the outside air. This changes the refrigerant to a high temperature and high pressure liquid.

From condenser coil (2), the refrigerant moves to in-line dryer (3). In in-line dryer (3), moisture is removed from the refrigerant by desiccant (4). Some orifice tube systems will not contain an in-line dryer. In this case, the desiccant is located in accumulator (7) .

Next, the refrigerant flows to the orifice tube. When the refrigerant is at the orifice tube, the refrigerant is changed from a high pressure and high temperature liquid to a liquid vapor mixture that is low pressure and low temperature.

The low pressure and low temperature refrigerant moves to evaporator coil (6). While the refrigerant is in the evaporator coil the refrigerant absorbs heat from the cab. This changes the refrigerant to a low pressure and low temperature vapor.

After the evaporator coil, the refrigerant flows to the accumulator. The accumulator stores liquid refrigerant that is exiting the evaporator and the accumulator allows only vapor to continue to the compressor.

The low pressure and low temperature vapor returns to the compressor. This marks the end of the cycle. The cycle is repeated continuously.

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i02998460

Refrigerant Compressor

SMCS - 1802

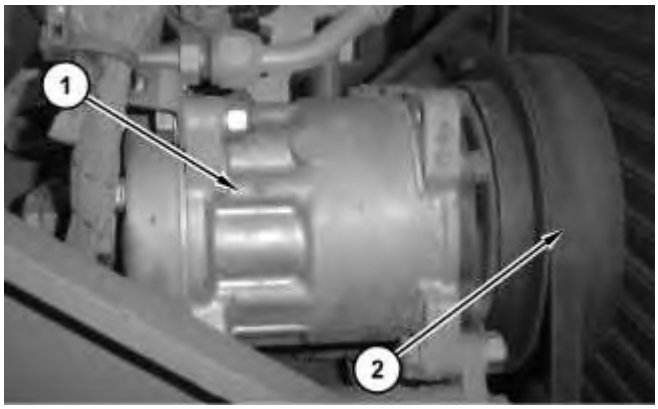


Illustration 1 g01257036

(1) Compressor

(2) Magnetic clutch and pulley assembly

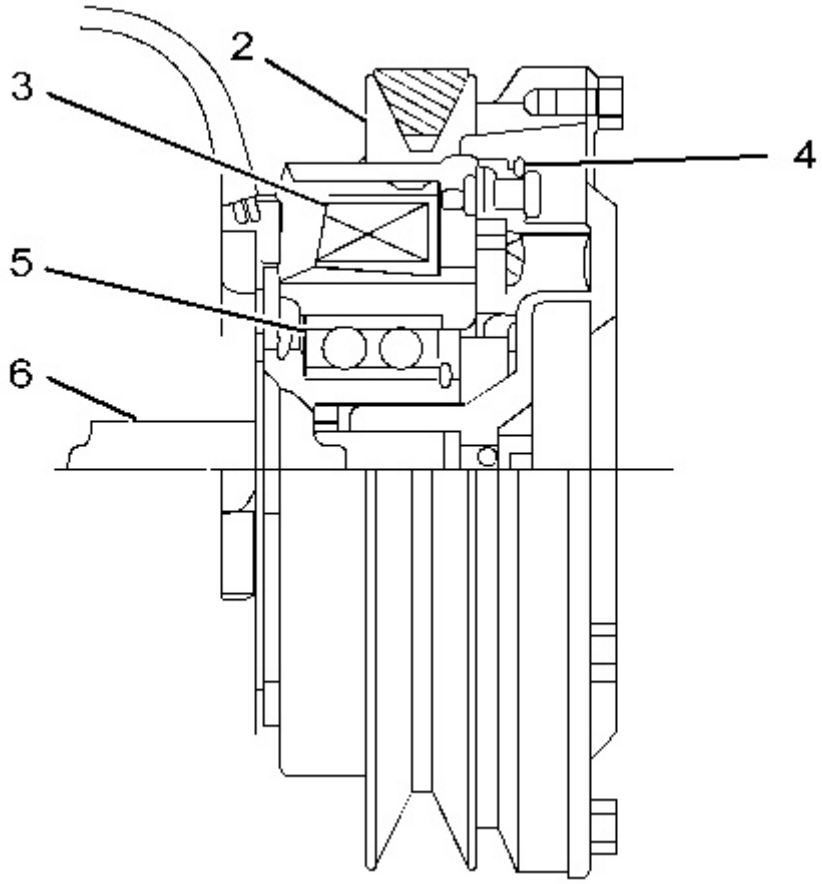


Illustration 2 g01266606

(2) Magnetic clutch and pulley assembly

(3) Coil assembly

(4) Drive plate

(5) Bearing

(6) Compressor shaft

The compressor is driven by the engine. A belt connects the engine to the clutch and pulley assembly (2). The pulley assembly is located on the clutch. The drive plate (4) is fastened to the shaft of the compressor. The clutch and pulley assembly (2) turns on the bearing (5). The clutch and pulley assembly (2) are not connected to the shaft (6). The electric current from the thermostat controls a magnetic field in the coil assembly (3) .

The magnetic field pulls the drive plate (4) against the clutch and pulley assembly (2). The clutch and the pulley assembly (2) turns the shaft (6) that operates the compressor. When the current to the coil assembly (3) is stopped, the magnetic field is removed. This allows the drive plate (4) to move away from the clutch and pulley assembly (2). The clutch and the pulley assembly (2) will turn freely on the bearing (5). The sequence of connecting and disconnecting the pulley to the compressor shaft (6) is called compressor cycling. The compressor cycling is controlled by the thermostat. The thermostat is controlled by the capillary tube, which is installed between the fins of the evaporator coil.

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i02982781

Refrigerant Condenser

SMCS - 1805



Illustration 1 g00289099

Typical Condenser

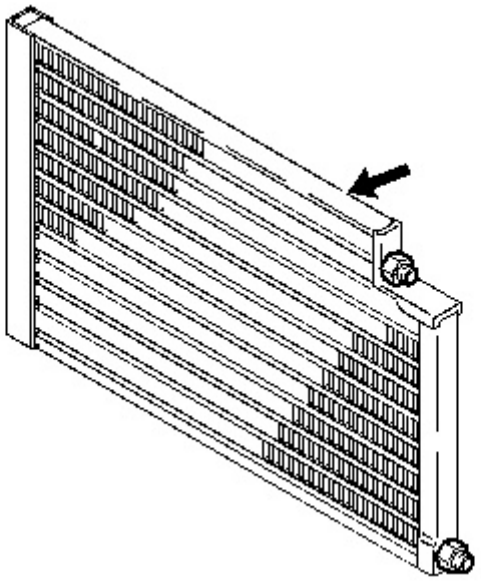


Illustration 2 g01514061

Typical Condenser

When the refrigerant leaves the compressor, the refrigerant is a vapor. The temperature of the refrigerant is high and the pressure of the refrigerant is high when the refrigerant leaves the compressor. The increase in pressure of the refrigerant causes an increase in temperature of the refrigerant. The refrigerant vapor leaves the compressor and the refrigerant enters the condenser (1) .

The refrigerant must be converted into a liquid that has high temperature and high pressure. The refrigerant must be converted into a liquid in order to increase the efficiency of the air conditioning system. The condenser (1) converts the refrigerant vapor into a liquid that has high temperature and high pressure.

When the refrigerant vapor leaves the compressor, the refrigerant vapor enters the condenser. The condenser is in a location that is exposed to outside air. In order to convert the refrigerant into a liquid, the refrigerant must lose heat. The refrigerant must reach the temperature of saturation. At the temperature of saturation, the refrigerant vapor will become a liquid. The temperature of saturation of the refrigerant depends on the pressure of the refrigerant.

As the high temperature, high pressure refrigerant vapor passes through the condenser (1), the condenser absorbs heat from the refrigerant vapor. The condenser transfers the heat to the outside air. The temperature of the refrigerant and the pressure of the refrigerant decrease until the temperature of saturation is reached. When the temperature of the refrigerant vapor is equal to the temperature of saturation, the refrigerant becomes a high temperature, high pressure liquid. When the refrigerant is converted into a liquid, the refrigerant leaves the condenser (1).

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i02980695

Refrigerant Receiver-Dryer

SMCS - 7322

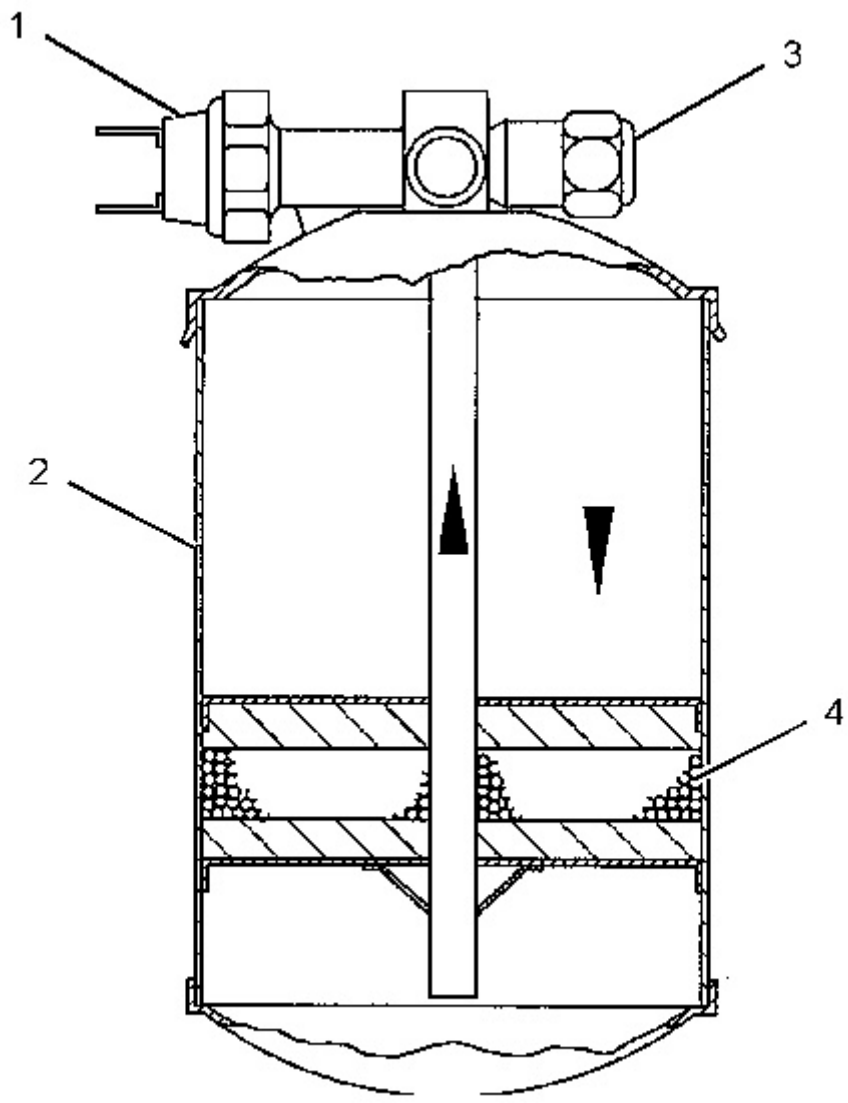


Illustration 1 g01508209

(1) Low pressure cutoff switch

(2) Receiver-dryer

(3) High pressure relief valve

(4) Desiccant

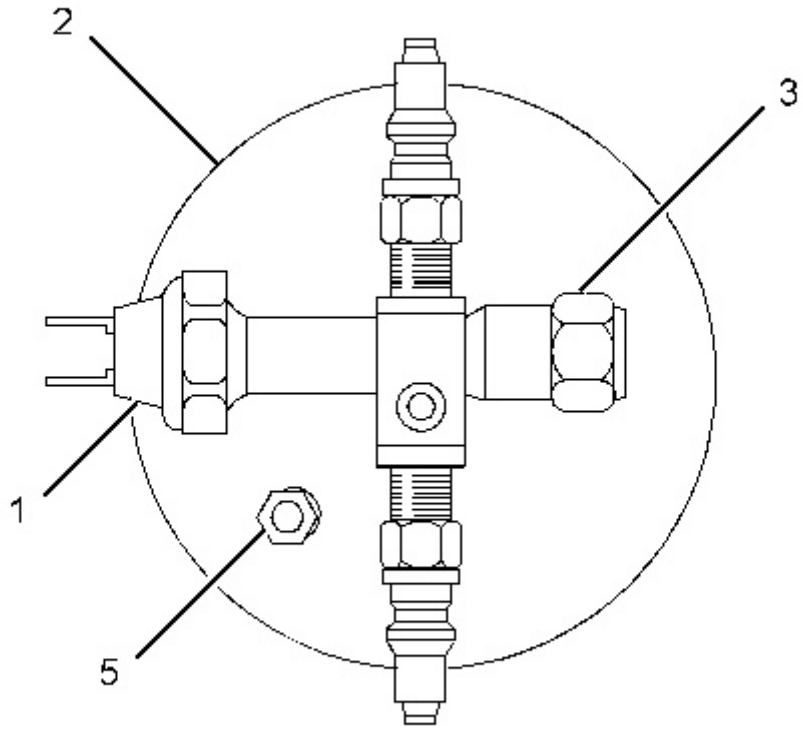


Illustration 2 g01508210

(1) Low pressure cutoff switch

(2) Receiver-dryer

(3) High pressure relief valve

(5) Moisture indicator

High pressure and high temperature refrigerant leaves the condenser coil and passes through the receiver-dryer (2). The liquid refrigerant inside the receiver-dryer passes through desiccant (4). The desiccant absorbs a small amount of moisture.

The receiver-dryer stores a small amount of refrigerant. This stored refrigerant is used in order to compensate for the changing system demands. These system demands can result from changing the speeds on the compressor, varying heat loads, or small losses of refrigerant.

A high pressure relief valve (3) is located on most receiver-dryers. The valve allows the refrigerant to be released to the atmosphere if the pressure increases to approximately 3450 kPa (500 psi). Most receiver-dryers also have a low pressure cutoff switch (1). If the system pressure lowers to approximately 175 kPa (25 psi), the switch opens. This will open the electric circuit to the magnetic clutch and the compressor will not operate.

Some receiver-dryers will have a moisture indicator (5). This moisture indicator is used in order to determine the relative moisture in the system. If the moisture indicator is blue, the system is dry. If the moisture indicator is pink or white, then the receiver-dryer must be replaced. Refer to Disassembly and Assembly, SENR5664, "Receiver-Dryer Remove and Install".

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i02979742

Refrigerant Expansion Valve

SMCS - 7320-EV

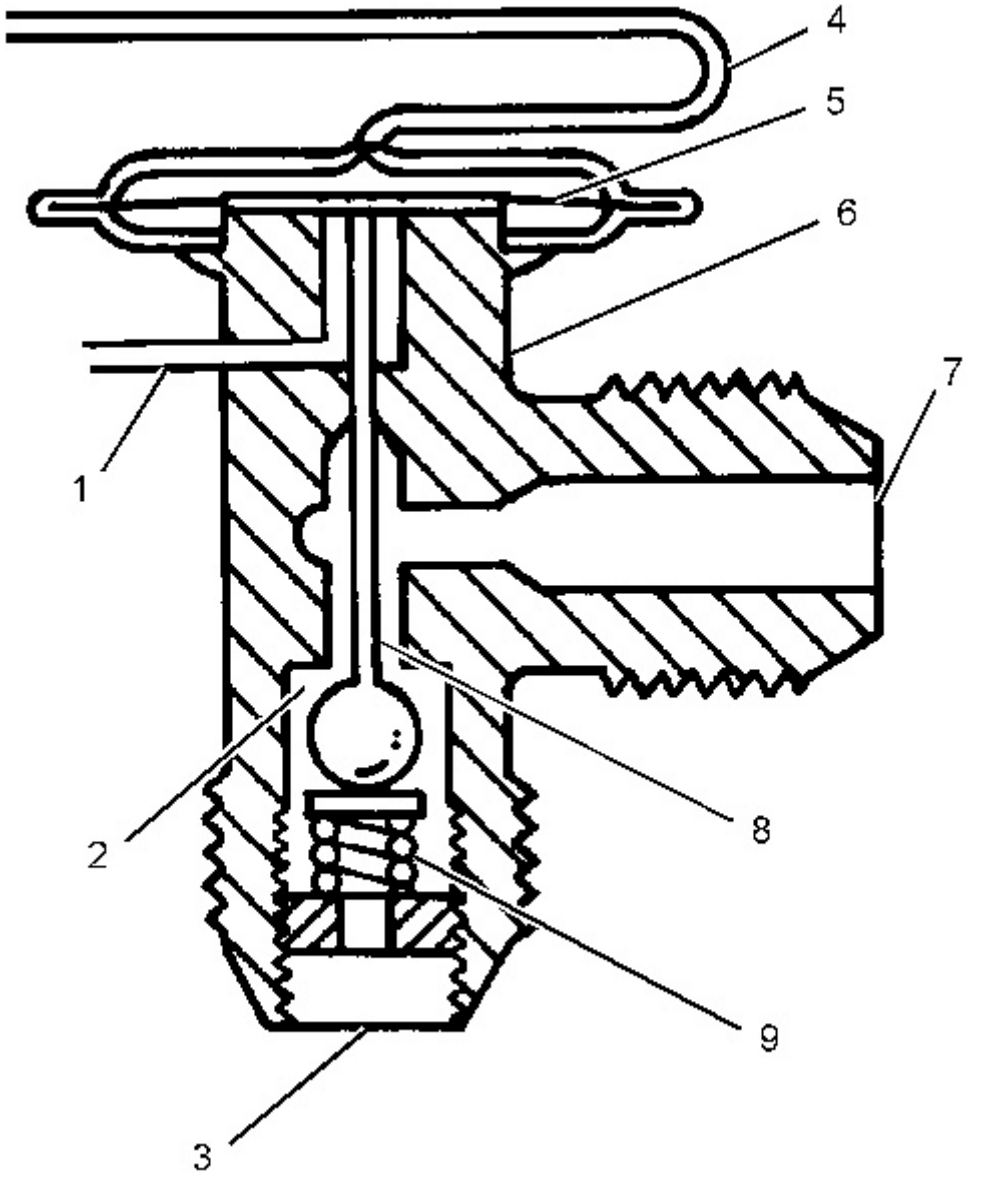


Illustration 1 g01507656

(1) External equalizer line

(2) Metered restriction

(3) Outlet

(4) Capillary tube and temperature sensing bulb

(5) Diaphragm

(6) 90° style expansion valve

(7) Inlet

(8) Ball and rod

(9) Spring

The expansion valve (6) is designed to convert the refrigerant from a high pressure and high temperature liquid into a low pressure and low temperature liquid vapor mixture. The expansion valve also controls the amount of refrigerant that is supplied to the evaporator.

The two main types of expansion valve are the 90° expansion valve and the block expansion valve. The internal operation is identical for both of the valves. The valve configuration on the air conditioning system can be found in Systems Operation, SENR5664, "Refrigerant Expansion Valve System".

The liquid refrigerant with high pressure and high temperature enters the expansion valve at the inlet (7) from the condenser. An amount of refrigerant is allowed to flow through the metered restriction (2) and the outlet (3) to the evaporator.

The size of the metered restriction is controlled by three components: ·

- Pressure in the capillary tube (4)
- Pressure in the external equalizer line (1)
- Force due to the spring (9)

The capillary tube is filled with saturated refrigerant. There is a temperature sensing bulb at the end of the capillary tube. The temperature sensing bulb is held to the evaporator outlet. As the temperature of the evaporator outlet increases, the pressure in the capillary tube increases. This pressure creates a downward force on the diaphragm (5). Some types of block valves have an internal temperature sensing bulb.

The external equalizer line connects the evaporator outlet with the underside of the diaphragm. The pressure in the line creates an upward force on the diaphragm. In a block style expansion valve, there is not a required separate external equalizer line. There is not a separate external equalizer line because the line for the evaporator outlet is routed through the block valve.

The ball and rod (8) is attached to the diaphragm and the spring. The spring creates an upward force on the ball and rod.

When the force due to the pressure in the capillary tube is greater than the combined forces due to the spring and the pressure in the external equalizer line, the valve opens wider. This allows more

refrigerant flow. When the force due to the pressure in the capillary tube is less than the combined forces due to the spring and the pressure in the external equalizer line, the valve closes. This restricts the refrigerant flow.

This metering action allows only the required amount of refrigerant to be supplied to the evaporator in varying load conditions.

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In-line Refrigerant Dryer

SMCS - 7322

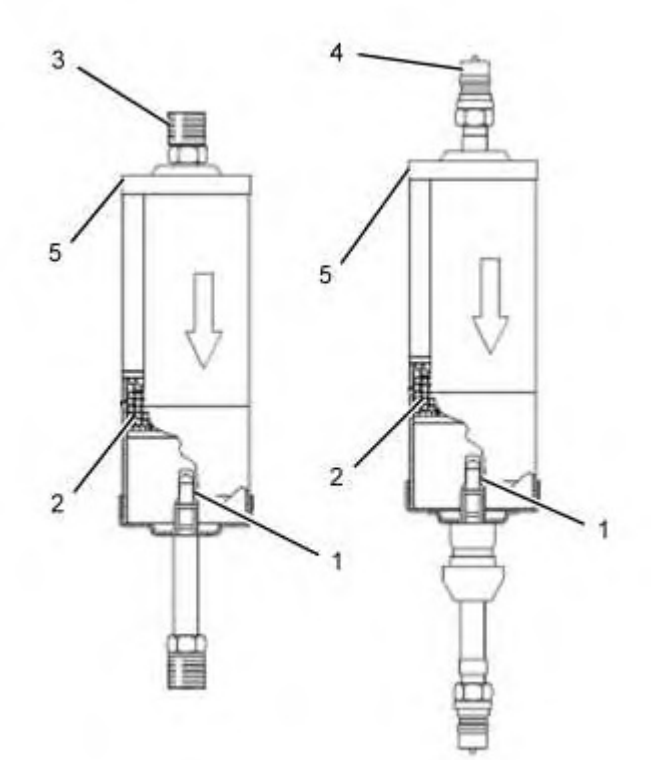


Illustration 1 g01507863

(1) Orifice tube assembly

(2) Desiccant

(3) Tube O-ring fitting

(4) Quick disconnect fitting

(5) In-line dryer

The in-line dryer (5) receives the high temperature high pressure liquid refrigerant from the condenser coil. The refrigerant passes through the desiccant (2). The moisture is removed in the desiccant (2). The refrigerant continues to the orifice tube assembly (1), which is the location where the high temperature high pressure liquid is changed into a liquid vapor mixture that is low temperature low pressure. After exiting the in-line dryer, the refrigerant continues to the evaporator coil.

The in-line dryer connects to the refrigerant circuit with either tube O-ring fitting (3) or a quick disconnect fitting (4).

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i03022273

Refrigerant Orifice Tube Assembly

SMCS - 7320-QT

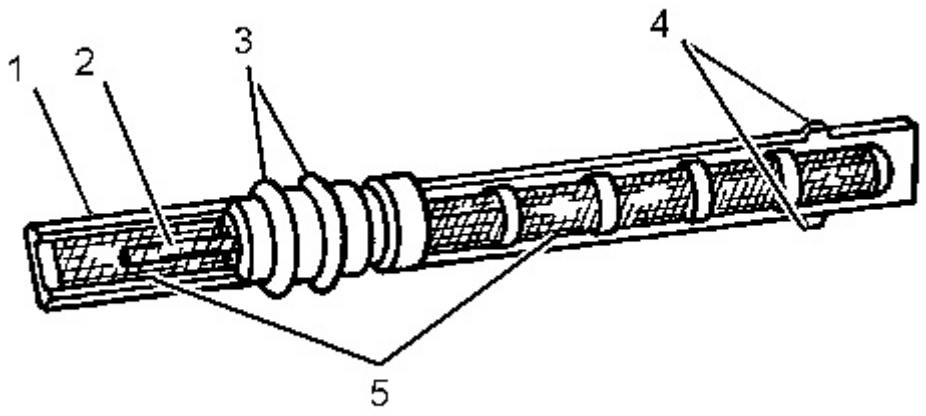


Illustration 1 g01507883

(1) Orifice tube assembly

(2) Orifice tube

(3) O-ring seal

(4) Tab

(5) Screen

The orifice tube assembly (1) contains a plastic body, two screens (5), and a small brass tube. The small brass tube is referred to as an orifice tube (2), and it is located in the center of the body. The O-ring seals (3) are positioned on the body of the orifice tube to seal against leakage around the orifice tube.

The orifice tube assembly is contained within the in-line dryer. If there is no in-line dryer, the orifice tube is located in the inlet to the evaporator.

The orifice tube (2) restricts the flow of refrigerant. This restriction creates a pressure drop across the orifice tube. This changes the refrigerant from a high temperature high pressure liquid into a liquid vapor mixture that is low temperature low pressure. The flow rate is controlled by the pressure difference across the orifice tube.

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Evaporator Coil

SMCS - 7343

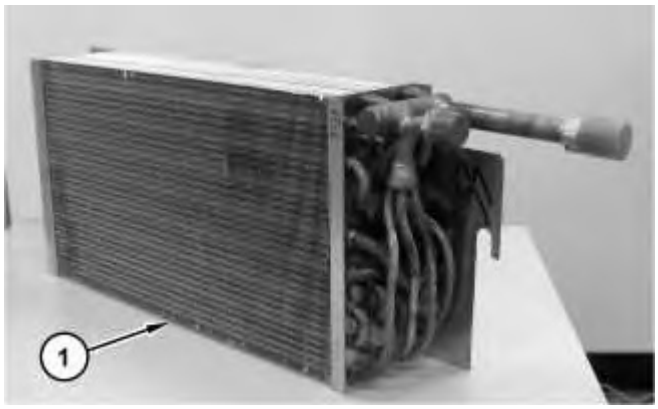


Illustration 1 g01265314

(1) Typical evaporator coil

In an expansion valve system, the evaporator coil receives liquid refrigerant from the expansion valve. In an orifice tube system, the evaporator receives liquid refrigerant from the orifice tube assembly. The liquid refrigerant that is received by the evaporator has low pressure and low temperature. Since the pressure of the liquid refrigerant is low, the temperature of saturation of the refrigerant is low. At the temperature of saturation, the refrigerant changes from a liquid into a vapor. The temperature of saturation of a fluid increases when the pressure of a fluid increases.

The evaporator coil is exposed to the air that is inside of the cab. The heat from the air that is inside of the cab is absorbed by the evaporator. The evaporator transfers the heat to the refrigerant. The amount of heat that is required to reach the temperature of saturation is called the latent heat of vaporization. When this heat is absorbed by the refrigerant, the temperature of the refrigerant will reach the temperature of saturation. The refrigerant will change from a liquid into a vapor. The vaporized refrigerant will leave the evaporator. The vaporized refrigerant will carry away the heat from the cab. The vaporized refrigerant will return to the compressor when the refrigerant leaves the evaporator. This process is repeated continuously.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02980104

Refrigerant Accumulator

SMCS - 7320-ZJ

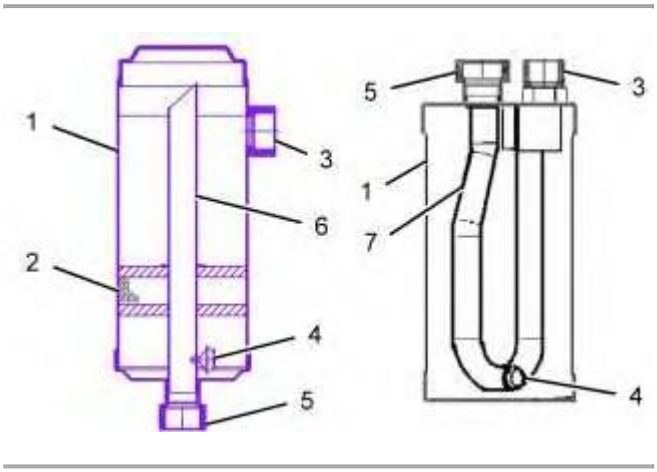


Illustration 1 g01507822

(1) Accumulator

(2) Desiccant

(3) Inlet

(4) Filter for the oil drain

(5) Outlet

(6) Standpipe

(7) J-tube

Low temperature low pressure refrigerant leaves the evaporator coil and passes into the accumulator (1) through the inlet (3). Liquid refrigerant that was not evaporated in the evaporator is stored in the bottom of the accumulator. Vapor refrigerant passes through either the standpipe (6) or the J-tube (7) before exiting through the outlet (5). The oil goes to the compressor through a filter for the oil drain (4).

The accumulator stores some refrigerant in order to compensate for the changing system demands. These system demands can result from changing speeds in the compressor, varying heat loads, or small losses of refrigerant.

The accumulator will contain desiccant (2) if the system does not contain an in-line dryer. The liquid refrigerant will pass through the desiccant, which will remove a small amount of moisture.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02980429

Refrigerant Compressor Protection System

SMCS - 1802

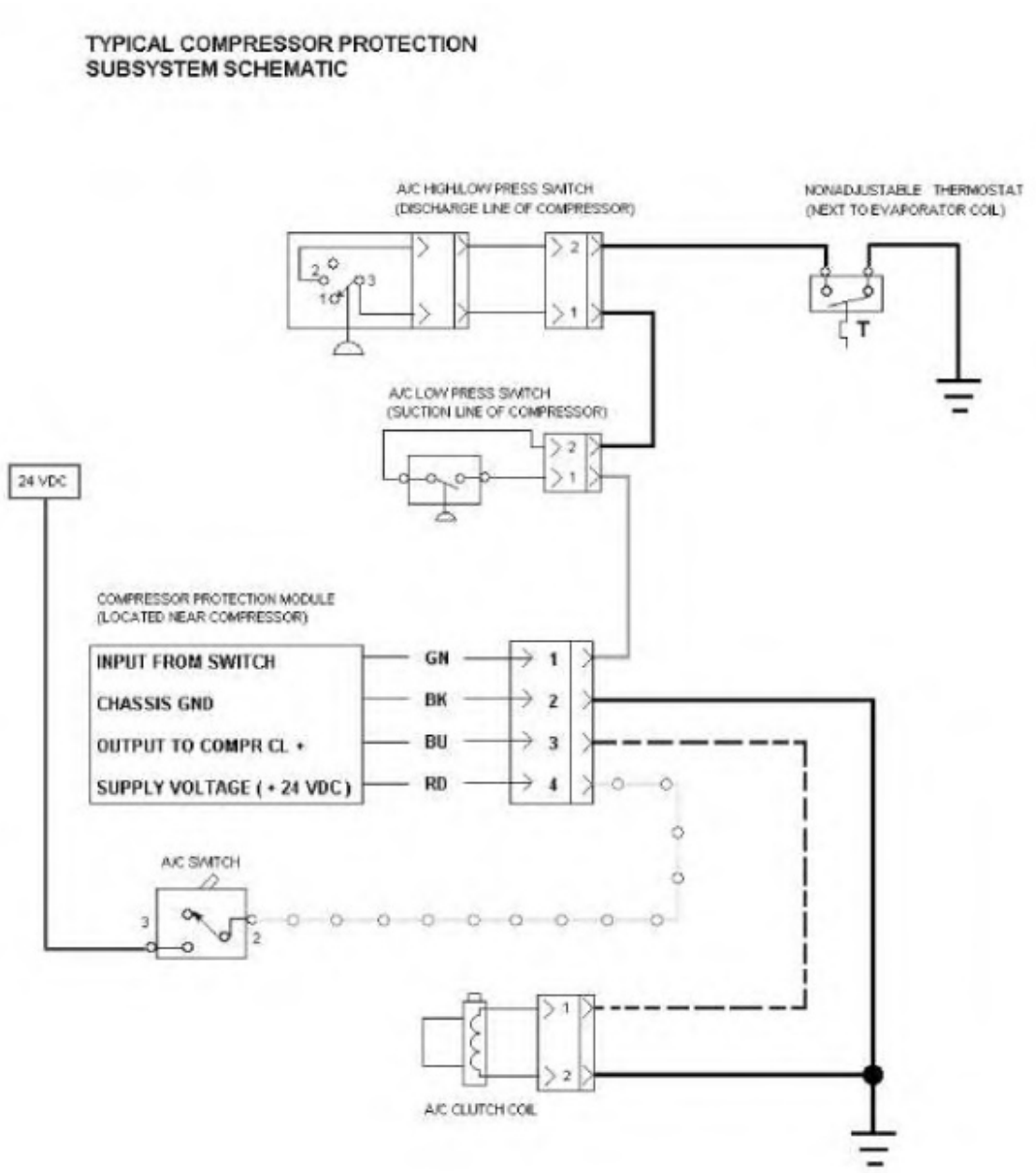


Illustration 1 g01518521

Compressor protection schematic with an on delay timer (Compressor Protection Module)

The protection system uses an on delay timer assembly for the refrigerant compressor that monitors three switches in order to protect the refrigerant compressor. The on delay timer assembly will perform the following functions:

- Increase the life of the refrigerant compressor if the air conditioning system has a low refrigerant charge.
- Delay the refrigerant compressor from engaging during engine start-up.
- Protect the compressor clutch from low voltage and high voltage.



Illustration 2 g01508064

On Delay Timer Assembly for the Refrigerant Compressor

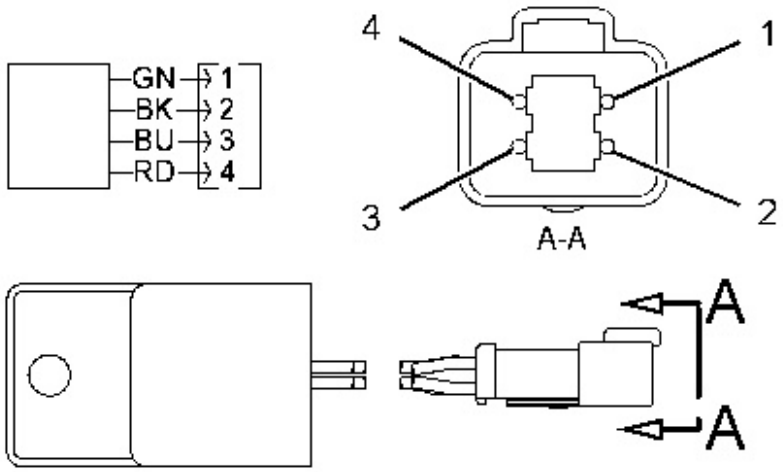


Illustration 3 g01512253

(1) Output (signal voltage)

(2) Chassis ground

(3) Compressor clutch

(4) Power supply

When the air conditioning switch is activated inside the cab, the air conditioning switch supplies voltage to the on delay timer assembly through pin (4). If the voltage at pin (4) is outside the acceptable range, the on delay timer assembly will not engage the compressor clutch coil. If the proper voltage is present, the on delay timer assembly delays the engagement of the compressor clutch for 15 to 20 seconds after the air conditioning switch is activated. The on delay timer assembly monitors the status of three switches by sending a signal voltage through pin (1). The following three switches are monitored by the on delay timer assembly:

- The high/low pressure switch on the high side of the air conditioning system
- The low pressure switch on the low side of the air conditioning system
- The thermostat switch

The three switches are connected in series to ground. If any one switch creates an open circuit, the on delay timer assembly detects the signal.

If any of the switches cycle on and off in rapid succession, the on delay timer assembly will start a time delay. The time delay limits the cycles of the refrigerant compressor to 4 times per minute.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i04923811

Temperature Control

SMCS - 7309

Adjustable Thermostat

A Heating Ventilation Air Conditioning (HVAC) system that is controlled by an adjustable thermostat contains two temperature control knobs.

The first temperature control knob is for the air conditioning system and the control knob is connected to the adjustable thermostat.

A thermostat is a switch that opens and closes. The thermostat switch opens and the thermostat switch closes because of the changes that can occur in the temperature of the sensing element. A sensing element is also known as a capillary tube. Sensing temperatures for the element less than the switch point on the thermostat will open the thermostat switch. Sensing temperatures for the element more than the switch point for the thermostat will close the thermostat switch.

When the first temperature control knob is in the OFF position, the electric circuit that connects the adjustable thermostat and the magnetic clutch is OPEN. In the OFF position, the compressor does not operate. The temperature of the air and the position of the temperature control knob determines if the thermostat switch is CLOSED. When the thermostat switch is CLOSED, the current moves through the switch and the coil assembly in the magnetic clutch, and this causes the compressor to operate. The temperature of the air through the evaporator coil is monitored by the capillary tube that is placed between the fins of the evaporator coil.

The second temperature control knob is for heating. This knob is connected to the heater control valve, which controls the flow of coolant through the heater coil. The temperature of the cab is maintained by the position of the air conditioning and heating temperature control knobs.

Nonadjustable Thermostat (Freeze Control System)

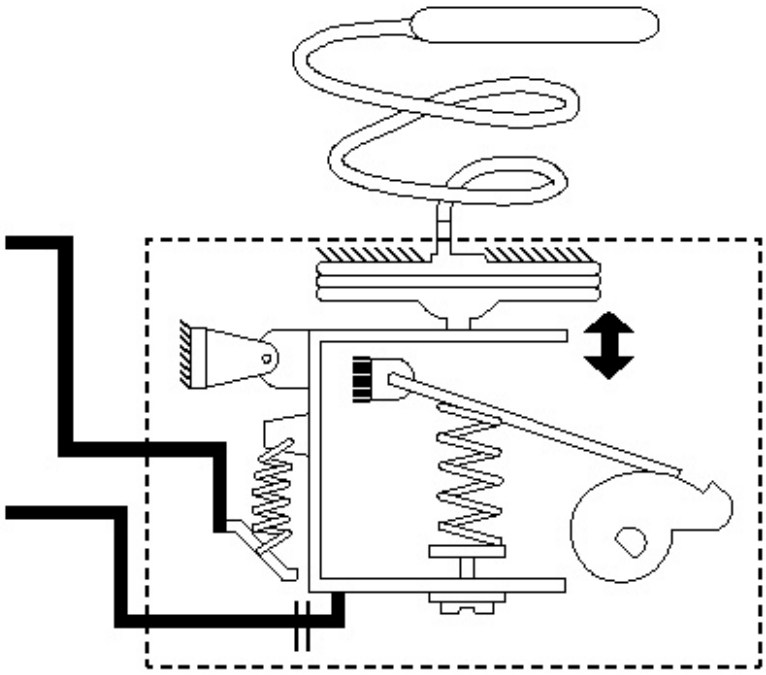


Illustration 1 g01510274

An HVAC system using a nonadjustable thermostat contains one temperature control knob. The temperature control knob is connected to the heater control valve, which controls the flow of coolant through the heater coil. The temperature of the cab is maintained by the position of the temperature control knob on the heater.

The temperature of the air that crosses the evaporator coil is kept at the coldest possible temperature allowed by the nonadjustable thermostat. The thermostat switch opens at a temperature of approximately -1.1 °C (30 °F) in order to prevent the condensation from freezing to the evaporator coil. In addition, the thermostat switch closes at approximately 2.2 °C (36 °F). Condensation that is frozen will restrict the air flow through the evaporator coils. When the switch opens, the electric circuit that connects the thermostat switch to the magnetic clutch is OPEN and the compressor does not operate. When the switch is CLOSED, the current moves through the switch and through the coil assembly in the magnetic clutch. This causes the compressor to operate. In order to operate the system in the correct manner, the heater core supply must not be closed. Also, in order to operate the system in the correct manner, the return coolant line valve must not be closed.

ATC System Operation

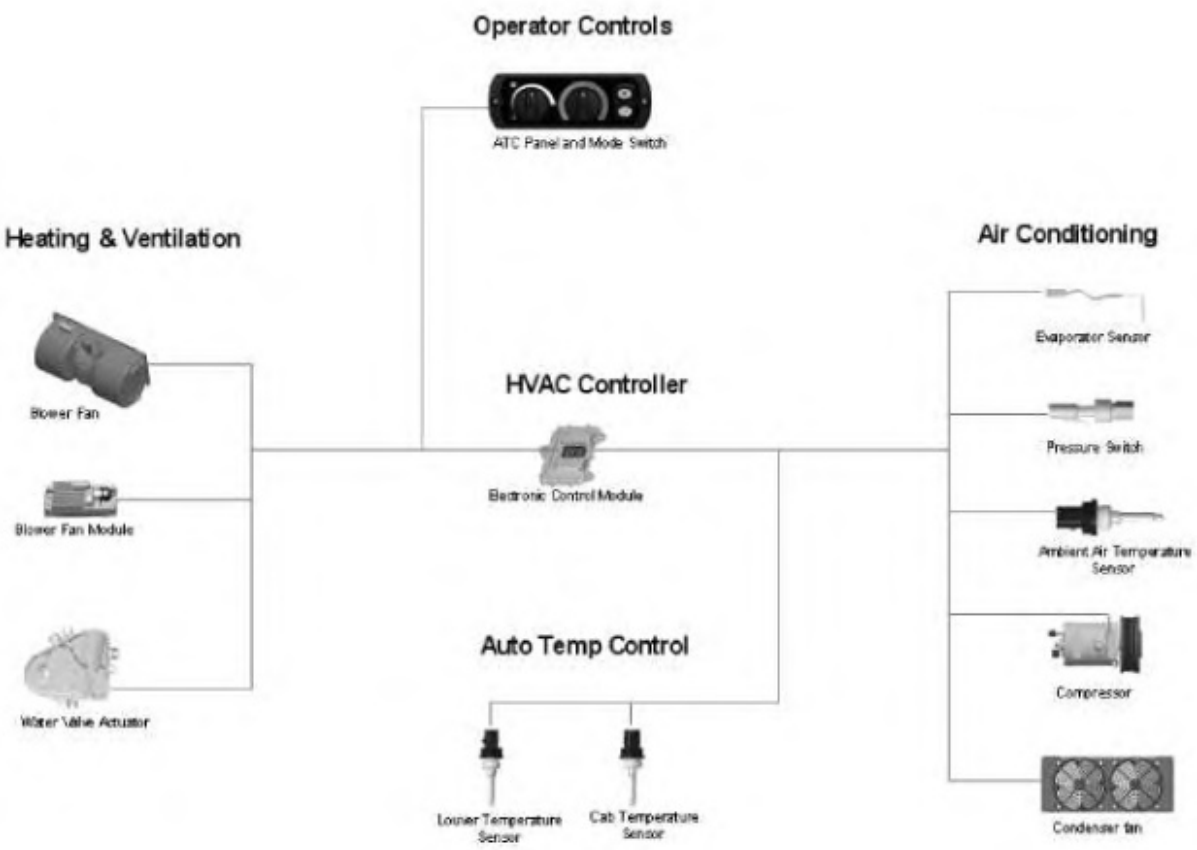


Illustration 2 g03090876

Typical HVAC Components

The Automatic Temperature Control (ATC) system includes all of the standard HVAC components for manual temperature control along with the louver and recirculation temperature sensors. There are a few steps to enable ATC.

- Select the Auto position on the mode selection switch located on the control panel
- Rotate the temperature dial to the desired temperature setting
- Rotate the blower fan dial to the desired speed – Note: There has to be some fan speed in order for the ATC to operate, full CW position of the dial will turn off the ATC.

The Electronic Control Module (ECM) receives the requested temperature from the control panel and the cab temperature sensor and automatically controls the water valve actuator and compressor to reach and maintain that temperature. Some machines are also equipped with an Auto Blower option that adjusts the blower fan speed based on the cab temperature error, the larger temperature difference the faster the blower fan speed.

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i02991866

Cab Pressurization and Filtration System

SMCS - 7320; 7342

Caterpillar machines with an enclosed cab area need to provide adequate air flow to the operator inside the cab area so that a standard air pressure is met. Maintaining a proper air pressure level is accomplished by ensuring that the appropriate seals are used. When the appropriate seals are correctly installed, the cab will be pressurized by the ventilation system. See Troubleshooting, SENR5664, "Troubleshooting Cab Pressurization and Filtration System" for tips on resolving problems.

Maintaining the proper pressurization level in the cab area is important to the health of the operator because changes to the air pressure may lead to problems with breathing. Low pressure can cause dust to enter the cab and the Heating Ventilation Air Conditioning (HVAC) system, which can lead to premature system deterioration. Low pressure is often caused by improper sealing of the cab. Poor sealing of the cab requires an increase in the fresh air flow to maintain pressurization. The increase in fresh air flow will lead to a lower air conditioning and heater performance. The increase in fresh air flow will also lead to increased intervals in filter service. Additional noise that is entering the cab can also result from poor sealing of the cab.

Cab sealing objectives for the operator cab environment are for the cab to pressurize to a minimum of 50 Pa (0.2 inch of H_2O) with no more than 76 m^3/hr (45 cfm) () of fresh air flow. The minimum cab fresh air flow while the ventilation system is operating on any fan speed is 43 m^3/hr (25 cfm). This objective satisfies the requirements for fresh air flow from SAE J1503 and ISO 10263-4. In HVAC systems with a mode door that controls the balance of fresh air and recirculation air, the control shall be set to minimum fresh air flow while measuring cab pressure.

The air flow of a HVAC system is used to pressurize a cab as the air flow passes through different components. First, outside air is drawn into the HVAC compartment after being filtered for dust particles. Air is drawn in with the help of a blower fan. The blower fan pulls air or pushes air across the heater and/or the evaporator coil. The air flow is then directed into the ventilation ducts of the system. The air flow travels into the environment of the cab through the directional louvers. Finally, the air inside the cab area returns to the HVAC system through the recirculation filter.

Some ventilation systems can be enhanced by using different options. One option that is available for a wide variety of Caterpillar machines is the inclusion of a powered precleaner unit. As part of the pressurized system of the cab, a precleaner removes additional dirt/dust from the fresh air flow that is entering the cab. This provides extended life for the filter to the fresh air filter. These precleaners are coupled with higher efficiency fresh air filters in order to prevent finer particles of

dirt from entering the cab area. In addition to the precleaner, some newer systems may include filters that are low restriction. A media filter that is low restriction can filter dust effectively, and offer more air flow through the HVAC system.

Cab Air Filters

Most Caterpillar machines with the R134a system have two cab air filters. One type of air filter is the fresh air filter and the other type of filter is a recirculation filter inside the cab. Some of the machines have a third air filter that is made of foam. The third filter is designed to remove large debris before the air reaches the fresh air filter.

Some Caterpillar machines are equipped with a precleaner for the cab. The system is designed to remove excessive dust and dirt from the air that is entering the cab. The precleaner is part of the pressurized cab.

There are optional replacement filters that are available for use in the field with certain machine applications. Carbon impregnated filters are used for improved odor reduction in place of the fresh air filter. High efficiency filters are also used as a replacement for the fresh air filter in environments with high concentrations of dust. High efficiency filters also provide better filtering efficiencies in order to reduce the intake of dust into the cab. Filters that are low restriction are also available for certain applications as a way to reduce the system restriction through the filter. Filters that are low restriction reduce the restriction that is in the system, and the filters continue to maintain efficiencies in filtering dust.

ReferenceFor optional replacement of filters, see Datasheet, PEHJ0092, "Cat Cabin Air Filters Datasheet".

Air filters for Caterpillar cabs are not intended for filtering out hazardous materials. When you are working in an environment with potentially hazardous materials, all of the safety precautions for working with that material should be followed. As the requirements are defined by the local agencies, additional personal protection equipment may be required for the operator.

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i02991847

Condensate Drainage System

SMCS - 7320

Caterpillar machines that are equipped with Heating Ventilation Air Conditioning (HVAC) units need to have an adequate system for drainage in order to properly remove condensate from the HVAC system. Condensate collects on the coils as moisture is removed from the air during air conditioning operation. After the condensate has developed on the coil, the condensate will drip off the coil. In order to prevent any condensate from entering the enclosure for the operator, a drainage system that is maintained correctly is needed.

Drainage of the condensate can be achieved in different ways. Some systems have a collection reservoir that is built into the case compartment that encloses the evaporator coil. The floor of the case slopes to the holes for drainage, and this allows condensate to drain away from the HVAC unit.

Other systems incorporate a separate drain pan that is located under the coil, in the case compartment that is used to collect condensate. The drain pan is shaped in order to allow condensate to flow toward the holes for drainage and away from the HVAC unit.

Whether integrated into the case design, or integrated through the use of a drain pan, the drain hoses and the valves are attached to the drain holes. Drainage hoses are commonly used to route the condensate around critical components on the machine, so that the water can be diverted to a proper point of exit below the machine. Drain valves are intended to prevent dust and debris from entering the HVAC unit. The location of the drainage unit may change the way that the condensate will be removed from the system. Some units will allow drainage to drain directly out of the case without the use of drain valves and hoses.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03861420

Service Intervals

SMCS - 7000; 7309; 7320

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Note: Before performing any maintenance, refer to Troubleshooting, SENR5664, "Machine Preparation for Troubleshooting" for the correct lockout procedure.

Regular maintenance must be performed in order to maximize the performance of the air conditioning system. Regular maintenance must be performed in order to minimize the downtime of the machine. Failure to inspect these systems will cause poor performance and premature failure. Inspect and maintain the Heater and the Air conditioner system per the chart below. For additional information on the component and system maintenance instructions, refer to Service Manual, SENR5664, "testing and adjusting".

Table 1

Component or System	Clean/Inspect	Replace
Dryer with Quick Disconnect		Every 2000 hours
Dryer with Tube O-Ring Connect		Every 4000 hours
Recirculation Filter	Weekly	Monthly
Condenser Coil	as needed	
Fresh Air Filter	Each shift	Weekly
Heating and A/C Maintenance checklist	Seasonal	

- Perform regular maintenance on the refrigerant service units in accordance to the instructions from the manufacturer. Change the oil that is in the vacuum pumps according to the instructions from the manufacturer.
- Check the scale that is used for charging for accuracy after every 30 days. Check after every 30 uses according to the instructions from the manufacturer.

Heating and A/C Maintenance Checklist

Table 2

Filters	
Operation	**Check if OK**
Check the cleanliness of the Fresh Air Filter.	
Check the cleanliness of the Recirculation Filter.	

Table 3

Coils	
Operation	**Check if OK**
Check the condenser coil for damage or debris.	
Check the evaporator coil for damage or debris.	
Check the heater coil for damage or debris.	

Table 4

Blowers and Fans	
Operation	**Check if OK**
Check the remote condenser fans in order to make sure that the fans operate when the air conditioning system is running.	
Make sure that the blower fans for the cab operate on all speed settings.	

Table 5

Condensate Drain Lines	
Operation	**Check if OK**
Make sure that the drain lines are clean and that the drain lines allow condensate flow.	
Make sure that the drain valves are present and correctly located.	

Table 6

Dryer	
Operation	**Check if OK**
If the dryer has quick disconnects, make sure that the dryer has been replaced within the last 2000 hours. Replace according to the maintenance chart	
If the dryer has tube connections that are an O-ring, make sure that the dryer has been replaced within the last 4000 hours. Replace according to the maintenance chart	

Table 7

Compressor	
Operation	**Check if OK**

Check the cleanliness of the wire connections for the compressor and make sure that the connections are free of damage.	
Make sure that the dust caps are securely installed on the service ports.	
Make sure that the clutch engages when the A/C switch is on and the thermostat is set to maximum cooling.	

Table 8

Compressor Drive Belt	
Operation	**Check if OK**
Check for wear and damage on the compressor drive belt.	
Make sure that the auto tension pulleys are functioning correctly.	
Make sure that the drive belt is aligned within 1/3 of a degree.	

Table 9

Hoses and Connections	
Operation	**Check if OK**
Check for wear and damage on the refrigerant lines	
Check for leaks on the refrigerant lines	
Check for wear and damage on the heater lines	
Check for leaks on the heater lines	
Make sure that the heater valves are open for use in the winter.	

Table 10

Performance	
Operation	**Check if OK**
Make sure that a performance check on the air conditioning indicates a system that is functioning properly. Refer to testing and adjusting, SENR5664, "Performance Checks for the Air Conditioning System".	
Make sure that a performance check on the heater system indicates that the system is properly functioning. Refer to testing and adjusting, SENR5664, "Performance Checks for the Air Conditioning System".	

Air Filters-Clean

The cab air filters are designed to provide clean air to the evaporator and the heater coils. The cab air filters are also designed to keep the cab pressurized. If the filters are not properly maintained, the coils will be coated with dirt. Dirty coils will result in loss of heating and cooling. Dirty coils could also result in failure of the compressor. Refer to testing and adjusting, SENR5664, "Coil Cleaning".

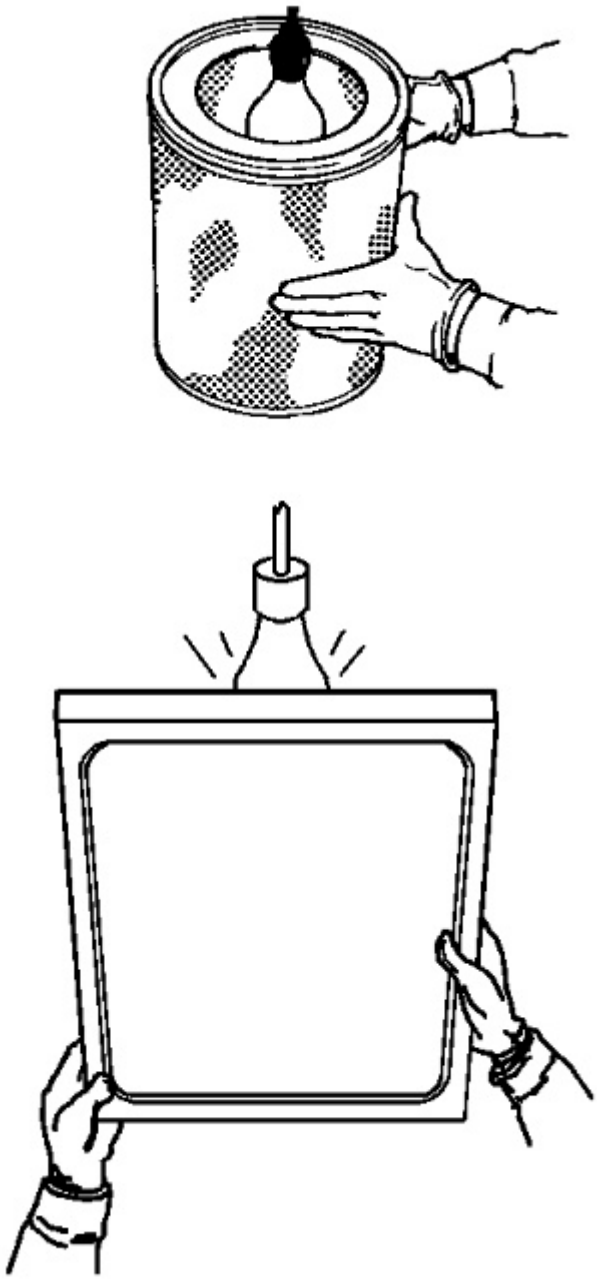


Illustration 1 g01517100

Cab air filters should be inspected regularly. Any inspection variance depends on the environmental conditions. Fresh air filters should be checked after every shift (8 to 10 hours). Fresh air filters should be changed after every week (40 to 50 hours). Recirculation filters should be checked after every week (40 to 50 hours). Recirculation filters should be changed after every

month (160 to 200 hours). Inspect the filter for holes. Look through the filter toward a bright light. Check for damaged gaskets or dented metal parts. Do not use damaged filters. For extreme dust conditions, the filters should be inspected daily, and the filters should be cleaned whenever is necessary.

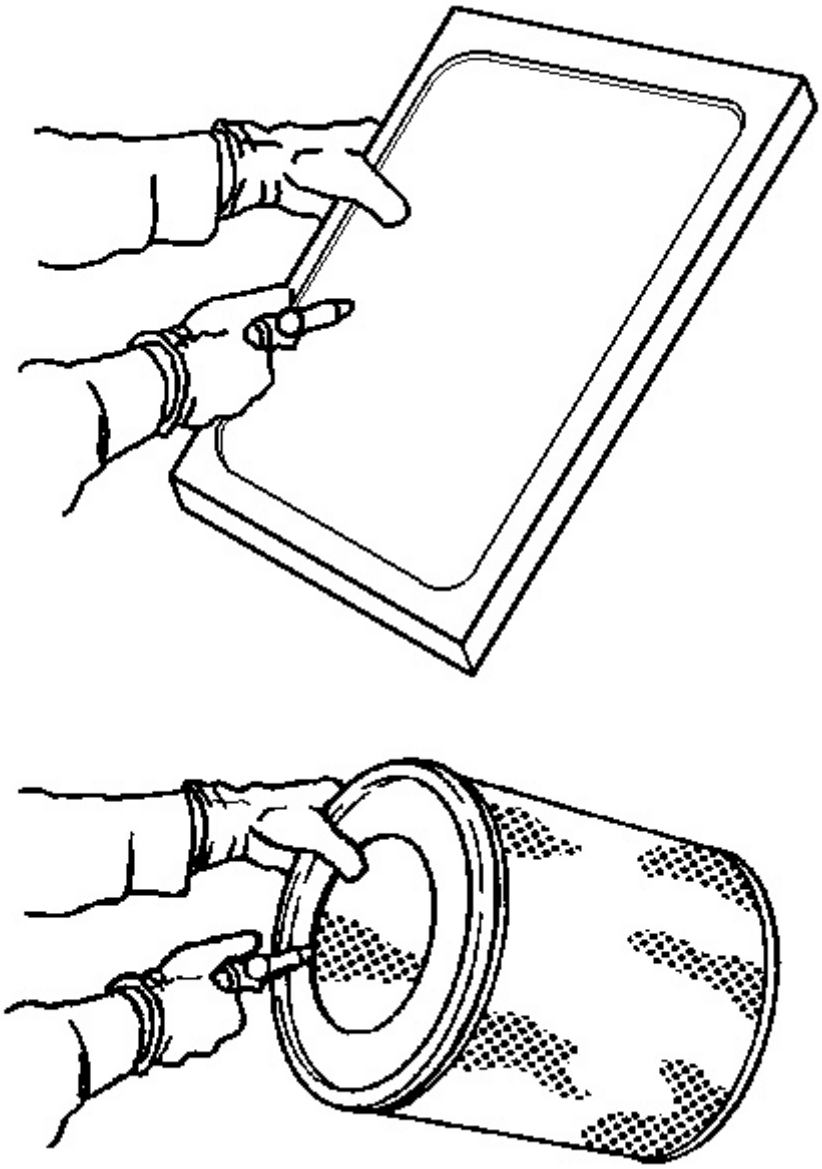


Illustration 2 g01517101

Remove loose dirt with compressed air. Do not exceed 690 kPa (100 psi) from an air nozzle that is 3.18 mm (0.125 inch)diameter. Keep the air nozzle at least 51 mm (2 inch) from the filter.

The filters that are made of foam can be blown out with low-pressure air. The filters that are made of foam can also be gently washed with a mild detergent. After washing the filters, dry the filters with low-pressure air.

If the carbon is still active, the carbon impregnated filters may be blown out with low-pressure air. Do not wash the carbon impregnated filters.

Standard filters or high efficiency filters may be blown out with low-pressure air. Do not wash the standard filters or the high efficiency filters.

Coil Cleaning

NOTICE

Do not use steam to clean the coils, under any circumstance. The heat from the steam will induce thermal stresses on the construction of the components of the coil. The stress can weaken the overall construction and permanently damaging the coil.

NOTICE

Do not use any other objects in order to straighten the fins, such as a screwdriver or a knife. These objects can damage the coil.

In order for an HVAC coil to function properly, air must be able to flow freely across the fins without any major obstructions. Because the coils need to stay clean, cleaning the coil is important in order for the coils to provide sufficient air flow. Some job applications may cause the coils to become dirty quickly, and dirty coils requires frequent cleaning. There are different methods that are utilized for proper cleaning. The different methods that are used depend on the type of coil that is used.

Condenser coils typically have a thicker, more durable fin structure that is designed to withstand the conditions of the environment. Due to the construction of the condenser coils, condenser coils can be washed with a low-pressure power washer. Power wash in order to remove any dirt from the coil and any debris from the coil. The coils should be cleaned from a safe distance. However, if the nozzle is too close to the coil the water still can damage the fins.

The evaporator and heater coils typically reside within an enclosed area. In order to protect the evaporator and the heater coils from the environment and outside dirt and debris. Therefore, the construction is not strong enough to withstand washing with direct pressure. In order to clean the coils, use a low-pressure air nozzle that is like the one that is used in cleaning the filter. Carefully use the low-pressure air nozzle in order to blow out any dirt and debris that is present on the coils.

During normal operation and routine cleaning, the fins may possibly get bent. The bent fins could cause blockages in the air flow, which will reduce overall system performance. Straighten the fins by using the **208-1350** Radiator Tool Gp . Start at one side of the coil and work toward the other side. Be careful not to rip or tear the fins during straightening, as this straightening will cause an unwanted reduction in performance.

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i03907232

Glossary of Terms

SMCS - 7320

Accumulator - The accumulator is a component in the air conditioning system that separates liquid refrigerants from the circuit. The accumulator is used to store a small amount of liquid refrigerant. The accumulator may also contain a desiccant which will remove moisture from the system.

Ambient air - Outside air

Charge - The charge is a predetermined amount of refrigerant that is put into the air conditioning system. The charge is measured in units of weight.

Compressor - The compressor is a component in the system that increases the pressure of the refrigerant. The compressor increases the pressure of the refrigerant in the system by pumping.

Condenser - The condenser is a component in the system where the refrigerant changes from a vapor to a liquid.

Contaminants - Dirt, water, and air

Desiccant - The desiccant is used in the receiver-dryer and in the accumulator. The desiccant removes moisture from the air conditioning system.

Detecting - Detecting is finding the source of the problem in the system.

Diaphragm - The diaphragm is a rubber-like material. The diaphragm divides the upper chamber and the lower chamber in the thermostatic expansion valve.

Discharge - Discharge is the removal of some of the refrigerant or the removal of all the refrigerant from the air conditioning system.

Discharge side - The discharge side is the outlet from the compressor to the condenser coil.

Evacuating - Evacuating is the removal of air and moisture from the air conditioning system.

Evaporation - Evaporation is the process of changing a liquid to a vapor.

Evaporator - The evaporator is the component in the air conditioning system that changes the refrigerant from a liquid to a vapor. The evaporator transfers heat to the liquid refrigerant in order to convert the refrigerant into a vapor.

Expansion Valve - The expansion valve is a component in the air conditioning system that regulates the flow of liquid refrigerants into the evaporator.

Fluid - Fluid is a liquid or a gas.

Flush - Flushing is the removal of foreign material and oil from the air conditioning system. Flush the system with a fluid that is approved. The fluid must be approved by SAE and ISO standards.

Freeze - Freezing causes a liquid to become a solid.

Gas - A gas is a substance that contains small particles which float in the air. A gas does not contain liquid or solid particles.

Graduated Container - A graduated container is a glass container with markings on the side of the container. The markings are used in order to measure the amount of fluid in the container. The markings normally have units of ounces or units of milliliters.

Heat - Thermal energy

Identifier - The identifier is an instrument that is used for testing the system. The identifier is used for determining the type of refrigerant that is in the system. The identifier is also used for determining the percentage of air that is in the system.

In-line Dryer - The in-line dryer is a component in the air conditioning system that removes moisture from the system. The in-line dryer may have an air conditioner quick disconnect in the system. The in-line dryer may have an orifice tube in the system.

Latent heat of evaporation - The quantity of heat that is absorbed by a liquid as the liquid is changed from a liquid into a vapor at a constant temperature.

Leak detector - The leak detector is a device that is used to locate leaks in the air conditioning system.

Liquid line - The liquid line is the line that connects the condenser coil, the dryer receiver, and the expansion valve together in an expansion valve system. The liquid line is also the line that connects the condenser coil and the orifice tube together in an orifice tube system.

Magnetic clutch - The magnetic clutch is a device which is used as a coupling between the pulley and the compressor. The magnetic clutch turns the compressor on and off. An electric current activates the clutch.

Manifold gauge set - The manifold gauge set contains gauges and hoses that are used to measure the pressures in the air conditioning system.

Moisture - Moisture is water that is in the air or water that is in the refrigerant.

Moisture indicator - The moisture indicator is a device that uses color to indicate if the material in the dryer is fully soaked with moisture. The moisture indicator will display a pink color or a white color if the moisture indicator is soaked with moisture. The moisture indicator will display a blue color if the moisture indicator can absorb more moisture.

Orifice tube - The orifice tube has a body that is plastic with a metal tube device. The orifice tube is a metering control. The orifice tube is located between the high-pressure side and the low-pressure side in the orifice tube system.

Overcharge - A system is overcharged when an excessive amount of refrigerant is present in the air conditioning system.

Partial charge - A partial charge is less than a full charge of refrigerant. An air conditioning system has a partial charge when there is not enough refrigerant in the system.

Performance test - The performance test is the notation of temperatures and pressures under controlled conditions. The performance test is used in order to determine if the air conditioning system is operating normally.

Refrigerant quick-check procedure - The refrigerant quick-check procedure is a brief inspection of the system. No instruments are required in order to perform a refrigerant quick-check procedure.

Receiver-dryer - The receiver-dryer is the component in the air conditioning system that removes the contaminants (moisture) from the circuit. The receiver-dryer is also a storage area for a small amount of liquid refrigerant. The receiver-dryer may also have a pressure switch that deactivates the compressor if the pressure of the refrigerant is lower than approximately 175 kPa (25 psi).

Reclaim - The reclaiming and the restoring of the air conditioner refrigerant must meet the SAE specifications and the specifications for the ISO. The reclaiming of the air conditioner refrigerant requires processes that are available only at a remanufacturing facility.

Recover - Recovering is the removal of the air conditioner refrigerant from the air conditioner system. The refrigerant must be stored in an approved container. The refrigerant should not be tested or processed when the refrigerant is recovered from the system.

Recycle - The recycling of the refrigerant is completed at the site or at the service shop. The refrigerant can be cleaned by using oil separation. The refrigerant can be cleaned by passing the refrigerant through a filter dryer.

Refrigerant - The refrigerant is the fluid that is used in the air conditioning system. The refrigerant removes heat from the operator compartment.

Refrigerant oil - Refrigerant oil is the oil that is used in the air conditioning system. The refrigerant oil lubricates the compressor.

Sight glass - The sight glass is used to observe the flow of refrigerant in the air conditioning system. A sight glass may be located at the top of the receiver-dryer or in the line that is leaving the receiver-dryer. Most newer systems do not have a sight glass.

Stabilize - If the performance of the system is constant, the system is stabilized.

Stuck - Sticking will cause the prevention of free movement.

Subcooling - The additional cooling of the refrigerant in the bottom of the condenser after the refrigerant has changed from a vapor to a liquid.

Suction side - The suction side is the connection that is between the evaporator coil and the compressor.

Superheat - The additional heating of the refrigerant in the bottom of the evaporator after the refrigerant has changed from a liquid to a vapor.

Temperature of saturation - At the temperature of saturation, a liquid will change into a vapor and a vapor changes into a liquid. The temperature of saturation depends on the pressure of the fluid. The temperature of saturation increases when the pressure of fluid increases.

Thermal Expansion Valve (TXV) - Thermal Expansion Valve or TXV is a device in the AC system that maintains the pressure difference between the condenser and the evaporator. The Thermal Expansion Valve is used to obtain the best performance in the refrigeration system.

Vapor - Gas

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i03862431

Machine Preparation for Testing and Adjusting

SMCS - 7000; 7309-025; 7309-081

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

Before any problem solving procedures are performed, read the manual for the heating and air conditioning system. Make a visual inspection of the complete air conditioning and heating system.

During any service of the Air conditioning System, all open connections are required to be capped or plugged with clean plastic part. Failure to cap open connections or failure to plug open connections will allow moisture into the system and lead to further damage.

When one is preparing to work on the air conditioning system, it is important to properly prepare the machine by performing a lockout/tagout procedure on the machine and on the air conditioning system. All charging and leak testing must be done in a well ventilated area.

Lockout/Tagout Procedure

1. When possible, park the machine on a smooth, level surface.
2. Set the parking brake.
3. Lower and lock all hydraulic implements.
4. Turn the key start switch to the OFF position and remove the key.
5. Turn the battery disconnect switch to the OFF position.



Illustration 1 g01518726

6. Tag the machine with a warning tag that is similar to the one that is shown in illustration 1 in order to ensure that no one else attempts to start the machine during service.

7. As it is necessary, continue to service the component.

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Testing and Adjusting
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03862449

Air Conditioning Performance - Test

SMCS - 7320-081

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

Note: A performance check of the air conditioning system must be made with a manifold gauge set. Refer to the Testing and Adjusting, SENR5664, "Manifold Guage Set - Install".

Note: Before you conduct a performance test, refer to the Troubleshooting, SENR5664, "Visual Inspection".

Note: Refer to the Troubleshooting, SENR5664, "Machine Preparation for Troubleshooting" section before service work is performed on the air conditioning system.

Note: The ambient temperature must be at least 21 °C (70 °F) in order to conduct the following test.

1. Install the manifold gauge set. Refer to the Testing and Adjusting, SENR5664, "Manifold Gauge Set (Refrigerant) - Install".
2. Start the engine and operate the engine at 1000 rpm (Low idle).
3. Move the temperature control knob to the maximum cool position. Put the fan switch in the HIGH position on the side that is for air conditioning.
4. In order to stabilize the system, continue to operate the system at 1000 rpm for a minimum of ten minutes.
5. Adjust the engine speed to approximately 1300 to 1400 rpm. Record the readings on the gauge for discharge (high pressure), and on the gauge for suction (low pressure).
6. Compare the discharge and suction pressures on the manifold gauge set to the pressure ranges in Table 1 in order to determine if the system is functioning correctly for the current ambient temperature.

Table 1

Pressure Range [1]		
Ambient Air Temperature C° (F°)	High Pressure Test Fitting kPa (psi) [2]	Low Pressure Test Fitting kPa (psi) [3]

21°C (70°F)	820 to 1300 kPa (120 to 190 psi)	70 to 138 kPa (10 to 20 psi)
27°C (80°F)	950 to 1450 kPa (140 to 210 psi)	70 to 173 kPa (10 to 25 psi)
32°C (90°F)	1175 to 1650 kPa (170 to 240 psi)	105 to 210 kPa (15 to 30 psi)
38°C (100°F)	1300 to 1850 kPa (190 to 270 psi)	105 to 210 kPa (15 to 30 psi)
43°C (110°F)	1450 to 2075 kPa (210 to 300 psi)	105 to 210 kPa (15 to 30 psi)

(1) This table is only for reference.

(2) Pressure may be slightly higher in very humid conditions and lower in very dry conditions.

(3) Pressure before clutch disengagement

7. If the suction and the discharge pressures are not within the normal operating range, refer to the Troubleshooting, SENR5664, "Air Conditioning System Troubleshooting".

During normal operation of the air conditioning system in 21 °C (70 °F) weather, the discharge pressure will be 820 kPa (120 psi) to 1300 kPa (190 psi). The suction side pressure will be 70 kPa (10 psi) to 130 kPa (20 psi).

The outside temperature and humidity will have an effect on the pressures. If the outside temperature is high, the discharge pressure will be high. In very hot weather, the suction and the discharge pressures will be high. In cooler weather, the suction and the discharge pressure will be normal or the pressure can be lower.

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Testing and Adjusting
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
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i03862452

Refrigerant Leakage - Test

SMCS - 1809-081

Dye

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that

the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Table 1

Required Tools		
Part Number	**Part Description**	**Quantity**
192-2331	Leak Detection Lamp Gp	1

In the middle of 1999, Caterpillar began installing dye in the refrigeration systems of Caterpillar machines. The dye is used in order to assist in identifying points of leakage in the refrigeration system.

Finding leaks and repairing leaks from refrigerant is important since the air conditioner is a closed circuit system.

The system must contain at least 0.4 kg (.88 lb) of refrigerant. Install the manifold gauge set. The manifold gauge set can determine if pressure exists in the system. A leak test can be performed if the system indicates pressure.

Note: Refrigerant vapor is heavier than air. For best results, place the black light directly below possible leaks.

Note: Leaks that are in the high pressure side of the system are more easily found if the air conditioner is operated for 5 to 10 minutes. The leak test must be performed immediately after the unit is turned OFF. The leak test for the high pressure side is performed before the pressures in the system equalize. Leaks that are in the low pressure side of the system are more easily found if the air conditioner has been turned OFF for 5 to 10 minutes. The leak test for the low pressure side is performed after the pressures in the system equalize.

1. Move the black light along possible leak points. When a leak is present, the black light will illuminate the dye that is in the refrigerant.

   Note: Leaks that are indicated by the presence of dye should always be confirmed with an electronic leak detector.

2. If a leak is found in the air conditioning system, use a **4C-2964** Refrigerant Leak Detector in order to confirm the leak that was detected by the use of the black light.

3. Repair the leak In the air conditioning system and clean the area with **192-4727** Dye Cleaning Solution .

Leak Detector

The **208-1374** Refrigerant Leak Detectors are designed in order to detect leaks as small as 7.4 mL (.25 oz) per year of refrigerant in the air conditioning system. Perform the following procedure in order to determine if the system has a leak.

The system must contain at least 0.4 kg (.88 lb) of refrigerant. Install the manifold gauge set. The manifold gauge set can determine if pressure exists in the system. A leak test can be performed if the system indicates pressure.

Note: Refrigerant vapor is heavier than air. For best results, place the sensor tip directly below possible leaks.

Note: Leaks in the high pressure side of the system are more easily found if the air conditioner is operated for a few minutes. The leak test must be performed immediately after the unit is turned OFF. The leak test for the high pressure side is performed before the pressures in the system equalize. Leaks in the low pressure side of the system are more easily found if the air conditioner has been turned OFF for several minutes. The leak test for the low pressure side is performed after the pressures in the system equalize.

1. Move the sensor tip along possible leak points at a rate of one inch per second.

2. It may not be necessary to recover refrigerant if a loose fitting or a loose connection is causing a leak. Tighten the loose connection and perform the performance check procedure. If necessary, add refrigerant to the air conditioning system. Refer to the Testing and Adjusting, "Refrigerant System - Charge" section for the proper procedure.

3. If the repair of a leak calls for the removal or the replacement of a component, refer to the Service Manual, SENR5664, "Machine Preparation for Disassembly and Assembly" section in Disassembly and Assembly.

Note: Refrigerants that are not approved by Caterpillar may have higher leakage rates.

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i03862454

Manifold Gauge Set (Refrigerant) - Install

SMCS - 7465-012

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

1. Use the **138-6629** Refrigerant Identifier in order to verify that the refrigerant that is in the air conditioning system is R134a.

2. Connect the manifold gauge set to the service ports near the refrigerant compressor. The service ports for charging are located on the refrigerant lines. Connect the low pressure hose to the service port on the suction side of the compressor. Connect the high pressure hose to the service port on the discharge side of the compressor. Make sure that the valved couplings are turned counterclockwise for installation. Then, turn the valved couplings clockwise in order to open the valves.

3. Turn the pressure valves clockwise and make sure that both pressure valves on the manifold gauge set are closed.

4. Place a clean rag over the charging hose fitting that is loosened at the manifold gauge set. This will prevent the spraying of compressor oil. Open the low pressure valve on the gauge set about 1/2 turn. Keep the valve open for 2 to 3 seconds in order to flush air from the low pressure hose. This will also flush air from the gauge set. Close the low pressure valve on the gauge set. Repeat this process for the high pressure valve. Tighten the charging hose fitting at the manifold gauge set.

Note: Use the refrigerant identifier. The refrigerant identifier will prevent refrigerants that are not R134a from contaminating the recovery and charging tools.

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i03862469

Refrigerant Recovery

SMCS - 1809-576

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

If service work is required on an air conditioning system, the refrigerant must be recovered first before components are removed or installed. Use the following procedure:

1. Use the refrigerant identifier. The refrigerant identifier will detect refrigerants that are not R134a. The refrigerant identifier will prevent the refrigerants from contaminating the tools for recovery and the tools for charging. The refrigerant identifier will also detect the percentage of air that may be in the system.

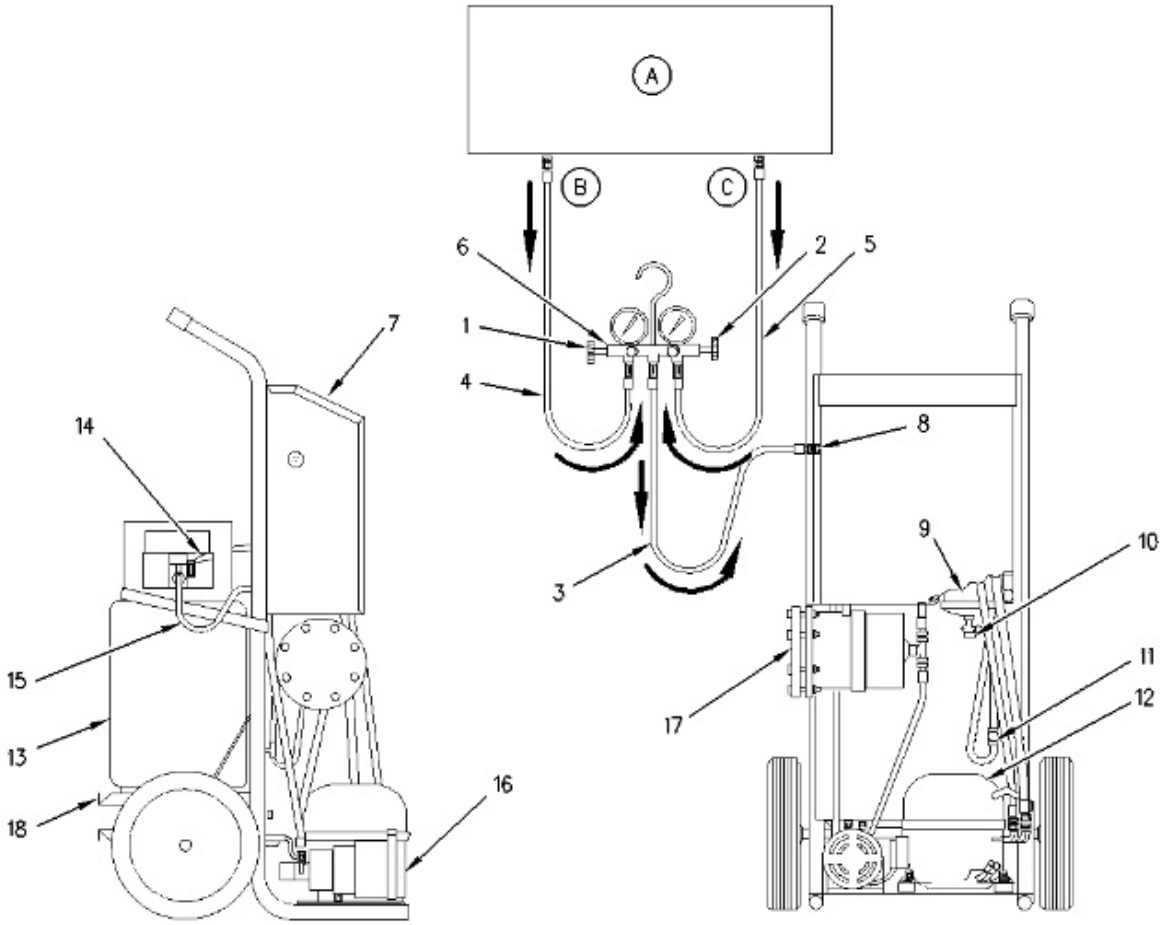


Illustration 1 g00389232

(1) Low pressure valve. (2) High pressure valve. (3) Charging hose. (4) Low pressure hose. (5) High pressure hose. (6) Manifold gauge set. (7) Control panel. (8) Inlet on recovery station. (9) Accumulator/oil separator. (10) Drain valve. (11) Pressure valve on accumulator. (12) Compressor. (13) Refrigerant tank. (14) Hose (liquid). (15) Hose (vapor). (16) Refrigerant pump. (17) Filter dryer. (18) Scale. (A) Refrigerant compressor. (B) Low pressure side (suction). (C) High pressure side (discharge).

2. Install the manifold gauge set (6) . Make sure that both valves are closed. Turn the valves clockwise in order to close the valves. Refer to theTesting and Adjusting, "Manifold Gauge Set (Refrigerant) - Install" section.

   Note: Do not operate the engine.

3. Attach charging hose (3) of the Manifold gauge set to the inlet (8) on the refrigerant service unit.

4. Slowly open valves (1) and (2) in order to release the air from the charging hose. Ensure that the valves on the refrigerant tank (13) are open. One valve is for vapor and the other valve is for liquid.

5. Plug the recovery station into an electrical outlet and turn the power switch ON. This switch is located on the control panel (7) .

6. Press the "Compressor Start". The amber "Compressor On" light will come on and compressor (12) will start. The compressor will automatically shut off when the recovery of refrigerant is complete.

7. Drain accumulator (9) of refrigerant oil. Open accumulator pressurizing valve (11) long enough so that some discharge from the compressor can flow back to the accumulator. Open oil drain valve (10) slowly and drain the oil into a measuring cup. Do not allow a complete loss of pressure in the accumulator/oil separator. When the oil stops draining, close oil drain valve (10) .

8. If 15.0 mL (.50 fl oz) of compressor oil was lost during the recovery process, new oil must be added to the system. Refer to the Testing and Adjusting, "Refrigerant Compressor Oil - Check" section.

9. The system must be cleaned and the system must be flushed if any particles of metal or other foreign material from a component failure have circulated through the system. **Debris in the system can cause the compressor to fail.** Refer to Service Manual, SENR5664, "Refrigerant System - Flush".

Oil and Refrigerant Charge for the Air Conditioning System

NOTICE

The addition of oil to the air conditioning system is applicable only after the flush of the entire air conditioning system. If an air conditioning system is overcharged with oil, the result is a decrease of the cooling performance and damage to the compressor may occur.

Note: Refer to one of the tables below for your particular application.

Table 1 contains the recommended charges for the compressors that are listed below :

- **214-4302** Refrigerant Compressor Gp
- **217-4448** Refrigerant Compressor Gp
- **222-2276** Refrigerant Compressor Gp
- **272-5767** Refrigerant Compressor Gp

Note: The new compressors that are listed above contain 180 ml of oil. The total charge for the air conditioning system must equal the total amount from Table 1 and the oil that is already added in a new compressor.

Table 1

Recommended Charges for the Air Conditioning System	
Refrigerant	**Oil [1] [2]**
1.1 kg (2.5 lb)	30
1.2 kg (2.75 lb)	60
1.4 kg (3 lb)	80
1.5 kg (3.25 lb)	100
1.6 kg (3.5 lb)	120
1.7 kg (3.75 lb)	140
1.8 kg (4 lb)	160
1.9 kg (4.25 lb)	190
2.0 kg (4.5 lb)	210
2.2 kg (4.75 lb)	230
2.3 kg (5.0 lb)	250
2.4 kg (5.25 lb)	270
2.5 kg (5.5 lb)	290
2.6 kg (5.75 lb)	320
2.7 kg (6.0 lb)	340
2.8 kg (6.25 lb)	360
2.9 kg (6.5 lb)	380
3.1 kg (6.75 lb)	400
3.2 kg (7.0 lb)	420
3.3 kg (7.25 lb)	440

3.4 kg (7.5 lb)	470
3.5 kg (7.75 lb)	490
3.6 kg (8.0 lb)	510
3.7 kg (8.25 lb)	530
3.9 kg (8.5 lb)	550
4.0 kg (8.75 lb)	570
4.1 kg (9.0 lb)	600

(1) The unit is mL.

(2) Refer to the Specifications section in order to obtain the part number for the correct type of oil.

Table 2 contains the recommended charges for the compressors that are listed below:

- **3E-1906** Refrigerant Compressor Gp
- **3E-1908** Refrigerant Compressor Gp
- **106-5122** Refrigerant Compressor Gp
- **163-0872** Refrigerant Compressor Gp
- **178-9570** Refrigerant Compressor Gp
- **183-5106** Refrigerant Compressor Gp
- **218-0324** Refrigerant Compressor Gp
- **277-7245** Refrigerant Compressor Gp

Note: The new compressors that are listed above contain 300 ml of oil. The total charge for the air conditioning system must equal the total amount from Table 2 and the oil that is already added in a new compressor.

Table 2

Recommended Charges for the Air Conditioning System	
Refrigerant	**Oil (1)**
1.1 kg (2.5 lb)	0
1.2 kg (2.75 lb)	0
1.4 kg (3 lb)	0
	0

1.5 kg (3.25 lb)	
1.6 kg (3.5 lb)	0
1.7 kg (3.75 lb)	30
1.8 kg (4 lb)	50
1.9 kg (4.25 lb)	70
2.0 kg (4.5 lb)	90
2.2 kg (4.75 lb)	110
2.3 kg (5.0 lb)	130
2.4 kg (5.25 lb)	150
2.5 kg (5.5 lb)	170
2.6 kg (5.75 lb)	190
2.7 kg (6.0 lb)	210
2.8 kg (6.25 lb)	230
2.9 kg (6.5 lb)	260
3.1 kg (6.75 lb)	280
3.2 kg (7.0 lb)	300
3.3 kg (7.25 lb)	330
3.4 kg (7.5 lb)	350
3.5 kg (7.75 lb)	370
3.6 kg (8.0 lb)	390
3.7 kg (8.25 lb)	410

3.9 kg (8.5 lb)	430
4.0 kg (8.75 lb)	450
4.1 kg (9.0 lb)	480

(1) The unit is mL.

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i03862489

Refrigerant System - Flush

SMCS - 1809-046

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

System Contamination and Flush Procedure

NOTICE

Debris in the air conditioning refrigerant circuit can cause the compressor to fail. Use the following procedure for cleaning and flushing the system.

This procedure provides a method and instructions to remove contamination from the air conditioning system refrigeration circuit and individual components. A primary instance where a system flush is necessary is any time a refrigerant compressor has had an internal failure, usually indicated by a locked or seized condition. The air conditioning system refrigeration circuit and components must be cleaned and flushed to remove any particles of metal or other foreign material. Failure to properly flush the air conditioning circuit will damage or shorten the operating life of the replacement compressor.

A general flow chart of the flush procedure is shown in Illustration 2. The detailed procedure is shown in Step 1 through Step 19 below.

1. Identify the refrigerant and then recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.

2. Remove the compressor. Refer to the Service Manual , SERN5664, "Refrigerant Compressor - Remove and Install" section.

3. Remove the receiver-dryer or the in-line dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly. For in-line dryers, refer to the Service Manual, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" section in Disassembly and Assembly.

4. Remove the accumulator. Refer to the Service Manual, SENR5664, "Air Conditioner Accumulator - Remove and Install" section in Disassembly and Assembly.

5. Remove the expansion valve or the orifice tube. Refer to the Service Manual, SENR5664, "Expansion Valve - (Air Conditioner) Remove and Install" section in disassembly and assembly. Refer to the Service Manual, SENR5664, "Orifice Tube (Air Conditioner) - Remove and Install" section in Disassembly and Assembly.

6. If necessary, remove the quick disconnect fittings from the dryer refrigerant lines.

NOTICE

In order to avoid component damage, do not flush system components with anything other than 153-8538 Refrigerant Flushing Solution .

7. **Replace any other failed component such as coils, fittings, etc.**.

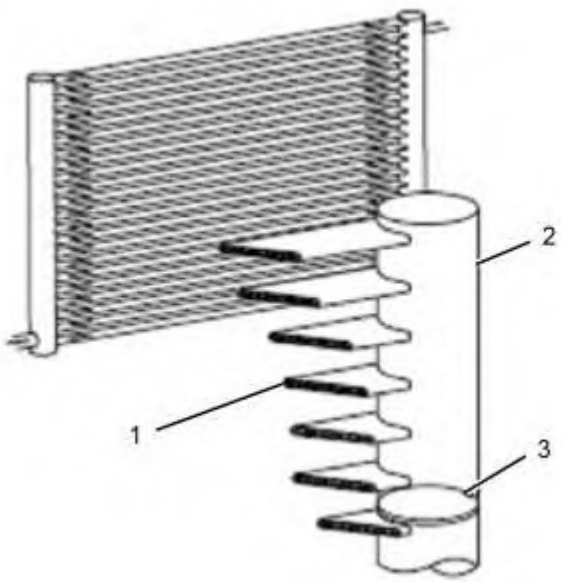


Illustration 1 g01519693

(1) Multichannel Extruded Tube

(2) Manifold

(3) Manifold Baffle

8. Replace condenser coils that are parallel flow or multiple flow. Refer to Illustration 1 for a reference example. Condenser coils that are parallel flow or multiple flow have very small passages. The proper flushing out of the passages will be difficult. Failure to replace the condenser coils may reduce the cooling performance of the air conditioner and premature failure of the compressor.

9. Flush the remainder of the system. Flush the air conditioning system with a **153-8537** Air Conditioner Flushing Unit . Also, a **153-8537** Air Conditioner Flushing Unit can be used in order to flush the system. Refer to the information that is provided with the flushing unit. Flush the system with **153-8538** Refrigerant Flushing Solution .

10. Blow out the air conditioning system with clean dry shop air for 5 to 10 minutes. Follow the instructions that are provided with the flushing unit.

NOTICE

It is extremely important that all of the flushing solvent is purged from the Air Conditioning System. Failure to purge all of the solvent will result in premature compressor failure. Components should be positioned in order to ensure that no solvent is trapped in the system.

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11. Install a new receiver-dryer or an in-line dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly. For in-line dryers, refer to the Service Manual, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" section in Disassembly and Assembly.

12. Install a new accumulator, if necessary. Refer to the Service Manual, SENR5664, "Air Conditioner Accumulator - Remove and Install" section in Disassembly and Assembly.

13. Install a new expansion valve or an orifice tube. Clean the original quick couplers or replace the original quick couplers.

    Note: If the Air Conditioning System has an in-line dryer, then the new orifice tube is already contained inside the dryer.

14. Install new quick couplers to the dryer inlet and outlet lines, if necessary.

15. Install a new compressor.

16. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.

17. Add additional oil to the air conditioning system, if necessary. Refer to "Oil Charge After System Flush".

    Note: New compressors are shipped with oil in the compressors. In many instances, it is not necessary to add extra oil to the air conditioning system.

18. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.

    Note: Also, Refer to Specifications, SENR5664, "System Capacities for Refrigerant".

19. In order to ensure proper operation of the system, refer to the Service Manual, SENR5664, "Performance Test" section in Testing and Adjusting.

A/C SYSTEM FLUSH REPAIR FLOWCHART

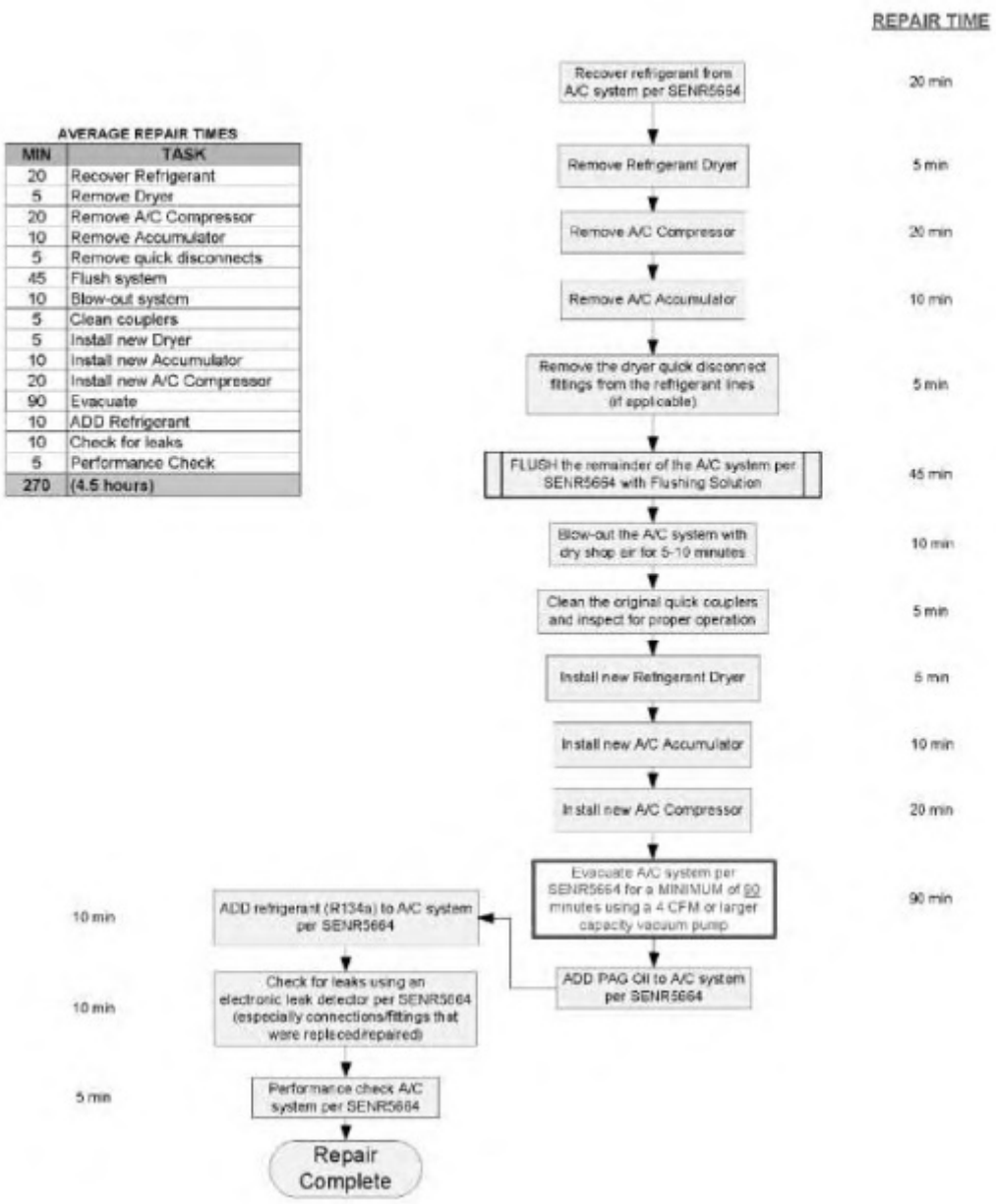


Illustration 2 g01519747

Oil Charge After System Flush

NOTICE

The addition of oil to the air conditioning system is applicable only after the flush of the entire air conditioning system. If an air conditioning system is overcharged with oil, the result is a decrease of the cooling performance and damage to the compressor may occur.

1. Locate the correct refrigerant charge for the machine that is being serviced. Refrigerant charge can be found on a tag inside the cab or by referencing the Service Manual, SENR5664, "System Capacities for Refrigerant" section in Specifications.

2. Locate the part number for the a/c compressor that is being serviced in the flush procedure.

3. Refer to table 1 or table 2 below for your particular application.

4. Use proper oil charging equipment. Usually, oil charge is a function that is provided by the refrigerant service unit. Refer to **208-1316** Refrigerant Service Unit for an example. A portable injection tool such as **9U-6494** Refrigerant Oil Injector can also provide the oil charge function.

Table 1 contains the recommended charges for the a/c compressors that are listed below :

- **214-4302** Refrigerant Compressor Gp
- **217-4448** Refrigerant Compressor Gp
- **218-4994** Refrigerant Compressor Gp
- **218-6833** Refrigerant Compressor Gp
- **222-2276** Refrigerant Compressor Gp
- **248-3978** Refrigerant Compressor Gp
- **272-5767** Refrigerant Compressor Gp
- **276-9875** Refrigerant Compressor Gp
- **318-4258** Refrigerant Compressor Gp

Note: The new a/c compressors that are listed above contain 150 mL (5.1 oz) to 180 mL (6.1 oz) of oil. Table 1 is only applicable for new compressors that contain 150 mL (5.1 oz) to 180 mL (6.1 oz) of oil. The total oil charge for the air conditioning system must equal the amount from Table 1 and the oil that is already contained inside the new compressor.

Table 1

Recommended Charges for the Air Conditioning System	
Refrigerant	**Oil** [(1) (2)]
0.5 kg (1.0 lb)	-80
0.6 kg (1.25 lb)	-60
0.7 kg (1.5 lb)	-30
0.8 kg (1.75 lb)	0
	0

0.9 kg (2.0 lb)	
1.0 kg (2.25 lb)	0
1.1 kg (2.5 lb)	0
1.2 kg (2.75 lb)	15
1.4 kg (3 lb)	33
1.5 kg (3.25 lb)	51
1.6 kg (3.5 lb)	69
1.7 kg (3.75 lb)	88
1.8 kg (4 lb)	107
1.9 kg (4.25 lb)	126
2.0 kg (4.5 lb)	146
2.2 kg (4.75 lb)	165
2.3 kg (5.0 lb)	185
2.4 kg (5.25 lb)	206
2.5 kg (5.5 lb)	226
2.6 kg (5.75 lb)	247
2.7 kg (6.0 lb)	268
2.8 kg (6.25 lb)	289
2.9 kg (6.5 lb)	311
	333

3.1 kg (6.75 lb)	
3.2 kg (7.0 lb)	355
3.3 kg (7.25 lb)	377
3.4 kg (7.5 lb)	400
3.5 kg (7.75 lb)	422
3.6 kg (8.0 lb)	446
3.7 kg (8.25 lb)	469
3.9 kg (8.5 lb)	493
4.0 kg (8.75 lb)	517
4.1 kg (9.0 lb)	541

(1) The unit is mL.

(2) Refer to the Specifications section in order to obtain the part number for the correct type of oil.

Table 2 contains the recommended charges for the a/c compressors that are listed below:

- **3E-1906** Refrigerant Compressor Gp
- **3E-1908** Refrigerant Compressor Gp
- **106-5122** Refrigerant Compressor Gp
- **114-9484** Refrigerant Compressor Gp
- **163-0872** Refrigerant Compressor Gp
- **178-9570** Refrigerant Compressor Gp
- **183-5106** Refrigerant Compressor Gp
- **218-0324** Refrigerant Compressor Gp
- **277-7245** Refrigerant Compressor Gp
- **299-2212** Refrigerant Compressor Gp

Note: The new a/c compressors that are listed above contain 300 mL (10.2 oz) of oil. Table 2 is applicable only for new compressors that contain 300 mL (10.2 oz) of oil. The total oil charge for

the air conditioning system must equal the total amount from Table 2 and the oil that is already contained inside the new compressor.

Table 2

Recommended Charges for the Air Conditioning System	
Refrigerant	**Oil [1]**
0.9 kg (2.0 lb)	-100
1.0 kg (2.25 lb)	-80
1.1 kg (2.5 lb)	-50
1.2 kg (2.75 lb)	-30
1.4 kg (3 lb)	0
1.5 kg (3.25 lb)	0
1.6 kg (3.5 lb)	0
1.7 kg (3.75 lb)	0
1.8 kg (4 lb)	0
1.9 kg (4.25 lb)	0
2.0 kg (4.5 lb)	11
2.2 kg (4.75 lb)	30
2.3 kg (5.0 lb)	50
2.4 kg (5.25 lb)	71
2.5 kg (5.5 lb)	91
2.6 kg (5.75 lb)	112
	133

2.7 kg (6.0 lb)	
2.8 kg (6.25 lb)	154
2.9 kg (6.5 lb)	176
3.1 kg (6.75 lb)	198
3.2 kg (7.0 lb)	220
3.3 kg (7.25 lb)	242
3.4 kg (7.5 lb)	265
3.5 kg (7.75 lb)	287
3.6 kg (8.0 lb)	311
3.7 kg (8.25 lb)	334
3.9 kg (8.5 lb)	358
4.0 kg (8.75 lb)	382
4.1 kg (9.0 lb)	406

(1) The unit is mL.

Note: Always use new refrigerant oil and clean equipment to avoid contamination inside the air conditioning system.

Note: Make sure that the equipment for oil injection does not contain air in the supply line to the air conditioning system. This prevents air from being injected into the system which can lead to poor cooling performance and possible system damage.

Note: Oil should only be charged into the discharge service port. Failure to charge the oil correctly can cause damage to the compressor from liquid slugging with oil.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03920609

Refrigerant Oil - Test

SMCS - 1809-081

Whenever the refrigerant or a component for the air conditioning unit is removed, some of the refrigerant oil is also removed. The correct amount of oil must be replaced.

Oil supplies the necessary lubrication in the refrigerant circuit for the compressor. Too little oil in the circuit can cause the compressor to seize. Too much oil decreases the amount of cooling that is supplied to the operator.

The following procedure describes a process for ensuring the appropriate concentration of oil in the refrigerant circuit when oil has been removed from the circuit. All systems are charged with oil from the factory. This process assumes that the factory fill oil amount is still in the system. This process assumes that a minimal amount of oil has been lost due to leakage of pressure relief.

Table 1

Oil Capacities for Component Replacements	
Accumulator	30 mL (1 fl. oz)
Compressor	Refer to the Service Manual, SENR5664, "Refrigerant Compressor Oil-Check"section in Testing and Adjusting
Condenser	30 mL (1 fl. oz)
Evaporator	90 mL (3 fl. oz)
In-Liner Dryer (1)	30 mL (1 fl. oz)
Receiver - Dryer	30 mL (1 fl. oz)

(1) **Refer to the Service Manual, SENR5664, "In Line Refrigerant Dryer - Remove and Install " before any oil is added.**

Oil is typically removed from the system in the following three ways.

In order to calculate the oil recharge quantity, use the following processes.

1. Oil that is removed from the system during refrigerant recovery. Refer to Testing and Adjusting, SENR5664, "Refrigerant Recovery" in order to see the correct procedure for recovering refrigerant.

   Record the amount of oil that is collected during the recovery. Add this amount of oil back into the system when recharging the refrigerant.

2. Oil that is removed from the system due to component replacement, other than the a/c compressor. Refer to "Oil Capacities for Component Replacements". Refer to Table 1.

   Add the recorded amount of oil from the recovery to the oil capacity for the component replaced. Refer to Table 1. Add this amount of oil back into the system when recharging the refrigerant.

3. Oil is removed due to replacing the a/c compressor. Refer to "Replacing the A/C Compressor".

Replacing the A/C Compressor

If the a/c compressor is being replaced, then the PAG oil must be adjusted by using the procedure that is outlined below:

- If refrigerant is still contained within the air conditioning system, then follow the steps for recovery.
- Remove the compressor from the air conditioning system and plug all lines and connections in order to prevent contamination.
- Open the oil filler plug on the old compressor and drain the oil into a clean container that allows the measurement of the quantity.
- Record the quantity of oil removed from the old compressor. This amount could be small or even zero. This amount is (3) in the formula below.

Note: The new A/C compressor will already contain oil inside. There is a possibility that an amount of oil will need to be drained from the new compressor. There is a possibility that an additional amount of oil will need to be charged into the system.

Use the following process to determine if oil must be drained from the new compressor. Use the following process to determine if an additional amount of oil will need to be charged into the A/C system.

- Determine the type and amount of oil contained inside the new compressor (New Comp Oil) by reading the value on the label. Determine the type and amount of oil contained inside by searching the compressor data in SENR by part number

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NOTICE

Do not use Polyalkylene Glycol (PAG) oil in 294-8140 Compressor Assembly . Use Polyol Ester (POE) oil. The use of any other will cause rapid dielectric failure of the compressor.

- Next, determine the amount of oil required by the A/C system (A/C System Oil). Add the oil from recovery (1), plus the amount of oil for other components being replaced (2) (per Table 1), plus the amount of oil removed from the old compressor (3).

The sum of the following: 1+2+3= A/C System Oil

- Finally, take the value for New Comp Oil and subtract A/C System Oil to determine the amount of oil that must be drained. The oil must be drained from the new compressor prior to installation to prevent an oil overcharge.

New Comp Oil - A/C System Oil = Oil amount to drain from new compressor

Note: The A/C compressor has an oil drain plug that can be removed for removing oil. Reference , SENR 5664 for proper torque of the drain plug when reinstalling.

Example:

- Amount of oil from recovery (1) equals 60 ml.
- If the dryer was replaced, the amount of oil due to component replacement (2) equals 30 ml.
- Oil drained from the old compressor (3) equals 90 ml.
- · Amount of oil contained inside new compressor as read from the label (New Comp Oil) equals 300 ml.

Then A/C System Oil = 1 + 2 + 3 = 60 + 30 + 90 = 180 ml

Finally, New Comp Oil - A/C System Oil = 300 – 180 = 120 ml

Therefore in the above example, 120 ml of oil should be drained from the new compressor.

Note: In some instances the above calculation could yield a negative value. In these instances the amount of oil should NOT be drained from the compressor, but rather the oil should be ADDED to the A/C system!

Install the new compressor and charge A/C system with oil if required.

Refer to Testing and Adjusting, SENR5664, "Charge process" and add , "Air Conditioning System PAG Oil Charge".

New Replacement Compressor

If the A/C compressor was replaced, then drain all the oil from the new replacement compressor.

Complete Check of Compressor Oil

When the replacement of a component is necessary, follow the procedures below. The procedure determines the amount of refrigerant oil (lost oil) that is needed in the compressor.

1. Operate the engine at 1000 rpm. Set the temperature on maximum cooling setting. Move the fan speed switch to HIGH. The system will stabilize in a minimum of 10 minutes.

2. Stop the engine. Remove the refrigerant charge from the system. Install a plug in all open lines. Refer to Testing and Adjusting, "Refrigerant Recovery" for the proper procedure.

3. Remove the compressor from the machine. Place protective caps on all fittings and hoses.

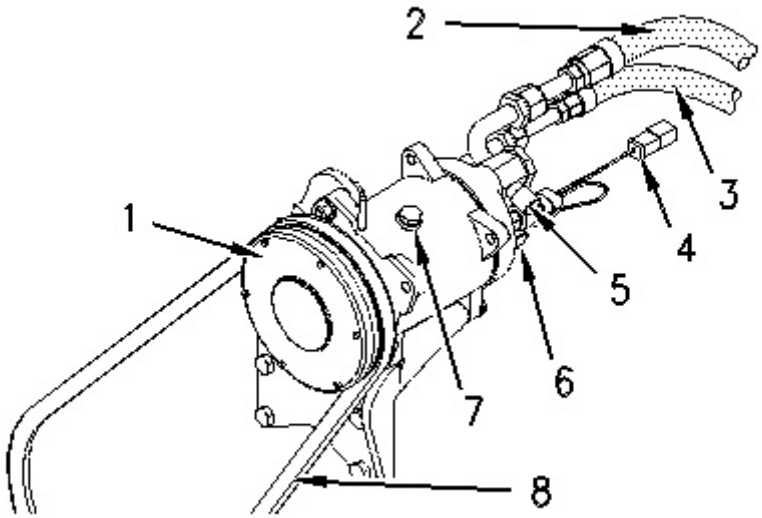


Illustration 1 g00296421

(1) Pulley

(2) Hose (low pressure)

(3) Hose (high pressure)

(4) Electrical harness

(5) Service valve (low pressure)

(6) Service valve (high pressure)

(7) Plug (oil change)

(8) Belt

4. Place the compressor in a horizontal position so oil plug (7) is facing downward. Remove oil plug (7) from the compressor. Drain the oil into a clean container. Rock the compressor back and forth in order to remove all of the oil. Also, rotate the compressor shaft in order to drain the rest of the oil that is in the oil sump. Record the volume of drained refrigerant. Inspect the oil for the following items:

- Contaminants
- Metal chips
- Rubber particles
- Foreign material

Dispose of the oil in a suitable container. Use the following list as a guide for adding oil into the compressor:

- If the amount of oil that is drained from the compressor is 177 mL (6 fl oz) to 237 mL (8 fl oz), put the same amount of new refrigerant oil in the compressor. **Never refill with more than 237 mL (8 fl oz) of oil to the compressor unless the system has been flushed.**
- If the amount of oil that is drained from the compressor is less than 177 mL (6 fl oz), add 177 mL (6 fl oz) to 237 mL (8 fl oz) of new refrigerant oil to the compressor.
- If a new compressor or a rebuilt compressor is installed, drain all of the oil from the compressor and add 177 mL (6 fl oz) to 237 mL (8.0 fl oz) of new refrigerant oil in the compressor.
- If the system was flushed do not remove the oil from a new compressor.
- Refer to 2 if individual components are replaced without charging the compressor or without flushing the system.

Table 2

Oil Capacities for Component Replacements	
Accumulator	30 mL (1 fl oz)
Compressor	Refer to the Service Manual, SENR5664, "Refrigerant Compressor Oil -Check" section in Testing and Adjusting.
Condenser	30 mL (1 fl oz)
Evaporator	90 mL (3 fl oz)
In-Line Dryer (1)	30 mL (1 fl oz)
Receiver-Dryer	30 mL (1 fl oz)

(1) **Refer to the Service Manual, SENR5664, "In-Line-Refrigerant Dryer - Remove and Install " before any oil is added.**

If too much oil has been added to the system and a total of more than 325 mL (11 fl oz) of oil is in the system, the cooling capacity of the system will be reduced. If too little oil has been added to the system, the compressor may fail due to a lack of lubrication.

If the failure of a component, causes particles of metal or other foreign material to be introduced into the system. flushing the system will be necessary. Refer to Troubleshooting, "Air Conditioning System Troubleshooting" for the proper diagnostics.

Note:

a. Add oil to the compressor through opening for the oil plug (7) or inject the oil through the ports that are for charging. The compressor must be positioned so that the refrigerant oil will not flow out-of-service valves (5) and (6) . Do not rest the compressor on the compressor shaft. Turn the compressor shaft by hand when you fill the compressor. The oil will slowly flow into the compressor. Only use refrigerant oil that is approved and recommended.

b. Add oil to any components that are being installed.

c. Inject oil into the pressurized system through the port for low pressure charging while the engine is running and the compressor is operating.

d. After the correct amount of refrigerant oil has been added to the system, install the compressor and the drive belt. Refer to Testing and Adjusting, "Refrigerant System - Charge" for the proper procedure.

Add Air Conditioning System PAG Oil Charge

Charge the a/c system at the high-pressure service port with the total oil recharge quantity that is shown in table 1.

Follow the instructions included with the oil charging equipment. Review the MSDS, and follow all recommendations when working with PAG oil. DO NOT use PAG oil in Electric Compressors.

Note: If oil has leaked from the system prior to service, then the system oil charge cannot be accurately determined using the Table 2 method. Proper oil charge can now only be determined by flushing and using method for oil charge after system flush.

NOTICE

Do not use Polyalkylene Glycol (PAG) oil in 294-8140 Compressor Assembly . Use Polyol Ester (POE) oil. The use of any other will cause rapid dielectric failure of the compressor.

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Testing and Adjusting
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03862974

Refrigerant Compressor - Test

SMCS - 1802-081

Identifying compressors that function is the purpose of this instruction. Compressors that function should be identified before the compressors are removed from a machine. Compressors that function should produce both high pressure and low pressure. If the compressor fails any one of Steps 3, 5, 7, or 8, then the compressor is considered to be a "failed" compressor. Please indicate the steps which were failed by the compressor in the story for a warranty claim.

Note: If the compressor fails one of the steps, then the air conditioning system should be diagnosed in order to find the root cause of the failure. The root cause of the failure should be repaired. If the compressor is considered to be "good", then additional assistance with the diagnosis of the air conditioning system can be found in Service Manual, SENR5664, "Air Conditioning and Heating R134a for all Caterpillar Machines" or by contacting your Caterpillar dealer.

Procedures

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

1. **Check the air filters.** If the complaint of the customer is poor cooling of the cab, past experience has shown that plugged air filters can often be the cause. Most air conditioning systems have return air filters and fresh air filters. Be sure to check both the return air filters and fresh air filters.

   Air Filters Checked? Yes or No.

2. **Test the voltage.** While the engine is running and the air conditioning is switched ON, check the voltage at the compressor. The voltage at the compressor should be a minimum of 11.5VDC for a 12VDC system or 23 volts for a 24VDC system. The routinely used electrical loads should be turned ON. For example, a lighting system which is added by the customer could cause available voltage to decrease below the minimum specification.

   Voltage Checked? Yes or No.

   Measured Voltage Level: ____ (volts)

   Note: When the air conditioning is switched ON, for air conditioning systems with a Compressor Protection System (CPS), there is approximately a 30 second delay before a voltage signal is detected at the compressor. Air conditioning systems with CPS can be identified by the use of either the **169-7443** On Delay Timer As or the **212-2204** Air Conditioner Control Gp. In most applications, the electronic control group is located near the compressor.

3. **Test the resistance.** Measure resistance of the clutch coil at the compressor connector. For 12VDC models, measured resistance should be within -0.3 to +1.1 ohms of the amount which is listed in the Specifications section of Service Manual, SENR5664, "Air Conditioning and Heating R134a for all Caterpillar Machines", "Refrigerant Compressor". For 24VDC models, measured resistance should be within -1.3 to +5.5 ohms of the amount which is listed in Specification section of Service Manual, SENR5664, "Air Conditioning and Heating R134a for

all Caterpillar Machines", "Refrigerant Compressor". The resistance ranges which are listed above compensate for the effect of temperature on the clutch coil. The values which are listed in the Specifications section of Service Manual, SENR5664, "Air Conditioning and Heating R134a for all Caterpillar Machines", "Refrigerant Compressor" are nominal for 20 °C (68 °F).

Resistance Checked? Yes or No.

Measured Level of Resistance: ____ (ohms)

4. **Check the belt tension.** For new belts and old belts, use the **144-0235** Belt Tension Gauge. For a new belt installation, the initial belt tension for a compressor which drives the system without an auto tensioning device should be 534 N (120 lb). For used belts, the belt tension should be 400 N (90 lb).

   Belt Tension Checked? Yes or No.

   Measured New Belt Tension: ____ (N) or (lbs)

   Measured Old Belt Tension: ____ (N) or (lbs)

WARNING

Accidental machine starting can cause injury or death to personnel working on the machine.

To avoid accidental machine starting, turn the battery disconnect switch to the OFF position and remove the key. If the machine is not equipped with a battery disconnect switch, disconnect the battery cables from the battery and tape the battery clamps.

Place a do not operate tag at the battery disconnect switch location to inform personnel that the machine is being worked on.

Note: The electrical power supply to the compressor should be switched OFF in order to perform this test.

5. **Test the rotation.** Rotate the compressor in the direction of belt travel by turning the nut on the end of the main shaft of the compressor. Rotation should be smooth with no binding.

   Rotation Checked? Yes or No.

   Rotation Smooth? Yes or No.

6. **Check the charge level.** The air conditioning system must be correctly charged per Caterpillar specification or an incorrect diagnosis will occur. Recovering, evacuating, and recharging with clean refrigerant to the correct level is the best method of achieving the correct refrigerant charge for the system. Charging the air conditioning system must be conducted by weighing refrigerant with a calibrated scale in order to ensure accuracy. Also, be sure to replace the oil which was removed during refrigerant recovery with new oil. Reference Service Manual, SENR5664, "Air Conditioning and Heating R134a for all Caterpillar Machines", "Refrigerant Compressor" for procedures regarding refrigerant charging and capacity of Caterpillar air conditioning systems.

Charge Level Checked? Yes or No.

Volume of Oil that was Removed During Recovery: ____ (ml) or (oz)

Weight of Refrigerant Charge: ____ (Kg) or (lbs)

7. **Test for low pressure.** The test for low pressure should be performed with ambient temperatures of less than 30 °C (86 °F). Park the machine in an area that is not in direct sunlight. Close all cab doors and windows. Block the flow of fresh air into the cab. If the air conditioning system is so equipped, bypass the low pressure switch. Start the machine. Operate the machine at high idle. Turn ON the air conditioning. Set the cab blower on LOW. After 10 to 15 minutes of operation, measure the low-side pressure at the refrigerant compressor. If the pressure reading is less than 69 kPa (10 psi) then the suction valves of the compressor are operating correctly.

   Low Pressure Checked? Yes or No.

   Low Pressure Reading: ____ (kPa) or (Psig)

   Note: If the cab temperature is above 25 °C (77 °F), then the cab blower may need to be set to HIGH in order to reduce the temperature before starting the procedure.

8. **Test for high pressure.** Start the engine and set the speed at approximately 1200 rpm. Turn ON the air conditioning. Place a sheet of cardboard over the condenser in order to block the flow of air. Limiting the flow of air over the condenser will cause the discharge pressure of the compressor to increase. Check if the discharge of the compressor is able to increase up to 2414 kPa (350 psi). Once the specified pressure is reached, immediately remove the cardboard. If the compressor passes the test, the discharge valves are operating correctly.

   High Pressure Checked? Yes or No.

   High Pressure Reading: ____ (kPa) or (Psig)

The functional test is now complete. If this test procedure results in inconclusive results, your dealership's Technical Communicator can report the problem by using the on-line Dealer Solution Network. The Dealer Solution Network will provide your Technical Communicator with additional troubleshooting support.

Illustrations 1 through 4 are provided as Good Air Conditioning System Practices and Troubleshooting Tips.

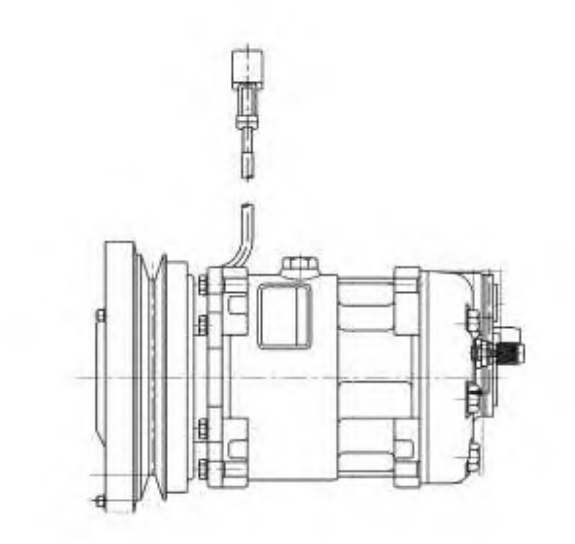


Illustration 1 g01127048

3E-1906 Refrigerant Compressor Gp (Typical Refrigerant Compressor)

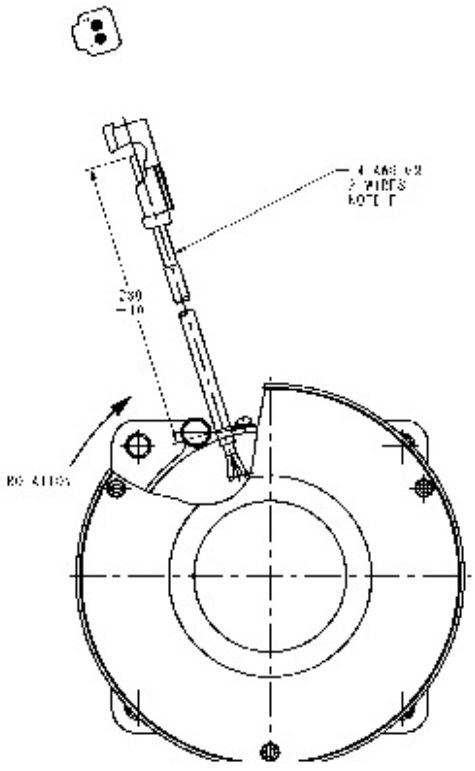


Illustration 2 g01123619

Wire lead and pin location for field coil

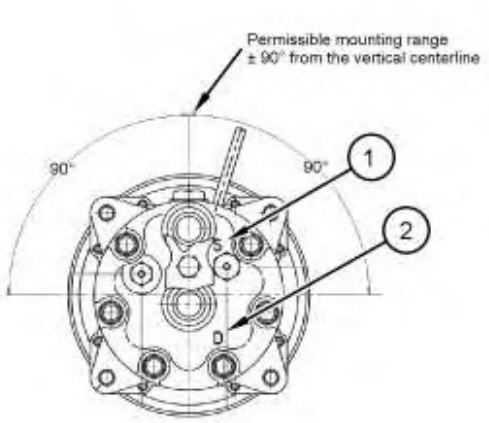


Illustration 3 g01126988

The permissible mounting location and orientation of Suction Port "S" and Discharge Port "D".

(1) Suction Port "S"

(2) Discharge Port "D"

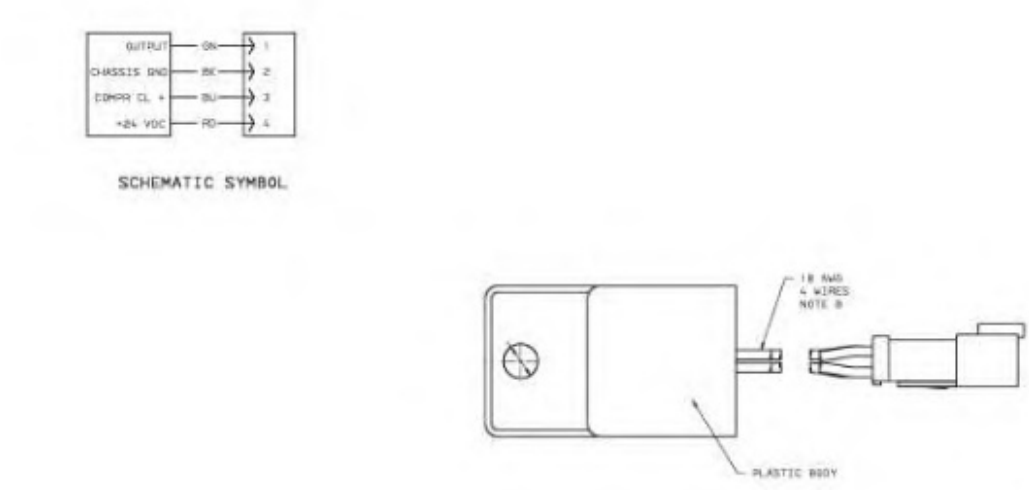


Illustration 4 g01127111

On Delay Timer Assembly (Compression Protection System)

Procedure to Test the On Delay Timer Assembly

The engine start switch must be in the ON position, and the air conditioning switch must be activated in order to diagnose a faulty on delay timer assembly for the refrigerant compressor.

Note: The on delay timer assembly will delay the power supply to the compressor clutch coil for 30 seconds after the air conditioning switch is activated.

1. Separate the four-pin connector from the wiring harness.
2. In order to check that power is getting from the on delay timer to the compressor, perform the following steps:
    a. Set the **146-4080** Digital Multimeter Gp to DC voltage.
    b. Connect the multimeter's positive probe to pin 4 on the wiring harness.
    c. Connect the multimeter's negative probe to a suitable ground. The multimeter should read 24VDC for 24 volt machines. The multimeter should read 12VDC for 12 volt machines.

       Note: On a 24 volt system, if the voltage is below 22VDC or if the voltage is above 35VDC, the on delay timer will not supply power to the compressor. On 12 volt systems, the range is 9VDC to 24VDC.
3. Set the **146-4080** Digital Multimeter Gp to OHMS. Connect the multimeter's positive probe to pin location 2 on the wiring harness. Connect the multimeter's negative probe to a suitable chassis ground. The multimeter will display "OL" if the ground is not present.
4. Set the **146-4080** Digital Multimeter Gp to OHMS. Connect the multimeter's positive probe to pin location 1 on the wiring harness. Connect the multimeter's negative probe to a suitable chassis ground. If the multimeter displays "OL", one of the three switches is open. If an open condition occurs, check each of the switches.

   Note: There must be refrigerant in the air conditioning system in order to close both of the pressure switches.
5. In order to check that power is getting from the on delay timer assembly to the compressor clutch coil, reconnect the on delay timer assembly to the wiring harness.
    a. Set the **146-4080** Digital Multimeter Gp to DC voltage.
    b. Remove the 2-pin connector from the compressor clutch coil.
    c. Connect the negative probe to a suitable chassis ground.
    d. Check each of the two pins on the wiring harness for voltage. On a 24 volt system, one of the pins should supply 24VDC. On a 12 volt system, one of the pins should supply 12VDC.
6. In order to check the ground path from the compressor clutch coil to the chassis, perform the following steps:
    a. Turn OFF the air conditioning switch in the cab.
    b. Set the **146-4080** Digital Multimeter Gp to Ohms.
    c. Remove the two-pin connector from the compressor clutch coil.

d. Connect the negative lead to a suitable ground.

e. Check each of the two pins on the two-pin connectors for continuity. One of the two pins should display "OL".

7. If both the correct ground and voltage are present, check the resistance of the compressor clutch coil. Refer to the Specifications section in Service Manual, SENR5664, "Air Conditioning and Heating R134a for all Caterpillar Machines", "Refrigerant Compressor".

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i03862991

Refrigerant System - Evacuate

SMCS - 1809-541

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

If replacement of a component is necessary or repair to a component is necessary, the refrigerant in the system must be recovered. Also, if the system has lost any charge after a long period of time, the refrigerant in the system must be recovered. It is necessary to perform the evacuating procedure in order to delete the system of all air and moisture. A complete charge must never be given to a system without first performing the evacuating procedure. Before evacuating the system, refer to the following manual.

- Testing and Adjusting, "Refrigerant Leakage - Test"
- Testing and Adjusting, "Refrigerant Recovery"
- Testing and Adjusting, "Refrigerant Compressor Oil - Check"

If the system has been left open for more than 1/2 hour, the system has been exposed to air or moisture and a new receiver-dryer, an in-line dryer or a desiccant accumulator needs to be installed. Moisture will combine with metals in the refrigerant system and this will produce highly corrosive by-products. The by-products are oxides, iron hydroxide, and aluminum hydroxide. Moisture can freeze the expansion valve and moisture can freeze the orifice tube. If there is water in the system the water must be removed. Remove the water by pumping the system with a vacuum pump and boiling the water. Refer to Table 1 that is shown below.

The time for the evacuation process will increase under the following conditions:

- The air conditioning system has been rebuilt.
- The air conditioning system has been flushed.
- The air conditioning system has new components.
- The air conditioning system has been retrofitted.

Table 1

Boiling Point of Water Under Vacuum	
Temperature of Work Area (°C (°F))	**Vacuum That Is Required In Order To Boil Water In An Air Conditioning System (m bar (Hg))**
38 °C (100 °F)	95 kPa (28 in Hg)
32 °C (89.6000 °F)	96.5 kPa (28.50 in Hg)
27 °C (81 °F)	97.5 kPa (28.80 in Hg)

21 °C (70 °F)	98.8 kPa (29.20 in Hg)

Note: After the leak test is completed, the system must be evacuated for a minimum of 30 minutes. In order to correctly evacuate the system, the vacuum gauge must be less than three inches away from the system port. If the gauge is more than three inches away from the system port, pull a vacuum and allow the system to equalize for ten minutes. This will ensure an accurate gauge reading.

NOTICE

All refrigerant must be recovered before the evacuating procedure is started. Never discharge the refrigerant through the vacuum pump. Never discharge the refrigerant into the atmosphere. Always use the Refrigerant Identifier tool in order to ensure that contamination of the system does not occur.

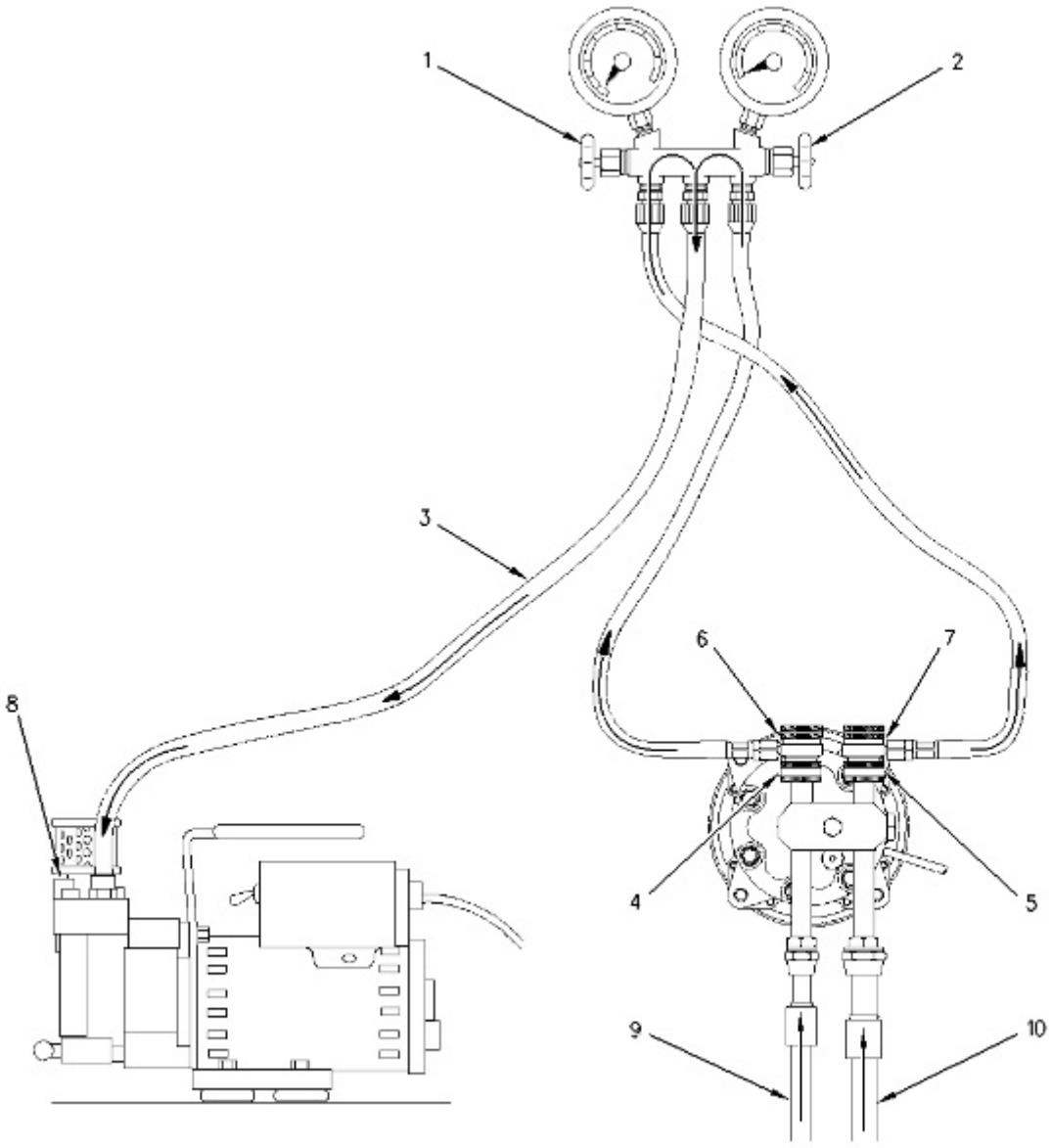


Illustration 1 g00452649

(1) Low pressure valve

(2) High pressure valve

(3) Charging hose

(4) Compressor block fitting (discharge)

(5) Compressor block fitting (suction)

(6) Service valve (discharge)

(7) Service valve (suction)

(8) Vented exhaust valve

(9) Line from condenser

(10) Line from evaporator

1. After the refrigerant is recovered from the system, make sure that the low pressure valve (1) and the high pressure valve (2) are closed. Disconnect the charging hose (3) of the manifold gauge set from the refrigerant service unit.

2. Check the oil level in the vacuum pump. Refer to the Testing and Adjusting, "Refrigerant Compressor Oil - Check" for the correct procedure. Add oil if oil is needed. If contamination of the system is indicated, change the oil.

3. Connect the electrical plug from the vacuum pump to an approved electrical outlet.

4. Connect the charging hose (3) to the inlet fitting on the vacuum pump. Refer to Illustration 1.

5. Open low pressure valve (1) and open high pressure valve (2) on the manifold gauge set completely. Turn the valves counterclockwise.

6. In order to start the pump motor, turn the power switch to the ON position.

7. In order to open the vented exhaust valve (8) , turn the valve counterclockwise.

   Note: The vented exhaust valve (8) must be closed until the vacuum pump has started.

8. Operate the vacuum pump until the low pressure gauge indicates a pressure that is between 95 kPa (28 in hg) and 98 kPa (29 in hg). After the vacuum in the system reaches a value that is between 95 kPa (28 in hg) and 98 kPa (29 in hg), close the vented exhaust valve (8) . Operate the vacuum pump for a minimum of 90 minutes after the vented exhaust valve is closed. Use a 113 L/min (4 cfm) pump. Make allowances for pumps that are smaller than 113 L/min (4 cfm) cfm.

   Note: 95 kPa (28 in hg) to 98 kPa (29 in hg) is the required specification at sea level. For every 305 m (1000 ft) above sea level, decrease the required specification by 3 kPa (1 in hg). At high elevations, less vacuum is required.

9. If the specific vacuum cannot be reached, the system may have a leak. Refer to the Testing and Adjusting, "Refrigerant Leakage - Test" section. Perform the procedures that are indicated. Repair all leaks and repeat Step 1 of the evacuating procedure.

   Note: The evacuating procedure removes air and moisture from the system. Do not use the vacuum pump primarily to indicate a system leak.

10. After 95 kPa (28 in hg) to 98 kPa (29 in hg) vacuum has been reached and held for an additional 90 minutes, close valve (1) and close valve (2) completely. Turn the power switch on the vacuum pump to the OFF position. The maximum amount of vacuum loss in five minutes must not be more than 7 kPa (2 in hg). Excessive vacuum loss is an indication of a possible leak in the system. Refer to the Testing and Adjusting, "Refrigerant Leakage - Test" section. Perform the procedures that are indicated. Repair all leaks and repeat Step 1 of the evacuating procedure.

11. If the vacuum loss does not exceed 7 kPa (2 in hg) in five minutes, the system is then ready for a complete charge. Refer to the Testing and Adjusting, "Refrigerant System - Charge" section. Perform the procedures that are indicated.

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Refrigerant System - Charge

SMCS - 1809-045

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Table 1

Required Tools		
Part Number	**Part Description**	**Quantity**
4C-4874	Heater Blanket As	1

Relationship Between Temperature and Pressure (R-134a Refrigerant)

Table 2 can be used in order to determine the pressure level and contamination level of a container of refrigerant. Table 2 can also be used for an air conditioning system that is not operating. This same system must be stabilized to the ambient temperature. In order to stabilize an air conditioning system at the ambient temperature, the machine must not operate for 10 to 12 hours. The machine must not be stored in direct sunlight.

If the measured pressure at any specific temperature does not match the pressure that is given in the chart, the following problems may exist:

- Contaminants in the system
- Incorrect refrigerant
- Incorrect refrigerant charge

Table 2

Relationship Between Temperature and Pressure (R-134a Refrigerant)	
Temperature °C (°F)	**Pressure kPa (psi) [1]**
-18 °C (0.0 °F)	44 kPa (6.4 psi)
-17° C (2.0 °F)	51 kPa (7.4 psi)
-16 °C (4.0 °F)	59 kPa (8.5 psi)
-14 °C (6.0 °F)	66 kPa (9.6 psi)

-13 °C (8.0 °F)	74 kPa (10.7 psi)
-12 °C (10.0 °F)	82 kPa (11.9 psi)
-11 °C (12.0 °F)	90 kPa (13.1 psi)
-10 °C (14.0 °F)	99 kPa (14.3 psi)
-9 °C (16.0 °F)	108 kPa (15.6 psi)
-8 °C (18.0 °F)	117 kPa (17.0 psi)
-7 °C (20.0 °F)	127 kPa (18.4 psi)
-6 °C (21.0 °F)	132 kPa (19.1 psi)
-6 °C (22.0 °F)	137 kPa (19.8 psi)
-5 °C (23.0 °F)	141 kPa (20.5 psi)
-4 °C (24.0 °F)	147 kPa (21.3 psi)
-4 °C (25.0 °F)	152 kPa (22.0 psi)
-3 °C (26.0 °F)	157 kPa (22.8 psi)
-3 °C (27.0 °F)	163 kPa (23.6 psi)
-2 °C (28.0 °F)	168 kPa (24.4 psi)
-2 °C (29.0 °F)	174 kPa (25.2 psi)
-1 °C (30.0 °F)	179 kPa (26.0 psi)
-1 °C (31.0 °F)	185 kPa (26.8 psi)
0 °C (32.0 °F)	191 kPa (27.7 psi)

1 °C (33.0 °F)	197 kPa (28.5 psi)
1 °C (34.0 °F)	203 kPa (29.4 psi)
2 °C (35.0 °F)	209 kPa (30.3 psi)
2 °C (36.0 °F)	215 kPa (31.2 psi)
3 °C (37.0 °F)	221 kPa (32.1 psi)
3 °C (38.0 °F)	228 kPa (33.0 psi)
4 °C (39.0 °F)	234 kPa (34.0 psi)
4 °C (40.0 °F)	241 kPa (34.9 psi)
5 °C (41.0 °F)	248 kPa (35.9 psi)
6 °C (42.0 °F)	254 kPa (36.9 psi)
6 °C (43.0 °F)	261 kPa (37.9 psi)
7 °C (44.0 °F)	263 kPa (38.9 psi)
7 °C (45.0 °F)	275 kPa (39.9 psi)
8 °C (46.0 °F)	283 kPa (41.0 psi)
8 °C (47.0 °F)	290 kPa (42.0 psi)
9 °C (48.0 °F)	297 kPa (43.1 psi)
9 °C (49.0 °F)	305 kPa (44.2 psi)
10 °C (50.0 °F)	312 kPa (45.3 psi)
11 °C (51.0 °F)	320 kPa (46.4 psi)

11 °C (52.0 °F)	328 kPa (47.5 psi)
12 °C (53.0 °F)	336 kPa (48.7 psi)
12 °C (54.0 °F)	344 kPa (49.9 psi)
13 °C (55.0 °F)	352 kPa (51.0 psi)
13 °C (56.0 °F)	360 kPa (52.2 psi)
14 °C (57.0 °F)	369 kPa (53.5 psi)
14 °C (58.0 °F)	377 kPa (54.7 psi)
15 °C (59.0 °F)	385 kPa (55.9 psi)
16 °C (60.0 °F)	394 kPa (57.2 psi)
16 °C (61.0 °F)	403 kPa (58.2 psi)
17 °C (62.0 °F)	412 kPa (59.8 psi)
17 °C (63.0 °F)	421 kPa (61.1 psi)
18 °C (64.0 °F)	430 kPa (62.4 psi)
18 °C (65.0 °F)	440 kPa (63.8 psi)
19 °C (66.0 °F)	450 kPa (65.2 psi)
19 °C (67.0 °F)	459 kPa (66.8 psi)
20 °C (68.0 °F)	469 kPa (68.0 psi)
21 °C (69.0 °F)	478 kPa (69.4 psi)
21 °C (70.0 °F)	488 kPa (70.8 psi)

22 °C (71.0 °F)	498 kPa (72.3 psi)
22 °C (72.0 °F)	509 kPa (73.8 psi)
23 °C (73.0 °F)	519 kPa (75.3 psi)
23 °C (74.0 °F)	530 kPa (76.8 psi)
24 °C (75.0 °F)	540 kPa (78.3 psi)
24 °C (76.0 °F)	551 kPa (79.9 psi)
25 °C (77.0 °F)	562 kPa (81.5 psi)
26 °C (78.0 °F)	573 kPa (83.1 psi)
26 °C (79.0 °F)	584 kPa (84.7 psi)
27 °C (80.0 °F)	595 kPa (86.3 psi)
27 °C (81.0 °F)	607 kPa (88.0 psi)
28 °C (82.0 °F)	618 kPa (89.7 psi)
28 °C (83.0 °F)	630 kPa (91.4 psi)
29 °C (84.0 °F)	642 kPa (93.1 psi)
29 °C (85.0 °F)	654 kPa (94.8 psi)
30 °C (86.0 °F)	666 kPa (96.6 psi)
31 °C (87.0 °F)	678 kPa (98.4 psi)
31 °C (88.0 °F)	691 kPa (100.2 psi)
32 °C (89.0 °F)	703 kPa (102.0 psi)

32 °C (90.0 °F)	716 kPa (103.8 psi)
33 °C (91.0 °F)	729 kPa (105.7 psi)
33 °C (92.0 °F)	742 kPa (107.6 psi)
34 °C (93.0 °F)	755 kPa (109.5 psi)
34 °C (94.0 °F)	768 kPa (111.4 psi)
35 °C (95.0 °F)	782 kPa (113.4 psi)
36 °C (96.0 °F)	796 kPa (115.4 psi)
36 °C (97.0 °F)	809 kPa (117.4 psi)
37 °C (98.0 °F)	823 kPa (119.4 psi)
37 °C (99.0 °F)	838 kPa (121.5 psi)
38 °C (100.0 °F)	852 kPa (123.5 psi)
38 °C (101.0 °F)	866 kPa (125.6 psi)
39 °C (102.0 °F)	881 kPa (127.8 psi)
39 °C (103.0 °F)	896 kPa (129.9 psi)
40 °C (104.0 °F)	911 kPa (132.1 psi)
41 °C (105.0 °F)	926 kPa (134.3 psi)
41 °C (106.0 °F)	941 kPa (136.5 psi)
42 °C (107.0 °F)	956 kPa (138.7 psi)
42 °C (108.0 °F)	972 kPa (141.0 psi)

43 °C (109.0 °F)	988 kPa (143.3 psi)
43 °C (110.0 °F)	1004 kPa (145.6 psi)
44 °C (111.0 °F)	1020 kPa (147.9 psi)
44 °C (112.0 °F)	1036 kPa (150.3 psi)
45 °C (113.0 °F)	1053 kPa (152.7 psi)
46 °C (114.0 °F)	1069 kPa (155.1 psi)
46 °C (115.0 °F)	1087 kPa (157.6 psi)
47 °C (116.0 °F)	1103 kPa (160.0 psi)
47 °C (117.0 °F)	1120 kPa (162.5 psi)
48 °C (118.0 °F)	1138 kPa (165.1 psi)
48 °C (119.0 °F)	1156 kPa (167.6 psi)
49 °C (120.0 °F)	1173 kPa (170.2 psi)
49 °C (121.0 °F)	1191 kPa (172.8 psi)
50 °C (122.0 °F)	1209 kPa (175.4 psi)
51 °C (123.0 °F)	1228 kPa (178.1 psi)
51 °C (124.0 °F)	1247 kPa (180.8 psi)
52 °C (125.0 °F)	1265 kPa (183.5 psi)
52 °C (126.0 °F)	1285 kPa (186.3 psi)
53 °C (127.0 °F)	1304 kPa (189.1 psi)

53 °C (128.0 °F)	1323 kPa (191.9 psi)
54 °C (129.0 °F)	1342 kPa (194.7 psi)
54 °C (130.0 °F)	1362 kPa (197.6 psi)
55 °C (131.0 °F)	1382 kPa (200.5 psi)
56 °C (132.0 °F)	1402 kPa (203.4 psi)
56 °C (133.0 °F)	1422 kPa (206.3 psi)
57 °C (134.0 °F)	1443 kPa (209.3 psi)

(1) All pressures in this table are gauge pressures.

Procedure for Labeling

Attach a label to the air conditioning system that indicates the system charge. Attaching a label to the system will allow easy identification of the system. Refer to Table 3 for the part number of the appropriate label. A **8L-8413** Cable Strap may be used in order to secure the tag to the air conditioning system.

Table 3

System Capacity	Part Number for Label
9U-7551 Air Conditioner Oil	
1.5 kg (3.31 lb)	130-4677
1.8 kg (3.97 lb)	114-0050
1.9 kg (4.19 lb)	114-0051
2.0 kg (4.41 lb)	114-0052
2.1 kg (4.63 lb)	114-0053
2.2 kg (4.85 lb)	114-0054
2.3 kg (5.07 lb)	114-0055

2.5 kg (5.51 lb)	114-0056
2.7 kg (5.95 lb)	114-0057
3.0 kg (6.61 lb)	114-0058
3.1 kg (6.83 lb)	140-7484
4C-2959 Air Conditioner Oil	
1.6 kg (3.54 lb)	114-0059
1.7 kg (3.75 lb)	114-0060
1.8 kg (3.97 lb)	114-0061
1.9 kg (4.19 lb)	114-0062
2.0 kg (4.41 lb)	114-0063
2.1 kg (4.63 lb)	114-0064
2.2 kg (4.85 lb)	114-0065
2.3 kg (5.07 lb)	114-0066
2.4 kg (5.29 lb)	114-0067
2.5 kg (5.51 lb)	114-0068
2.6 kg (5.73 lb)	114-0048
2.7 kg (5.95 lb)	114-0069
3.0 kg (6.61 lb)	114-0070
3.8 kg (8.38 lb)	114-0071
4C-2960 Air Conditioner Oil	

1.1 kg (2.42 lb)	122-3300
1.4 kg (3.09 lb)	114-0072
1.5 kg (3.31 lb)	114-0073
1.6 kg (3.53 lb)	114-0074
1.7 kg (3.75 lb)	114-0075
1.8 kg (3.97 lb)	114-0076
1.9 kg (4.19 lb)	114-0077
2.0 kg (4.41 lb)	114-0078
2.1 kg (4.63 lb)	114-0079
2.2 kg (4.85 lb)	114-0080
2.3 kg (5.07 lb)	114-0081
2.4 kg (5.29 lb)	114-0082
2.5 kg (5.51 lb)	114-0083
2.6 kg (5.73 lb)	114-0084
2.7 kg (5.95 lb)	122-3301
2.8 kg (6.17 lb)	114-0085
3.0 kg (6.61 lb)	122-3302

Charging the System

Pressure cannot accurately be used to charge the air conditioning system

An accurate refrigerant charge may only be determined by weight. Several variables affect the pressure and the variables cause the system to be incorrectly charged.

Compressor Speed -

- The rate of refrigerant that is pumped by the compressor will affect the pressure that is built by the compressor.

Air Flow and Air Temperatures Through the Condenser and Evaporator -

- The amount of air flow and the temperature of the air that is moving through the condenser or evaporator will affect the pressures that are seen at the compressor. Blockages in the stream of air flow will affect the amount of heat that is rejected from the refrigerant or absorbed into the refrigerant. This process affects the working pressures.

Ambient Temperature -

- Pressures are affected by ambient air temperature and solar load to the cab.
- Temperature that is around hoses and other components affect the ambient temperature. As the engine heats up, some of the heat is absorbed into the refrigerant during the refrigerant ride through the hoses and components. The pressure in the compressor can be greatly affected by the heat that is absorbed in many locations.
- Ambient temperatures will change throughout the operation of the AC, resulting in constant pressure fluctuations.

Internal Blockages -

- Blockages that are at different locations in the refrigerant circuit will affect the pressures and the blockages will cause various concerns with pressure and fluctuations.

Note: Do not add or remove part of the refrigerant.

Note: Never charge liquid or gas through the discharge side (high side) of the system when the engine is in operation.

NOTICE

In an expansion valve system which uses poly alkaline glycol (PAG), the sight glass is not a reliable way to determine the system charge.

Note: For expansion valve systems that contain PAG oil, the sight glass cannot be used for charging the system. In order to achieve a full charge for the system, the refrigerant must be recovered from the system and the system must be evacuated. After the system has been recovered and the system has been evacuated, charge the system with the correct amount of refrigerant. This process is the only procedure that is recommended. Refer to the Specifications, "System Capacities for Refrigerant" section for the proper capacity. Also, refer to the Service Manual, SENR5664, "Identifying the Air Conditioning System" section.

Note: Before you charge the system, these important items should be checked.

1. Condenser and evaporator

    - Inspect the condenser and inspect the evaporator for foreign material such as dirt, insects, plastic bags, and so on, that would inhibit air flow.

    - With condensers that are mounted on the roof and with remote mounted condensers, always check that both fan motors are running. Check for restrictions. A clean condenser will lead to improved life for the compressor.

2. Check for a loose belt on the compressor.

3. Clean the fresh air filter and clean the recirculation filter.

4. Check the moisture indicator on either the receiver-dryer or the in-line dryer. If the moisture indicator is pink or white, there is moisture in the system. Replace the receiver-dryer or the in-line dryer. Refer to the Service Manual, SENR5664, "Machine Preparation for Disassembly and Assembly" section. If the moisture indicator is blue, the system is normal.

5. Check the condensate tube on the evaporator. Make sure that the tube is not plugged and that the valve is properly in place.

   Note: Before an accurate reading for moisture can be attained, a new receiver-dryer requires 2 to 3 hours of operation.

   Refer to the Troubleshooting, "Machine Preparation for Troubleshooting" section in Testing and Adjusting before service work is performed on the air conditioning system.

   Note: The preferred method for charging the air conditioning system is listed below.

    - Recover the refrigerant.

    - Evacuate the system.

    - Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight.

   Note: After the system has been recovered and the system has been evacuated, charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Specifications, "System Capacities for Refrigerant" section for the proper capacity. Also, refer to the Service Manual, SENR5664, "Identifying the Air Conditioning System" section.

Complete Charge of the System from a Refrigerant Tank with a Scale

The use of a refrigerant tank, heat blanket, and a scale is necessary in order to charge the system. Use the procedure that follows to charge the system.

Note: Ensure that you have enough refrigerant in the tank for a complete charge. Do not use multiple cans of refrigerant, using multiple cans of refrigerant leads to incorrect charge amounts.

NOTICE

Evacuate the system before charging any Refrigerant system. Refer to Service Manual, SENR5664, "Refrigerant System - Evacuate".

In order to find the refrigerant capacity for the system that needs a refrigerant charge, refer to the Specifications, "System Capacities for Refrigerant" section. Also, refer to the Service Manual, SENR5664, "Identifying the Air Conditioning System" section.

Engine OFF

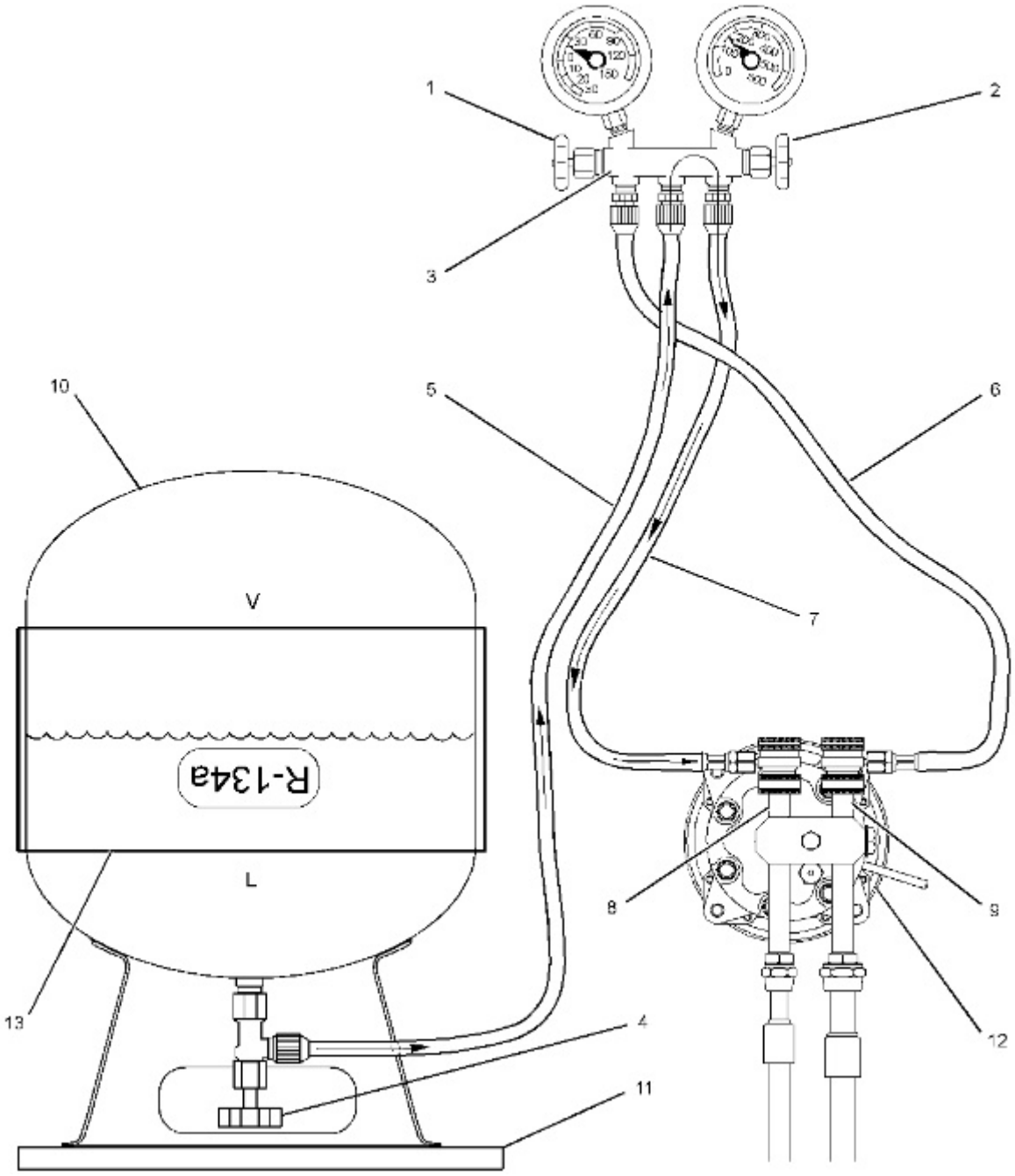


Illustration 1 g02885759

Refrigerant tank inverted for liquid charging

(1) Low-pressure valve

(2) High-pressure valve

(3) Manifold gauge set

(4) Valve on top of refrigerant tank

(5) Charging hose

(6) Low-pressure hose

(7) High-pressure hose

(8) Service valve (discharge)

(9) Service valve (suction)

(10) Refrigerant tank

(11) Scale

(12) Compressor

(13) Heat blanket

(V) Vapor

(L) Liquid

1. Hand tighten charging hose (5) from the manifold gauge set directly to the valve (4) on refrigerant tank (10) . Open the valve (4) on top side of refrigerant tank (10) .

2. Turn the tank over so that the tank is resting on handles of tank. This procedure allows the flow of liquid refrigerant through the charging hose (5) to the manifold gauge set (3) .

   Place the refrigerant tank (10) on the scale (11) so that the valve (4) is at the bottom. Check and record the weight of the tank.

3. Loosen the hose (5) at the manifold gauge set (3) for 2 to 3 seconds. Then tighten the connection. This procedure will purge the air from the line.

4. Open the high-pressure valve (2) on the manifold gauge set (3) . This action allows the refrigerant liquid to charge the system through the high-pressure side of the compressor.

5. Check the weight of the refrigerant tank (10) often. The weight will decrease as the refrigerant leaves the tank and the refrigerant enters the system. When the required amount of refrigerant (system capacity) has entered the system, close the valve (4) on the tank and close the high-pressure valve (2) . Closing the valves stops the flow of the refrigerant. For example, 1.8 kg (4 lb) of refrigerant has entered a system with 1.8 kg (4 lb) capacity.

   Note: Heater blanket (13) is required when you charge an air conditioning system.

6. Record the following information in the "SIMSi" ticket.

   - Record the amount of refrigerant you recovered from the "HVAC" system.

- Record the amount of oil that you recovered from the "HVAC" system or removed from the "HVAC" components.
- Record the amount of refrigerant you charged back into the system.
- Record the amount of oil you replenished into the system. Refer to Service Manual, SENR5664, "Refrigerant Oil-Test" to determine the correct amount of oil to replace.

7. In order to ensure correct system operation, disconnect charging hose (5) and conduct a performance check. Refer to the Service Manual, SENR5664, "Performance Checks for the Air Conditioning System" section.

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i03863033

Manifold Gauge Set (Refrigerant) - Remove

SMCS - 7465-011

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Remove charging hoses properly. A low system charge will result from charging hoses that are not removed correctly. In order to ensure accuracy of the refrigerant charge, the refrigerant should be removed from the charging hoses. Refer to the following steps in order to remove the refrigerant from the charging hoses:

1. Allow the compressor to continue operating. Close the valve on the high pressure side. The valve is located near the charging ports on the compressor. Disconnect the high pressure hose from the air conditioning system.

2. Open the high pressure valve and open the low pressure valve at the gauge set . The refrigerant that is in the hoses will be removed by the compressor through the low pressure hose.

3. Close the valve on the low pressure side. This valve is located near the charging ports on the compressor. Disconnect the low pressure hose from the air conditioning system. The system is now charged.

Note: After the manifold gauge set is removed, it is necessary to cap the charging valves.

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i03863034

Compressor Protection System - Test

SMCS - 1802-081

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

The air conditioning systems on Caterpillar machines use pressure switches in order to protect the air conditioning system. Some air conditioning systems on Caterpillar machines use pressure switches and the on delay timer assembly for the refrigerant compressor in order to protect the air conditioning system. Arc suppressors protect other electrical components in the air conditioning system. Arc suppressors are applied in order to discharge electrical inductance when the compressor disengages. Failure of the arc suppressor can affect the reliability of the pressure switch. Failure of the arc suppressor may cause failure of the pressure switch.

The following procedures are for the testing of the on delay timer assembly, pressure switches, and components of the arc suppressor.

Table 1

Required Tools	
Part Number	**Part Description**
146-4080	Digital Multimeter (RS-232)

On Delay Timer Assembly for the Refrigerant Compressor Tests

In order to diagnose a faulty on delay timer assembly for the refrigerant compressor, the engine start switch must be in the ON position and the air conditioning switch activated.

Note: The on delay timer assembly will delay the power supply to the compressor clutch coil for 30 seconds after the air conditioning switch is activated.

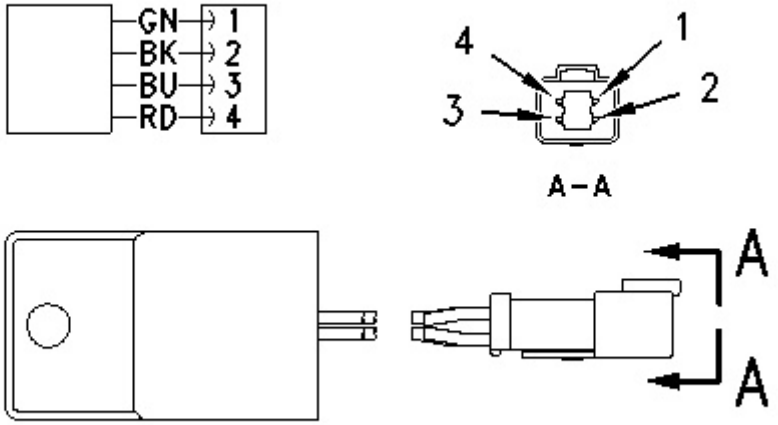


Illustration 1 g00754249

(1) Output (signal voltage)

(2) Chassis ground

(3) Compressor clutch

(4) Power supply

1. Separate the four pin connectors from the wiring harness.
2. Set the **146-4080** Digital Multimeter to DC voltage. Connect the positive probe to pin (4) on the wiring harness and connect the negative probe to a suitable ground. The multimeter should read 12 volts for a 12 volt system or the multimeter should read 24 volts for a 24 volt system.

   Note: If the voltage is below 9 volts or the voltage is above 24 volts for a 12 volt system the on delay timer assembly will not supply power to the compressor.

   Note: If the voltage is below 18 volts or the voltage is above 32 volts for a 24 volt system the on delay timer assembly will not supply power to the compressor.
3. Set the **146-4080** Digital Multimeter to OHMS. Connect the positive probe to pin location (2) on the wiring harness and connect the negative probe to a suitable chassis ground. The multimeter will display OL if the ground is not present.
4. Set the **146-4080** Digital Multimeter OHMS. Connect the positive probe to pin location (1) on the wiring harness and connect the negative probe to a suitable chassis ground. If the multimeter displays OL one of the three switches are open. Check each of the switches if an open condition occurs.

   Note: There must be refrigerant in the air conditioning system in order to close both of the pressure switches.

5. In order to check that power is getting from the on delay timer assembly to the compressor clutch coil, reconnect the on delay timer assembly to the wiring harness. Set the **146-4080** Digital Multimeter to DC voltage. Remove the 2-pin connector from the compressor clutch coil. Connect the negative probe to a suitable chassis ground. Check each one of the two pins on the wiring harness for voltage. One of the two pins should supply 12 volts for a 12 volt system or 24 volts for a 24 volt system.

6. In order to check the ground path from the compressor clutch coil to the chassis, turn off the air conditioning switch in the cab. Set the **146-4080** Digital Multimeter OHMS. Remove the 2-pin connector from the compressor clutch coil. Connect the negative lead to a suitable ground. Check each of the two pins on the two pin connectors for continuity. One of the two pins should display OL.

7. If both the correct voltage and ground are present check the resistance of the compressor clutch coil. Refer to the Service Manual, SENR 5664, "Refrigerant Compressor" section in Specifications.

Pressure Switch Tests

Test Procedure for 114-5333 Pressure Switch and 114-5334 Pressure Switch (NORMALLY OPEN)

Pressure switches are used in order to protect the a/c compressor. The two most commonly used pressure switches are the **114-5333** Pressure Switch and the **114-5334** Pressure Switch . The only difference between the two switches is the connector. Only one of these switches is used per machine. The high pressure and low pressure switches have three possible switch positions which are given below:

OPEN - System pressure is low.

CLOSED - System pressure is correct.

OPEN - System pressure is high.

The two OPEN positions of the pressure switch protect the air conditioning system. The OPEN position prevents the compressor from actuating when potentially harmful pressures exist in the system. The CLOSED position is the normal operating switch position. The following table contains the logic for the pressure switches:

Table 2

Pressure	Range	Contact Position (Pressure Rise)	Contact Position (Falling Pressure)
High Position 3	Above 2800 kPa (406 psi)	OPEN	OPEN
Hysteresis Band [1]	1750 kPa (254 psi) to 2800 kPa (406 psi)	CLOSED	OPEN
		CLOSED	CLOSED

Middle (Position 2)	275 kPa (40 psi) to 1750 kPa (254 psi)		
Hysteresis Band [1]	170 kPa (25.0 psi) to 275 kPa (40 psi)	OPEN	CLOSED
Low Position 1	0 kPa (0 psi) to 170 kPa (25.0 psi)	OPEN	OPEN

[1] Pressure must pass through the hysteresis band in order to provide the correct conditions for the switch contact.



Illustration 2 g00651406

Use the following procedures in order to test the pressure switch:

1. Disconnect the pressure switch from the machine harness.
2. Connect the **146-4080** Digital Multimeter to the two connector pins. Set the multimeter to the OHMS test mode.
3. Measure the resistance of the pressure switch.
4. If the system pressure is between 275 kPa (40 psi) and 1750 kPa (254 psi), the multimeter will display a value that is less than 1 ohm.
5. If the resistance that is displayed is a value of OL (high resistance), and the system pressure is within acceptable limits, replace the pressure switch.
6. When the pressure switch fails, test the arc suppressor for proper operation.

7. If the pressure switch is removed, make sure that the wires on the new pressure switch are tie-wrapped. Securing the pressure switch prevents damage that may be caused by vibration.

Note: The multimeter may display OL if the contacts on the pressure switch are dirty. The contacts on the pressure switch can become dirty if the arc suppressor is no longer functioning.

Note: The multimeter will display OL if the pressure switch is not threaded into the air conditioning system.

8T-8639 Low Pressure Switch (NORMALLY OPEN)

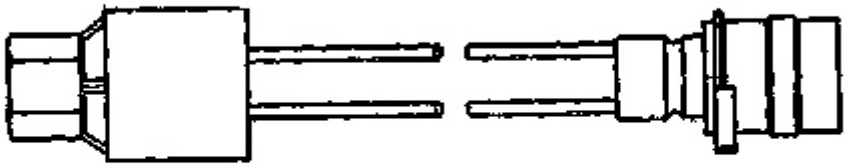


Illustration 3 g00651418

Table 3

Specifications for Pressure Switch	
Actuation Pressure [2]	344 ± 34 kPa (50 ± 5 psi)
Deactuation Pressure [3]	172 ± 21 kPa (25 ± 3 psi)

[2] Close when pressure increases.

[3] Open when pressure decreases.

Use the following procedures in order to test the pressure switch:

1. Disconnect the pressure switch from the machine harness.
2. Connect the **146-4080** Digital Multimeter to the two connector pins. Set the multimeter to the OHMS test mode.
3. Measure the resistance of the pressure switch.

4. If the system pressure is above 344 ± 34 kPa (50 ± 5 psi), the multimeter will display less than 1 ohm.
5. If the resistance that is displayed is a value of OL (high resistance), and the system pressure is not below the acceptable limit, replace the pressure switch.
6. When the pressure switch fails, test the arc suppressor for proper operation.
7. If the pressure switch is removed, make sure that the wires on the new pressure switch are tie-wrapped. Securing the pressure switch prevents damage that may be caused by vibration.

Note: The multimeter may display OL if the contacts on the pressure switch are dirty. The contacts on the pressure switch can become dirty if the arc suppressor is no longer functioning.

Note: The multimeter will display OL if the pressure switch is not threaded into the air conditioning system.

149-6371 Low Pressure Switch (NORMALLY OPEN)

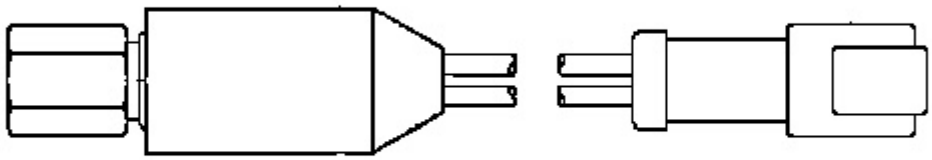


Illustration 4 g00651452

Table 4

Specifications for Pressure Switch	
Actuation Pressure [2]	103 ± 14 kPa (15 ± 2 psi)
Deactuation Pressure [3]	35 ± 7 kPa (5 ± 1 psi)

[2] Close when pressure increases.

[3] Open when pressure decreases.

Use the following procedures in order to test the pressure switch:

1. Disconnect the pressure switch from the machine harness.
2. Connect the **146-4080** Digital Multimeter to the two connector pins. Set the multimeter to the OHMS test mode.
3. Measure the resistance of the pressure switch.
4. If the system pressure is above 103 ± 14 kPa (15 ± 2 psi), the multimeter will display less than 1 ohm.
5. If the resistance that is displayed is a value of OL (high resistance), and the system pressure is not below the acceptable limit, replace the pressure switch.
6. When the pressure switch fails, test the arc suppressor for proper operation.
7. If the pressure switch is removed, make sure that the wires on the new pressure switch are tie-wrapped. Securing the pressure switch prevents damage that may be caused by vibration.

Note: The multimeter may display OL if the contacts on the pressure switch are dirty. The contacts on the pressure switch can become dirty if the arc suppressor is no longer functioning.

Note: The multimeter will display OL if the pressure switch is not threaded into the air conditioning system.

3E-6462 High Pressure Switch (NORMALLY CLOSED)



Illustration 5 g00651464

Table 5

Specifications for Pressure Switch	

Actuation Pressure [4]	2400 ± 140 kPa (348 ± 20 psi)
Deactuation Pressure [5]	1725 ± 100 kPa (250 ± 15 psi)

[4] Open when pressure increases.

[5] Close when pressure decreases.

Note: A pressure switch that is NORMALLY CLOSED will open when the system pressure increases. The pressure switch will close when the system pressure decreases.

Use the following procedures in order to test the pressure switch:

1. Disconnect the pressure switch from the machine harness.
2. Connect the **146-4080** Digital Multimeter to the two connector pins. Set the multimeter to the OHMS test mode.
3. Measure the resistance of the pressure switch.
4. If the system pressure is below 2400 ± 140 kPa (348 ± 20 psi), the multimeter will display less than 1 ohm.
5. If the resistance that is displayed is a value of OL (high resistance), and the system pressure is not above the acceptable limit, replace the pressure switch.
6. When the pressure switch fails, test the arc suppressor for proper operation.
7. If the pressure switch is removed, make sure that the wires on the new pressure switch are tie-wrapped. Securing the pressure switch prevents damage that may be caused by vibration.

Note: The multimeter may display OL if the contacts on the pressure switch are dirty. The contacts on the pressure switch can become dirty if the arc suppressor is no longer functioning.

Note: The multimeter will display OL if the pressure switch is not threaded into the air conditioning system.

7X-1076 High Pressure Switch (NORMALLY CLOSED)

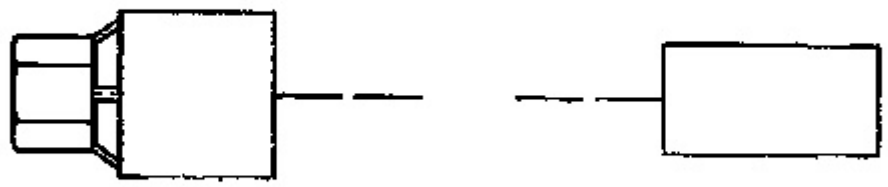


Illustration 6 g00651571

Table 6

Specifications for Pressure Switch	
Actuation Pressure [4]	2412 ± 140 kPa (350 ± 20 psi)
Deactuation Pressure [5]	1723 ± 100 kPa (250 ± 15 psi)

[4] Open when pressure increases.

[5] Close when pressure decreases.

Use the following procedures in order to test the pressure switch:

1. Disconnect the pressure switch from the machine harness.
2. Connect the **146-4080** Digital Multimeter to the two connector pins. Set the multimeter to the OHMS test mode.
3. Measure the resistance of the pressure switch.
4. If the system pressure is below 2412 ± 140 kPa (350 ± 20 psi), the multimeter will display less than 1 ohm.
5. If the resistance that is displayed is a value of OL (high resistance), and the system pressure is not above the acceptable limit, replace the pressure switch.
6. When the pressure switch fails, test the arc suppressor for proper operation.
7. If the pressure switch is removed, make sure that the wires on the new pressure switch are tie-wrapped. Securing the pressure switch prevents damage that may be caused by vibration.

Note: The multimeter may display OL if the contacts on the pressure switch are dirty. The contacts on the pressure switch can become dirty if the arc suppressor is no longer functioning.

Note: The multimeter will display OL if the pressure switch is not threaded into the air conditioning system.

Test Procedures for Arc Suppressors:

106-8704 Arc Suppressor

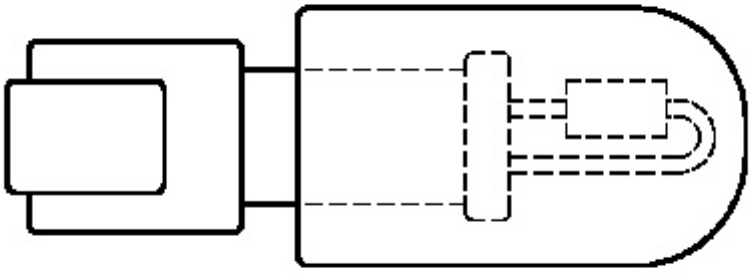


Illustration 7 g00651378

106-8704 Arc Suppressor

1. Place the multimeter in the DIODE test mode.
2. Place the red probe in the red terminal (positive terminal) of the multimeter.
3. Place the black probe in the black terminal (negative terminal) of the multimeter.
4. Place the red probe on Pin 2 of the connector on the arc suppressor. Place the black probe on Pin 1 of the connector.
5. The multimeter should display a value between 0.5 VDC and 1.0 VDC.
6. Place the red probe on Pin 1 of the connector on the arc suppressor. Place the black probe on Pin 2 of the connector on the arc suppressor.
7. The multimeter should display OL.
8. If the above conditions do not exist, the component should be considered faulty. The component will not provide adequate protection if the above conditions do not exist.
9. Replace the component if the component has failed.

3E-9169 Arc Suppressor and 130-8134 Arc Suppressor

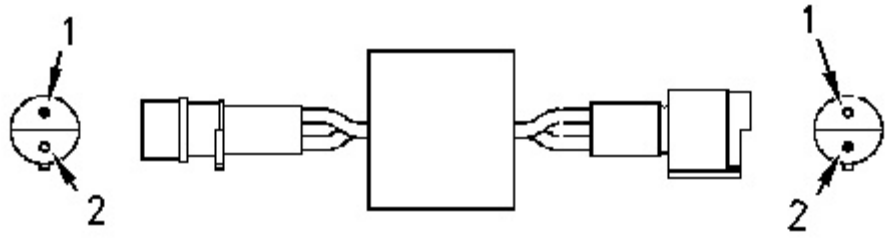


Illustration 8 g00651923

Arc Suppressor with Sure Seal Connectors

(1) Pin 1

(2) Pin 2

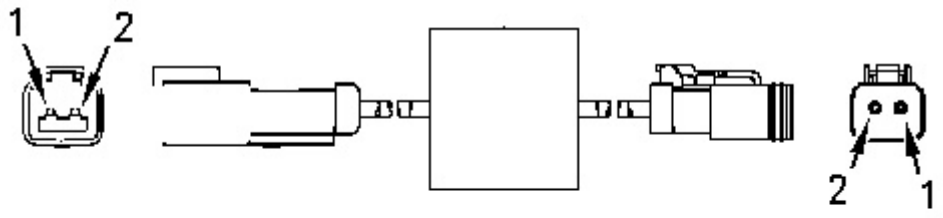


Illustration 9 g00651621

Arc Suppressor with DT Connectors

(1) Pin 1

(2) Pin 2

1. Place the multimeter in the DIODE test mode.
2. Place the red probe in the red terminal (positive terminal) of the multimeter.
3. Place the black probe in the black terminal (negative terminal) of the multimeter.
4. Place the red probe on Pin 1 of either connector on the arc suppressor. Place the black probe on Pin 2 of either connector.
5. The multimeter should display a value between 0.5 VDC and 1.0 VDC.
6. Place the red probe on Pin 2 of either connector of arc suppressor. Place the black probe on Pin 1 of either connector on the arc suppressor.
7. The multimeter should display OFL or OL.
8. Place the red probe on pin 1 of the female connector. Place the black probe on pin 1 of the male connector.
9. The multimeter should have a reading of less than 0.01 VDC.
10. Place the red probe on Pin 2 of the female connector. Place the black probe on Pin 2 of the male connector.
11. The multimeter should have a reading of less than 0.01 VDC.
12. The component is faulty if any of the conditions do not exist.
13. If the component is faulty, replace the component.

105-8827 Arc Suppressor and 130-0956 Arc Suppressor

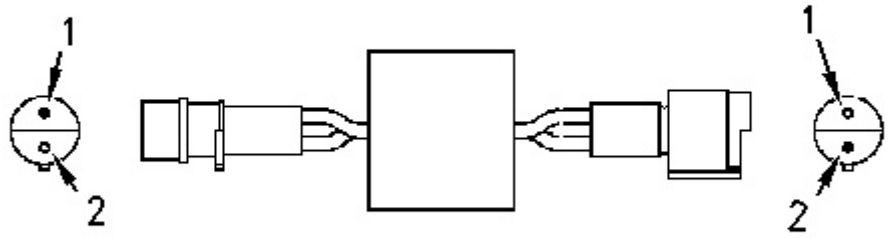


Illustration 10 g00651923

Arc Suppressor with Sure Seal Connectors

(1) Pin 1

(2) Pin 2

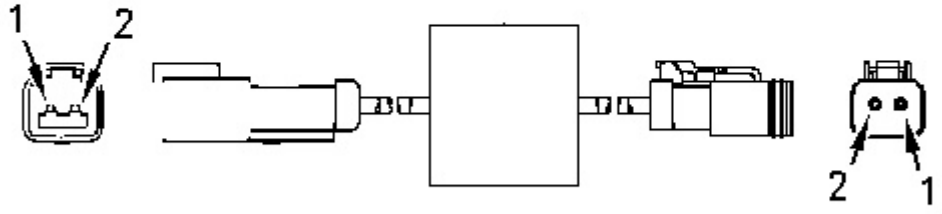


Illustration 11 g00651621

Arc Suppressor with DT Connectors

(1) Pin 1

(2) Pin 2

1. Place the multimeter in the DIODE test mode.
2. Place the red probe in the red terminal (plus terminal) of the multimeter.
3. Place the black probe in the black terminal (negative terminal) of the multimeter.
4. Place the red probe on Pin 1 of either connector on the arc suppressor. Place the black probe on Pin 2 of either connector.
5. The multimeter should display a value between 0.5 VDC and 1.0 VDC.
6. Place the red probe on pin 2 of either connector of arc suppressor. Place the black probe on pin 1 of either connector on the arc suppressor.
7. The multimeter should display OFL or OL.
8. Place the red probe on pin 1 of the female connector. Place the black probe on pin 1 of the male connector.
9. The multimeter should have a reading of less than 0.01 VDC.
10. Place the red probe on pin 2 of the female connector. Place the black probe on pin 2 of the male connector.
11. The multimeter should have a reading of less than 0.01 VDC.
12. The component is faulty if any of the conditions do not exist.
13. If the component is faulty, replace the component.

Correct Mounting of Arc Suppressors

Certain arc suppressors may experience failure of the wire leads due to vibration if the arc suppressor is not properly supported.

Use a **2U-4497** Strap to tie-wrap the arc suppressor. The arc suppressor should be securely tie-wrapped to a stationary support in order to prevent any motion of the body of the arc suppressor. Additionally, the connectors on both ends of the arc suppressor should be secured.

A suitable bracket for supporting an arc suppressor is the **116-6100** Plate . The addition of a **9R-2926** Plate should permit the mounting of the **116-6100** Plate around obstacles. Use the **9R-2926** Plate if the **116-6100** Plate cannot be installed directly in an existing application.

The Sure Seal connectors on the **3E-9169** Arc Suppressor and the **105-8827** Arc Suppressor should be secured with two **9G-9150** Clips in order to prevent movement of the connectors relative to the body of the arc suppressor. The DT connectors on the **130-0956** Arc Suppressor and **130-8134** Arc Suppressor should be secured with two **9U-2297** Clips . The clips should be bolted through the slotted holes on the **116-6100** Plate .

The **106-8704** Arc Suppressor is an integral arc suppressor. The integral arc suppressor can be found on the newer machines. The **106-8704** Arc Suppressor is lighter than the other arc suppressors. The **106-8704** Arc Suppressor can be strapped directly to the wiring harnesses that are connected to the arc suppressor.

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i02998053

Electronic Heat Control - Test

SMCS - 7304-081-VL; 7309-081-VL

Type 1 - Electronic Water Valve Only

Type 1A - Electronic Heat control Circuit for Water Valve using External Control Assembly, Nominal System Voltage

Note: An electronic heat control that only has an electronic water valve is classified as a Type 1 electronic heat control.

Table 1

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

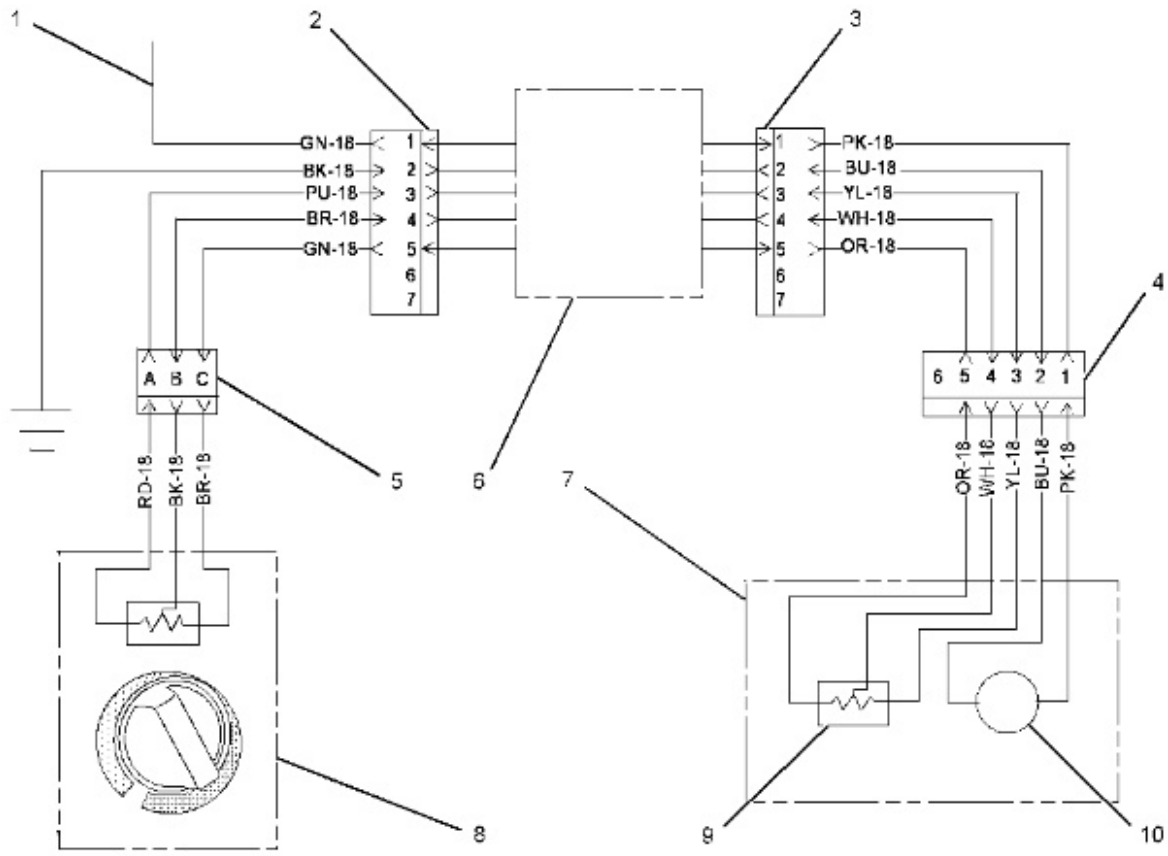


Illustration 1 g01371347

Typical Electronic Control Circuit for the Heater Valve

(1) 24 VDC power supply from blower motor breaker

(2) Sure seal connector (7 pin)

(3) Sure seal connector (7 pin)

(4) Sure seal connector (6 pin)

(5) Sure seal connector (3 pin)

(6) Board Control Assembly

(7) Electronic water valve assembly

(8) Potentiometer assembly (temperature control)

(9) Feedback potentiometer for the electronic water valve assembly

(10) Motor for the electronic water valve assembly

1. Turn off the power supply.
2. Disconnect the sure seal connector (2) .
3. Hook the multimeter leads to pin (1) and pin (2). Set the multimeter to DC voltage.
4. Turn on the power supply. The multimeter should read approximately 24 VDC.

5. Turn off the power supply.
6. Reconnect the sure seal connector (2) .
7. Disconnect the sure seal connector (5) .
8. Connect the multimeter leads to pin (A) and pin (C) on the sure seal connector that is on potentiometer assembly (6). Set the multimeter to read ohms. The multimeter should read 5000 ± 500 ohms.
9. Connect the multimeter leads to pin (A) and pin (B) on the sure seal connector that is on potentiometer assembly (6). Turn the knob on the potentiometer assembly (6). The resistance should vary smoothly.
10. Reconnect sure seal connector (5) .
11. Disconnect sure seal connector (4) .
12. Connect the multimeter leads to pin (3) and pin (5) on the sure seal connector that is on electronic water valve assembly (8). Set the multimeter to read ohms. The multimeter should read 5000 ± 500 ohms.
13. Connect the multimeter leads to pin (1) and pin (2) on the sure seal connector that is on board control assembly (7). Set the multimeter to DC voltage.
14. Turn on the power supply.
15. Turn the knob on the potentiometer assembly (6). The multimeter should read either 9 to 10 VDC or the multimeter should read −9 to −10 VDC.
16. Turn off the power supply.
17. Connect two wires to a remote 12 volt DC power supply.

    Note: Do not use a power supply higher than 12 volts DC. If you use a power supply higher than 12 volts DC, you may damage the water valve assembly.
18. Connect one wire to pin (2) on the sure seal connector that is on the electronic water valve assembly (8) .
19. Touch the other wire to pin (1) on the sure seal connector that is on electronic water valve assembly (8) in order to pulse motor (10). The motor should turn clockwise or counterclockwise. The polarity of the power supply determines the direction of rotation.

    Note: Do not pulse motor (10) for more than a fraction of a second. If you supply power for a longer period of time you may damage the water valve assembly.
20. Disconnect the test equipment and reconnect sure seal connector (4) .

Type 1B - Electronic Heat Control Circuit for Water Valve using a Potentiometer and Series Resistor, Regulated Supply Voltage

Note: An electronic heat control that only has an electronic water valve is classified as a Type 1 electronic heat control.

Table 2

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

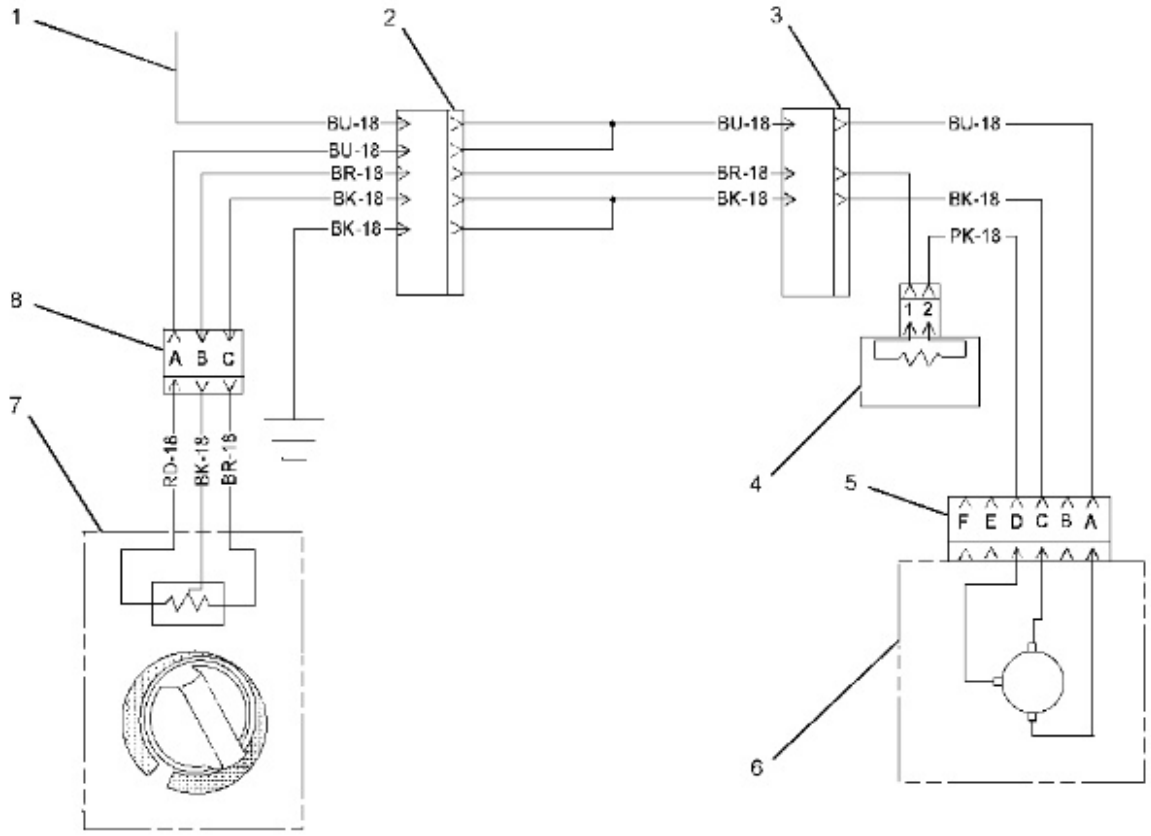


Illustration 2 g01365822

Typical view of the Electronic water valve control system with a potentiometer and a 12 volt regulated power supply

(1) 12 VDC from DC to DC converter

(2) Deutsch connector (pin number will vary depending on the application)

(3) Deutschconnector (pin number will vary depending on the application)

(4) In-line resister

(5) Packard six pin connector

(6) Electronic rotational actuator

(7) Potentiometer assembly (temperature control)

(8) Deutsch three pin connector

1. Turn off the power supply.

2. Disconnect Packard connector (5) .
3. Connect the leads of the multimeter to pin (A) and pin (C) of Packard connector (5). Select the DC voltage setting of the multimeter.
4. Turn on the power supply. The multimeter should read approximately 12 VDC.
5. Connect the leads of the multimeter to pin (C) and pin (D) of Packard connector (5). In a counterclockwise direction, fully rotate the dial of potentiometer assembly (7). In a clockwise direction, fully rotate the dial on potentiometer assembly (7). The amount of voltage that is measured from pin (D) should vary between the power supply and the ground ± 0.5 volts.

   Note: When Packard connector (5) is connected to rotational actuator (6) the measured voltage will be different from the previous measured voltage. When actuator (6) is connected to the system the voltage drop across in-line resister (4) will limit the control signal to 10% of the supply voltage on the low limit and 90% of the supply voltage on the upper limit. The following is an example. A power supply of 14 volts will produce approximately 1.4 to 12.6 VDC when the potentiometer assembly is rotated from a clockwise position to a counterclockwise position.
6. Turn off the power supply.
7. Reconnect Packard connector (5) .
8. Disconnect in-line resistor (4) from the harness.
9. Connect the leads of the multimeter to pin (1) and pin (2) of in-line resister (4). Select the setting of the multimeter to ohms. The multimeter should read 27,000 ± 300 ohms.
10. Reconnect in-line resister (4) to the harness.
11. Disconnect Deutsch connector (8) .
12. Connect the leads of the multimeter to pin (A) and pin (C) of the Deutsch connector that is located on potentiometer assembly (7). Select the setting of the multimeter to ohms. The multimeter should read 5,000 ± 500 ohms.
13. Connect the leads of the multimeter to pin (A) and pin (B) of the Deutsch connector that is located on potentiometer assembly (7). Turn the knob on potentiometer assembly (7). The resistance should vary smoothly.
14. Reconnect Deutsch connector (8) .

NOTICE

Do not use a power supply higher than 12 volts DC. A power supply higher than 12 volts DC may damage the water valve assembly.

---

15. Connect two wires to a remote 12 volt DC power supply.
16. Disconnect Packard connector (5) from rotational actuator (6) .
17. Connect the Positive wire to pin (A) and the Negative wire to pin (C) of rotational actuator (6) .

Note: If necessary, use a **241-7691** Heater and Air Conditioner Harness As in order to create the temporary connection.

18. Turn on the remote 12 volt power supply.
19. Obtain a third wire. Short pin (D) of rotational actuator (6) to ground. Next, short pin (D) of rotational actuator (6) to the battery. The actuator should move fully to the clockwise position. Next, the actuator should move completely to a counterclockwise position. The movement of the actuator is dependent on the voltage that is going to pin (D) of rotational actuator (6) .

    Note: When pin (D) is in an open circuit condition the actuator will default to a center rotational position. This condition is normal operation for this type of actuator. Refer to **245-1596** Actuator .
20. Disconnect all of the test equipment and reconnect Packard connector (5) .

Type 1C - Electronic Heat Control Circuit for Water Valve using a HVAC Panel, Regulated Supply Voltage

Note: An electronic heat control that only has an electronic water valve is classified as a Type 1 electronic heat control.

Table 3

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

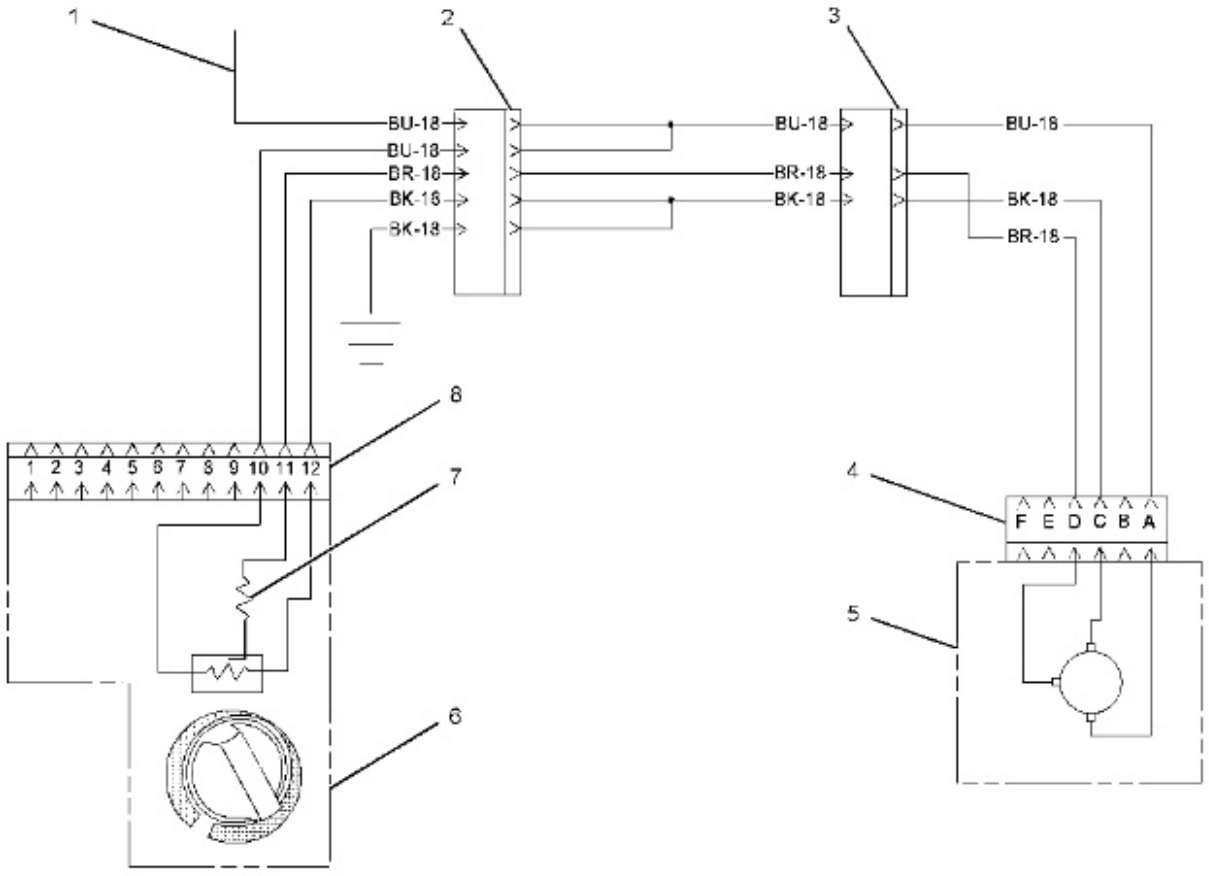


Illustration 3 g01366758

Typical view of the Electronic water valve control system with a HVAC panel and a 12 volt regulated power supply

(1) 12 VDC from DC to DC converter

(2) Deutsch connector (pin number will vary depending on the application)

(3) Deutschconnector (pin number will vary depending on the application)

(4) Packard six pin connector

(5) Electronic rotational actuator

(6) HVAC panel assembly

(7) In-line series resister

(8) 12 pin Deutsch connector

1. Turn off the power supply.
2. Disconnect Packard connector (4) .
3. Connect the leads of the multimeter to pin (A) and pin (C) of Packard connector (4). Select the DC voltage setting of the multimeter.
4. Turn on the power supply. The multimeter should read approximately 12 VDC.
5. Connect the leads of the multimeter to pin (C) and pin (D) of Packard connector (4). In a counterclockwise direction, fully rotate the dial of HVAC panel assembly (6). In a clockwise

direction, fully rotate the dial on HVAC panel assembly (6). The amount of voltage that is measured from pin (D) should vary between the power supply and the ground ± 0.5 volts.

Note: When Packard connector (4) is connected to rotational actuator (5) the measured voltage will be different from the previous measured voltage. When actuator (5) is connected to the system the voltage drop across in-line resister (7) will limit the control signal to 10% of the supply voltage on the low limit and 90% of the supply voltage on the upper limit. The following is an example. A power supply of 14 volts will produce approximately 1.4 to 12.6 VDC when the HVAC panel assembly is rotated from a clockwise position to a counterclockwise position.

6. Turn off the power supply.
7. Reconnect Packard connector (4) .
8. Disconnect Deutsch connector (8) .
9. Connect the leads of the multimeter to pin (10) and pin (12) of the Deutsch connector that is located on HVAC panel assembly (6). Select the setting of the multimeter to ohms. The multimeter should read 10000 ± 1000 ohms.
10. Connect the leads of the multimeter to pin (11) and pin (12) of the Deutsch connector that is located on HVAC panel assembly (6). Turn the knob on HVAC panel assembly (6). The resistance should vary smoothly. The multimeter should display a range from 27000 to 37000 ± 1300 ohms.
11. Reconnect Deutsch connector (8) .

NOTICE

Do not use a power supply higher than 12 volts DC. A power supply higher than 12 volts DC may damage the water valve assembly.

---

12. Connect two wires to a remote 12 volt DC power supply.
13. Disconnect Packard connector (4) from rotational actuator (5) .
14. Connect the Positive wire to pin (A) and the Negative wire to pin (C) of rotational actuator (5) .

    Note: If necessary, use a **241-7691** Heater and Air Conditioner Harness As in order to create the temporary connection.

15. Turn on the remote 12 volt power supply.
16. Obtain a third wire. Short pin (2) of rotational actuator (5) to ground. Next, short pin (2) of rotational actuator (5) to the battery. The actuator should move fully to the clockwise position. Next, the actuator should move completely to a counterclockwise position. The movement of the actuator is dependent on the voltage that is going to pin (D) of rotational actuator (5) .

    Note: When pin (D) is in an open circuit condition the actuator will default to a center rotational position. This condition is normal operation for this type of actuator. Refer to **245-1596** Actuator .

17. Disconnect all of the test equipment and reconnect Packard connector (4) .

Type 1D - Electronic Heat Control Circuit for Water Valve using a Nominal System Voltage, HVAC Panel

Note:

An electronic heat control that only has an electronic water valve is classified as a Type 1 electronic heat control.

Table 4

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

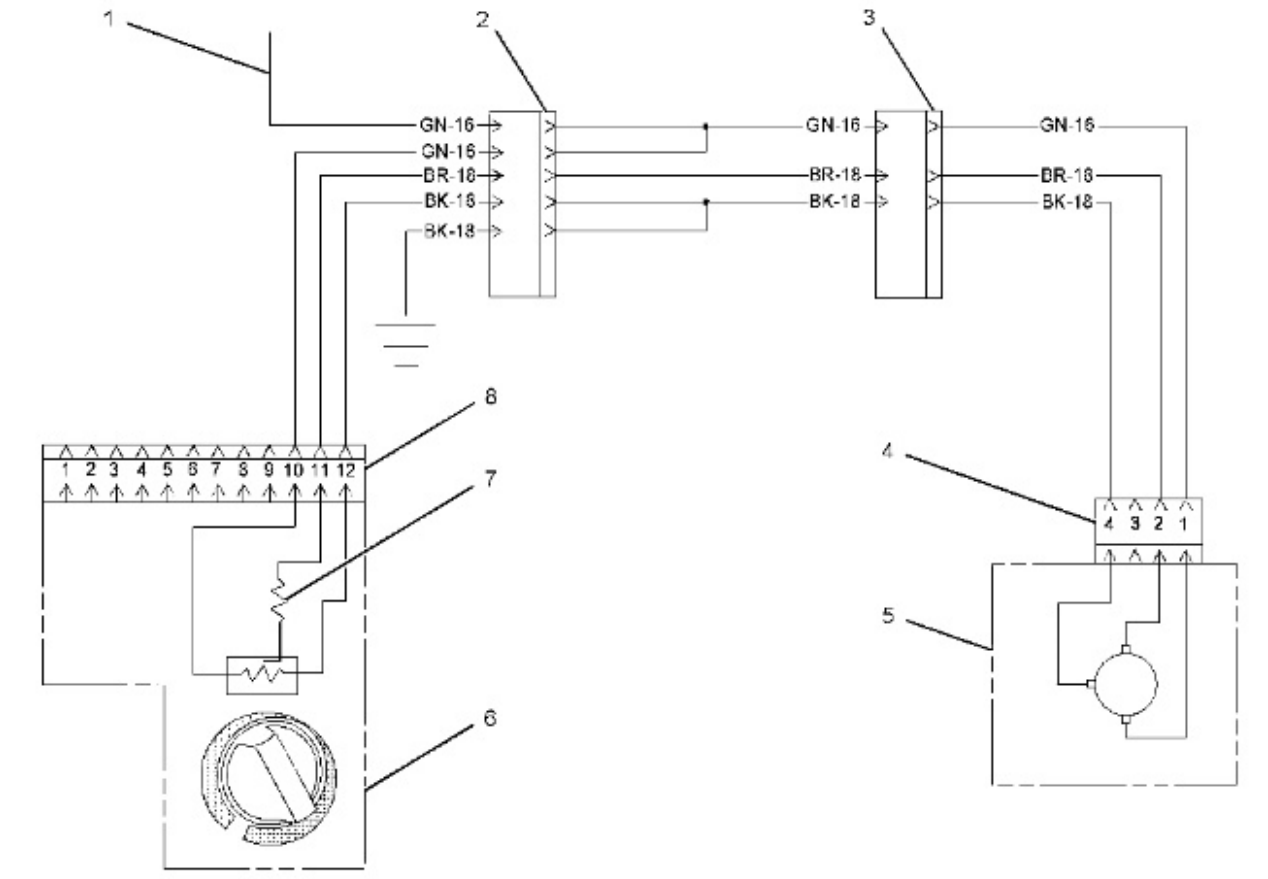


Illustration 4 g01366857

Typical view of the Electronic water valve control system with a HVAC panel and nominal vehicle system voltage

(1) +12/24 VDC from HVAC circuit

(2) Deutsch connector (pin number will vary depending on the application)

(3) Deutschconnector (pin number will vary depending on the application)

(4) Deutsch four pin connector

(5) Electronic rotational actuator

(6) HVAC panel assembly

(7) In-line series resister

(8) 12 pin Deutsch connector

1. Turn off the power supply.
2. Disconnect Deutsch connector (4) .
3. Connect the leads of the multimeter to pin (1) and pin (4) of Deutsch connector (4). Select the DC voltage setting of the multimeter.
4. Turn on the power supply. The multimeter should read approximately 24 VDC.

   Note: Some 24 volt machine applications may run an actuator with a 12 volt supply. Verify the correct voltage signal with the schematic of the machine before conducting this test.
5. Connect the leads of the multimeter to pin (2) and pin (4) of Deutsch connector (4). In a counterclockwise direction, fully rotate the dial of HVAC panel assembly (6). In a clockwise direction, fully rotate the dial on HVAC panel assembly (6). The amount of voltage that is measured from pin (2) should vary between the power supply and the ground ± 0.5 volts.

   Note: When Deutsch connector (4) is connected to rotational actuator (5) the measured voltage will be different from the previous measured voltage. When actuator (5) is connected to the system the voltage drop across in-line resister (7) will limit the control signal to 0% of the supply voltage on the low limit and 75% of the supply voltage on the upper limit. The following is an example. A power supply of 24 volts will produce approximately 0 to 18 VDC when the HVAC panel assembly is rotated from a clockwise position to a counterclockwise position.
6. Turn off the power supply.
7. Reconnect Deutsch connector (4) .
8. Disconnect Deutsch connector (8) .
9. Connect the leads of the multimeter to pin (10) and pin (12) of the Deutsch connector that is located on HVAC panel assembly (6). Select the setting of the multimeter to ohms. The multimeter should read 10000 ± 1000 ohms.
10. Connect the leads of the multimeter to pin (11) and pin (12) of the Deutsch connector that is located on HVAC panel assembly (6). Turn the knob on HVAC panel assembly (6). The resistance should vary smoothly. The multimeter should display a range from 27000 to 37000 ± 1300 ohms.
11. Reconnect Deutsch connector (8) .
12. Connect two wires to a remote 12/24 volt DC power supply.
13. Disconnect Deutsch connector (4) from rotational actuator (5) .
14. Connect the Positive wire to pin (1) and the Negative wire to pin (4) of rotational actuator (5) .

15. Turn on the remote 12/24 volt power supply.

16. Obtain a third wire. Short pin (2) of rotational actuator (5) to ground. Next, short pin (2) of rotational actuator (5) to the battery. The actuator should move fully to the clockwise position. Next, the actuator should move completely to a counterclockwise position. The movement of the actuator is dependent on the voltage that is going to pin (2) of rotational actuator (5) .

    Note: When the actuator and signal pin (2) is in an open circuit condition, it is normal for the actuator to default travel to an end of travel position. This condition is similar if pin (2) for the control signal is shorted to ground. This condition is normal operation for this type of actuator. Refer to **265-9620** Actuator .

17. Disconnect all of the test equipment and reconnect Deutsch connector (4) .

Type 1E - Electronic Heat Control Circuit for Water Valve using a Potentiometer, Nominal System Voltage

Note: An electronic heat control that only has an electronic water valve is classified as a Type 1 electronic heat control.

Table 5

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

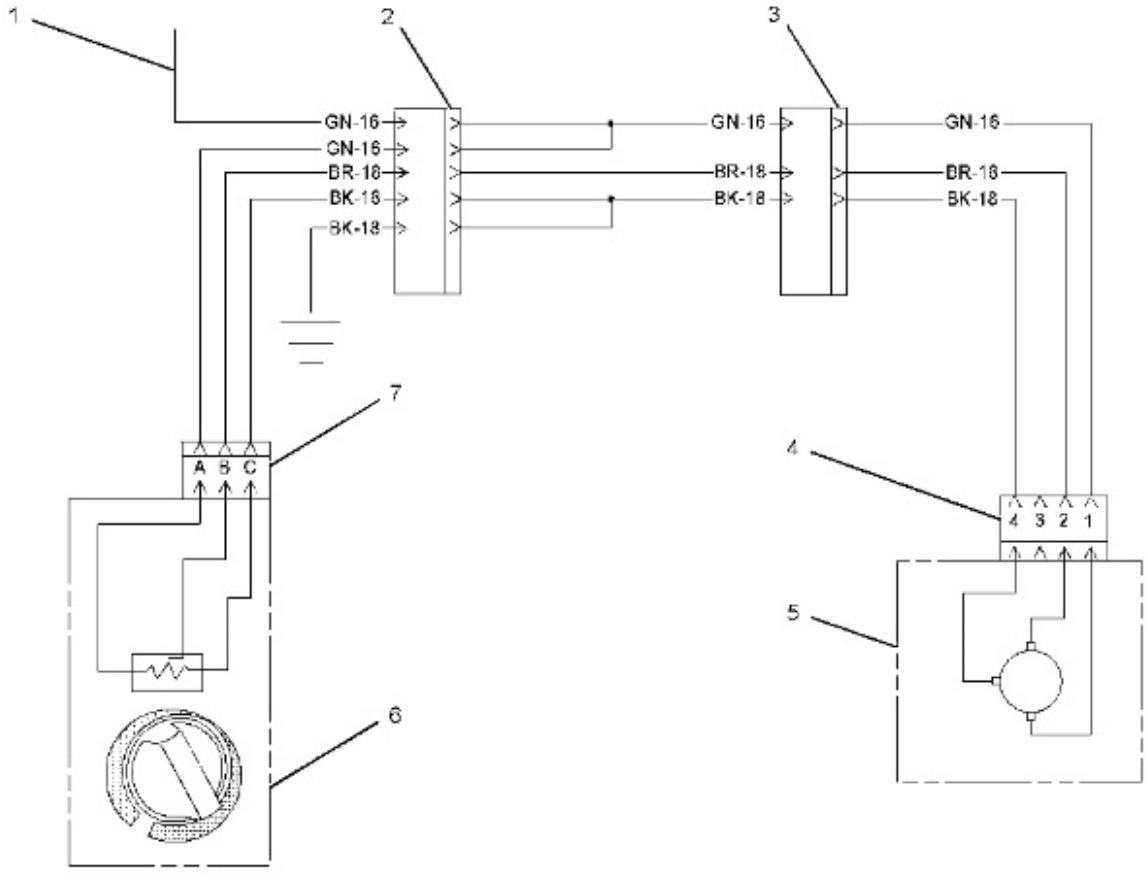


Illustration 5 g01520264

Typical view of the Electronic water valve control system with a potentiometer and nominal vehicle system voltage

(1) +12/24 VDC from HVAC circuit

(2) Deutsch connector (pin number will vary depending on the application)

(3) Deutschconnector (pin number will vary depending on the application)

(4) Deutsch four pin connector

(5) Electronic rotational actuator

(6) Potentiometer assembly (Temperature control)

(7) Deutsch three pin connector

1. Turn off the power supply.
2. Disconnect Deutsch connector (4) .
3. Connect the leads of the multimeter to pin (1) and pin (4) of Deutsch connector (4). Select the DC voltage setting of the multimeter.
4. Turn on the power supply. The voltage that is measured by the multimeter should be approximately the same voltage as the system voltage.

   Note: Some 24 volt machine applications may run an actuator with a 12 volt supply. Verify the correct voltage signal with the schematic of the machine before conducting this test.
5. Connect the leads of the multimeter to pin (2) and pin (4) of Deutsch connector (4). In a counterclockwise direction, fully rotate the dial of potentiometer assembly (6). In a clockwise direction, fully rotate the dial on HVAC panel assembly (6). The amount of voltage that is measured from pin (2) should vary between the power supply and the ground ± 0.5 volts.
6. Turn off the power supply.
7. Reconnect Deutsch connector (4) .
8. Disconnect Deutsch connector (7) .
9. Connect the leads of the multimeter to pin (A) and pin (C) of the Deutsch connector that is located on potentiometer assembly (6). Select the setting of the multimeter to ohms. The multimeter should read 5000 ± 500 ohms.
10. Connect the leads of the multimeter to pin (A) and pin (B) of the Deutsch connector that is located on potentiometer assembly (6). Turn the knob on potentiometer assembly (6). The resistance should vary smoothly.
11. Reconnect Deutsch connector (7) .
12. Connect two wires to a remote 12/24 volt DC power supply.
13. Disconnect Deutsch connector (4) from rotational actuator (5) .
14. Connect the Positive wire to pin (1) and the Negative wire to pin (4) of rotational actuator (5) .

15. Turn on the remote 12/24 volt power supply.

16. Obtain a third wire. Short pin (2) of rotational actuator (5) to ground. Next, short pin (2) of rotational actuator (5) to the battery. The actuator should move fully to the clockwise position. Next, the actuator should move completely to a counterclockwise position. The movement of the actuator is dependent on the voltage that is going to pin (2) of rotational actuator (5) .

    Note: When the actuator and signal pin (2) is in an open circuit condition, it is normal for the actuator to default travel to an end of travel position. This condition is similar if pin (2) for the control signal is shorted to ground. This condition is normal operation for this type of actuator. Refer to **279-0850** Actuator .

17. Disconnect all of the test equipment and reconnect Deutsch connector (4) .

Type 2 - Electronic Heat Control Circuit for Water Valve and Blend Door HVAC System using External Control Assembly

Electronic heat controls that have a blend door actuator and an electronic water valve are classified as a type 2 electronic heat control.

Table 6

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

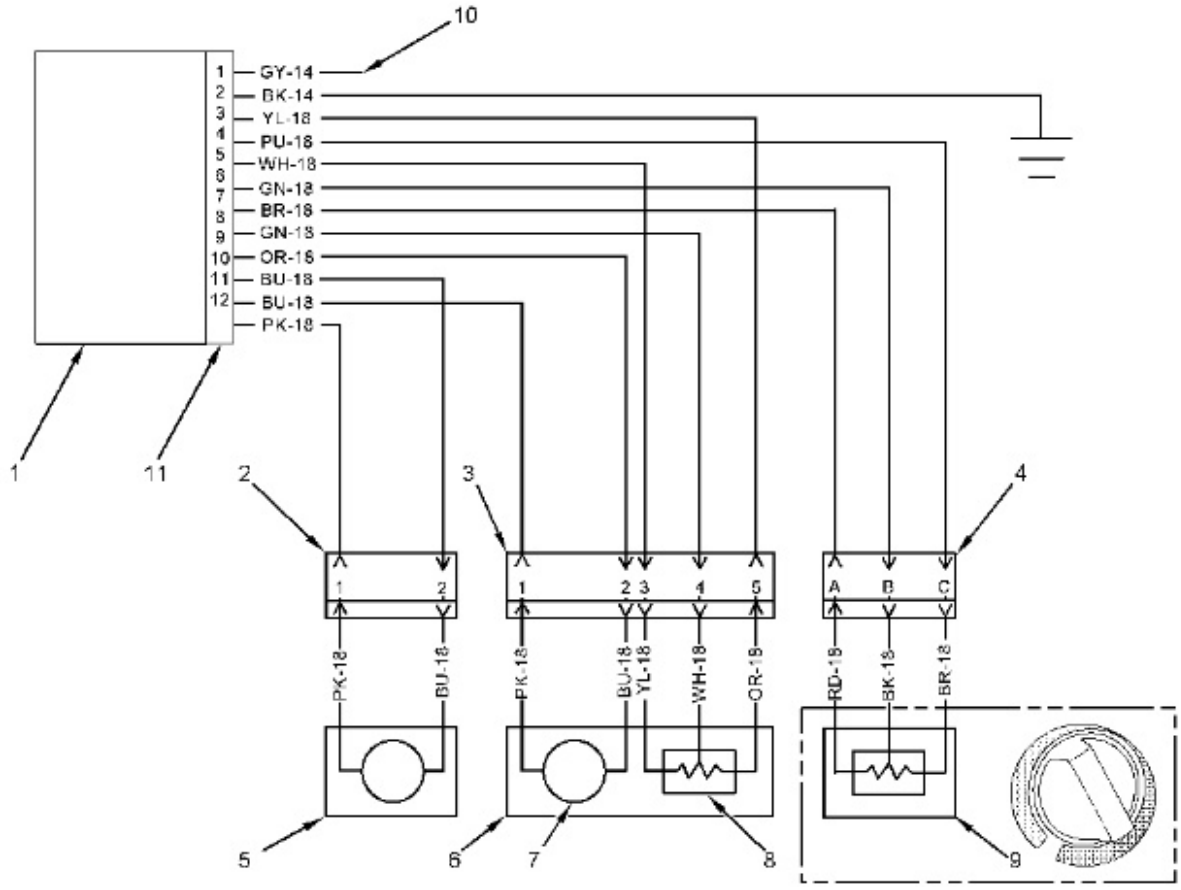


Illustration 6 g01069275

Typical Electronic Control Circuit for the Heater Valve

(1) Electronic controller

(2) Deutsch connector (2 pin)

(3) Deutsch connector (6 pin)

(4) Deutsch connector (3 pin)

(5) Electronic water valve assembly

(6) Electronic blend door actuator

(7) Motor for the electronic blend door actuator

(8) Feedback potentiometer for the electronic blend door actuator

(9) Potentiometer assembly (temperature control)

(10) 24 VDC power supply from blower motor breaker

(11) Deutsch connector (12 pin)

1. Turn off the power supply.
2. Disconnect Deutsch connector (11) .
3. Hook the multimeter leads to pin (1) and pin (2). Set the multimeter to DC voltage.
4. Turn on the power supply. The multimeter should read approximately 24 VDC.
5. Turn off the power supply.
6. Reconnect the Deutsch connector (11) at electronic controller (1) .
7. Disconnect Deutsch connector (4) .
8. Connect the multimeter leads to pin (A) and pin (C) on the Deutsch connector that is on potentiometer assembly (9). Set the multimeter to read ohms. The multimeter should read 5000 ± 500 ohms.
9. Connect the multimeter leads to pin (A) and pin (B) on the Deutsch connector that is on potentiometer assembly (9). Turn the knob on the potentiometer assembly (9). The resistance should vary smoothly.
10. Reconnect Deutsch connector (4) .
11. Disconnect Deutsch connector (3) .
12. Connect the multimeter leads to pin (3) and pin (5) on the Deutsch connector that is on electronic blend door actuator (6). Set the multimeter to read ohms. The multimeter should read 10000 ± 1000 ohms.
13. Connect the multimeter leads to pin (1) and pin (2) on the Deutsch connector that is on electronic blend door actuator (6). Set the multimeter to DC voltage.

14. Turn on the power supply.

15. Turn the knob on the potentiometer assembly (9). The multimeter should read either −11 to −12 VDC or the multimeter should read 11 to 12 VDC while the actuator is rotating. The multimeter should read 0 VDC after the motor has stopped rotating.

16. Turn off the power supply.

17. Connect two wires to a remote 12 volt DC power supply.

18. Connect one wire to pin (2) on the Deutsch connector that is on the electronic blend door actuator (6) .

19. Touch the other wire to pin (1) on the Deutsch connector that is on electronic blend door actuator (6) in order to pulse motor (7). The motor should turn clockwise or counterclockwise. The polarity of the motor determines the direction of rotation.

    Note: Do not pulse motor (7) for more than a fraction of a second. If you supply power for a longer period of time you may damage the actuator.

20. Disconnect the test equipment and reconnect Deutsch connector (3) .

21. Disconnect Deutsch connector (2) .

22. Rotate the potentiometer assembly (9) to full cooling.

    Note: The actuators must be given 60 seconds in order to completely stroke.

23. Connect the multimeter leads to pin (1) and pin (2) on the Deutsch connector that is on the electronic water valve assembly (5). Set the multimeter to read DC voltage.

24. Turn on the power supply.

25. Turn the knob on potentiometer assembly (9). The multimeter should read −11 to −12 VDC or the multimeter should read 11 to 12 VDC while the actuator is rotating. The multimeter should read 0 VDC, after the motor has completed rotating.

26. Turn the knob to full cooling on the potentiometer assembly (9). The multimeter should read −11 to −12 VDC or the multimeter should read 11 to 12 VDC while the actuator is rotating. The multimeter should read 0 VDC after the motor has completed rotating.

27. Turn off the power supply.

28. Connect two wires to a remote 12 volt DC power supply.

29. Connect one wire to pin (1) on Deutsch connector (2) that is on the electronic water valve assembly.

30. Touch the other wire to pin (2) on the Deutsch connector (2) that is on electronic water valve assembly in order to pulse motor (5). The motor should turn clockwise or counterclockwise. The polarity of the motor determines the direction of rotation.

    Note: Do not pulse motor (5) for more than a fraction of a second. If you supply power for a longer period of time you may damage the actuator.

31. Disconnect the test equipment and reconnect the Deutsch connector (2) .

Type 3 - Electronic Heat Control Circuit for Blend Door Only HVAC System using Two Series Resistors and a Potentiometer

Electronic heat controls that have a blend air door are classified as a Type 3 electronic heat control.

Table 7

Required Tools		
Part Number	**Description**	**Quantity**
146-4080	Digital Multimeter (RS-232)	1

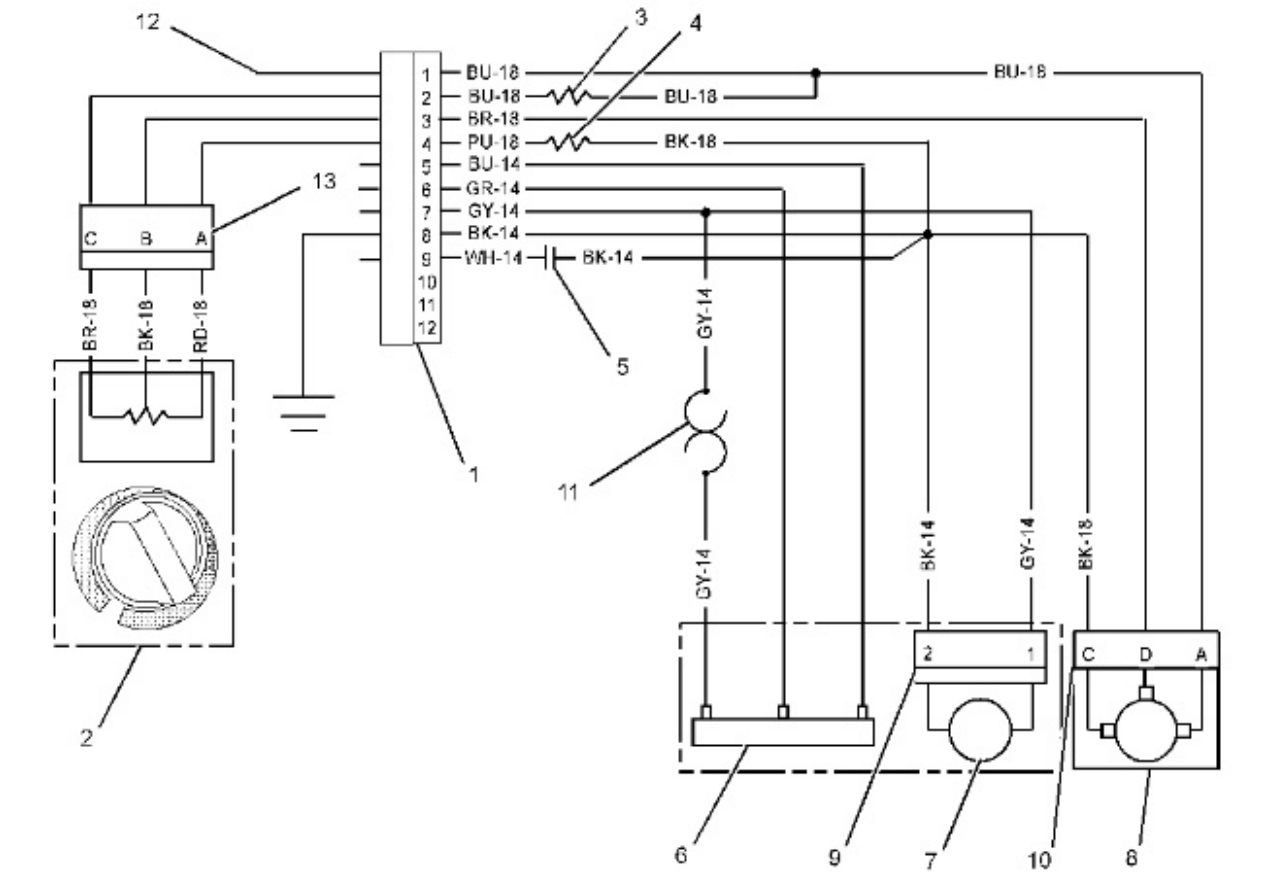


Illustration 7 g01191792

Typical Electronic Control Circuit for the blend air door

(1) Deutsch connector (12 pin)

(2) Potentiometer assembly (temperature control)

(3) Resistor 6.2 kΩ

(4) Resistor 3.3 kΩ

(5) Freeze switch

(6) Blower resistor

(7) Blower motor

(8) Electronic blend door actuator

(9) Deutsch connector (2 pin)

(10) Packard connector (3 pin)

(11) Thermal fuse

(12) 12 VDC power supply (converter)

(13) Deutsch connector (3 pin)

1. Turn off the power supply.
2. Disconnect Deutsch connector (1) .
3. Hook the multimeter leads to pin (1) and pin (8). Set the multimeter to DC voltage.
4. Turn on the power supply. The multimeter should read approximately 12 VDC.
5. Turn off the power supply.
6. Reconnect the Deutsch connector (1) .
7. Disconnect Deutsch connector (13) .
8. Connect the multimeter leads to pin (A) and pin (C) on the Deutsch connector that is on potentiometer assembly (2). Set the multimeter to read ohms. The multimeter should read 5000 ± 500 ohms.
9. Connect the multimeter leads to pin (A) and pin (B) on the Deutsch connector that is on potentiometer assembly (2). Turn the knob on the potentiometer assembly (2). The resistance should vary smoothly.
10. Reconnect Deutsch connector (13) .
11. Disconnect Packard connector (10) that is located on electronic blend door actuator (8) .
12. Disconnect Deutsch connector (1) again.
13. Connect the multimeter leads to pin (1) and pin (2) on the Deutsch connector. Set the multimeter to read ohms. The multimeter should read 6200 ± 500 ohms for the value of resistor (3) .
14. Disconnect Deutsch connector (9) that is located on blower motor (7) .
15. Connect the multimeter leads to pin (4) and pin (8) on the Deutsch connector (1). Set the multimeter to read ohms. The multimeter should read 3300 ± 500 ohms for the value of resistor (4) .
16. Reconnect Deutsch connector (9) .
17. Reconnect Deutsch connector (1) .
18. Reconnect Packard connector (10) that is located on electronic blend door actuator (8) .

19. Attach the positive multimeter leads to pin (D) and pin (C) on thePackard connector (10). Set the multimeter to DC voltage.

20. Turn on the power supply.

21. Turn the knob on potentiometer assembly (2) to full heat. The electronic blend door actuator (8) should rotate counterclockwise. The multimeter should read either −2.7 VDC or the multimeter should read 2.7 VDC.

22. Turn the knob on potentiometer assembly (2) to full cold. The electronic blend door actuator (8) should rotate clockwise. The multimeter should read either −7.0 VDC or the multimeter should read 7.0 VDC.

23. Turn off the power supply.

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i03863071

Heater Performance - Test

SMCS - 7309-081

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

In order to conduct a performance of the heating system, perform the following procedure.

1. Run the engine at 1000 rpm (low idle speed) until the engine coolant temperature is in the normal operating range.
2. Adjust the temperature control knob to the hottest position.
3. Put the fan switch in the HIGH position on heat.
4. Check the system for normal operating conditions.
    - The temperature of the air that is flowing from the louvers (air ducts) should be warm.
    - The temperature of the air should be easily controllable by the control panel in the dash.
    - There should not be a smell of coolant that is present in the cab.

If any of the three items are not working properly, refer to Service Manual, SENR5664, "Heating System Troubleshooting".

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02226499

MID 106 - CID 0070 - FMI 04

SMCS - 7332-038-BRK

Conditions Which Generate This Code:

This diagnostic code is associated with the parking brake switch. The FMI 04 means that the ECM determined that the voltage is below normal. The circuit is possibly shorted to ground.

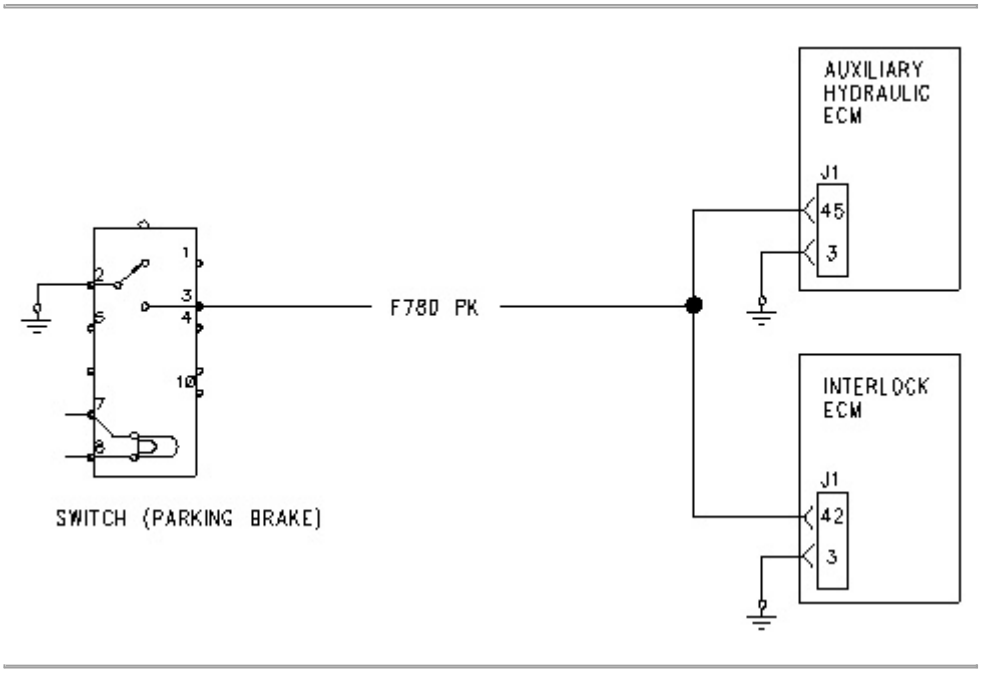


Illustration 1 g00778371

Schematic of the switch circuit for the parking brake

Test Step 1. RECHECK FOR THE DIAGNOSTIC CODE

A. Turn the key start switch to the OFF position.

B. Occupy the seat.

C. Place the armrest in the DOWN position.

D. Turn the key start switch to the ON position.

E. Press and release the parking brake switch.

F. Wait at least 30 seconds. Note the status of the parking brake indicator.

G. Check the Caterpillar ET for an active diagnostic code of CID 0070 FMI 04.

Expected Result:

The parking brake indicator should be off and the ET should not show an active diagnostic code of CID 0070 FMI 04.

Results:

- **OK -** The parking brake indicator is off and an active diagnostic code of CID 0070 FMI 04 is not displayed on the ET.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The parking brake indicator is flashing and an active diagnostic code of CID 0070 FMI 04 is displayed on the ET. Proceed to Test Step 3.

- **NOT OK -** The parking brake indicator is off and an active diagnostic code of CID 0070 FMI 04 is displayed on the ET. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 45 of the wire harness.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the

cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The wire harness is damaged between the interlock ECM and the auxiliary hydraulic ECM.

  Stop.

Test Step 3. CHECK THE PARKING BRAKE SWITCH

A. Remove the parking brake switch.

B. Disconnect the wire harness from the switch.

C. Measure the resistance from terminal 2 to terminal 3 of the parking brake switch.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The parking brake switch has failed. Replace the parking brake switch.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234253

MID 106 - CID 1187 - FMI 04

SMCS - 7332-038-FW

Conditions Which Generate This Code:

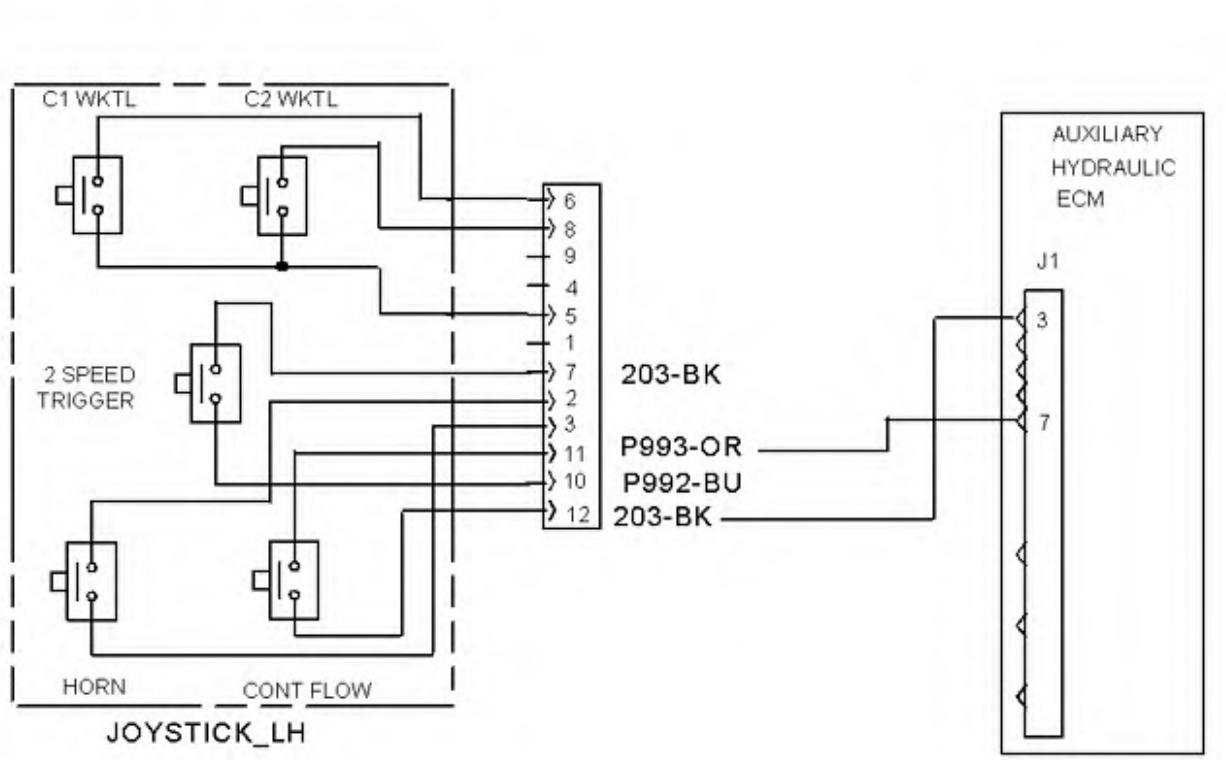


Illustration 1 g01035064

Schematic of the continuous flow switch

This diagnostic code is recorded when the ECM sees the input of the switch as grounded for more than 30 seconds.

The possible causes of the diagnostic code are listed:

- A short to ground
- The switch has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK FOR A SHORT TO GROUND.

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Turn the key start switch to the OFF position.

D. At the J1 machine harness connector, measure the resistance from contact J1-7 to all sources of ground.

Expected Result:

The resistance measurement should be greater than 5000 ohms for each measurement.

Results:

- **OK -** The resistance measurement is greater than 5000 ohms. Proceed to test step 2.
- **NOT OK -** The resistance measurement is not 5000 ohms.

  Repair: Repair the harness or replace the harness. Verify that the problem has been corrected.

  Stop.

Test Step 2. CHECK THE RESISTANCE OF THE SWITCH.

A. Press the continuous flow switch on the left joystick handle.

B. At the J1 machine harness connector, measure the resistance from contact J1-3 to J1-7.

Expected Result:

The resistance measurement should be less than 5 ohms.

Results:

- **OK -** The resistance measures less than 5 ohms. The switch is correct.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not less than 5 ohms.

  Repair: The switch has failed. The switch is internal to the handle. Replace the handle.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234274

MID 106 - CID 1188 - FMI 04

SMCS - 7332-038-L7

Conditions Which Generate This Code:

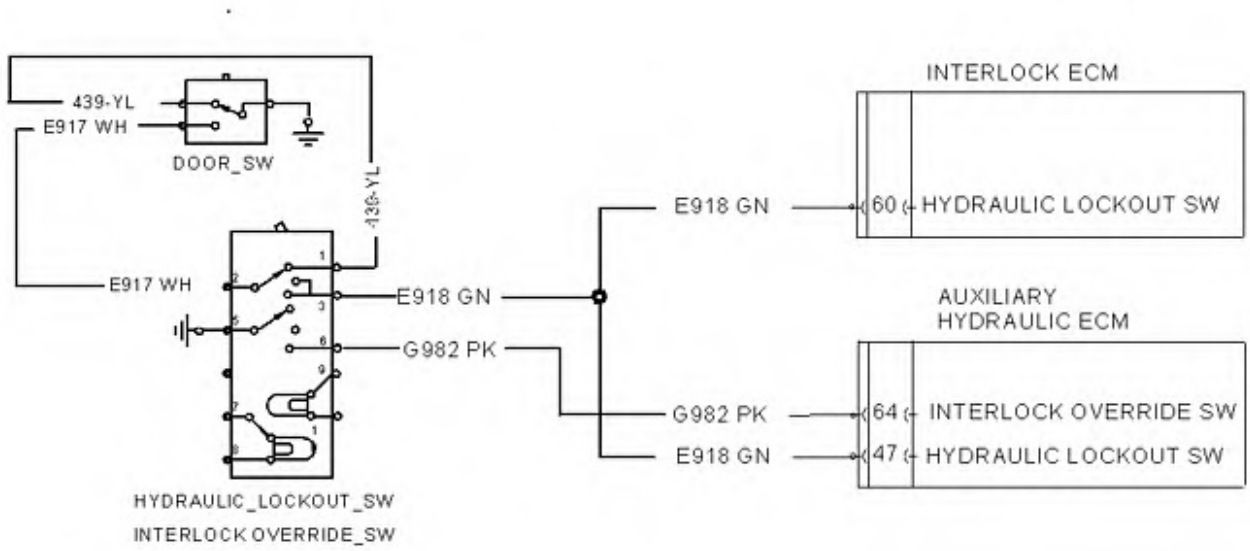


Illustration 1 g01035973

Schematic of the switch circuit for the interlock override and hydraulic lockout

This diagnostic code is associated with the switch for interlock override. The FMI 04 means that the ECM determined that the voltage is below normal. The circuit is possibly shorted to ground.

Test Step 1. CHECK THE CONTINUITY OF THE SWITCH

A. Remove the switch from the headliner.

B. Unplug the switch from the wire harness.

C. With the switch in the center position, check the resistance from terminal 6 to terminal 5.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance was less than 5000 Ohms.

  Repair: The switch has failed. Replace the switch.

  Stop.

Test Step 2. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Measure the resistance from contact 6 to contact 64 of the wiring harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was less than 5000 Ohms.

  Repair: The circuit is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234276

MID 106 - CID 1189 - FMI 00

SMCS - 5702-038-PSN

Conditions Which Generate This Code:

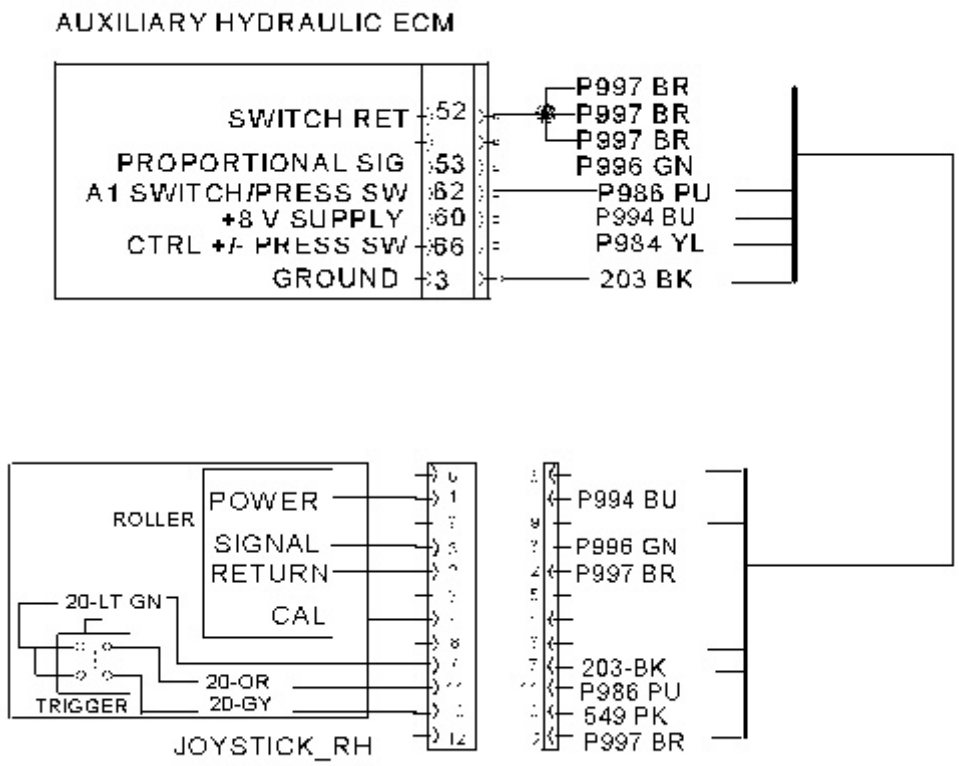


Illustration 1 g01036152

This diagnostic code is associated with the position sensor for the control of the auxiliary hydraulics. The FMI 00 means that the ECM determined that the signal is above normal operating range.

Do NOT start the machine for any of the following Test Steps.

Note: After any repair to the auxiliary hydraulic control, cycle the key start switch five times with at least five seconds between cycles in order to reset the calibrations within the auxiliary hydraulic ECM.

Test Step 1. CHECK THE DUTY CYCLE OF THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Remove the access panel for the work tool control.

C. Locate the connector for the auxiliary hydraulic control beneath the work tool control (joystick).

D. Connect the **7X-1710** Multimeter Probe to contact 3 (P996-GN) and contact 2 (P997-BR) on the harness side of the connector.

E. Turn the key start switch to the ON position.

   Do NOT start the machine.

F. By using the multimeter, measure the duty cycle of the auxiliary hydraulic control.

   Note: This measurement is performed without actuating the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%. Proceed to Test Step 5.
- **NOT OK -** The duty cycle is NOT 50% ± 3%. Proceed to Test Step 2.

Test Step 2. CHECK THE CONTINUITY OF THE GROUND CIRCUIT OF THE WIRING HARNESS

Check the resistance from contact 2 (wire P997-BR) to frame ground.

Expected Result:

The resistance should be less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is greater than 5 ohms.

Repair: The machine harness has an open in wire P997-BR.Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

Stop.

Test Step 3. CHECK THE VOLTAGE OF THE POWER CIRCUIT OF THE WIRING HARNESS

Check the voltage from contact 2 (wire P997-BR) to contact 1 (wire P994-BU).

Expected Result:

The voltage should be approximately 8 volts.

Results:

- **OK -** The voltage is approximately 8 volts. Proceed to Test Step 4.
- **NOT OK -** The voltage is NOT approximately 8 volts.

  Repair: The machine harness has an open in wire P994-BU.Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

  Stop.

Test Step 4. CHECK THE DUTY CYCLE OF THE SIGNAL CIRCUIT FROM THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Remove the pin (wire P996-GN) from contact 3 of the machine side of the connector.

C. Connect the **7X-1710** Multimeter Probe to contact 2 (P997-BR) and contact 3 (P996-GN) on the joystick's side of the connector.

D. Turn the key start switch to the ON position.

   Do NOT start the machine.

E. By using the multimeter, measure the duty cycle of the auxiliary hydraulic control.

   Note: This measurement is performed without actuating the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%.

  Repair: There is a short in the machine harness between contact 3 (P996-GN) of the connector and contact 53 of the auxiliary hydraulic ECM. Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

  Stop.

- **NOT OK -** The duty cycle is NOT 50% ± 3%.

  Repair: Contact the Technical Communicator for your Caterpillar dealership before replacing the work tool control (joystick).

  Stop.

Test Step 5. ACTUATE THE AUXILIARY HYDRAULIC CONTROL AND CHECK THE DUTY CYCLE

A. The key start switch remains in the ON position.

B. The multimeter probes remain in contact 3 and contact 2.

C. Actuate the right side of the auxiliary hydraulic control and measure the duty cycle.

D. Actuate the left side of the auxiliary hydraulic control and measure the duty cycle.

Expected Result:

The duty cycle should vary from approximately 50% to at least 20% in the A2 position and the duty cycle should vary from approximately 50% to at least 80% in the A1 position.

Results:

- **OK -** The duty cycles are within the range of the Expected Results. Proceed to Test Step 6.
- **NOT OK -** The duty cycles are NOT within the range of the Expected Results.

  Repair: The auxiliary hydraulic control has failed. Replace the work tool control (joystick).

  Stop.

Test Step 6. CHECK THE SIGNAL OF THE AUXILIARY CONTROL AT THE ECM

A. Turn the key start switch to the OFF position.

B. Remove the access panel for the auxiliary hydraulic ECM.

C. Locate the machine harness connector for the auxiliary hydraulic ECM.

D. The **7X-1710** Multimeter Probe remains in contact 2 (P997-BR) on the harness side of the connector.

E. Connect the other **7X-1710** Multimeter Probe to contact 53 (P996-GN) to the machine harness connector at the ECM.

F. Turn the key start switch to the ON position.

   Do NOT start the machine.

G. Use the multimeter and measure the duty cycle of the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%.

  Repair: Check the machine harness connectors for the proper connection. Cycle the key start switch and check for an active diagnostic code. If the diagnostic code is still active, contact the Technical Communicator for your Caterpillar dealership.

  Stop.

- **NOT OK -** The duty cycle is NOT 50% ± 3%.

  Repair: The machine harness has an open in wire P996-GN between contact 53 of the ECM and contact 3 of the connector for the auxiliary hydraulic control.Repair the wire harness and retest this Test Step. After the repair, verify that the diagnostic code is no longer active. If the diagnostic code is still active, contact the Technical Communicator for your Caterpillar dealership.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02003425

MID 106 - CID 1189 - FMI 01

SMCS - 5702-038-PSN

Conditions Which Generate This Code:

This diagnostic code is associated with the position sensor for the control of the auxiliary hydraulics. The FMI 01 means that the ECM determined that the signal is below normal operating range.

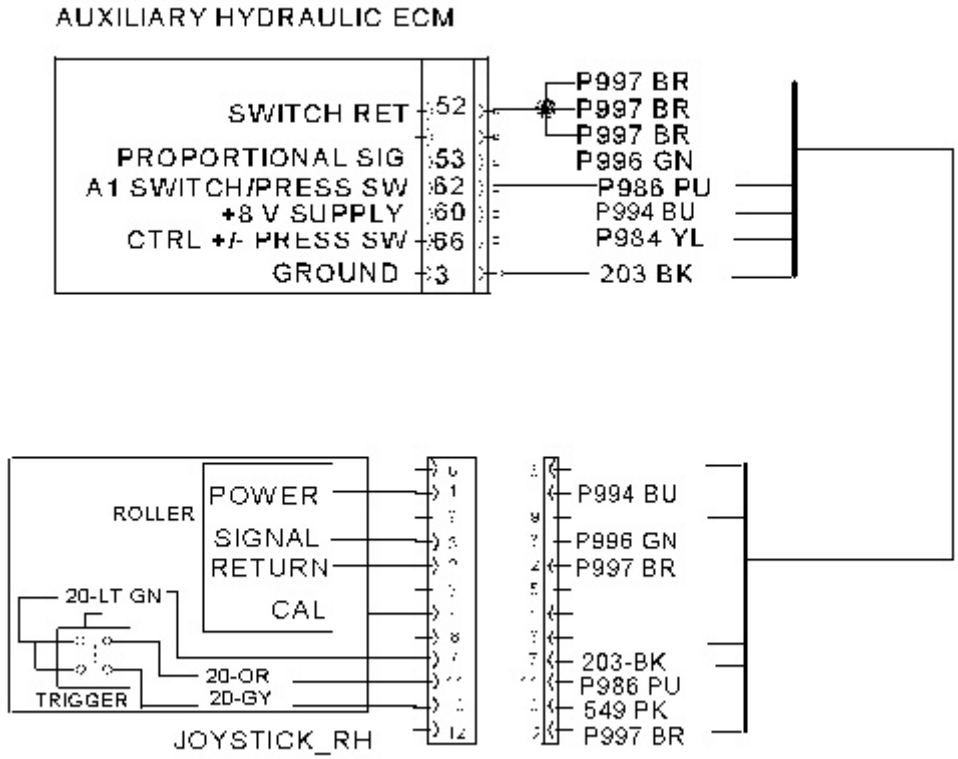


Illustration 1 g01036152

Schematic of the auxiliary control for the auxiliary hydraulics

Do NOT start the machine for any of the following Test Steps.

Note: After any repair to the auxiliary hydraulic control, cycle the key start switch five times with at least five seconds between cycles in order to reset the calibrations within the auxiliary hydraulic ECM.

Test Step 1. CHECK THE DUTY CYCLE OF THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Remove the access panel for the work tool control (joystick).

C. Locate the connector for the auxiliary hydraulic control beneath the work tool control (joystick).

D. Connect the **7X-1710** Multimeter Probe to contact 3 (P996-GN) and contact 2 (P997-BR) on the harness side of the connector.

E. Turn the key start switch to the ON position.

Do NOT start the machine.

F. Measure the duty cycle of the auxiliary hydraulic control by using the multimeter.

Note: This measurement is performed without actuating the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%. Proceed to Test Step 5.
- **NOT OK -** The duty cycle is NOT 50% ± 3%. Proceed to Test Step 2.

Test Step 2. CHECK THE CONTINUITY OF THE GROUND CIRCUIT OF THE WIRING HARNESS

Check the resistance from contact 2 (wire P997-BR) to frame ground.

Expected Result:

The resistance should be less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. Proceed to Test Step 3.

- **NOT OK -** The resistance is greater than 5 ohms.

  Repair: The machine harness has an open in wire P997-BR.Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

  Stop.

Test Step 3. CHECK THE VOLTAGE OF THE POWER CIRCUIT OF THE WIRING HARNESS

Check the voltage from contact 2 (wire P997-BR) to contact 1 (wire P994-BU).

Expected Result:

The voltage should be approximately 8 volts.

Results:

- **OK -** The voltage is approximately 8 volts. Proceed to Test Step 4.
- **NOT OK -** The voltage is NOT approximately 8 volts.

  Repair: The machine harness has an open in wire P994-BU.Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

  Stop.

Test Step 4. CHECK THE DUTY CYCLE OF THE SIGNAL CIRCUIT FROM THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Remove the pin (wire P996-GN) from contact 3 of the machine side of the connector.

C. Connect the **7X-1710** Multimeter Probe to contact 2 (P997-BR) and contact 3 (P996-GN) on the joystick's side of the connector.

D. Turn the key start switch to the ON position.

   Do NOT start the machine.

E. By using the multimeter, measure the duty cycle of the auxiliary hydraulic control.

   Note: This measurement is performed without actuating the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%.

  Repair: There is a short in the machine harness between contact 1 (P996-GN) of the connector and contact 53 of the auxiliary hydraulic ECM. Repair the wire harness. After the repair, retest the Tests from Test Step 1 if the diagnostic code is still active.

Stop.

- **NOT OK -** The duty cycle is NOT 50% ± 3%.

  Repair: Contact the Technical Communicator for your Caterpillar dealership before replacing the work tool control (joystick).

  Stop.

Test Step 5. ACTUATE THE AUXILIARY HYDRAULIC CONTROL AND CHECK THE DUTY CYCLE

A. The key start switch remains in the ON position.

B. The multimeter probes remain in contact 3 and contact 2.

C. Actuate the right side of the auxiliary hydraulic control and measure the duty cycle.

D. Actuate the left side of the auxiliary hydraulic control and measure the duty cycle.

Expected Result:

The duty cycle should vary from approximately 50% to at least 20% in the A2 position and the duty cycle should vary from approximately 50% to at least 80% in the A1 position.

Results:

- **OK -** The duty cycles are within the range of the Expected Results. Proceed to Test Step 6.
- **NOT OK -** The duty cycles are NOT within the range of the Expected Results.

  Repair: The auxiliary control has failed. Replace the control handle.

  Stop.

Test Step 6. CHECK THE SIGNAL OF THE AUXILIARY HYDRAULIC CONTROL AT THE ECM

A. Turn the key start switch to the OFF position.

B. Remove the access panel for the auxiliary hydraulic ECM.

C. Locate the machine harness connector for the auxiliary hydraulic ECM.

D. The **7X-1710** Multimeter Probe remains in contact 2 (P997-BR) on the harness side of the connector.

E. Connect the other **7X-1710** Multimeter Probe to contact 53 (P996-GN) to the machine harness connector at the ECM.

F. Turn the key start switch to the ON position.

   Do NOT start the machine.

G. Use the multimeter and measure the duty cycle of the auxiliary hydraulic control.

Expected Result:

The duty cycle should be 50% ± 3%.

Results:

- **OK -** The duty cycle is 50% ± 3%.

  Repair: Check the machine harness connectors for the proper connection. Cycle the key start switch and check for an active diagnostic code. If the diagnostic code is still active, contact the Technical Communicator for your Caterpillar dealership.

  Stop.

- **NOT OK -** The duty cycle is NOT 50% ± 3%.

  Repair: The machine harness has an open in wire P996-GN between contact 53 of the ECM and contact 3 of the connector for the auxiliary hydraulic control.Repair the wire harness and retest this Test Step. After the repair, verify that the diagnostic code is no longer active. If the diagnostic code is still active, contact the Technical Communicator for your Caterpillar dealership.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234277

MID 106 - CID 1189 - FMI 04

SMCS - 7332-038-AX

Conditions Which Generate This Code:

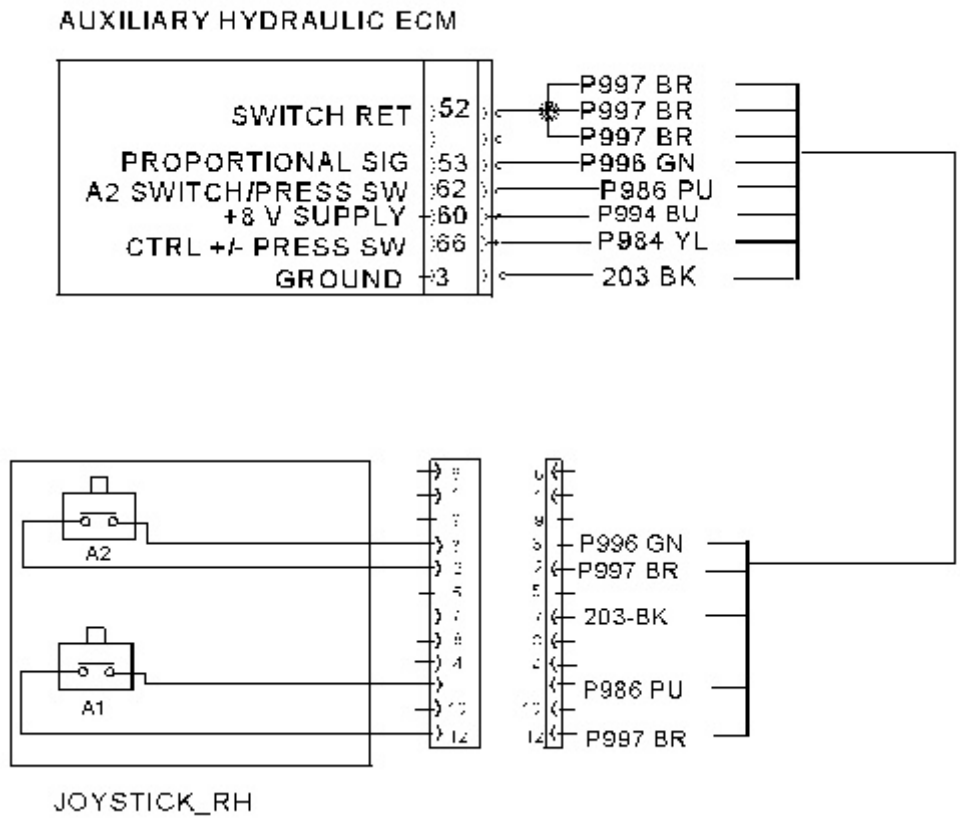


Illustration 1 g01044758

Schematic of the switch circuit for the auxiliary hydraulics



Illustration 2 g00778978

Location of the switch connections for the auxiliary hydraulics

This diagnostic code is associated with the switches for the auxiliary hydraulics. The FMI 04 means that the ECM determined that the voltage is below normal. The circuit is possibly shorted to ground.

Test Step 1. CHECK THE CONTINUITY OF THE SWITCHES

A. Locate the switch connector harness for the auxiliary hydraulic circuit beneath the right hand joystick through the access panel.

B. Unplug the switch connector harness.

C. Measure the resistance from contact 1 to contact 2 and from contact 3 to contact 4 of the switch side of the connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: The switch has failed. Replace the joystick.

  Stop.

Test Step 2. CHECK FOR A SHORT CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Measure the resistance from contact 52 to contacts 53 and 62 of the wire harness connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 3. CHECK FOR A SHORT TO GROUND IN THE CIRCUIT

A. Measure the resistance from contact 3 to contacts 52, 53, and 62 of the wire harness connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234278

MID 106 - CID 1189 - FMI 08

SMCS - 5702-038-PSN

Conditions Which Generate This Code:

This diagnostic code is associated with the position sensor for the auxiliary control. The FMI 08 means that the ECM determined that the signal is abnormal.

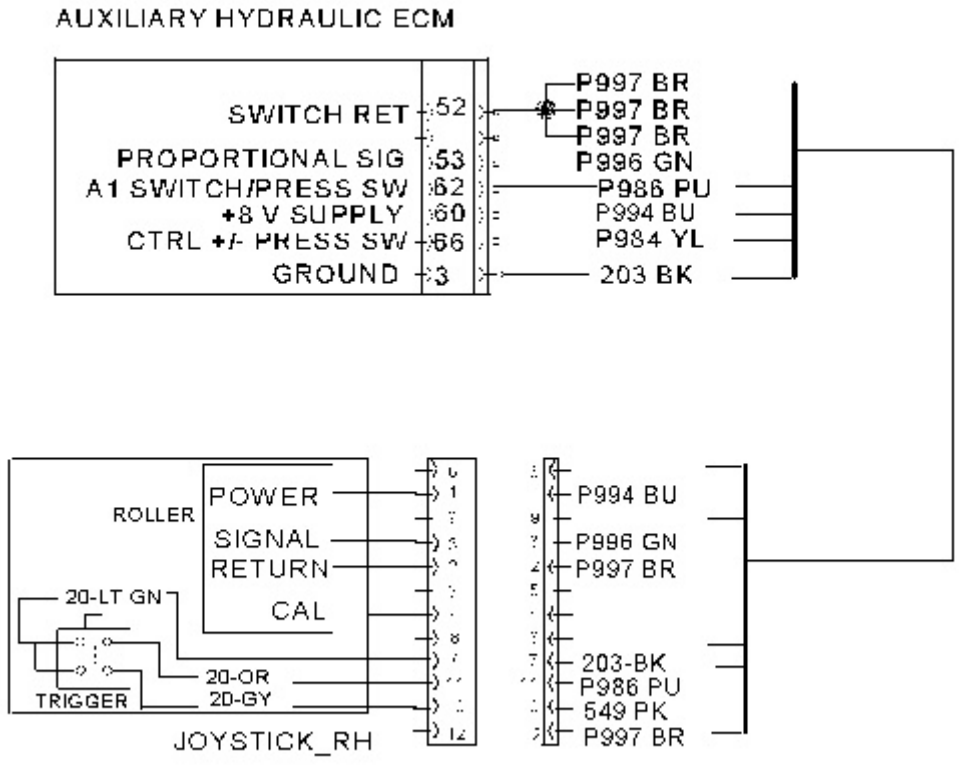


Illustration 1 g01036152

Schematic of the auxiliary control for the auxiliary hydraulics

Do NOT start the machine for any of the following Test Steps.

Note: After any repair to the auxiliary hydraulic control, cycle the key start switch five times with at least five seconds between cycles in order to reset the calibrations within the auxiliary hydraulic ECM.

Test Step 1. CHECK THE DUTY CYCLE OF THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Remove the access panel for the work tool control (joystick).

C. Locate the connector for the auxiliary hydraulic control beneath the work tool control (joystick).

D. Connect the **7X-1710** Multimeter Probe to contact 3 (P996-GN) and contact 2 (P997-BR) on the harness side of the connector.

E. Turn the key start switch to the ON position.

Do NOT start the machine.

F. By using the multimeter, measure the duty cycle of the auxiliary hydraulic control.

Without actuating the auxiliary hydraulic control, the duty cycle should be 50% ± 3%.

G. Actuate the right side of the auxiliary hydraulic control and measure the duty cycle.

H. Actuate the left side of the auxiliary hydraulic control and measure the duty cycle.

Expected Result:

The duty cycle should vary from 50% ± 3% to at least 20% in the right direction and 50% ± 3% to at least 80% in the left direction.

Results:

- **OK -** The duty cycles are within the range of the Expected Results. Proceed to Test Step 2.
- **NOT OK -** The duty cycles are NOT within the range of the Expected Results. Proceed to Test Step 4.

Test Step 2. CHECK THE FREQUENCY OF THE AUXILIARY HYDRAULIC CONTROL

A. With the auxiliary hydraulic control in the center position, measure the frequency of the auxiliary hydraulic control from contact 3 to contact 2 of the connector for the auxiliary control.

Expected Result:

The frequency should be between 400 Hz and 700 Hz.

Results:

- **OK -** The frequency is between 400 Hz and 700 Hz. Proceed to Test Step 3.
- **NOT OK -** The frequency is less than 400 Hz or the frequency is greater than 700 Hz.

  Repair: The auxiliary control has failed. Replace the control handle.

  Stop.

Test Step 3. CHECK THE FREQUENCY OF THE AUXILIARY HYDRAULIC CONTROL AT THE ECM

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the auxiliary hydraulic ECM.

C. Connect the **7X-1710** Multimeter Probe to contact 53 (P996-GN) and contact 52 (P997-BR).

D. Turn the key start switch to the ON position.

E. Measure the frequency.

Expected Result:

The frequency should be between 400 Hz and 700 Hz.

Results:

- **OK -** The frequency is between 400 Hz and 700 Hz.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The frequency is less than 400 Hz or the frequency is greater than 700 Hz.

  Repair: The wire harness and/or the connector has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 4. CHECK FOR VOLTAGE AT THE AUXILIARY HYDRAULIC CONTROL

A. Turn the key start switch to the OFF position.

B. Disconnect the 12-pin connector from the auxiliary hydraulic control.

C. Turn the key start switch to the ON position.

D. Measure the voltage from contact 8 (P994-BU) to contact 2 (P997-BR).

Expected Result:

The voltage should be approximately 8 VDC.

Results:

- **OK -** The voltage is approximately 8 VDC.

  Repair: The auxiliary hydraulic control has failed. Replace the work tool control (joystick).

  Stop.

- **NOT OK -** The voltage is considerably less than 8 VDC. Proceed to Test Step 5.

Test Step 5. CHECK FOR VOLTAGE AT THE ECM

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the auxiliary hydraulic ECM.

C. Connect the **7X-1710** Multimeter Probe to contact 60 (P994-BU) and contact 52 (P997-BR).

D. Turn the key start switch to the ON position.

E. Measure the voltage.

Expected Result:

The voltage should be approximately 8 VDC.

Results:

- **OK -** The voltage is approximately 8 VDC.

  Repair: The wire harness and/or the connector has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The voltage is considerably less than 8 VDC.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234279

MID 106 - CID 1190 - FMI 04

SMCS - 1435-038-AN

Conditions Which Generate This Code:

The diagnostic code is associated with the switches for the seat and the armrest. The FMI 04 means that the ECM determined that the voltage is below normal. Both circuits are possibly shorted to ground.

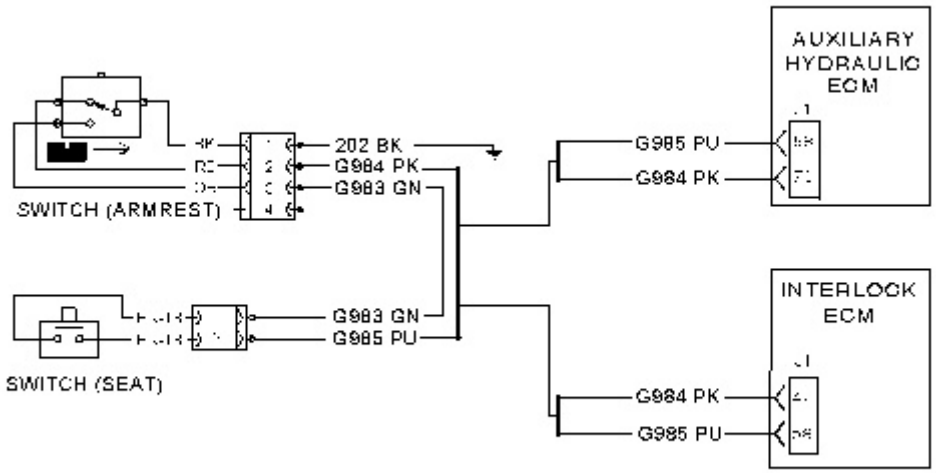


Illustration 1 g01047879

Schematic for the switch circuit (armrest and seat)

Test Step 1. CHECK FOR AN ACTIVE DIAGNOSTIC CODE WITH ARMREST IN THE UP POSITION

A. Do not occupy the seat.

B. Place the armrest in the UP position.

C. Turn the key start switch to the ON position.

Expected Result:

An active diagnostic code of CID 1190 FMI 04 should not be displayed on the Caterpillar ET and the armrest indicator should be on.

Results:

- **OK -** An active diagnostic code of CID 1190 FMI 04 is not displayed on the Caterpillar ET and the armrest indicator is on. Proceed to Test Step 5.
- **NOT OK -** An active diagnostic code of CID 1190 FMI 04 is displayed on the Caterpillar ET and the armrest indicator is flashing. Proceed to Test Step 3.
- **NOT OK -** An active diagnostic code of CID 1190 FMI 04 is displayed on the Caterpillar ET and the armrest indicator is on. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 58 of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The wire harness is damaged between the interlock ECM and the auxiliary hydraulic ECM.

  Stop.

Test Step 3. CHECK THE CIRCUIT FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 58 of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms. Proceed to Test Step 4.

Test Step 4. CHECK THE CIRCUIT WHILE THE INTERLOCK ECM IS DISCONNECTED

A. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

B. Locate the Interlock ECM. The interlock ECM is located on the back side of the cab. The cab must be in the RAISED position in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 58 of the wire harness for the auxiliary hydraulic ECM.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still

exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The circuit is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

Test Step 5. CHECK FOR AN ACTIVE DIAGNOSTIC CODE WITH THE ARMREST IN THE UP POSITION AND WITH OCCUPYING THE SEAT

A. Occupy the seat.

B. Leave the armrest in the UP position.

Expected Result:

An active diagnostic code of CID 1190 FMI 04 should not be displayed on the Caterpillar ET .

Results:

- **OK -** An active diagnostic code of CID 1190 FMI 04 is not displayed on the Caterpillar ET. Proceed to Test Step 7.
- **NOT OK -** An active diagnostic code of CID 1190 FMI 04 is displayed on the Caterpillar ET. Proceed to Test Step 6.

Test Step 6. CHECK THE ARMREST SWITCH



Illustration 2 g00779041

Location of the connector for the armrest switch

A. Turn the key start switch to the OFF position.

B. Disconnect the connector for the armrest switch.

C. Measure the resistance from contact 1 to contact 3 of the switch connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: Wire G983-GN is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The armrest switch has failed. Replace the switch.

  Stop.

Test Step 7. CHECK FOR AN ACTIVE DIAGNOSTIC CODE WITH THE ARMREST IN THE DOWN POSITION AND WITH OCCUPYING THE SEAT

A. Occupy the seat.

B. Place the armrest in the DOWN position.

Expected Result:

An active diagnostic code of CID 1190 FMI 04 should not be displayed on the Caterpillar ET and the armrest indicator should be off.

Results:

- **OK -** An active diagnostic code of CID 1190 FMI 04 is not displayed on the Caterpillar ET and the armrest indicator is off.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** An active diagnostic code of CID 1190 FMI 04 is displayed on the Caterpillar ET and the armrest indicator is flashing. Proceed to Test Step 8.

- **NOT OK -** An active diagnostic code of CID 1190 FMI 04 is displayed on the Caterpillar ET and the armrest indicator is on. Proceed to Test Step 9.

Test Step 8. CHECK THE ARMREST SWITCH



Illustration 3 g00779041

Location of the connector for the armrest switch

A. Turn the key start switch to the OFF position.

B. Leave the armrest in the DOWN position.

C. Disconnect the connector for the armrest switch.

D. Measure the resistance from contact 1 to contact 2 of the switch connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: Wire G984-PK is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The armrest switch has failed. Replace the switch.

  Stop.

Test Step 9. CHECK THE CIRCUIT FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 47 of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is less than 5000 Ohms.

  Repair: The wire harness is damaged between the interlock ECM and the auxiliary hydraulic ECM.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234290

MID 106 - CID 1695 - FMI 04

SMCS - 7332-038-VF

Conditions Which Generate This Code:

This diagnostic code is associated with the switch for the two speed. The FMI 04 means that the ECM determined that the voltage is below normal. The circuit has been shorted to ground for more than 30 seconds.

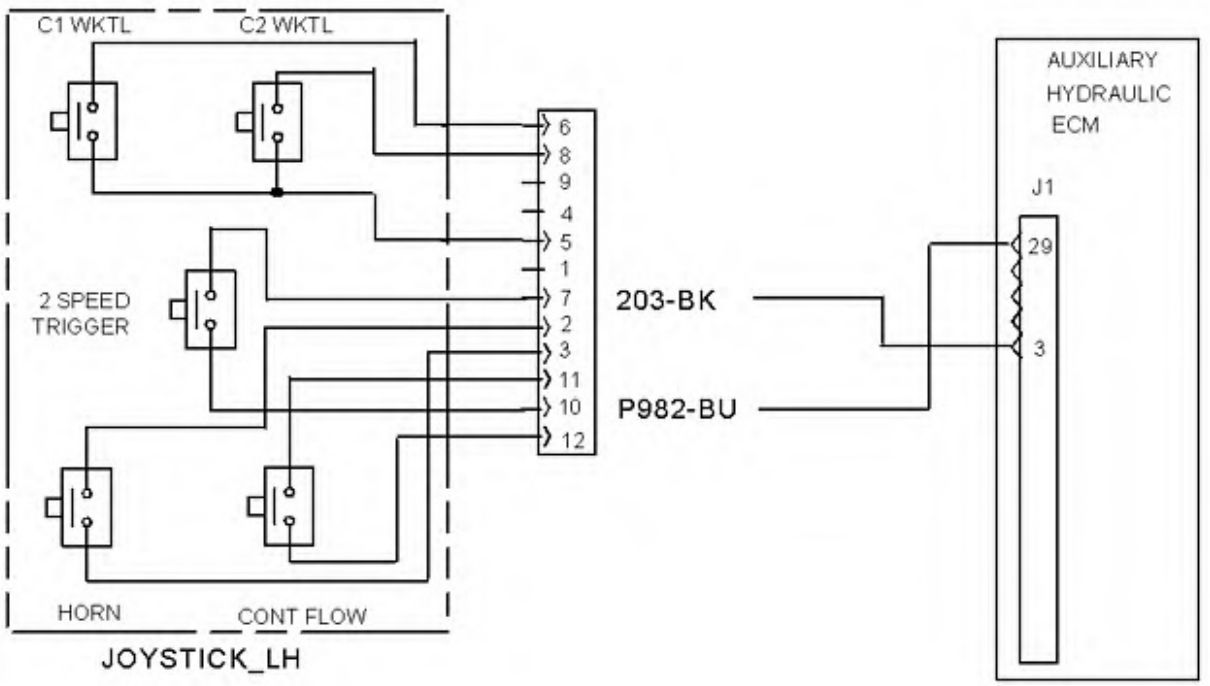


Illustration 1 g01035773

Schematic of the switch circuit for the two speed

Test Step 1. CHECK THE CONTINUITY OF THE SWITCHES

A. Locate the switch connector harness for the two speed circuit beneath the left hand joystick through the access panel.

B. Unplug the switch connector harness.

C. Measure the resistance from contact 7 to contact 10 of the switch side of the connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 2.

- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: The switch has failed. Replace the joystick.

  Stop.

Test Step 2. CHECK FOR A SHORT CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Measure the resistance from contact 3 to contact 29 of the wire harness connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: The circuit is shorted to ground in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234297

MID 106 - CID 1935 - FMI 03

SMCS - 7332-038

Conditions Which Generate This Code:

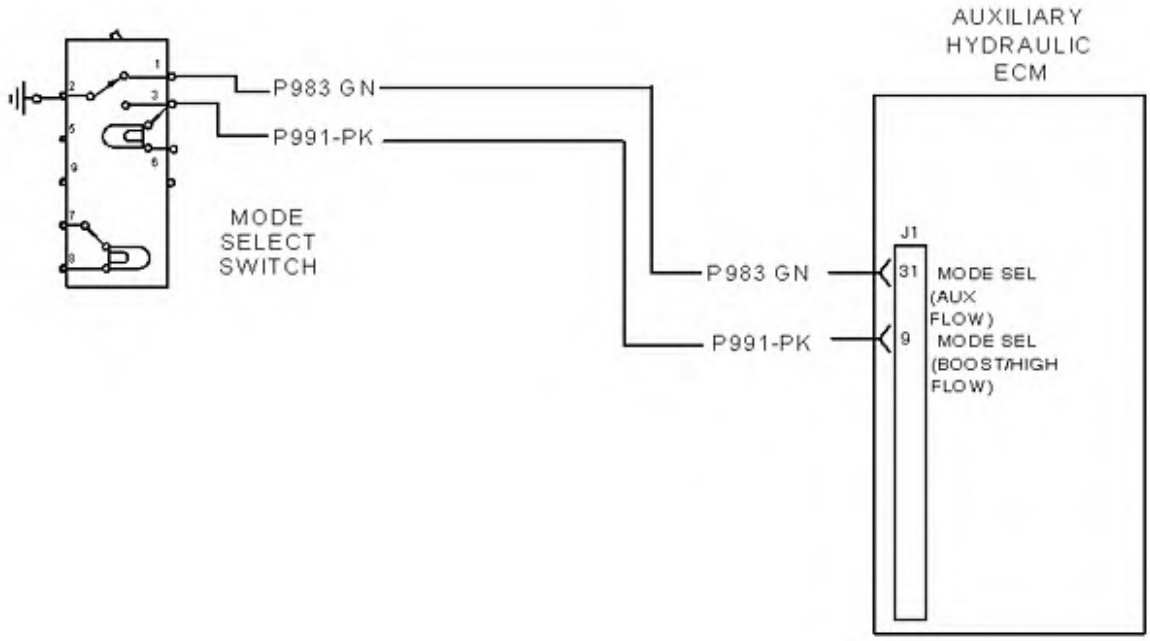


Illustration 1 g01037370

Schematic of the circuit for the auxiliary hydraulic mode select switch

The circuit for the mode select switch has two inputs for the ECM. One contact is open and the other contact is grounded during proper operation. A failure is detected when both inputs are in the open state.

The possible causes of the problem are listed below:

- The machine harness has failed.
- The switch has failed.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE HARNESS.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. Measure the resistance between contact J1-3 (wire 203-BK) of the machine harness for the ECM and the contact 2 (wire 203-BK) .

Expected Result:

The resistance is less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 2.
- **NOT OK -** The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  Repair: Repair the machine harness or replace the machine harness.

  Stop.

Test Step 2. CHECK THE SWITCH CIRCUITS FOR A SHORT TO THE +BATTERY CIRCUIT.

A. The machine harness connector(s) remains disconnected from the ECM.

B. The disconnect switch and the key start switch remain in the OFF position.

C. Disconnect contact 3 (wire P991-PK) and contact1 (wire P983-GN) from the connector of the switch.

D. At the machine harness connector for the ECM, measure the resistance from contact J1-31 (wire P983-GN) and contact J1-9 (wire P991-PK) of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **OK -** Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 3.
- **NO -** One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  Repair: The short is between wire P983-GN and the circuit with the lowest resistance measurement or the short is between wire P991-PK and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  Stop.

Test Step 3. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

A. The machine harness remains disconnected from the ECM and the switch.

B. At the harness connector for the switch, connect a jumper wire between contact 3 (wire P991-PK) and contact 1 (wire P983-GN).

C. At the harness connector for the ECM, measure the resistance from contact J1-31 (wire P983-GN) to contact J1-9 (wire P991-PK).

Expected Result:

The resistance is less than 5 ohms.

Results:

- **OK -** The resistance is less than 5 ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is greater than 5000 ohms. The circuit is open.

  Repair: The machine harness has failed. Repair the machine harness or replace the machine harness.

  Stop.

Test Step 4. CHECK THE OPERATION OF THE SWITCH.

A. Remove the jumper that was installed in the previous Test Step.

B. The machine harness remains disconnected from the switch.

C. Connect one lead from a multimeter to contact 2 (wire 203-BK) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 3 (wire P991-PK) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 203-BK) and contact 3 (wire P991-PK). Note the resistance.

F. Disconnect the lead from contact 3 (wire P991-PK) and connect the lead to contact 1 (wire P983-GN).

G. Measure the resistance between contact 2 (wire 203-BK) and contact 1 (wire P983-GN).

Expected Result:

The resistance from contact 2 to contact 1 is less than 5 ohms, and the resistance from contact 2 to contact 3 is greater than 5000 ohms.

Results:

- **YES -** The resistance from contact 2 to contact 1 is less than 5 ohms, and the resistance from contact 2 to contact 3 is greater than 5000 ohms. The switch is operating correctly. Proceed to Test Step 5.
- **NO -** The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

Stop.

Test Step 5. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 203-BK) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 3 (wire P991-PK) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 203-BK) and contact 3 (wire P991-PK). Note the resistance.

F. Disconnect the lead from contact 3 (wire P991-PK) and connect the lead to contact 1 (wire P983-GN).

G. Measure the resistance between contact 3 (wire P991-PK) and contact 1 (wire P983-GN).

Expected Result:

The resistance from contact 2 (wire 203-BK) to contact 3 (wire P991-PK) is less than 5 ohms, and the resistance from contact 2 (wire 203-BK) and contact 1 (wire P983-GN) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- **YES -** The resistance from contact 2 to contact 3 is less than 5 ohms, and the resistance from contact 2 and contact 1 is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 6.

- **NO -** The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  Stop.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the harness connectors.

B. Reconnect all the harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Check the status of the CID 1935 FMI 03.

Expected Result:

The CID 1935 FMI 03 is active.

Results:

- **YES -** The CID 1935 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1935 FMI 03 is not active. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234299

MID 106 - CID 1935 - FMI 04

SMCS - 7332-038

Conditions Which Generate This Code:

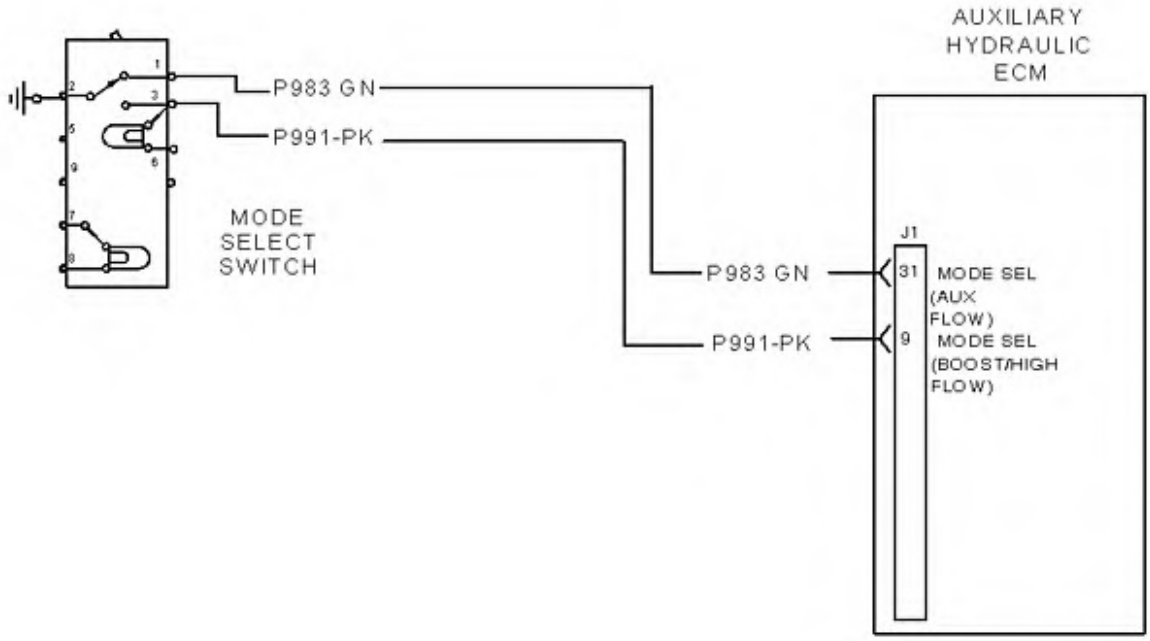


Illustration 1 g01037370

The circuit for the mode select switch has two inputs for the ECM. One contact is open and the other contact is grounded during proper operation. A failure is detected when the ECM has determined that the normally open or the normally closed circuits are shorted to ground.

The possible causes of the problem are listed below:

- The machine harness has failed.
- The switch has failed.
- The ECM has failed. This is unlikely.

Note: Ensure that CID 1935 FMI 04 is on hold and that the diagnostic code is active.

Test Step 1. CHECK THE SWITCH

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness from the switch.

C. Turn the key start switch to the ON position.

Expected Result:

The CID 1935 FMI 04 has been replaced by CID 1935 FMI 03.

Results:

- **OK -** The CID 1935 FMI 04 has been replaced by CID 1935 FMI 03. The machine harness and the ECM are correct. Proceed to Test Step 3.
- **NOT OK -** The CID 1935 FMI 04 is still active. Proceed to Test Step 2.

Test Step 2. CHECK THE HARNESS

A. Turn the key start switch to the OFF position.

B. The machine harness remains disconnected from the switch.

C. Disconnect the machine harness connector(s) from the ECM.

D. Measure the resistance between contacts J1-31 (wire P983-GN) and J1-9 (wire P991-PK) of the machine harness to all the contacts that are used in machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **YES -** Each resistance measurement is greater than 5000 ohms. The ECM has failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** One or more of the resistance measurements are less than 5 ohms. The harness has failed. The short is between J1-31 (wire P983-GN) and the circuit with the lowest resistance or the short is between J1-9 (wire P991-PK) and the circuit with the lowest resistance.

  Repair: Repair the wiring harness or replace the wiring harness.

  Stop.

Test Step 3. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Connect one lead from a multimeter to contact2 (wire 203-BK) of the harness connector for the switch.

C. Connect the other lead from a multimeter to contact 3 (wire P991-PK) of the harness connector for the switch.

D. Measure the resistance between contact 2 (wire 203-BK) and contact 3(wire P991-PK). Note the resistance.

E. Disconnect the lead from contact 3 (wire P991-PK) and connect the lead to contact 1 (wire P983-GN) .

F. Measure the resistance between contact 3 (wire P991-PK) and contact 1 (wire P983-GN).

Expected Result:

The resistance from contact 2 (wire 203-BK) to contact 1 (wire P983-GN) is less than 5 ohms, and the resistance from contact 2 (wire 203-BK) to contact 3 (wire P991-PK) is greater than 5000 ohms.

Results:

- **YES -** The resistance from contact 2 (wire 203-BK) to contact 1 (wire P983-GN) is less than 5 ohms, and the resistance from contact 2 (wire 203-BK) to contact 3 (wire P991-PK) is greater than 5000 ohms. Proceed to Test Step 4.
- **NO -** The resistance measurements do not differ. The switch has failed.

  Repair: Replace the switch.

  Stop.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

A. The machine harness remains disconnected from the switch.

B. Press and hold the switch.

C. Connect one lead from a multimeter to contact 2 (wire 203-BK) of the harness connector for the switch.

D. Connect the other lead from a multimeter to contact 3(wire P991-PK) of the harness connector for the switch.

E. Measure the resistance between contact 2 (wire 203-BK) and contact 3 (wire P991-PK). Note the resistance.

F. Disconnect the lead from contact 3 (wire P991-PK) and connect the lead to contact 1 (wire P983-GN).

G. Measure the resistance between contact 2 (wire 203-BK) and contact 1 (wire P983-GN).

Expected Result:

The resistance from contact 2 (wire 203-BK) to contact 3 (wire P991-PK) is less than 5 ohms, and the resistance from contact 2 (wire 203-BK) and contact 1 (wire P983-GN) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step.

Results:

- **YES -** The resistance from contact 2 (wire 203-BK) to contact 1 (wire P991-PK) is less than 5 ohms, and the resistance from contact 2 (wire 203-BK) and contact 1 (wire P983-GN) is greater than 5000 ohms. These measurements are opposite of the measurements from the previous Test Step. The switch is operating correctly. Proceed to Test Step 5.
- **NO -** The resistance measurements do not differ for both contacts, or the measurements have not changed from the previous Test Step. The switch has failed.

  Repair: Replace the switch.

  Stop.

Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS.

A. Inspect the contacts of the harness connectors and clean the connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine.

E. Determine if CID 1935 FMI 04 is present.

Expected Result:

The CID 1935 FMI 04 is active.

Results:

- **YES -** The CID 1935 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NO -** The CID 1935 FMI 04 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  Stop.

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Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234325

Switch (Two Speed)

SMCS - 7332-038-VF

System Operation Description:

The two speed switch activates the two speed function. When the two speed function is activated, the indicator for the two speed will illuminate.

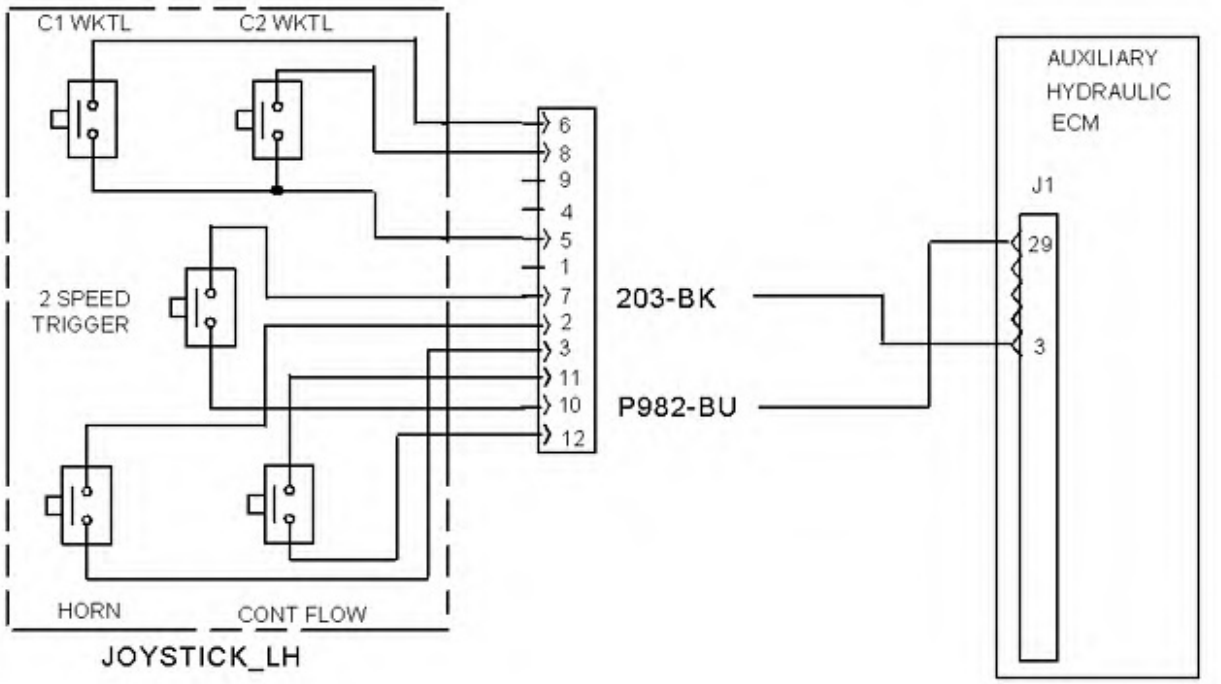


Illustration 1 g01035773

Schematic of the switch circuit for the two speed

Test Step 1. CHECK FOR PROPER OPERATION

A. Enable the machine.

B. Depress the two speed switch.

Expected Result:

The indicator for the two speed should illuminate.

Results:

- **OK -** The indicator for the two speed illuminates.

  Repair: The switch is operating correctly.

Stop.

- **NOT OK -** The indicator for the two speed does not illuminate. Proceed to Test Step 2.

Test Step 2. CHECK THE STATUS OF THE SWITCH

A. Depress the two speed switch.

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The status of the switch changed from the "CLOSED" status to the "OPEN" status.

  Repair: The switch is operating correctly.If the two speed function is not operating, check the solenoid circuit.

  Stop.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 3.

Test Step 3. CHECK THE CONTINUITY OF THE SWITCH

A. Locate the switch connector harness for the two speed circuit beneath the left hand joystick through the access panel.

B. Unplug the switch connector harness.

C. Press the switch.

D. Measure the resistance from contact 7 to contact 10 of the switch side of the connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The switch has failed. Replace the joystick.

  Stop.

Test Step 4. CHECK THE SWITCH CIRCUIT

A. Reinstall the connector for the switch.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch.

E. Measure the resistance from contact 3 to contact 29 of the wiring harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i01997422

Switch (Hydraulic Lockout)

SMCS - 7332-038-HR

System Operation Description:

The switch tells the auxiliary hydraulic ECM that the operator wants to disable the auxiliary hydraulic circuit and the high flow auxiliary circuit. The switch also tells the interlock ECM that the operator wants to disable the work tool.

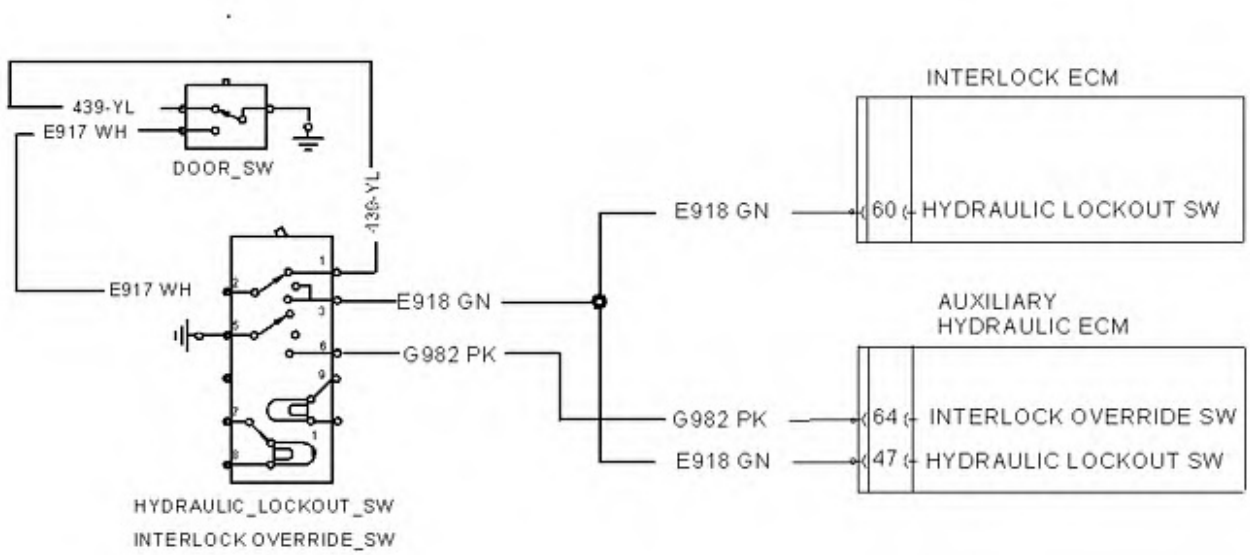


Illustration 1 g01035973

Schematic for the switch circuit for the hydraulic lockout

Test Step 1. CHECK FOR PROPER OPERATION

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Place the work tool lockout switch in the OFF position.

E. Press and release the parking brake switch.

Expected Result:

The auxiliary hydraulics and/or the high flow should function.

Results:

- **OK -** The auxiliary hydraulics and/or the high flow is functioning. Proceed to Test Step 2.
- **NOT OK -** The auxiliary hydraulics and/or the high flow does not function and the main work tool is functioning. Proceed to Test Step 3.
- **NOT OK -** The auxiliary hydraulics and/or the high flow does not function and the main work tool does not function.

  Repair: See Troubleshooting, RENR6417, "Switch (Hydraulic Lockout)".

  Stop.

Test Step 2. CHECK FOR PROPER OPERATION

A. Place the hydraulic lockout switch in the ON position.

Expected Result:

The auxiliary hydraulics and/or the high flow should not function.

Results:

- **OK -** The auxiliary hydraulics and/or the high flow does not function.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics and/or the high flow is functioning and the main work tool is not functioning. Proceed to Test Step 3.
- **NOT OK -** The auxiliary hydraulics and/or the high flow is functioning and the main work tool is functioning.

  Repair: See Troubleshooting, RENR6417, "Switch (Hydraulic Lockout)".

  Stop.

Test Step 3. CHECK THE CONTINUITY OF THE SWITCH

A. Remove the switch from the headliner.

B. Unplug the switch from the wire harness.

C. Place the switch in the ON position.

D. Measure the resistance from contact 3 to contact 2 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms. Proceed to Test Step 4.
- **NOT OK -** The resistance is not less than 5 Ohms.

  Repair: The switch has failed. Replace the switch.

  Stop.

Test Step 4. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Place the switch in the ON position.

D. Measure the resistance from contact 3 to contact 47 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: See Troubleshooting, RENR6417, "Switch (Hydraulic Lockout)".

  Stop.

- **NOT OK -** The resistance is not less than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector between the interlock ECM and the auxiliary hydraulic ECM. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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i02234328

Switch (Armrest) and Switch (Seat)

SMCS - 1435-038-AN

System Operation Description:

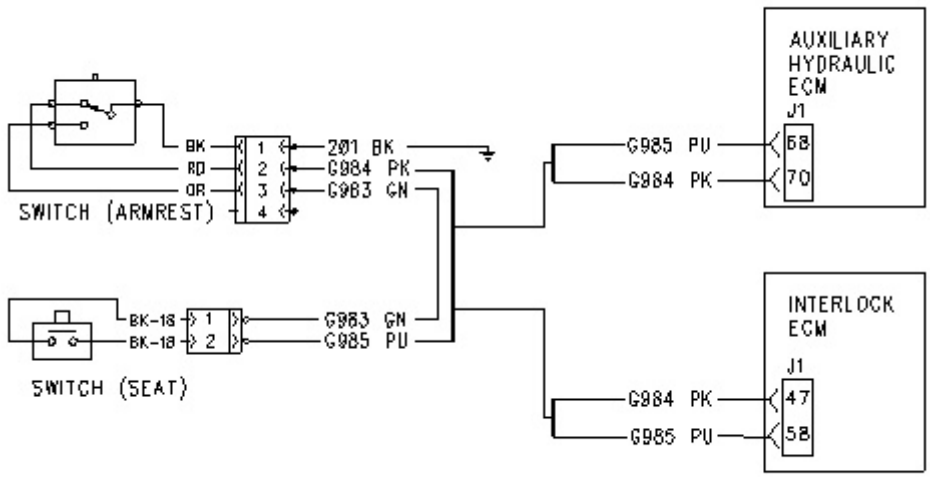


Illustration 1 g00778771

Schematic of the switch circuit for the armrest and the seat

Test Step 1. CHECK THE SYSTEM WITH THE ARMREST IN THE UP POSITION

A. Do not occupy the seat.

B. Place the armrest in the UP position.

C. Turn the key start switch to the ON position.

D. Check the status of the armrest/seat switch on the Caterpillar ET and the armrest indicator on the left headliner.

Expected Result:

The Caterpillar ET should display "Armrest Up, Not In Seat" and the armrest indicator should be on.

Results:

- **OK -** "Armrest Up, Not In Seat" is displayed on the Caterpillar ET and the armrest indicator is on. Proceed to Test Step 3.
- **NOT OK -** "Armrest Up, Not In Seat" is not displayed on the Caterpillar ET and the armrest indicator is on. Proceed to Test Step 2.
- **NOT OK -** The armrest indicator is flashing.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator Is Flashing".

  Stop.

- **NOT OK -** The armrest indicator is off.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator And Parking Brake Indicator Do Not Function Correctly".

  Stop.

Test Step 2. CHECK THE CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 70 of the wire harness connector.

E. Measure the resistance from contact 3 to contact 68 of the wire harness connector.

Expected Result:

The resistance from contact 3 to contact 70 should be less than 5 Ohms and the resistance from contact 3 to contact 68 should be greater than 5000 Ohms.

Results:

- **OK -** The resistance from contact 3 to contact 70 is less than 5 Ohms and the resistance from contact 3 to contact 68 is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on

the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** Either the resistance from contact 3 to contact 70 is not less than 5 Ohms or the resistance from contact 3 to contact 68 is not greater than 5000 Ohms.

  Repair: The circuit is interrupted between the auxiliary hydraulic ECM and the interlock ECM. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 3. CHECK THE SYSTEM WITH THE ARMREST IN THE DOWN POSITION

A. Do not occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Check the status of the armrest/seat switch on the Caterpillar ET and the armrest indicator on the left headliner.

Expected Result:

The Caterpillar ET should display "Armrest Down, Not In Seat" and the armrest indicator should be flashing.

Results:

- **OK -** "Armrest Down, Not In Seat" is displayed on the Caterpillar ET and the armrest indicator is flashing. Proceed to Test Step 5.

- **NOT OK -** "Armrest Down, Not In Seat" is not displayed on the Caterpillar ET and the armrest indicator is flashing. Proceed to Test Step 4.

- **NOT OK -** The armrest indicator is off.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator And Parking Brake Indicator Do Not Function Correctly".

  Stop.

Test Step 4. CHECK THE CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 70 of the wire harness connector.

E. Measure the resistance from contact 3 to contact 68 of the wire harness connector.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** One of the resistances was not greater than 5000 Ohms.

  Repair: The circuit is interrupted between the auxiliary hydraulic ECM and the interlock ECM. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 5. CHECK THE SYSTEM WITH THE ARMREST IN THE DOWN POSITION AND OCCUPYING THE SEAT

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Check the status of the armrest/seat switch on the Caterpillar ET and the armrest indicator on the left headliner.

Expected Result:

The Caterpillar ET should display "Armrest Down, In Seat" and the armrest indicator should be off.

Results:

- **OK -** "Armrest Down, In Seat" is displayed on the Caterpillar ET and the armrest indicator is off.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** "Armrest Down, In Seat" is not displayed on the Caterpillar ET and the armrest indicator is off. Proceed to Test Step 6.
- **NOT OK -** The armrest indicator is flashing.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator Is Flashing".

  Stop.
- **NOT OK -** The armrest indicator is on.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator And Parking Brake Indicator Do Not Function Correctly".

  Stop.

Test Step 6. CHECK THE CIRCUIT

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Measure the resistance from contact 3 to contact 70 of the wire harness connector.

E. Measure the resistance from contact 3 to contact 68 of the wire harness connector.

Note: Two people will be needed to perform the measurements. One person will need to occupy the seat in order to keep the machine enabled. The other person will take the measurement.

Expected Result:

The resistance from contact 3 to contact 70 should be greater than 5000 Ohms and the resistance from contact 3 to contact 68 should be less than 5 Ohms.

Results:

- **OK -** The resistance from contact 3 to contact 70 is greater than 5000 Ohms and the resistance from contact 3 to contact 68 is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.
- **NOT OK -** Either resistance from contact 3 to contact 70 was not greater than 5000 Ohms or the resistance from contact 3 to contact 68 was not less than 5 Ohms.

Repair: The circuit is interrupted between the auxiliary hydraulic ECM and the interlock ECM. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234380

Switch (Parking Brake)

SMCS - 7332-038-BRK

System Operation Description:

The switch tells the ECM that the operator wants to enable the auxiliary hydraulics. The interlock ECM releases the parking brake.

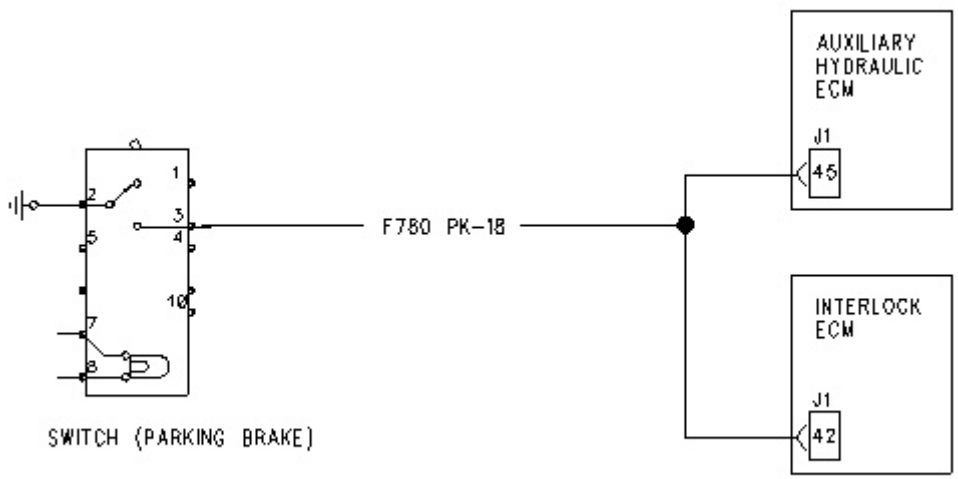


Illustration 1 g00739370

Schematic of the switch circuit for the parking brake

Test Step 1. CHECK FOR PROPER OPERATION

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Press and release the parking brake switch.

Expected Result:

The parking brake indicator should be off and the auxiliary hydraulics should be enabled.

Results:

- **OK -** The parking brake indicator is off and the auxiliary hydraulics are enabled.

  Repair: There is no problem at this time.

  Stop.

- **OK -** The parking brake indicator is off and the auxiliary hydraulics are not enabled. Proceed to Test Step 2.

- **NOT OK -** The parking brake indicator is on.

  Repair: See Troubleshooting, RENR6417, "Switch (Parking Brake)".

  Stop.

- **NOT OK -** The parking brake indicator is on and the armrest indicator is flashing.

  Repair: See Troubleshooting, RENR6417, "Armrest Indicator Is Flashing".

  Stop.

- **NOT OK -** The parking brake indicator is flashing.

  Repair: The parking brake indicator is not working properly. See Troubleshooting, RENR6417, "Parking Brake Indicator Is Flashing".

  Stop.

Test Step 2. CHECK THE STATUS OF THE SWITCH

A. Press and hold the parking brake switch.

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The status of the switch changed from the "CLOSED" status to the "OPEN" status.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 3.

Test Step 3. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Press and hold the switch.

D. Measure the resistance from contact 3 to contact 45 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector between the interlock ECM and the auxiliary hydraulic ECM. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234386

Switch (Interlock Override)

SMCS - 7332-038-L7

System Operation Description:

Turn on the continuous flow function. See Operation and Maintenance Manual, "Continuous Flow Control" for the proper procedure. After you have turned on the continuous flow function, push the bottom of the interlock override switch. The armrest can be moved to the RAISED position and the auxiliary hydraulic circuits will remain functional. Press on either side of the auxiliary hydraulic control or the continuous flow switch in order to turn off the interlock override function. This will also turn off the continuous flow function.

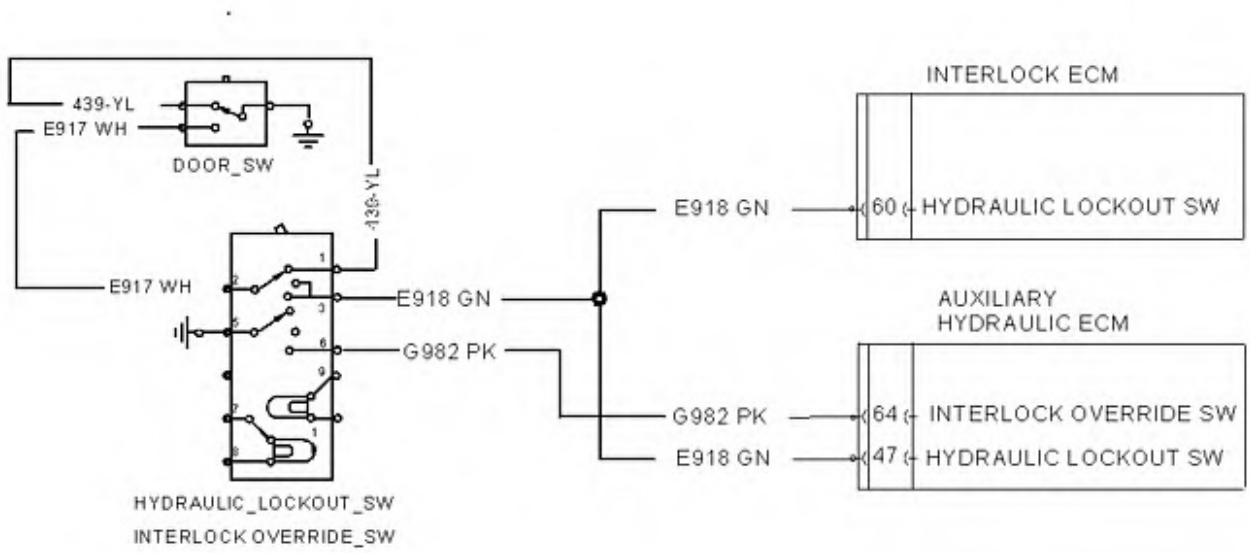


Illustration 1 g01035973

Schematic for the switch circuit for the interlock override

Test Step 1. CHECK FOR PROPER OPERATION

A. Enable the machine.

B. Push down on either the A1 switch or the A2 switch.

C. Push the continuous flow switch and then release the continuous flow switch.

D. Immediately release the auxiliary hydraulic switch.

Note: If the auxiliary hydraulic switch is not released within one second of releasing the continuous flow switch, the continuous flow function will not be activated.

Expected Result:

The auxiliary hydraulics (A1 or A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1 or A2) are active. Proceed to Test Step 2.
- **NOT OK -** The auxiliary hydraulics (A1 or A2) are not active.

  Repair: See Troubleshooting, "Switch (Continuous Flow)".

  Stop.

Test Step 2. CHECK FOR PROPER OPERATION

A. Push the interlock override switch and then release the interlock override switch.

B. Raise the armrest.

Expected Result:

The auxiliary hydraulics (A1 or A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1 or A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A1 or A2) are not active. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE SWITCH

A. Press the interlock override switch.

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The status of the switch changed from the "CLOSED" status to the "OPEN" status.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 4.

Test Step 4. CHECK THE CONTINUITY OF THE SWITCH

A. Remove the switch from the headliner.

B. Unplug the switch from the wire harness.

C. Press the switch.

D. Measure the resistance from terminal 6 to terminal 5.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms. Proceed to Test Step 5.
- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The switch has failed. Replace the switch.

  Stop.

Test Step 5. CHECK THE SWITCH CIRCUIT

A. Reinstall the switch.

B. Remove the floorplate in order to get to the ECM.

C. Remove the wire harness from the ECM.

D. Press the switch.

E. Measure the resistance from contact 6 to contact 64 of the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System
Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234402

Switch (Continuous Flow)

SMCS - 7332-038-FW

System Operation Description:

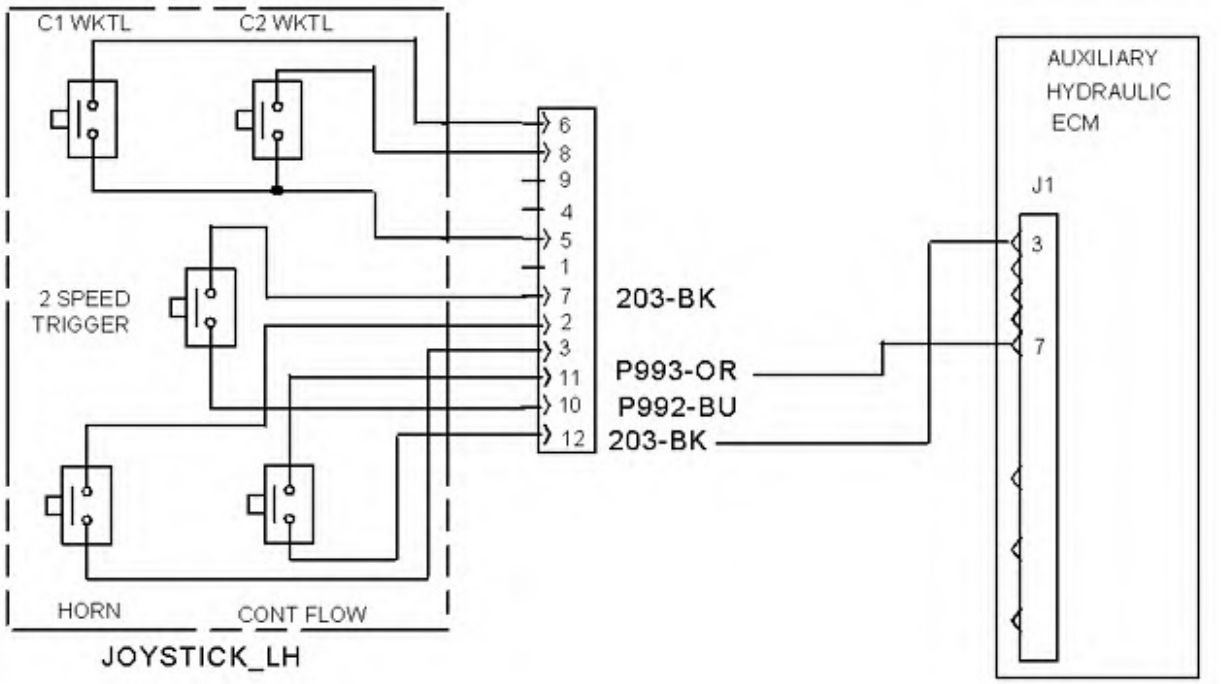


Illustration 1 g01035064

Schematic of the continuous flow switch



Illustration 2 g01033276

Location of the continuous flow switch

The continuous flow switch is located on the left joystick on all machines.

The continuous flow switch tells the auxiliary hydraulic ECM that the operator wants to supply a flow of hydraulic oil to the auxiliary circuit without the need to continuously hold the auxiliary hydraulic control.

Push down on either of the auxiliary hydraulic switches (A1 and A2). Push on the bottom of the continuous flow switch and then release the continuous flow switch. Immediately release the auxiliary hydraulic control after you release the continuous flow control. If the auxiliary hydraulic control is not released within one second of releasing the continuous flow control, the continuous flow function will not be activated. Push on either the auxiliary hydraulic control or the continuous flow switch in order to stop the flow to the auxiliary circuit.

The switch is a momentary, normally open switch. When the switch is closed the circuit puts a ground on the pin 7 of the ECM.

The ECM monitors the status of the switch. If the input is grounded for 30 seconds or more the ECM will interpret the signal as a stuck switch and the ECM will produce a diagnostic code.

Test Step 1. CHECK FOR PROPER OPERATION

A. Enable the machine.

B. Push down on either the A1 switch or the A2 switch.

C. Push the continuous flow switch and then release the continuous flow switch.

D. Immediately release the auxiliary hydraulic switch.

Note: If the auxiliary hydraulic switch is not released within one second of releasing the continuous flow switch, the continuous flow function will not be activated.

Expected Result:

The auxiliary hydraulics (A1 or A2) should be active.

Results:

- **OK -** The auxiliary hydraulics (A1 or A2) are active.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The auxiliary hydraulics (A1 or A2) are not active. Proceed to Test Step 2.

Test Step 2. CHECK THE STATUS OF THE SWITCH

A. Press the continuous flow switch.

B. Observe the status on the Caterpillar ET.

C. Release the switch.

D. Observe the status on the Caterpillar ET.

Expected Result:

The switch status should have changed from the "CLOSED" status to the "OPEN" status.

Results:

- **OK -** The status of the switch changed from the "CLOSED" status to the "OPEN" status.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The switch status did not change from the "CLOSED" status to the "OPEN" status. Proceed to Test Step 3.

Test Step 3. CHECK THE SWITCH CIRCUIT

A. Remove the floorplate in order to get to the ECM.

B. Remove the wire harness from the ECM.

C. Press the continuous flow switch on the left joystick handle.

D. Measure the resistance from contact 3 to contact 7 of the wiring harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The circuit is open in the wire harness and/or the connector. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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i05335730

Armrest Indicator Is Flashing

SMCS - 7630-038-IND

Test Step 1. CHECK FOR A FLASHING ARMREST INDICATOR BEFORE THE SYSTEM IS ENABLED



Illustration 1 g01032907

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

Expected Result:

The armrest indicator should be off.

Results:

- **OK -** The armrest indicator is off. Proceed to Test Step 11.
- **NOT OK -** The armrest indicator is flashing. Proceed to Test Step 2.
- **NOT OK -** The armrest indicator is on.

  Repair: The armrest switch is not being actuated. Adjust the switch or replace the switch.

  STOP

Test Step 2. CHECK THE ARMREST SWITCH FOR PROPER OPERATION WITH THE ARMREST IN THE DOWN POSITION

Note: Refer to the Electrical Schematic.

A. Turn the key start switch to the OFF position.
B. Locate the connector for the armrest switch.
C. Disconnect the connector for the armrest switch.
D. Place the armrest in the DOWN position.
E. Measure the resistance of the armrest switch from contact 1 to contact 2.
F. Measure the resistance of the armrest switch from contact 1 to contact 3.

Expected Result:

The resistance should be greater than 5000 Ohms from contacts 1 to 2. The resistance should be less than five Ohms from contacts 1 to 3.

Results:

- **OK -** The resistance is greater than 5000 Ohms from contacts 1 to 2 and less than five Ohms from contacts 1 to 3. Proceed to Test Step 3.
- **NOT OK -** The resistance is less than 5000 Ohms from contacts 1 to 2 or is not less than five Ohms from contacts 1 to 3.

  Repair: The armrest switch has failed. Replace the armrest switch.

  STOP

Test Step 3. CHECK THE ARMREST SWITCH FOR PROPER OPERATION WITH THE ARMREST IN THE UP POSITION

A. Place the armrest in the UP position.
B. Measure the resistance of the armrest switch from contact 1 to contacts 2.
C. Measure the resistance of the armrest switch from contact 1 to contacts 3.

Expected Result:

The resistance should be greater than 5000 Ohms from contacts 1 to 3. The resistance should be less than five Ohms from contacts 1 to 2.

Results:

- **OK -** The resistance is greater than 5000 Ohms from contacts 1 to 3 and is less than five Ohms from contacts 1 to 2. Proceed to Test Step 4.
- **NOT OK -** The resistance is less than 5000 Ohms from contacts 1 to 3 or is not less than five Ohms from contacts 1 to 2.

  Repair: The armrest switch has failed. Replace the armrest switch.

  STOP

Test Step 4. CHECK WIRE 202 AT THE CONNECTOR FOR THE ARMREST FOR AN OPEN

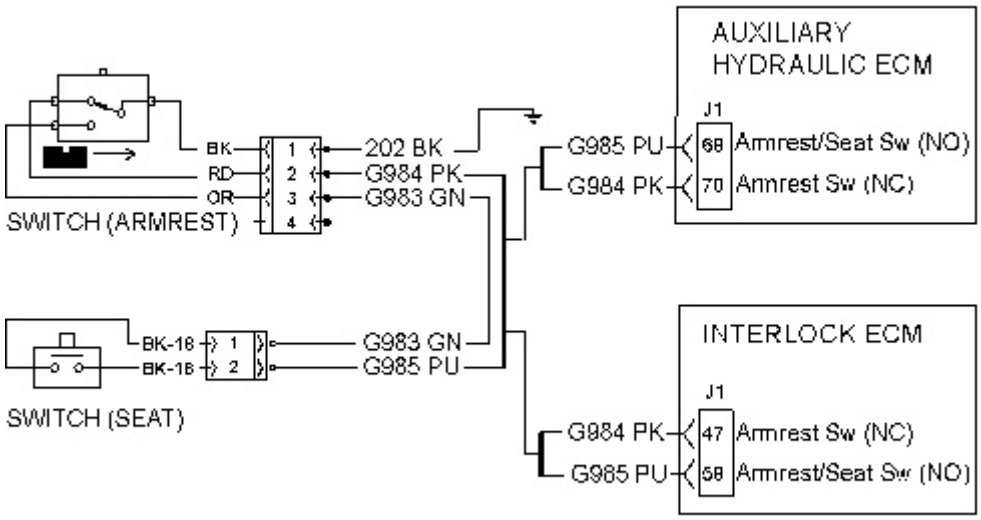


Illustration 2 g03380432

Schematic for the switch circuit (armrest and seat)

A. Use the connector that had been connected to the armrest switch. Measure the resistance from contact 1 (wire 202-BK) to the machine frame.

Expected Result:

The resistance should be less than five Ohms.

Results:

- **OK -** The resistance is less than five Ohms. Proceed to Test Step 5.
- **NOT OK -** The resistance is not less than five Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 5. CHECK WIRE G984 AT THE CONNECTOR FOR THE ARMREST FOR A SHORT TO GROUND

A. Use the connector that had been connected to the armrest switch. Measure the resistance from contact 2 (wire G984-PK) to the machine frame or to contact 1.

Expected Result:

The resistance should be greater than 3000 Ohms.

Results:

- **OK -** The resistance is greater than 3000 Ohms. Proceed to Test Step 6.
- **NOT OK -** The resistance is not greater than 3000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 6. CHECK WIRE G983 AT THE CONNECTOR FOR THE ARMREST FOR A SHORT TO GROUND

A. Use the connector that had been connected to the armrest switch. Measure the resistance from contact 3 (wire G983-GN) to the machine frame or to contact 1.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 7.
- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 7. CHECK THE SEAT SWITCH.

A. Reconnect the armrest switch.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the connector for the seat switch.

D. Disconnect the connector for the seat switch.

E. Jumper contact 1 to contact 2 (wire G983-GN to wire G985-PU) together.

F. Lower the cab.

G. Place the armrest in the DOWN position.

H. Turn the key start switch to the ON position.

Expected Result:

The armrest indicator should be off.

Results:

- **OK -** The armrest indicator is off.

  Repair: The seat switch has failed. Replace the switch. DO NOT OPERATE THE MACHINE WITH THE JUMPER IN PLACE.

  STOP

- **NOT OK -** The armrest indicator is flashing. Proceed to Test Step 8.

Test Step 8. CHECK WIRE G983 FOR AN OPEN

A. Raise the cab.

B. Remove the jumper.

C. Disconnect the armrest switch.

D. Measure the resistance from contact 3 of the connector for the armrest switch to contact 1 of the connector for the seat switch. The wire number that is being checked is G983-GN.

Expected Result:

The resistance should be less than five Ohms.

Results:

- **OK -** The resistance is less than five Ohms. Proceed to Test Step 9.
- **NOT OK -** The resistance is not less than five Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 9. CHECK WIRE G985 FOR A SHORT TO GROUND

A. Locate the Interlock ECM. The Interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

B. Disconnect the wire harness from the Interlock ECM.

C. Measure the resistance from contact 3 to contact 58 on the Interlock ECM (wire 201-BK to wire G985-PU) of the wire harness connector.

Expected Result:

The resistance should be greater than 3000 Ohms.

Results:

- **OK -** The resistance is greater than 3000 Ohms. Proceed to Test Step 10.
- **NOT OK -** The resistance is not greater than 3000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 10. CHECK WIRE G985 FOR AN OPEN

A. Measure the resistance from contact 58 of the connector for the Interlock ECM to contact 2 of the connector for the seat switch. The wire number that is being checked is G985-PU.

Expected Result:

The resistance should be less than five Ohms.

Results:

- **OK -** The resistance is less than five Ohms.

  Repair: The ECM may have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again. Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistance is not less than five Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

Test Step 11. CHECK FOR A FLASHING ARMREST INDICATOR AFTER THE SYSTEM IS ENABLED.

Note: The seat will still need to be occupied and the armrest will need to be down. The key start switch will also need to be in the ON position.

A. Press and release the parking brake switch.

Expected Result:

The armrest indicator should be off.

Results:

- **OK -** The armrest indicator is off.

  Repair: There is no problem at this time.

  STOP

- **NOT OK -** The armrest indicator is flashing. Proceed to Test Step12.

Test Step 12. CHECK THE CIRCUIT OF THE WORK TOOL PILOT SOLENOID FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the Interlock ECM. The Interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 3 to contact 24 (wire 202-BK to wire G988-OR) of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 15.
- **NOT OK -** The resistance is not greater than 5000 Ohms. Proceed to Test Step 13.

Test Step 13. CHECK THE WORK TOOL PILOT SOLENOID FOR A SHORT TO GROUND

A. Locate the work tool pilot solenoid.

B. Disconnect the wire harness from the work tool pilot solenoid.

C. Measure the resistance between both of the solenoid wires to the machine frame.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 14.
- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The work tool pilot solenoid has failed. Replace the coil of the work tool pilot solenoid.

  STOP

Test Step 14. CHECK THE WORK TOOL DETENT COIL FOR A SHORT TO GROUND

A. Locate the work tool detent coil .

B. Disconnect the work tool detent coil from the wire harness.

C. Measure the resistance between both of the coil wires to the machine frame.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The wire harness has shorted to ground. Repair the wire harness or replace the wire harness.

  STOP

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The work tool detent coil has failed. Replace the work tool detent coil.

  STOP

Test Step 15. CHECK THE CIRCUIT OF THE WORK TOOL PILOT SOLENOID FOR AN OPEN CIRCUIT

A. Measure the resistance from contact 24 to contact 68 (wire G988-OR to wire 975-WH) of the wire harness connector.

Expected Result:

The resistance should be approximately six Ohms.

Results:

- **OK -** The resistance is approximately six Ohms.

  Repair: The ECM may have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again. Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP

- **NOT OK -** The resistance is considerably greater than six Ohms.

  Repair: Wire 975-WH of the wire harness has an open. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

- **NOT OK -** The resistance is less than three Ohms. Proceed to Test Step 16.

Test Step 16. CHECK THE WORK TOOL PILOT SOLENOID FOR A SHORTED WINDING

A. Locate the work tool pilot solenoid.

B. Disconnect the work tool pilot solenoid from the wire harness.

C. Measure the resistance between the two solenoid wires.

Expected Result:

The resistance should be approximately 10.5 Ohms.

Results:

- **OK -** The resistance is approximately 10.5 Ohms. Proceed to Test Step 17.
- **NOT OK -** The resistance is not approximately 10.5 Ohms.

  Repair: The work tool pilot solenoid has failed. Replace the coil of the work tool pilot solenoid.

  STOP

Test Step 17. CHECK THE WORK TOOL DETENT COIL FOR A SHORTED WINDING

A. Locate the work tool detent coil. The detent coil is located beneath the right-hand joystick. Remove the access panel in order to get to the connector.

B. Disconnect the work tool detent coil from the wire harness.

C. Measure the resistance between the two wires of the coil.

Expected Result:

The resistance should be approximately 12 Ohms.

Results:

- **OK -** The resistance is approximately 12 Ohms.

  Repair: The wire harness is shorted. Repair the wire harness or replace the wire harness.

  STOP

- **NOT OK -** The resistance is not approximately 12 Ohms.

  Repair: The work tool detent coil has failed. Replace the work tool detent coil.

  STOP

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995621

Parking Brake Indicator Is Flashing

SMCS - 7630-038-IND

Test Step 1. CHECK FOR A FLASHING PARKING BRAKE INDICATOR BEFORE THE SYSTEM IS ENABLED



Illustration 1 g01032924

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

Expected Result:

The parking brake indicator should be on.

Results:

- **OK -** The parking brake indicator is on. Proceed to Test Step 4.
- **NOT OK -** The parking brake indicator is flashing. Proceed to Test Step 2.
- **NOT OK -** The parking brake indicator is off.

  Repair: The parking brake indicator is not working properly. See Testing and Adjusting, "Parking Brake Indicator and Armrest Indicator Do Not Function Correctly".

  Stop.

Test Step 2. CHECK THE CIRCUIT FOR THE PARKING BRAKE SWITCH FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Disconnect the wire harness from the ECM.

E. Measure the resistance from contact 42 to contact 3 (wire F780-PK to wire 201-BK) on the wire harness connector.

Expected Result:

The resistance should be greater than 3000 Ohms.

Results:

- **OK -** The resistance is greater than 3000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not greater than 3000 Ohms. Proceed to Test Step 3.

Test Step 3. CHECK THE PARKING BRAKE SWITCH

A. Lower the cab.

B. Remove the parking brake switch.

C. Disconnect the wire harness from the switch.

D. Measure the resistance from terminal 2 to terminal 3 of the parking brake switch.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The parking brake switch has failed. Replace the parking brake switch.

  Stop.

Test Step 4. CHECK FOR A FLASHING PARKING BRAKE INDICATOR AFTER THE SYSTEM IS ENABLED

Note: The seat will still need to be occupied and the armrest will need to be down. The key start switch will also need to be in the ON position.

A. Press and release the parking brake switch.

Expected Result:

The parking brake light should be off.

Results:

- **OK -** The parking brake light is off.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The parking brake is flashing. Proceed to Test Step 5.

Test Step 5. CHECK THE CIRCUIT OF THE HYDROSTATIC PILOT VALVE

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Disconnect the wire harness from the ECM.

E. Measure the resistance between contact 29 and contact 68 (wire H416-GN and wire 975-WH) of the wire harness connector.

Expected Result:

The resistance should be approximately 11 Ohms.

Results:

- **OK -** The resistance is approximately 11 Ohms. Proceed to Test Step 7.
- **NOT OK -** The resistance is not approximately 11 Ohms. Proceed to Test Step 6.

Test Step 6. CHECK THE HYDROSTATIC PILOT VALVE

A. Locate the hydrostatic pilot valve.

B. Disconnect the wire harness from the hydrostatic pilot valve.

C. Measure the resistance of the coil of the hydrostatic pilot valve.

Expected Result:

The resistance should be approximately 10.5 Ohms.

Results:

- **OK -** The resistance is approximately 10.5 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The resistance is not approximately 10.5 Ohms.

  Repair: The coil of the hydrostatic pilot valve has failed. Replace the coil.

  Stop.

Test Step 7. CHECK THE CIRCUIT OF THE HYDROSTATIC PILOT SOLENOID FOR A SHORT TO GROUND

A. Measure the resistance from contact 3 to contact 24 (wire 201-BK to wire G988-OR) of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms. Proceed to Test Step 8.

Test Step 8. CHECK THE HYDROSTATIC PILOT SOLENOID FOR A SHORT TO GROUND

A. Locate the hydrostatic pilot solenoid.

B. Disconnect the hydrostatic pilot solenoid from the wire harness.

C. Measure the resistance from the two solenoid wires to the machine frame.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The hydrostatic pilot solenoid has failed. Replace the coil of the hydrostatic pilot solenoid.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995627

Parking Brake Indicator and Armrest Indicator Are Flashing

SMCS - 7630-038-IND

Test Step 1. CHECK FOR A FLASHING PARKING BRAKE INDICATOR AND/OR A FLASHING ARMREST INDICATOR BEFORE THE SYSTEM IS ENABLED

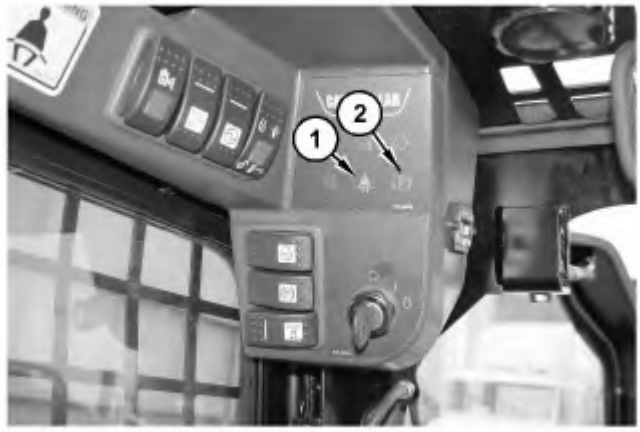


Illustration 1 g01032933

(1) Armrest indicator

(2) Parking brake indicator

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

Expected Result:

The armrest indicator should be off and the parking brake indicator should be on.

Results:

- **OK -** The armrest indicator is off and the parking brake indicator is on. Proceed to Test Step 9.
- **NOT OK -** The armrest indicator is flashing and the parking brake indicator is flashing. Proceed to Test Step 2.
- **NOT OK -** The parking brake indicator is flashing.

  Repair: See Troubleshooting, "Parking Brake Indicator Is Flashing".

  Stop.
- **NOT OK -** The armrest indicator is flashing.

  Repair: See Troubleshooting, "Armrest Indicator Is Flashing".

  Stop.

Test Step 2. CHECK THE RETURN SOLENOID WIRE FOR A SHORT TO GROUND

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 3 to contact 68 (wire 201-BK and wire 975-WH) of the wire harness connector.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms. Proceed to Test Step 6.
- **NOT OK -** The resistance is not greater than 5000 Ohms. Proceed to Test Step 3.

Test Step 3. CHECK THE HYDROSTATIC PILOT SOLENOID FOR A SHORT TO GROUND

A. Locate the hydrostatic pilot solenoid.

B. Disconnect the wire harness from the hydrostatic pilot solenoid.

C. Measure the resistance from contact 3 to contact 68 (wire 201-BK and wire 975-WH) of the wire harness for the ECM.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The hydrostatic pilot solenoid has failed. Replace the coil for the hydrostatic pilot solenoid.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms. Proceed to Test Step 4.

Test Step 4. CHECK THE WORK TOOL PILOT SOLENOID FOR A SHORT TO GROUND

A. Locate the work tool pilot solenoid.

B. Disconnect the wire harness from the work tool pilot solenoid.

C. Measure the resistance from contact 3 to contact 68 (wire 201-BK and wire 975-WH) of the wire harness for the ECM.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The work tool pilot solenoid has failed. Replace the coil for the work tool pilot solenoid.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms. Proceed to Test Step 5.

Test Step 5. CHECK THE WORK TOOL DETENT COIL FOR A SHORT TO GROUND

A. Locate the work tool detent coil. The detent coil is located beneath the right hand joystick. Remove the access panel in order to get to the connector.

B. Disconnect the wire harness from the work tool detent coil.

C. Measure the resistance from contact 3 to contact 68 (wire 201-BK and wire 975-WH) of the wire harness for the ECM.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The work tool detent coil has failed. Replace the coil for the work tool detent coil.

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 6. CHECK THE CIRCUIT FOR THE HYDROSTATIC PILOT SOLENOID FOR A SHORT TO THE + BATTERY TERMINAL

A. Measure the resistance at the wire harness connector from contact 29 (wire H416-GN) to the following contacts: contact 1, contact 11, contact 13, contact 24, contact 42, contact 47, contact 58, contact 60, contact 62 and contact 70.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 7.
- **NOT OK -** The resistance is not greater than 5000 Ohms on at least one of the readings.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 7. CHECK THE CIRCUIT OF THE WORK TOOL PILOT SOLENOID FOR A SHORT TO + BATTERY

A. Measure the resistance at the wire harness connector from contact 24 (wire 126-PK) to the following contacts: contact 1, contact 11, contact 13, contact 42, contact 47, contact 58, contact 60, contact 62 and contact 70.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms. Proceed to Test Step 8.
- **NOT OK -** The resistance is not greater than 5000 Ohms on at least one of the readings.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

Stop.

Test Step 8. CHECK THE CIRCUIT OF THE WORK TOOL PILOT SOLENOID FOR A SHORT TO + BATTERY

A. Measure the resistance at the wire harness connector from contact 66 (wire 975-WH) to the following contacts: contact 1, contact 11, contact 13, contact 42, contact 47, contact 58, contact 60, contact 62 and contact 70.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances are greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not greater than 5000 Ohms on at least one of the readings.

  Repair: The wire harness has failed. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

Test Step 9. CHECK FOR A FLASHING PARKING BRAKE INDICATOR AND/OR A FLASHING ARMREST INDICATOR AFTER THE SYSTEM IS ENABLED

Note: The seat will still need to be occupied and the armrest will need to be down. The key start switch will also need to be in the ON position.

A. Press and release the parking brake switch.

Expected Result:

The armrest indicator and the parking brake indicator should be off.

Results:

- **OK -** The armrest indicator and the parking brake indicator are off.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** Both indicators are flashing. Proceed to Test Step 10.

- **NOT OK -** The parking brake indicator is flashing.

Repair: See Troubleshooting, "Parking Brake Indicator Is Flashing".

Stop.

- **NOT OK -** The armrest indicator is flashing.

  Repair: See Troubleshooting, "Armrest Indicator Is Flashing".

  Stop.

Test Step 10. CHECK THE RETURN SOLENOID WIRE FOR AN OPEN CIRCUIT

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 29 to contact 68 (wire H416-GN to wire 975-WH) of the wire harness connector.

Expected Result:

The resistance should be approximately 11 Ohms.

Results:

- **OK -** The resistance is approximately 11 Ohms.

  Repair: There is more than one problem. Start by troubleshooting one of the fault indicators. See Troubleshooting, "Parking Brake Indicator Is Flashing" or Troubleshooting, "Armrest Indicator Is Flashing".

  Stop.

- **NOT OK -** The resistance is considerably greater than 11 Ohms.

  Repair: There is an open in the return solenoid wire. Check all connections. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i01995636

Parking Brake Indicator and Armrest Indicator Do Not Function Correctly

SMCS - 7630-038-IND

Test Step 1. CHECK THE GAUGE FUSE



Illustration 1 g01032879

Fuse panel

A. Locate the fuse panel on the back side of the operator's station. See Illustration 1.

B. Remove the gauge fuse and inspect the gauge fuse.

Expected Result:

The fuse should be good.

Results:

- **OK -** The fuse is good. Proceed to Test Step 2.

- **NOT OK -** The fuse is bad.

  Repair: Replace the fuse.

  Stop.

Test Step 2. CHECK FOR POWER AT THE WARNING INDICATOR MODULE

A. Disconnect the wire harness from the warning indicator module.

B. Turn the key start switch to the ON position.

C. Measure the voltage from contact 1 (wire 123-WH) to machine ground.

Expected Result:

Voltage should be greater than 10 DCV.

Results:

- **OK -** Voltage is greater than 10 DCV. Proceed to Test Step 3.
- **NOT OK -** Voltage is less than 10 DCV.

  Repair: The wire harness has failed. Repair the wire harness and/or connectors or replace the wire harness and/or connectors.

  Stop.

Test Step 3. CHECK THE GROUND WIRE ON THE WARNING INDICATOR MODULE

A. Turn the key start switch to the ON position.

B. Measure voltage from contact 1 to contact 2 (wire 123-WH to 200-BK).

Expected Result:

Voltage should be greater than 10 DCV.

Results:

- **OK -** Voltage is greater than 10 DCV. Proceed to Test Step 4.
- **NOT OK -** Voltage is less than 10 DCV.

  Repair: The ground wire is faulty in the wire harness. Repair the wire harness and/or connectors or replace the wire harness and/or connectors.

  Stop.

Test Step 4. CHECK FOR POWER TO THE PARKING BRAKE INDICATOR.

A. Turn the key start switch to the ON position.

B. Measure voltage from contact 1 to contact 4 (wire 123-WH to wire 674-BU) of the wiring harness for the warning indicator module.

Expected Result:

Voltage should be greater than 10 DCV.

Results:

- **OK -** The voltage is greater than 10 DCV. Proceed to Test Step 6.
- **NOT OK -** The voltage is less than 10 DCV. Proceed to Test Step 5.

Test Step 5. CHECK THE WIRE FROM THE ECM TO THE WARNING INDICATOR MODULE (PARKING BRAKE INDICATOR)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 70 to contact 4 (wire 674-BU to wire 201-BK) of the wire harness connector.

Expected Result:

The resistance should be approximately 75 Ohms.

Results:

- **OK -** The resistance is approximately 75 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not approximately 75 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or connectors or replace the wire harness and/or connectors.

  Stop.

Test Step 6. CHECK FOR POWER TO THE ARMREST INDICATOR.

A. With the armrest in the UP position, turn the key start switch to the ON position.

B. Measure voltage from contact 1 to contact 7 (wire 123-WH to wire 676-PU) of the wire harness for the warning indicator module.

Expected Result:

Voltage should be greater than 10 DCV.

Results:

- **OK -** The voltage is greater than 10 DCV.

  Repair: There is no problem at this time. Check wire harness connectors for tightness. If the problem reoccurs, start the procedures from the beginning.

  Stop.

- **NOT OK -** The voltage is less than 10 DCV. Proceed to Test Step 7.

Test Step 7. CHECK THE WIRE FROM THE ECM TO THE WARNING INDICATOR MODULE (ARMREST INDICATOR)

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Remove the wire harness from the ECM.

E. Measure the resistance from contact 11 to contact 3 (wire 676-PU to wire 201-BK) of the wiring harness for the ECM.

Expected Result:

The resistance should be approximately 75 Ohms.

Results:

- **OK -** The resistance is approximately 75 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance is not approximately 75 Ohms.

  Repair: The wire harness has failed. Repair the wire harness and/or connectors or replace the wire harness and/or connectors.

  Stop.

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i03765647

Switch (Hydraulic Lockout)

SMCS - 7332-038-HR

Test Step 1. CHECK FOR PROPER OPERATION

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Place the hydraulic lockout switch in the OFF position.

E. Shut the door.

F. Press and release the parking brake switch.

Expected Result:

The work tool should function.

Results:

- **OK -** The work tool is functioning. Proceed to Test Step 2.
- **NOT OK -** The work tool does not function and the parking brake indicator is off. Proceed to Test Step 5.
- **NOT OK -** The work tool does not function and the parking brake indicator is on.

  Repair: See Troubleshooting, "Switch (Parking Brake)".

  STOP
- **NOT OK -** The work tool does not function and the parking brake indicator is flashing.

  Repair: See Troubleshooting, "Parking Brake Indicator Is Flashing ".

STOP

Test Step 2. CHECK FOR PROPER OPERATION

A. Press and release the hydraulic lockout switch.

Expected Result:

The work tool should not function.

Results:

- **OK -** The work tool does not function.

  Repair: There is no problem at this time.

  STOP

- **NOT OK -** The work tool is functioning. Proceed to Test Step 3.

Test Step 3. CHECK THE CIRCUIT FOR THE HYDRAULIC LOCKOUT SWITCH

A. Place the hydraulic lockout switch in the ON position.

B. Turn the key start switch to the OFF position.

   Note: Ensure that the door to the cab is closed. This will complete the circuit from the door switch to the hydraulic lockout switch. If the door is NOT mounted to the machine, ensure that the jumper is installed in the circuit.

C. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

D. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

E. Disconnect the wire harness from the ECM.

F. Measure the resistance from contact 60 to contact 3 (wire E918-GN to wire 201-BK) on the wire harness connector.

Expected Result:

The resistance should be greater than 3000 Ohms.

Results:

- **OK -** The resistance is greater than 3000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the problem still exists. If the problem still exists, perform the Test Steps again.Replace the ECM, if the cause of the problem was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP

- **NOT OK -** The resistance is less than 3000 Ohms. Proceed to Test Step 4.

Test Step 4. CHECK THE HYDRAULIC LOCKOUT SWITCH

A. Lower the cab.

B. Remove the hydraulic lockout switch.

C. Disconnect the wire harness from the switch.

D. Place the switch in the ON position.

E. Measure the resistance from terminal 3 to terminal 5 of the hydraulic lockout switch.

Expected Result:

The resistance should be greater than 5000 Ohms.

Results:

- **OK -** The resistance is greater than 5000 Ohms.

  Repair: The wire harness has a short. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

- **NOT OK -** The resistance is not greater than 5000 Ohms.

  Repair: The hydraulic lockout switch has failed. Replace the switch.

  STOP

Test Step 5. CHECK THE CIRCUIT FOR THE HYDRAULIC LOCKOUT SWITCH

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Disconnect the wire harness from the ECM.

E. Measure the resistance from contact 60 to contact 3 (wire E918-GN to wire 201-BK) on the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the problem still exists. If the problem still exists, perform the Test Steps again.Replace the ECM, if the cause of the problem was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP

- **NOT OK -** The resistance is greater than 5 Ohms. Proceed to Test Step 6.

Test Step 6. CHECK THE HYDRAULIC LOCKOUT SWITCH

A. Lower the cab.

B. Remove the hydraulic lockout switch.

C. Disconnect the wire harness from the switch.

D. Place the switch in the OFF position.

E. Measure the resistance from terminal 1 to terminal 2 of the hydraulic lockout switch.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The wire harness has an open. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  STOP

- **NOT OK -** The resistance is not less than 5 Ohms.

  Repair: The switch has failed. Replace the switch.

  STOP

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i01995806

Switch (Parking Brake)

SMCS - 7332-038-BRK

Test Step 1. CHECK FOR PROPER OPERATION

A. Occupy the seat.

B. Place the armrest in the DOWN position.

C. Turn the key start switch to the ON position.

D. Press and release the parking brake switch.

Expected Result:

The parking brake indicator should be off.

Results:

- **OK -** The parking brake indicator is off.

  Repair: There is no problem at this time.

  Stop.

- **NOT OK -** The parking brake indicator is on and the armrest indicator is off. Proceed to Test Step 2.

- **NOT OK -** The parking brake indicator is on and the armrest indicator is flashing.

  Repair: See Troubleshooting, "Armrest Indicator Is Flashing".

  Stop.

- **NOT OK -** The parking brake indicator is flashing.

  Repair: The parking brake indicator is not working properly. See Troubleshooting, "Parking Brake Indicator Is Flashing".

Stop.

Test Step 2. CHECK THE PARKING BRAKE SWITCH

A. Turn the key start switch to the OFF position.

B. Remove the parking brake switch.

C. Disconnect the wire harness from the switch.

D. Press the switch.

E. Measure the resistance from terminal 2 to terminal 3 of the parking brake switch.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms. Proceed to Test Step 3.
- **NOT OK -** The resistance is not less than 5 Ohms.

  Repair: The parking brake switch has failed. Replace the parking brake switch.

  Stop.

Test Step 3. CHECK THE CIRCUIT FOR THE PARKING BRAKE SWITCH

A. Jumper wire F780-PK to wire 201-BK in the wire harness for the parking brake switch.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Locate the interlock ECM. The interlock ECM is located on the left side of the machine beneath the access cover on the floor of the machine.

D. Disconnect the wire harness from the ECM.

E. Measure the resistance from contact 42 to contact 3 (wire F780-PK to wire 201-BK) on the wire harness connector.

Expected Result:

The resistance should be less than 5 Ohms.

Results:

- **OK -** The resistance is less than 5 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the Test Steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

Stop.

- **NOT OK -** The resistance is greater than 5 Ohms.

  Repair: The wire harness has an open. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

  Stop.

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i05026830

Required Tools

SMCS - 7309

Table 1

Required Tools	
Part Number	**Part Description**
Recovery, Recycling, and Recharging Systems	
285-7352	Refrigerant Service Unit (Recovery/Recyling/Recharging) (115 V / 60 Hz)
285-7353	Refrigerant Service Unit (Recovery/Recyling/Recharging) (220-240 V / 50 Hz)
208-1338	Refrigerant Service Unit (Recovery)
197-1915	Refrigerant Service Unit (230 V / 50/60 Hz)
208-1317	Refrigerant Filter-Dryer
Charging Scales and Manifold Gauges	
168-1959	Electronic Charging Scale (115 V / 60 Hz)
168-1961	Electronic Charging Scale (220-240 V / 50 Hz)
168-1958	Electronic Charging Scale (Battery)
208-1341	Manifold Gauge Set
Tanks and Hoses	
300-3526	Refrigerant Tank (22.7 kg (50 lb))
208-1352	Heater Blanket As
272-3090	Refrigerant Charging Hose
208-1332	Refrigerant Hose

208-1333	Refrigerant Hose
208-1339	Refrigerant Coupler (Low Pressure)
208-1340	Refrigerant Coupler (High Pressure)
Vacuum Pumps and Accessories	
208-1381	Vacuum Pump (1.2 CFM, 110 V / 60 Hz)
208-1356	Vacuum Pump (4 CFM, 110V / 60Hz)
208-1357	Vacuum Pump (4 CFM, 220-250 V / 50-60 Hz)
208-1353	Thermistor Gauge
1U-9763	Vacuum Pump Oil
Miscellaneous Air Conditioning Tools	
208-1378	Refrigerant Analyzer Tool Gp
262-4934	Refrigerant Identifier (110/220 V 60/50 Hz)
153-8537	Air Conditioner Flushing Unit (Cart)
153-8538	Refrigerant Flushing Solution
153-9033	Adapter Kit (Air Conditioner Flushing)
208-1374	Leak Detector Kit
9U-6494	Refrigerant Oil Injector
208-1375	Orifice Tool Gp
144-0235	Belt Tension Gauge
208-1350	Radiator Tool Gp
9U-5325	Thermometer
270-1540	O-ring Kit
383-3518	Air Conditioner Kit
Miscellaneous Tools	
233-8583	Eye Protection Goggles (Vented)
5P-7277	Voltage Tester
8T-0500	Continuity Tester
269-3123	Pen Light UV Leak Detection
146-4080	Digital Multimeter Gp
1U-8590	Spanner Wrench

Note: The schrader valves used in the high and low-pressure sides of the A/C system are located in **149-2491** Air Conditioner Fitting As which contains **3E-4051** Seal Cap and **3E-4057** Valve As for the low-pressure side. **236-9888** Air Conditioner Fitting As which contains **3E-4052** Seal Cap and **3E-4058** Valve As for the high-pressure side.

Note: Use of a portable flushing unit is permissible only if **153-8538** Refrigerant Flushing Solution is used and all procedures are followed per Testing and Adjusting, SENR5664, "Refrigerant System - Flush". The refrigerant flushing solution can ONLY be reused after being filtered.

Note: The **383-3518** Air Conditioner Kit provides the valves and caps required when replacing the lines group air conditioner. The kit includes the following: one **3E-4051** Seal Cap , one **3E-4052** Seal Cap , one **3E-4057** Valve As and one **3E-4058** Valve As .

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03861422

Machine Preparation for Troubleshooting

SMCS - 7000; 7320-035

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

Before any problem solving procedures are performed, read the manual for the heating and air conditioning system. Make a visual inspection of the complete air conditioning and heating system.

During any service of the Air conditioning System, all open connections are required to be capped or plugged with clean plastic part. Failure to cap open connections or failure to plug open connections will allow moisture into the system and lead to further damage.

When one is preparing to work on the air conditioning system, it is important to properly prepare the machine by performing a lockout/tagout procedure on the machine and on the air conditioning system. All charging and leak testing must be done in a well ventilated area.

Lockout/Tagout Procedure

1. When possible, park the machine on a smooth, level surface.
2. Set the parking brake.
3. Lower and lock all hydraulic implements.
4. Turn the key start switch to the OFF position and remove the key.
5. Turn the battery disconnect switch to the OFF position.



Illustration 1 g01518726

6. Tag the machine with a warning tag that is similar to the one that is shown in illustration 1 in order to ensure that no one else attempts to start the machine during service.

7. As it is necessary, continue to service the component.

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i03861423

General Troubleshooting Information

SMCS - 7320-035

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

The following is a list of general concerns and comments regarding the function of the air conditioning and heating systems. Additional information can be found in the troubleshooting articles that are specific to troubleshooting each system.

- Low refrigerant charge will cause a loss of cooling ability and a loss of lubrication in the compressor, which will result in failure of the compressor.
- Overcharge of refrigerant will cause a loss of cooling ability. A system that is overcharged will contain excess liquid refrigerant, which will severely damage the compressor.
- The appearance of frost does not always indicate a failure. Refer to troubleshooting, SENR5664, "Air Conditioning System Troubleshooting" in order to diagnose a blockage in the air conditioning system properly.
- A small amount of moisture will penetrate the hoses that are used in R134a systems. Replace the dryer or replace the accumulator that is containing the desiccant according to recommendations in System Operations, SENR5664, "Service Intervals".
- The formation of black sludge deposits in the system is caused by the presence of moisture in R134a systems and by mixing charges of R134a and R12. The black sludge deposits can cause a blockage in the system.

A loss of cooling ability of the system and failure of the compressor may be caused by one or more of the following conditions.

- Low charge
- Overcharge
- Too much oil
- Too little oil
- Dirty filter or plugged filter
- Dirty condenser or plugged condenser

- Dirty evaporator or plugged evaporator
- Dirty orifice tube or plugged orifice tube
- Dirty expansion valve or plugged expansion valve
- Too much moisture in the system
- Missing drain valves for the evaporator

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i03862392

Visual Inspection (Troubleshooting)

SMCS - 7320-035

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

⚠ WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

A visual inspection is essential before conducting any performance tests or before conducting any service to the air conditioning system or to the heating system.

1. Inspect and clean the fresh air filter.
2. Inspect and clean the recirculation air filter.
3. Inspect the condenser and the evaporator.
   a. Check for any type of restriction that will obstruct the air flow. Check for dirt, insects, plastic bags, etc.
   b. For machines that are equipped with condensers that are mounted on the roof, always make sure that both fan motors are running. Check for restrictions.
4. Check for a loose belt on the compressor.
5. If there is a moisture indicator on either the receiver-dryer or the in-line dryer, check the indicator.
   a. If the moisture indicator is blue, the system is normal.
   b. If the indicator is pink or white, there is moisture in the system. Replace the receiver-dryer or the in-line dryer.

      Note: Refer to Disassembly and Assembly, SENR5664, "Refrigerant Receiver-Dryer - Remove and Install" for instructions on replacing the receiver-dryer.

      Note: Refer to Disassembly and Assembly, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" for instructions on replacing the in-line dryer.
6. Inspect the condensate drain tube on the evaporator. The drain plug should not be obstructed.
7. Inspect refrigerant lines and hoses for damage from excessive heat or rubbing. Check for oily surfaces along hose and coupling connections. This can be an indication of a refrigerant leak. Refer to Testing and Adjusting, SENR5664, "Refrigerant Leakage – Test".

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i04703141

Air Conditioning System Troubleshooting

SMCS - 7320-035-YC

Note: Before you conduct a performance check, refer to the Service Manual, SENR5664, "Visual Inspection" section.

Note: Refer to the Service Manual, SENR5664, "Machine Preparation for Troubleshooting" section before service work is performed on the air conditioning system.

Problem Solving

The following problem solving section is provided for identifying and correcting problems that may occur in the air conditioning system. Several problems can have the same system condition or similar system conditions. Before you start the procedure in order to correct the problems, it is necessary to be complete in the diagnosis of the problems.

The problem solving procedures are based on the system condition during the problem. In order to indicate the system pressures, the manifold gauge set must be installed. The manifold gauge set is used only in order to diagnose problems. The refrigerant lines can give an indication of system operation that is abnormal. Temperature differences between the high-pressure side and the low-pressure side can be an indication of abnormal operation in a line. This can also be found by cold spots (frost) on the line. In R134a air conditioning systems, the lines can have spots of frost and the system can be operating normally. Frost will most often form after the orifice and on the lower portion of the accumulator. The temperature of the air flow from the evaporator will also indicate a problem with the system. Knowing the complete system condition is an important step in making a correct diagnosis.

Note: R134a air conditioning system problem diagnosis requires a combination of symptoms or indicators in order to correctly identify problems and solve problems.

Problem Solving Procedure

1. Install the manifold gauge set. Refer to the Service Manual, SENR5664, "Manifold Gauge Set (Refrigerant) - Install" section in Testing and Adjusting.

2. Run the engine at 1000 rpm. Put the air conditioner temperature control knob in the Maximum COOL position. Put the fan switch in the HIGH position on the AIR

CONDITIONING side. In order to stabilize the system, operate the engine for a minimum of 10 minutes.

3. Adjust the engine speed to approximately 1300 to 1400 rpm. Record the readings on the low -pressure gauges and the high-pressure gauges. The gauge readings will be a partial indication of the system condition.

4. Compare the discharge and suction pressures on the manifold gauge set to the Pressure Ranges that are in Table 1 in order to determine if the system is functioning correctly for the current ambient temperature. Use the table to determine if the system is operating normally. If the pressures according to the chart are high or the pressures according to the chart are low, refer to the system conditions that are listed in "Refrigerant Circuit Problems".

   During normal operation of the air conditioning system in 21 °C (70 °F) weather, the discharge pressure will be 820 kPa (120 psi) to 1300 kPa (190 psi).

   The pressure on the suction side will be 70 kPa (10 psi) to 130 kPa (20 psi).

   The outside temperature and humidity will have an effect on the pressures. If the outside temperature is high, the discharge pressure will be high. In very hot weather, the suction and the discharge pressures will be high. In cooler weather, the suction and the discharge pressure will be normal or the pressure can be lower.

   Note: All pressures are given as a guide only. Weight is the only absolute means of determining proper refrigerant charge. Improper refrigerant charge will cause premature failure of the compressor .

Table 1

Pressure Range [1]		
Ambient Air Temperature C° (F°)	High-pressure Test Fitting kPa (psi) [2]	Low-pressure Test Fitting kPa (psi) [3]
21°C (70°F)	820 to 1300 kPa (120 to 190 psi)	70 to 138 kPa (10 to 20 psi)
27°C (80°F)	950 to 1450 kPa (140 to 210 psi)	70 to 173 kPa (10 to 25 psi)
32°C (90°F)	1175 to 1650 kPa (170 to 240 psi)	105 to 210 kPa (15 to 30 psi)
38°C (100°F)	1300 to 1850 kPa (190 to 270 psi)	105 to 210 kPa (15 to 30 psi)
43°C (110°F)	1450 to 2075 kPa (210 to 300 psi)	105 to 210 kPa (15 to 30 psi)

[1] This table is only for reference.

(2) Pressure may be slightly higher in very humid conditions and lower in very dry conditions.

(3) Pressure before clutch disengagement

Indications from the Compressor Pressures

Use Table 2 in order to diagnose indications from the pressures.

Table 2

	High Discharge	High Suction	Low Discharge	Low Suction	Pressure's Sporadically Fluctuating
Too much refrigerant charge	X	X			
too much oil	X				
Restriction on air side of condenser	X				
Plugged orifice tube	X				
Restriction in high side of refrigerant circuit	X				
Condenser fans are not operating correctly	X				
System load high (high ambient, high humidity, doors open)	X				
Air in the refrigerant circuit	X				
Missing orifice tube		X			
Thermostat faulty or improperly adjusted		X			
			X	X	

Low refrigerant charge					
Belt slipping - check tension			X		
Clutch slipping			X		
Restriction on low side of refrigerant circuit			X		
Leak in the refrigerant circuit				X	
Moisture in the refrigerant circuit					X
Blockage in the refrigerant circuit					X
Air in the refrigerant circuit					X

Refrigerant Circuit Problems

There is no or only little cool temperature to the air flow from the evaporator.

System Condition 1

1. **Low-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. From the evaporator, the temperature of the air flow is partially cool.

Probable Cause

Leaks in the refrigerant circuit will cause the system to be low on refrigerant.

- Perform a leak test. refer to the Service Manual, SENR5664, "Refrigerant Leakage - Test" section in Testing and Adjusting.

- If leaks are found, recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- Repair leaks.
- If a large amount of refrigerant was lost, it is important to check the compressor for loss of oil.
- Perform a partial charge of the system.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Service Manual, SENR5664, "Air Conditioning Performance - Test"

System Condition 2

1. **Low-pressure gauge reading is normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading bounces or the reading is unsteady.**

Probable Cause

Air is in the system.

- Reclaim the refrigerant from the air conditioning system.
- Evacuate the air conditioning system.
- Recharge the air conditioning system.

System Condition 3

1. **Low-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. The temperature of the air flow from the evaporator is warm.

Probable Cause

Air or moisture (water) in the system

- Recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- Replace the receiver-dryer or the in-line dryer. The desiccant may be full of moisture. This will release water into the system. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly. For in-line dryers, refer to the Service Manual, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" section in Disassembly and Assembly.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Service Manual, SENR5664, "Air Conditioning Performance - Test"

System Condition 4

1. **Low-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is normal to the below normal range.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. The temperature of the air flow from the evaporator is partially cool.
4. The high side liquid line or the receiver-dryer is frosted. The high side liquid line or the receiver-dryer is cool to the touch.

Probable Cause

Restriction in the high-pressure liquid line can cause the refrigerant to be removed from the evaporator at a faster rate. The restriction can cause the evaporator to be low on refrigerant from the receiver-dryer or from the in-line dryer. Clogged filters or a failure of the blower motor can cause possible restrictions to the air flow.

- Recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- If the restriction is found at the receiver-dryer, replace the receiver-dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly.
- If the restriction is found at the in-line dryer, replace the in-line dryer.
- If the restriction is found at the liquid line, replace the liquid line.
- Cap all the open lines and fittings.

Note: Restrictions of the refrigerant flow are identified by frost or cold spots in the line. Also, restrictions of the refrigerant flow are identified by frost or cold spots in the receiver-dryer or the in-line dryer.

- Replace filters or remove any of the restrictions.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Service Manual, SENR5664, "Air Conditioning Performance - Test"

System Condition 5

Note: The system only cools the cab in the morning and in the evening. The system does not cool the cab during the hot part of the day.

1. **Low-pressure gauge reading is normal, but the gauge reading may drop into the vacuum range during the testing procedure.** For normal operating pressures, refer to Table 1.
2. **The high-pressure gauge reading is normal, but the gauge reading is below normal when the low-pressure gauge drops into the vacuum range.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. Air flow from the evaporator is very cold, but the air flow will become warm when the low-pressure gauge drops into vacuum.

Probable Cause

The system has a large amount of moisture. The desiccant in the receiver-dryer or the in-line dryer is full of water. The water is released during high ambient temperatures. Ice collects in the orifice or the expansion valve and the ice can block the flow of refrigerant.

- Recover the refrigerant from the system. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
- Replace the receiver-dryer or the in-line dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly. For in-line dryers, refer to the Service Manual, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" section in Disassembly and Assembly.
- Remove the moisture from the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.

- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

Note: Low-pressure (suction) drops into vacuum when ice forms in the expansion valve. High-pressure (discharge) drops when low-pressure drops into vacuum.

System Condition 6

1. The low-pressure gauge reading does not change. **The pressure should rise when the compressor is not in operation.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is at the high end of the normal range.**

   Note: Ambient temperature is above 21°C (70°F).
3. The temperature of the air flow from the evaporator is partially cool.

Probable Cause

The system has air or moisture in the system. The system does not have a full charge of refrigerant.

- Perform a leak test and carefully test around the compressor seal. Refer to the Service Manual, SENR5664, "Refrigerant Leakage - Test" section in Testing and Adjusting.
- Recover the refrigerant from the system. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
- Repair leaks.
- Check the compressor for loss of oil.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

System Condition 7

1. **Low-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).

3. High-pressure (liquid line) is very hot.
4. The compressor may become noisy and the drive belt may slip.

   Note: The compressor is not operating under ambient temperatures that are extreme. The compressor is not operating under high humidity that is extreme.

Probable Cause

The system is overcharged.

- Recover the remaining refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- Perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

Note: Perform the following procedure if the system has not been serviced for an extended period. Perform the following procedure if the pressures of the system are not within the correct specifications.

- Recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting. If service work has not been performed for an extended period, replace the receiver-dryer or the in-line dryer.
- Charge the system with the correct amount of refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

System Condition 8

1. **Low-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F) and the system has a refrigerant charge that is full.

3. The temperature of the air flow from the evaporator is partially cool.

Probable Cause

The compressor has internal leaks. The reed valve has leakage. The compressor piston, rings, or cylinders are worn.

- Check the compressor drive belt for the correct tension.
- Perform a leak test. Isolate the problem to the compressor. Refer to the Service Manual, SENR5664, "Refrigerant Leakage - Test" section in Testing and Adjusting.

If an internal leak is found, perform the following procedure.

- Replace the compressor. Refer to the Service Manual, SENR5664, "refrigerant Compressor - remove and Install" section in Disassembly and Assembly.
- Replace the receiver-dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Testing and Adjusting.
- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

If an external leak such as a hose connection is found, perform the following procedure.

- Recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section.
- Repair leaks.

If a large amount of refrigerant is lost, check the compressor for the loss of oil.

- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

System Condition 9

1. **Low-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is normal or low.** For normal operating pressures, refer to Table 1.

Note: Ambient temperature is above 21°C (70°F) and the system has a refrigerant charge that is full.

3. The temperature of the air flow from the evaporator is warm.
4. The suction hose and the evaporator are covered with moisture (sweating).

Probable Cause

Flow of refrigerant through the evaporator coil is excessive. The expansion valve could be stuck or held in the OPEN position.

1. Test the expansion valve for the correct operation. Use the following procedure.
    - Position the air conditioner temperature control knob in the maximum COOL position and the fan switch in the HIGH position.
    - Cool the head of the expansion valve diaphragm chamber and the capillary tube with ice or liquid nitrogen. Record the low-pressure gauge reading. The low-pressure gauge should indicate a vacuum.
    - If the low-pressure gauge indicates a vacuum, place a hand over the expansion valve diaphragm chamber. The hand will warm the expansion valve diaphragm chamber. In order to ensure the correct operation of the expansion valve, cool the head of the expansion valve diaphragm chamber and the capillary tube with ice or liquid nitrogen again. If the operation of the expansion is correct, refer to Step 2.
    - If the low-pressure gauge does not indicate the proper operation of the expansion valve, recover the refrigerant from the system. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
    - Replace the expansion valve. Refer to the Service Manual, SENR5664, "Expansion Valve - (Air Conditioner) Remove and Install" section in Disassembly and Assembly.

    Note: The sensing bulb must be installed correctly in order to ensure the proper operation of the expansion valve.

    - Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
    - Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
    - After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".
2. If the pressure gauge indicates the correct operation of the expansion valve, perform the following procedure.
    - Use a **8P-6355** Clip in order to hold the sensing bulb onto the evaporator outlet pipe. The sensing bulb should be as close to the evaporator as possible. The bulb should be upstream of the pressure sensing connection on the evaporator outlet pipe. The

following items must be wound tightly with **5P-7070** Strip Insulation : the clip, the sensing bulb and the outlet pipe. There should be no insulation between the bulb and the outlet pipe.

- In order to ensure that the system operates correctly, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

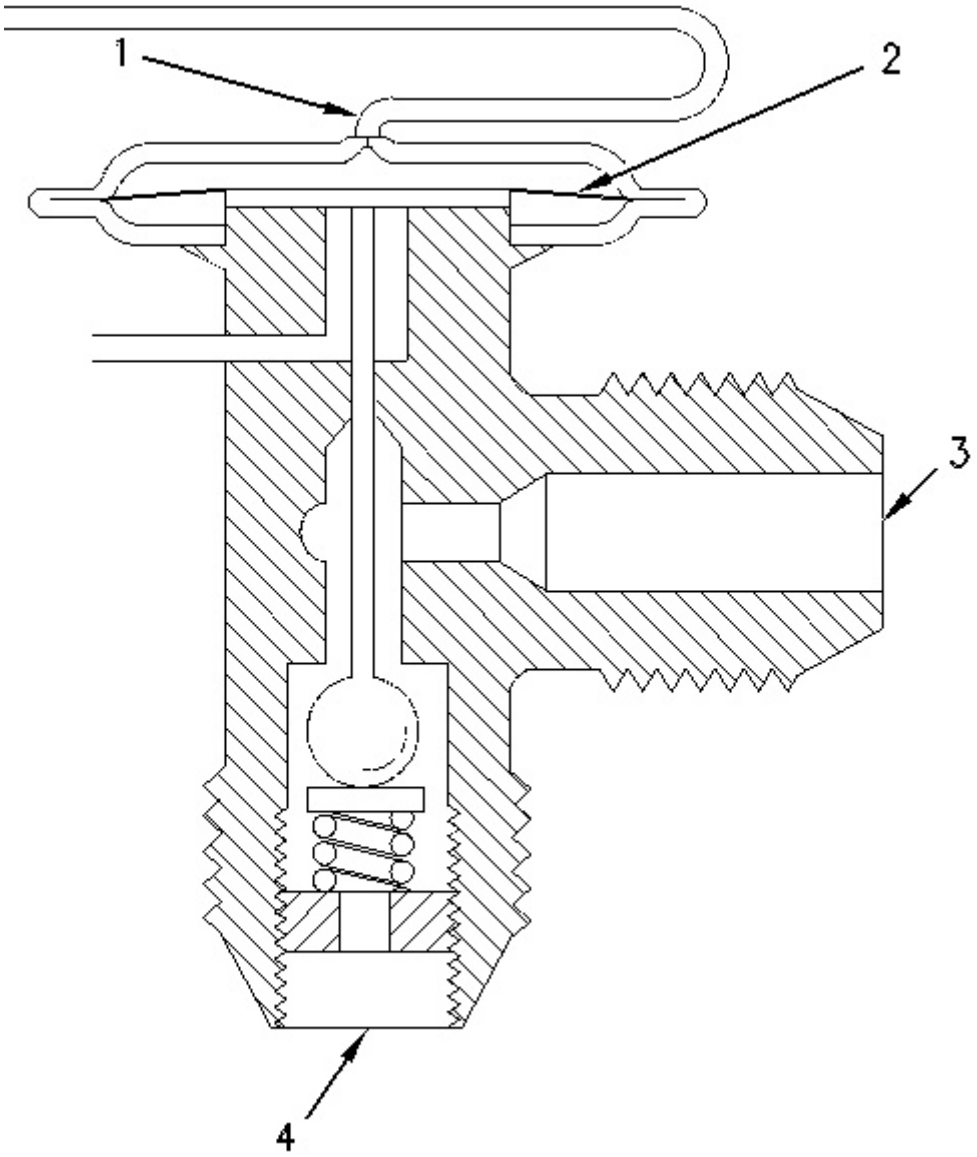


Illustration 1 g00409166

Expansion valve in the open position (Typical Example)

(1) Capillary tube

(2) Expansion valve diaphragm chamber

(3) Inlet

(4) Outlet

System Condition 10

1. **Low-pressure gauge reading is too low.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is too low.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. The temperature of the air flow from the evaporator is partially cool or warm.
4. Moisture (water) or frost is on the expansion valve inlet or orifice tube assembly.

Probable Cause

The problems that are described in Step 1 through Step 4 can be caused by the following faults:

Note: The following faults will cause a restriction of the flow of refrigerant to the evaporator.

- Improper operation of the expansion valve (stuck valve)
- Blockage at the evaporator inlet
- No charge in temperature sensing bulb

  Note: The inlet to the expansion valve will be warm during normal operation.

1. If the expansion valve inlet is cool to the touch, perform the following procedure:
   - Position the air conditioner temperature control knob to the maximum COOL position and the fan switch to the HIGH position.
   - Cool the head of the expansion valve diaphragm chamber and capillary tube with ice or liquid nitrogen. Record the low-pressure gauge reading. The low-pressure gauge should indicate a vacuum.
   - If a vacuum is indicated on the low-pressure gauge, place a hand over the expansion valve diaphragm chamber. The hand will warm the expansion valve diaphragm chamber. In order to ensure the correct operation of the expansion valve, cool the head of the expansion valve diaphragm chamber and the capillary tube with ice or liquid nitrogen again. If the operation of expansion valve is correct, refer to Step 2.
   - If the low-pressure gauge does not indicate proper operation of the expansion valve, remove the refrigerant from the system. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
   - Replace the expansion valve. Refer to the Service Manual, SENR5664, "Expansion Valve - (Air Conditioner) Remove and Install" section in Disassembly and Assembly.

   Note: The sensing bulb must be installed correctly in order to ensure the correct operation of the expansion valve. Clean the location for the sensing bulb with steel wool or emery paper. Use a **8P-6355** Clip in order to attach the sensing bulb securely to the evaporator coil outlet pipe. Completely cover the assembly with **5P-7070** Strip Insulation .

- Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

2. If the low-pressure gauge indicates the correct operation of the expansion valve, perform the following procedure:
   - The sensing bulb must be in the correct position on the evaporator outlet pipe and the sensing bulb must be the correct distance away from the evaporator outlet. The bulb should be upstream from the pressure sensing connection in the evaporator outlet pipe. The insulation must be around the sensing bulb and the clip on the evaporator outlet pipe.
   - In order to ensure the correct systems operation, perform a performance check. Service Manual, SENR5664, "Air Conditioning Performance - Test"
3. Replace the in-line dryer or replace the orifice tube.
   - Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
   - Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
   - After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

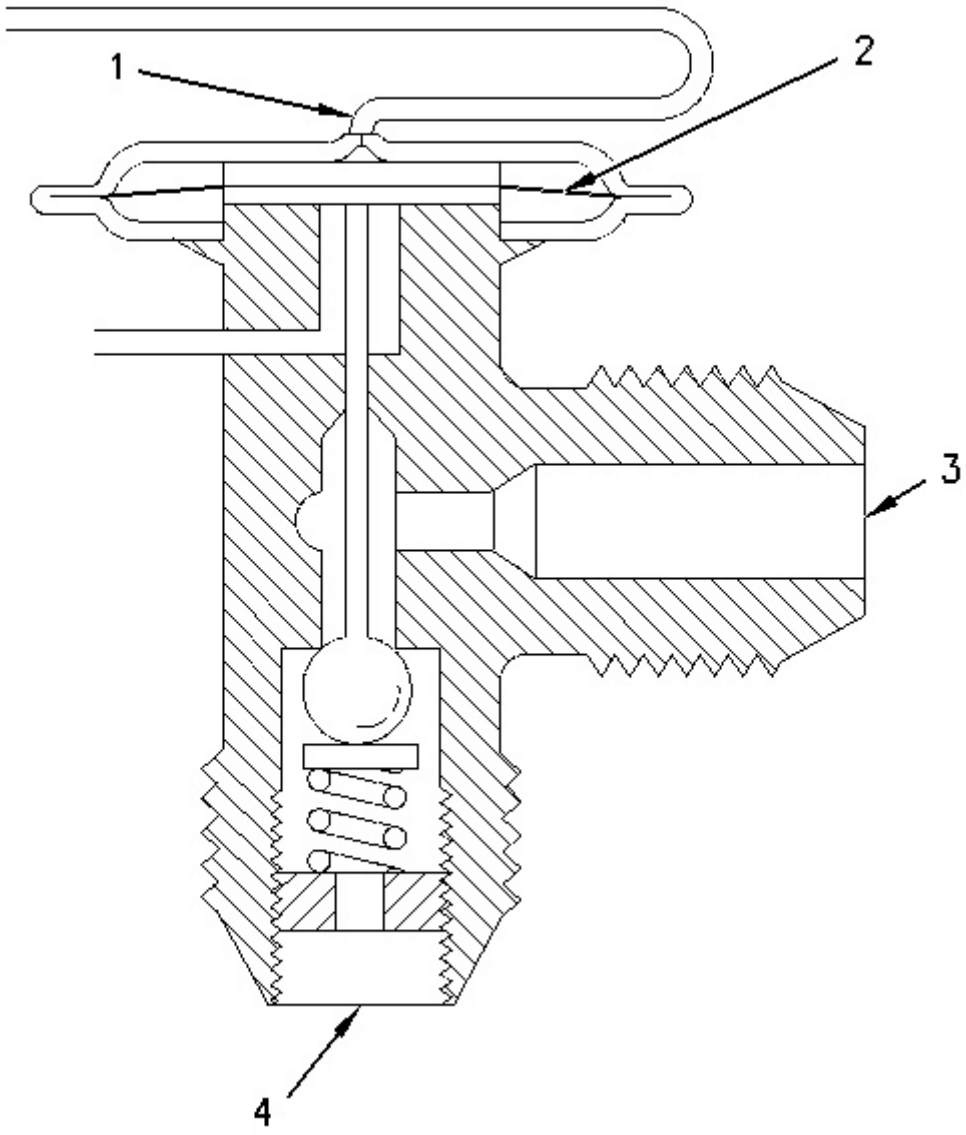


Illustration 2 g00415456

Expansion valve in the closed position (Typical Example)

(1) Capillary tube

(2) Expansion valve diaphragm chamber

(3) Inlet

(4) Outlet

Note: For expansion valve systems, refer to Step 1. For orifice tube systems, refer to Step 3.

System Condition 11

1. **Low-pressure gauge reading is too high.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is too high.** For normal operating pressures, refer to Table 1.

Note: Ambient temperature is above 21°C (70°F).

3. The temperature of the air flow from the evaporator is warm.

Probable Cause

The condenser is not functioning properly.

Note: The system may have a normal or overcharge of refrigerant.

1. Check for a blockage in the flow of air through the condenser.
2. If a blockage is found in the condenser, remove all blockages and perform a performance check. The performance check will ensure proper system operation. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".
3. If the problem still exists, perform the following procedure. Check the system for an overcharge of refrigerant.

   Note: Do not operate the engine.

   - Recover the refrigerant. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
   - Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.
   - Recharge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.

   Note: With the ambient temperature above 21°C (70°F), the normal gauge reading for the low-pressure side is 70 to 138 kPa (10 to 20 psi) while the normal gauge reading for the high-pressure side is 820 to 1300 kPa (120 to 190 psi).

   - In order to ensure the correct systems operation, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

4. If the low-pressure gauge reading and the high-pressure gauge readings are too high, perform the following procedure:

   - Recover the refrigerant from the system. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.
   - Replace the receiver-dryer or replace the in-line dryer. Refer to the Service Manual, SENR5664, "Receiver-Dryer - Remove and Install" section in Disassembly and Assembly. For in-line dryers, refer to the Service Manual, SENR5664, "In-Line Refrigerant Dryer - Remove and Install" section in Disassembly and Assembly.
   - If the receiver-dryer or the in-line dryer is not equipped with quick couplers, evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.

- Charge the system with the correct amount of refrigerant. Measure the refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.
- After the system is charged and operated for a minimum of 10 minutes, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

System Condition 12

- **Water is in the vents.**
- **Water is leaking from the unit.**

Probable Cause

- The non-return valve of the drain

1. Check the non-return valve for proper positioning and proper direction.

The Compressor will not Engage

If the machine is equipped with the protection system for the refrigerant compressor, Refer to the Service Manual, SENR 5664, "Troubleshooting Heating and Air Conditioning Control Systems" in order to test the on delay timer assembly for the refrigerant compressor.

System Condition 13

1. **Low-pressure gauge reading is above normal.** For normal operating pressures, refer to Table 1.
2. **High-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).
3. Air flow to the operator's compartment is warm.

Probable Cause

1. The thermostatic switch is stuck open. This does not allow the magnetic clutch to cycle the compressor.
   a. Check the wire connectors on the thermostatic switch and on the magnetic clutch.
2. The connection of wire leads on switch is improper. The connection of wire leads on the magnetic clutch is improper.
   a. Check for insulation that is broken. The insulation failure can expose the wires from the switch to the magnetic clutch.
3. The wire that connects the switch to the magnetic clutch has an opening.

a. Check the resistance of the coil with a multimeter. Refer to the Service Manual, SENR5664, "Refrigerant Compressor" section in Specifications.

b. Check for the proper electrical ground at the magnetic clutch.

c. Touch the two wires on the switch together. Check for the proper operation of the magnetic clutch.

d. In order to check the electrical components, refer to Service Manual, SENR5664, "Troubleshooting Heating and Air Conditioning Control System" in Testing and Adjusting.

   If the problem is a loose wire on the switch or a loose wire on the magnetic clutch, make the repairs that are needed. If the wires to the clutch were damaged, the damaged wires can cause the switch to remain open. Make the needed repairs to the damaged wires. In order to ensure the correct system operation, perform a performance check. Service Manual, SENR5664, "Air Conditioning Performance - Test"

4. The charge of refrigerant in the capillary tube has been lost.

   a. If the capillary tube has no charge or the switch remains open, the problem is in the thermostatic switch.

      - Replace the switch.

      - In order to ensure the correct system operation, perform a performance check. Refer to Service Manual, SENR5664, "Air Conditioning Performance - Test".

The Compressor Continues to Cycle or the Clutch will not Disengage.

Note: The cause of the problem may be one of the following conditions: low charge, overcharge and evaporator freeze-up .

System Condition 14

1. **Low-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.

2. **High-pressure gauge reading is below normal.** For normal operating pressures, refer to Table 1.

   Note: Ambient temperature is above 21°C (70°F).

3. The air flow to the operator's compartment is very cold, or the air flow may be restricted completely at times.

Probable Cause

The thermostat switch is held closed. There is a short in the wire to the magnetic clutch. The magnetic clutch will not release.

- Check the wire that goes to the magnetic clutch. The wire may have an electrical short.

- Replace the thermostat switch.
- Make the necessary repairs to the magnetic clutch.

Additional Refrigerant Circuit Problems for Orifice Tube System

System Condition 15

The compressor clutch is engaged but the system has insufficient cooling.

Probable Cause

- The system is improperly charged.
- A compressor drive belt that is loose or a compressor drive belt that is worn can cause insufficient cooling.
- Restrictions, insects, foreign material in the condenser, or any restriction of air flow can cause insufficient cooling.
- A missing or a plugged orifice tube can cause insufficient cooling.
- A restriction in a liquid line or a low amount of refrigerant charge can cause insufficient cooling.

1. Install the manifold gauge set. Refer to the Service manual, SENR5664, "Manifold Gauge Set (Refrigerant) - Install" section.
2. Start the engine. Operate the engine at 1400 rpm. Move the temperature control knob to the Maximum position and the fan to the High position. Close all windows and doors. In order to stabilize the system, operate the system for a minimum of 10 minutes.

   Note: Ambient temperature is above 21°C (70°F).
3. The outlet on the accumulator should be cold to the touch. If the outlet is not cold, check the readings on the manifold gauges.
   - If the low side reading is above 345 kPa (50 psi), check for a missing orifice tube. Refer to Service Manual, SENR5664, "Orifice Tube (Air Conditioner) - Remove and Install" in Disassembly and Assembly.
   - If the low side reading is into vacuum, check for a plugged orifice tube or a restriction in the line.
   - A restriction in the liquid line can be detected by running a hand along the line until there is a change in temperature. A change in temperature in the line will usually indicate the location of the restriction.
4. If the inlet and the outlet on the accumulator are warm, refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting. Also, refer to the Service Manual, SENR5664, "Refrigerant Leakage-Test" section in Testing and Adjusting.

False Seizure of the Compressor

Table 3

Required Tools	
Part Number	**Part Description**
1U-8590	Spanner Wrench

On the initial start-up of the air conditioner system, slipping drive belts and broken drive belts may be experienced if the air conditioner system has not been used for an extended period. Also, scored clutch surfaces may be experienced. This would indicate a seized compressor. However, replacement of the compressor may not be necessary.

Changes in temperature can cause expansion of the refrigerant in the compressor during extended periods of nonuse. Also, changes in temperature can cause contraction of the refrigerant in the compressor during extended periods of nonuse. During this movement, lubricating oil that is carried by the refrigerant migrates. The lubricating oil moves away from highly polished surfaces in the compressor. Without lubricating oil at the polished surfaces, the polished surfaces rub together. This can appear as a seized compressor.

The compressor should be checked for seizure before the compressor is replaced. Use the procedures that follow in order to check the compressor for seizure.

1. With a spanner wrench on the clutch drive plate, rock the shaft in the opposite direction of normal rotation.

2. After the clutch drive plate is movable, rotate the clutch drive plate at least three complete revolutions in the counterclockwise direction.

3. Start the engine. Operate the compressor for a minimum of one minute.

   This procedure will not correct a seized compressor. However, this procedure should be attempted before you replace a compressor that has been idle for a month or longer.

Red Dot Automatic Temperature Control (ATC) - Fault Codes: (only for 584 Forwarders and 584HD Forwarders)



Illustration 3 g01912574

To display fault codes, depress the ON key three times in rapid succession. The digital display will then display any active fault codes. Pressing the ON key again repeatedly will scroll through any existing error codes. After five seconds without further key presses, the system will exit the diagnostics mode and return to normal operation.

No Faults - E0

Cab Sensor Shorted - E1

Cab Sensor Open - E2

Evaporator Probe Shorted - E3

Evaporator Probe Open - E4

Duct Sensor Shorted - E5

Duct Sensor Open - E6

Pressure Transducer Open - E151

Pressure Transducer Shorted - E12

Water Valve Actuator Error - E13

Electronics or Comm. Error - E17

Clutch Open - E18*

Clutch Shorted - E19*

No Refrigerant - E20*

High-pressure - E22*

Low Voltage Error - E23*

* Future implementation

Advanced Diagnostics:

The Red Dot ATC Advanced Diagnostics control panel allows the technician to see real-time system information on the control panel display. Control panel display will assist in A/C-heater servicing. This real-time information can help the service technician diagnose certain system problems.

To display advanced diagnostics, depress ON key three times in rapid succession (fault codes displayed) then immediately press and hold ON key for five seconds. The text "CAB" will be displayed. After a few seconds, the real-time value of the cab temperature measured by the ATC is displayed. This value, as well as any other value displayed by the control panel, will continuously

update. Pressing the ON key again repeatedly will scroll through all of the available diagnostics information

CAB - Cab Air Temperature (°C or °F)

EVAP - Evaporator Core Temperature (°C or °F)

DUCT - Duct Air Temperature (°C or °F)

HEAT - Water Valve Command (% of valve open)

A-C - A-C Clutch Request (on / off)

FAN - Blower Fan Speed (% of maximum fan speed)

DEF - Defrost Mode Active (On/Off)

HI-P - High Side Pressure (psig or bar)

PRHT - Blower Enable Active (On/Off)

VOLT - System Voltage (DC Volts)

Note: The system can be operated normally while in advanced diagnostics mode, including changing the temperature set point or changing the blower fan speed, to evaluate the response of the system.

Firmware Version Mode

The firmware version of the control panel and Electronic Control Unit (ECU) can be displayed. From the advanced diagnostics mode, press and hold the ON key for five seconds. The text CTRL will be displayed and after a few seconds, the control panel firmware version number will be displayed. Pressing the ON key will toggle to the ECU firmware version.

The following firmware version information is available:

CTRL - Control Panel Version

ECU - ECU Version

Exiting the Diagnostic Mode:

To exit the advanced diagnostic mode or firmware Version mode, turn the system OFF by pressing the OFF key.

Additional Troubleshooting:

No Display

- Turn on control panel with the ON key.
- Check to see if the display Illuminates.
- Verify that the control panel is plugged into the wire harness.

- Check to see if wire harness is wired into vehicle properly.

No Fan

- Turn up fan with the fan UP key.
- Make sure that the fan is plugged into wire harness, verify all wiring connections.
- Verify that the circuit breakers or fuses are intact.
- If all other functions work properly, replace ECU.

No Heat

- Turn up heat with the Temperature UP key. Use the advanced diagnostics to verify that the water valve is commanded open.
- Inspect and verify all wiring connections.
- Verify that any coolant shut off valves on the engine are open.
- Verify that warm coolant is flowing into the heater core by testing the heater hoses.
- Inspect and replace the electronic water valve if necessary.
- Inspect and replace ECU if necessary.

No Cooling

- Turn down heat with the Temperature DOWN key and enable the defrost mode. Use the advanced diagnostics to verify that the A/C clutch is requested ON.
- Verify that the system is fully charged with refrigerant.
- Verify that voltage is present at the compressor clutch.
- Verify that the correct voltage is present at the clutch relay on the wire harness.
- Inspect and verify all wiring connections.
- Inspect and replace clutch relay if necessary.
- Inspect and replace refrigerant high-pressure and/or low-pressure cut out switches if necessary.
- Inspect compressor and clutch assembly and replace clutch if necessary.

The system is not controlling the cab temperature properly

- Inspect the cab air temperature sensor.
- Verify that the recirculation vent inlet is not obstructed. Inspect and replace recirculation vent air filter if necessary.

- Inspect and replace recirculation vent air filter, if necessary.
- Change the setpoint temperature in small increments.
- Verify that the water valve is working properly. Refer "No Heat"(see No Heat).
- Verify that the compressor clutch is working properly. Refer "No Cooling".

The evaporator core is icing up and restricting airflow

- Inspect the evaporator core probe.
- Verify that the probe is making good contact with the evaporator fins and is not loosely inserted.
- Reposition the probe and check the core temperature during operation using the advanced diagnostics.
- Replace the evaporator core if necessary.

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Troubleshooting
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02995666

Heating System Troubleshooting

SMCS - 7304-035; 7309-035-YC

The following problem solving section is provided for identifying and correcting problems that may occur in the heating system. Several problems can have the same system condition (symptom) or similar system conditions. Before you start the procedure in order to correct the problems, evaluate the performance using the Testing and Adjusting, SENR 5664, "Heater Performance –Test". It is necessary to be complete in the diagnosis of the problem. Repair the components or replace any damaged component if the components are faulty during the inspection.

Symptom: There is little or no warm air that is flowing to the cab when the heater control knob is set to the position of maximum heat.

Possible Cause 1

The blower motor is not working.

1. Inspect the circuit breaker or the fuse panel in order to ensure that there is no open circuit.
2. Visually inspect the wire harnesses in order to check for any broken wires or missing connectors. Use the electrical schematic for the respective machine to ensure proper connections.
3. Check the fan blade in order to make sure that the fan blade is not blocked or seized.
4. Check for the proper function of the fan switch at each setting. The blower motor should engage at all settings and temperatures.

Possible Cause 2

There is a leak that is present in the system.

1. Check the hose clamps in order to make sure that the hose clamps are present and that the hose clamps are also tightened to the correct torque value that is shown on the drawing.

2. Check the heater coil for any visible cracks or signs of a leak.
3. Check the water valve in order to make sure that the water valve is properly installed and operational.

Possible Cause 3

The inlet/outlet ports for the engine cooling system are closed.

1. Inspect the valves that connect the heater hoses to the engine block.
2. Make sure that the valves are adjusted so that the valves are fully open.

Possible Cause 4

The hose that is connecting the system together is kinked or blocked.

1. Check for blockage or bends in the hoses. Blockages and bends in the heater hoses restrict the flow of coolant and the blockages reduce the performance of the entire heating system.
2. Replace any hoses that appear to be restricting the flow of coolant.

Possible Cause 5

There is a failure with the device for the heater control.

1. Determine the type of controlling device that is used on the machine.
2. If there is a water valve that is present, continue to Step 3. If there is a blend door that is present, continue to Step 6.
3. Inspect the water valve for any signs of damage.
4. Check the water valve in order to make sure that the water valve opens completely when the temperature control knob is set to the position of maximum heat.
5. If the water valve fails to open or the water valve fails to close, move to "Possible Cause 6".
6. Inspect the blend door.
7. Check the blend door for any damage.
8. Make sure that the insulation is still attached to the blend door.
9. Make sure that the actuator is connected to the blend door.
10. Check the blend door in order to make sure that the blend door opens completely when the temperature control knob is set to the position of maximum heat.

Possible Cause 6

There is a failure with the cable for the water valve or the potentiometer.

1. Determine the type of control for the water valve that is being used on the machine.

2. If there is a cable that is attached to the water valve, continue to Step 3. If the machine has a built-in potentiometer, continue to Step 5.

3. Check the machine in order to make sure that the cable is attached to the water valve handle.

4. Check the water valve in order to make sure that the water valve opens completely when the temperature control knob is moved to the position of maximum heat.

5. Check the machine in order to make sure that the potentiometer is attached to the wire harness within the dash of the cab.

6. Check the water valve in order to make sure that the water valve opens completely when the temperature control knob is moved to the position of maximum heat.

Symptom: The heat that is within the cab is uncontrollable.

Possible Cause 1

The water valve is installed incorrectly or backward.

1. If the machine is equipped with a water valve control, check the water valve in order to make sure that the water valve is installed properly.

2. Some water valves are manufactured so that there is an arrow that shows the flow direction on the side of the valve body. Make sure that the arrow is pointed toward the line that leads to the heater coil.

3. If the machine is equipped with a cable driven water valve, make sure that the cable is not wrapped around the water valve, or that the cable is not wrapped around the frame of the machine.

4. If the machine is equipped with an electronically driven water valve, make sure that the actuator is attached securely to the water valve.

Possible Cause 2

There is an electrical failure with the control panel.

1. Inspect the control panel in order to make sure that the control panel is receiving power when the machine is turned on.

2. Check in order to make sure that the wire harness is connected to the control panel.

3. Inspect the wire harness for any breakage or exposed wires.

4. Inspect the circuit breaker or the fuses in order to ensure that there is not an open circuit.

Possible Cause 3

There is a failure with the cable for the water valve or the potentiometer.

1. Determine the type of water valve control that is present on the machine.

2. If there is a cable that is attached to the water valve, continue to Step 3. If the machine has a built-in potentiometer, continue to Step 5.
3. Check in order to make sure that the cable is attached to the water valve handle.
4. Check in order to make sure that the water valve opens completely when the temperature control knob is moved to the position of maximum heat.
5. Check in order to make sure that the potentiometer is attached to the wire harness within the dash of the cab.
6. Check in order to make sure that the water valve opens completely when the temperature control knob is moved to the position of maximum heat.

Symptom: There is a coolant smell that is present within the cab.

Possible Cause 1

There is a leak that is present at the hose or the hose clamps.

1. Inspect the connections between the heater coil and the heater hoses.
2. Check the hoses for cuts.
3. Check in order to make sure that the hose clamps are tightened to the proper torques that are shown on the dimension drawings.

Possible Cause 2

There is a leak that is present at the heater coil.

1. Inspect the heater coil in order to determine if there are any visible cracks or holes in the tubing.
2. Check in order to make sure that the hose clamps are tightened to the proper torques.

Possible Cause 3

There is a leak that is present at the water valve.

1. Inspect the water valve for any damage.
2. Check in order to make sure that the hose clamps are tightened to the proper torques.
3. If the water valve passes both these initial tests, refer to the Troubleshooting, SENR5664, "Troubleshooting Heating & Air Conditioning Control System".

Symptom: There is no flow of air to the operators compartment. The evaporator blower motors do not operate when the fan switch is activated.

Probable Cause 1

There is an open circuit.

1. Inspect the circuit breaker or inspect the fuses for an open circuit.
2. Perform a visual inspection of all wire connections. Use the electrical schematic for the respective machine.
3. Use a **5P-7277** Voltage Tester or use a **9U-7330** Digital Multimeter in order to check the voltage in all components of the electrical system. Refer to the electrical schematic section for additional information for the machine.
4. Check for the proper function of the fan switch at each setting. The evaporator blower motor must run at each setting. The evaporator blower motor should be operating in the cold mode and in the heating mode.

Probable Cause 2

There is a blockage in the fan blades.

1. Check for blockages at the fan blades.

Probable Cause 3

The motor has failed.

1. Make necessary repairs or replace motors and components.
2. After a new motor or blower wheel is installed, inspect operation for the correct rotation.

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Troubleshooting Condensate Drainage System

SMCS - 7320-035

Regular inspection is needed in order to ensure that the holes for the condensate drainage are not plugged with debris. Regular inspection is also needed in order to ensure that adequate flow is seen from the case. When the air conditioning system is in operation, there should be evidence of condensate that is exiting the machine from the drain lines.

- Check the drain lines in order to ensure that the drain lines are not pinched.
- Inspect the drain valves in order to ensure that the drain valves are present and installed correctly. The valve should be located between 0.0 mm (0.0 inch) and 76 mm (3 inch) from the end of the drain line.
- If the lines are plugged with dirt and debris, flush the lines with water and relocate the valve.

In order to make sure that the drainage system is working, open the HVAC case and inspect the interior sloped floor or the drain pan.

- Ensure that no large debris is clogging the drain valves from the case.
- If any large debris is observed, the HVAC case should be cleaned in order to prevent any future buildup from clogging the path of drainage.
- Once the area for drainage has been cleaned, reassemble the HVAC case in order to make sure that the system works. Run the system and check the drain lines for condensate flow.

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Specifications
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
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i05377099

System Capacities for Refrigerant (Skid Steer Loaders)

SMCS - 1809

S/N - 4NZ3400-UP

S/N - 4YZ1-UP

S/N - 5SZ1-UP

S/N - A9H1-UP

S/N - BXM1-UP

S/N - CAB1-UP

S/N - CED1-UP

S/N - CMB1-UP

S/N - DWS1-UP

S/N - FDG1-UP

S/N - HEN1-UP

S/N - JAY1-UP

S/N - JXM1-UP

S/N - LBA1-UP

S/N - MJH1-UP

S/N - MST1-UP

S/N - MWD1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - RED1-UP

S/N - SCL1-UP

S/N - SCP1-UP

S/N - SRS1-UP

S/N - TMW1-UP

S/N - TNK1-UP

216 Refrigerant Capacities

216

4NZ3400-UP ... 0.68 kg (1.500 lb)

216B

RLL1-UP ... 0.81 kg (1.5 lb)

216B3

JXM1-UP ... 0.81 kg (1.5 lb)

CD31-UP ... 0.81 kg (1.5 lb)

DSN1-UP ... 0.81 kg (1.5 lb)

226 Refrigerant Capacities

226

5FZ1-UP ... 0.68 kg (1.500 lb)

226B

MJH1-UP ... 0.81 kg (1.786 lb)

226B3

MWD1-UP ... 0.81 kg (1.786 lb)

AS21-UP ... 0.81 kg (1.5 lb)

SNA1-UP ... 0.81 kg (1.5 lb)

232

232

CAB1-UP ... 0.68 kg (1.500 lb)

232B

SCH1-UP ... 0.81 kg (1.786 lb)

236 Refrigerant Capacities

236

4YZ1-UP ... 0.68 kg (1.500 lb)

236B

HEN1-UP ... 0.81 kg (1.786 lb)

236B3

A9H1-UP ... 0.81 kg (1.786 lb)

236D

BGZ1-UP ... 1 kg (2.2 lb)

SEN1-UP ... 1 kg (2.2 lb)

MPW1-UP ... 1 kg (2.2 lb)

242 Refrigerant Capacities

242

CMB1-UP ... 0.68 kg (1.500 lb)

242B

BXM1-UP ... 0.81 kg (1.786 lb)

242B3

SRS1-UP ... 0.81 kg (1.786 lb)

242D

DZT1-UP ... 1 kg (2.2 lb)

DML1-UP ... 1 kg (2.2 lb)

A9W1-UP ... 1 kg (2.2 lb)

246 Refrigerant Capacities

246

5SZ1-UP ... 0.68 kg (1.500 lb)

246B

PAT1-UP ... 0.81 kg (1.786 lb)

246C

JAY1-UP ... 1.27 kg (2.80 lb)

246D

BYF1-UP ... 1 kg (2.2 lb)

JSL1-UP ... 1 kg (2.2 lb)

HMR1-UP ... 1 kg (2.2 lb)

248 Refrigerant Capacities

248

6LZ1-UP ... 0.68 kg (1.500 lb)

248B

SCL1-UP ... 0.81 kg (1.786 lb)

252 Refrigerant Capacities

252

FDG1-UP ... 0.68 kg (1.500 lb)

252B

SCP1-UP ... 0.81 kg (1.786 lb)

252B3

TNK1-UP ... 0.81 kg (1.786 lb)

256 Refrigerant Capacities

256C

DWS1-UP ... 1.27 kg (2.80 lb)

262 Refrigerant Capacities

262

CED1-UP ... 0.68 kg (1.500 lb)

262B

PDT1-UP ... 0.81 kg (1.786 lb)

262C

MST1-UP ... 1.27 kg (2.80 lb)

TMW1-UP ... 1.27 kg (2.80 lb)

262D

DTB1-UP ... 1 kg (2.2 lb)

LST1-UP ... 1 kg (2.2 lb)

KTS1-UP ... 1 kg (2.2 lb)

268 Refrigerant Capacities

268B

LBA1-UP ... 0.81 kg (1.786 lb)

272 Refrigerant Capacities

272C

RED1-UP ... 0.81 kg (1.786 lb)

272D

SHY1-UP ... 1.0 kg (2.2 lb)

GSL1-UP ... 1.0 kg (2.2 lb)

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i03863074

General Information

SMCS - 1808; 7309

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

- All refrigerant lines that are metal or flexible hose must be free of sharp bends. Also, do not use a refrigerant line that is kinked. Sharp bends will cause a restriction in the refrigerant flow. Restrictions in the refrigerant lines are identified by cold spots or frost on the line at the location of the restriction. Restrictions in the lines reduce the performance and the efficiency of the system.
- The radius of bends in the flexible hose must never be less than 10 times the outside diameter of the hose.
- Do not allow the flexible hoses to come within 63.5 mm (2.50 inch) of the exhaust manifold.
- The hoses need to be inspected yearly for leaks and for hardness. Conduct a leak test on all the hoses and the lines. Refer to the Service Manual, SENR5664, "Refrigerant Leakage - Test" section in testing and adjusting. Replace hoses if leaks or hardness are in the hoses. Replace hoses with new hose that is sealed and free of contaminants.
- The correct use of wrenches is very important when connections are made. The type of wrench that is used is also important. Only use wrenches that are made for use with tube-type fittings. When a hose is connected or disconnected from the system, use a wrench on the fitting and use a wrench on the nut. When a metal line is connected or disconnected from the system, use a wrench on the fitting and use a wrench on the nut.
- Install protective plugs or protective caps on all components and hoses that are disconnected or removed.
- O-ring seals and O-ring seats must be in good condition. Small cuts, scratches, or particles of dirt will cause a leak in the system. Put new refrigerant oil on all new O-ring seals at the time of installation. Do not use any kind of sealant on connections.
- Dust caps on the compressor block fittings are the primary seals on the air conditioning system.
- All machines should have an identification tag that specifies the refrigerant charge for the machine. The tag should be located in the operator compartment.
- If water is in the vents check the non-return valve. If water leaks from the air conditioning system, check the non-return valve. The non-return valve should have the proper position and the proper direction.
- If engine coolant is leaking into the operator compartment, check for loose clamps on the heater hoses.

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i03863078

Machine Preparation for Disassembly and Assembly

SMCS - 7320-017

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

Note: Before you conduct a performance check, refer to the Service Manual, SENR5664, "Visual Inspection" section.

Note: Refer to the Service Manual, SENR5664, "Machine Preparation for Troubleshooting" section before service work is performed on the air conditioning system.

When the service work is done on the air conditioning system, the service work must keep the system clean and free from contamination. Plugs and caps must be used in order to close the components and hoses when the components and hoses are open. The plugs and caps protect the system from dirt and air (moisture). Only new refrigerant oil of the correct viscosity and new refrigerant can be added to the system. Refer to the Service Manual, SENR5664, "Refrigerant Compressor" section in this manual for the correct oil. Any other material or any other substance is considered non-condensable and the material will contaminate the system. Keep the work area clean.

- Dust caps on the refrigerant compressor block fitting are the primary seal on the air conditioning system.
- All machines should have an identification tag in the cab that specifies the proper refrigerant charge for the machine.

When replacement or repair of components and hoses are required, perform the following procedure:

1. Remove the refrigerant charge. Measure the amount of oil recovered. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" and , , "Refrigerant Oil-Test" section in Testing and Adjusting, for proper procedures.
2. Remove the component or remove the hose that is being repaired or replaced. Install protective plugs on components or hoses that are left exposed to the air.
3. Replace any damaged component or hose.

4. Use the following table in order to determine the amount of oil that is lost during individual replacements of components. Follow the process provided in Service Manual, SENR5664, "Refrigerant Oil-Test" to calculate the correct amount of oil needed for the system.

Table 1

Oil Capacities for Component Replacements	
Accumulator	30 mL (1 fl oz)
Compressor	Refer to the Service Manual, SENR5664, "Refrigerant Compressor Oil-Check" section in Testing and Adjusting.
Condenser	30 mL (1 fl oz)
Evaporator	90 mL (3 fl oz)
In-Line Dryer (1) before any oil is installed	30 mL (1 fl oz)
Receiver-Dryer	30 mL (1 fl oz)

(1) Refer to the Service Manual, "In Line Refrigerant Dryer - Remove and Install"

5. Refer to the Service Manual, SENR5664, "Refrigerant System-Evacuate" section in testing and adjusting.

6. Refer to the Service Manual, SENR5664, "Refrigerant System-Charge" section in Testing and Adjusting.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03863090

Air Conditioner Lines - Remove and Install

SMCS - 1808-010

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld or solder any charged components.

Care must be taken during removal of air conditioner lines. Before disconnecting any tube fittings, refer to Testing and Adjusting, SENR5664, "Refrigerant Recovery" in order to recover all refrigerant from the system.

Place dust caps on all hoses and fittings upon disconnecting.

Do not fold or twist hoses when you are routing the new hoses onto the machine. Damage can occur to the inner layers of the hoses and damage can cause premature failure.

Reassemble fittings by using the correct torque values for assembly of the air conditioning unit. Refer to Specifications, SENR3130, "Torque Specifications" in order to find the correct torque value.

Use the following procedure to reassemble the connections.

Proper Technique for Assembly

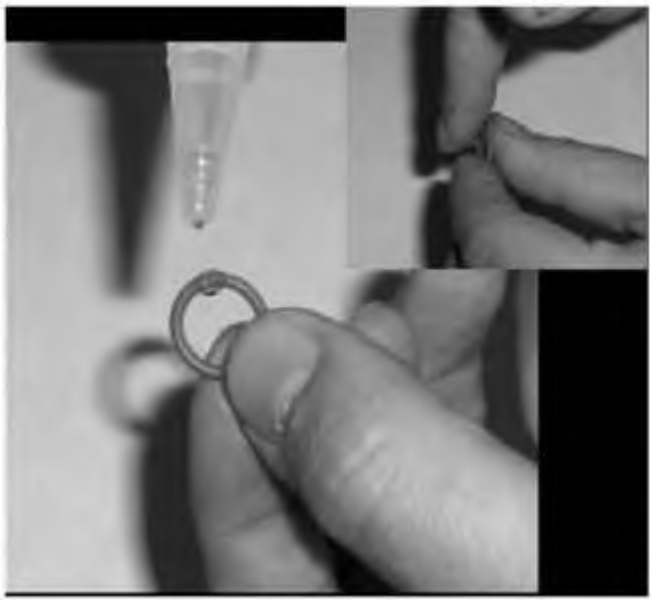


Illustration 1 g01519272

1. Drip clean mineral oil onto the clean O-ring.



Illustration 2 g01519286

2. Place the O-ring on fitting.



Illustration 3 g01519288

3. Oil the O-ring again.



Illustration 4 g01519290

4. Align fittings and ensure that the seal is seated correctly. Hand tighten the fittings together.

   Note: DO NOT CROSS THREAD.



Illustration 5 g01519291

5. Tighten the connection with proper torque. Use a wrench to avoid twisting parts.

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Refrigerant Compressor - Remove and Install

SMCS - 1802-010

Removal

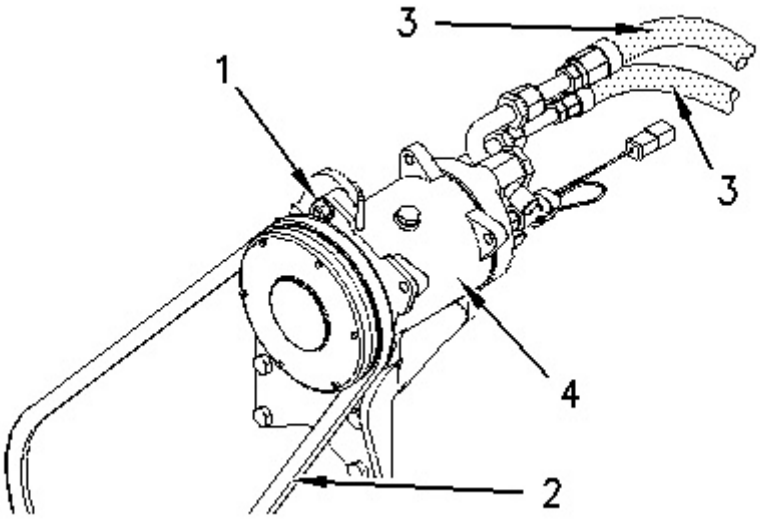


Illustration 1 g00742981

(1) Bolt

(2) Drive belt

(3) Suction and discharge hoses

(4) Compressor

1. Remove the refrigerant charge. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.

2. Disconnect electrical wires from the magnetic clutch.

3. Loosen all the mounting bolts and loosen the belt tightener (if equipped). Remove drive belt (2) .

4. Disconnect hoses (3) and put plugs or caps on the hoses. Put plugs or caps on the fittings of the compressor. Put identification marks on the hoses. The marks will ensure that the hoses will be connected correctly at a later time.

5. Remove all the mounting bolts and remove the compressor (4). The weight of the compressor is approximately 18 kg (40 lb).

Installation

1. Check the amount and condition of the oil in the compressor (4). Refer to the Service Manual, SENR5664, "Refrigerant Compressor Oil-Test" section in Testing and Adjusting.

2. Inspect the drive belt (2). If the drive belt (2) is damaged or worn replace the belt.

3. Install the compressor (4). Do not tighten the mounting bolts until drive belt (2) is installed and adjusted.

4. Connect the discharge and the suction hoses (3) to the discharge and suction ports on the compressor.

5. Connect the electrical wires to the magnetic clutch.

6. Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting.

7. Charge the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.

8. For the correct system operation, refer to the Service Manual, SENR5664, "Troubleshooting Heating and Air Conditioning Control System" section in Testing and Adjusting.

   Note: Refer to the Service Manual, SENR5664, "Refrigerant Compressor" in the Specifications Section for the correct belt tension.

9. For the oil level in the system, refer to Service Manual, SENR5664, "Refrigerant Compressor Oil - Check".

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02998485

Refrigerant Accumulator - Remove and Install

SMCS - 1808-010-ZJ; 7320-010-ZJ

The refrigerant must be recovered before the accumulator is removed. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting.

Refer to the Service Manual, SENR5664, "Machine Preparation for troubleshooting" section in Testing and Adjusting before service work is performed.

Remove the accumulator. The accumulator has an internal oil drain hole which could become plugged. The oil could be trapped inside the accumulator. It is necessary to check for excessive oil when the accumulator is changed. Add the same amount of oil that was drained from the old accumulator. Add an additional 30 mL (1 fl oz) to the new accumulator before the new accumulator is installed. Do not add oil if the compressor was changed also. Evacuate the system and recharge the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in Testing and Adjusting. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in Testing and Adjusting.

Note: If the accumulator has frost on the outside, the air conditioning system still contains refrigerant.

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i02998486

Refrigerant Expansion Valve - Remove and Install

SMCS - 7320-010-EV

To replace the expansion valve, use the procedure that follows. Refer to Service Manual, SENR5664, "Troubleshooting Heating and Air Conditioning Control System" before service work is performed on the air conditioning system.

1. Recover the refrigerant.

   Note: Cap all disconnected lines and hoses.

2. Remove the insulation and the clip. The insulation and the clip hold the sensing bulb to the evaporator outlet pipe.

3. Disconnect the sensing line for pressure from the evaporator outlet pipe.

4. Loosen and remove the two connections at the expansion valve. Remove the expansion valve.

   Note: Check the O-ring seals. The seals must be in good condition and the seals must be properly lubricated with the correct refrigerant oil before assembly.

5. Install the expansion valve for replacement and tighten the two connections.

6. Tighten the pressure sensing connection on the evaporator outlet pipe.

7. Use a **8P-6355** Clip to hold the sensing bulb onto the evaporator outlet pipe. The sensing bulb should be as close to the coil as possible. The bulb should be upstream of the pressure sensing connection on the evaporator outlet pipe. The **5P-7070** Insulation should be wrapped tightly around the clip, the sensing bulb and the outlet pipe. There should be no insulation between the bulb and the outlet pipe.

8. Tighten all the connections correctly.

9. Evacuate the system. Refer to the Service Manual, SENR5664, "Refrigerant System - Evacuate" section in testing and adjusting.

10. Charge the system with the correct amount of refrigerant by weight. Refer to the Service Manual, SENR5664, "Refrigerant System - Charge" section in testing and adjusting.

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Refrigerant Receiver-Dryer - Remove and Install

SMCS - 7322-010

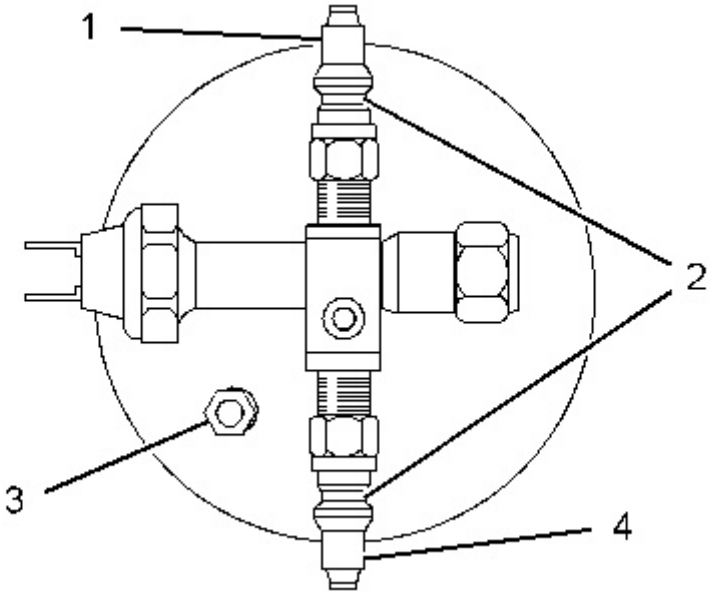


Illustration 1 g01257459

Top View of Receiver-Dryer

(1) Inlet

(2) Quick Disconnect Fittings

(3) Moisture Indicator

(4) Outlet

NOTICE

If the receiver-dryer does not have air conditioner quick disconnects, the system must be completely recovered, evacuated, and recharged after the receiver-dryer has been replaced.

The refrigerant that is in the system must be recovered if the receiver-dryer does not have air conditioner quick disconnects (2). Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in Testing and Adjusting before you remove the receiver-dryer. If the receiver-dryer has air conditioner quick disconnects (2) use the procedure that follows.

Refer to Safety Requirements before service is performed on the air conditioning system.

1. Stop the engine for five minutes. This allows the air conditioning system to equalize the pressure.
2. Disconnect the inlet hose (1) from the old receiver-dryer at the air conditioner quick disconnects.
3. Connect the hose that was disconnected in Step 2 to the inlet on the new receiver-dryer.
4. Disconnect the electrical connections on the old receiver-dryer. Connect the electrical connections to the new receiver-dryer.

   Note: If the receiver-dryer has quick disconnects, do not add additional oil or refrigerant to the system.
5. Start the engine. Operate the air conditioning system for one minute.
6. With the air conditioning system in operation, disconnect the outlet hose (4) from the old receiver-dryer. Disconnect the old receiver-dryer at the air conditioner quick disconnects.
7. Stop the engine for five minutes. This allows the air conditioning system to equalize pressure.
8. Connect the outlet hose (4) that was disconnected in step 6 to the new receiver-dryer.

Note: The receiver-dryer must be replaced annually. The receiver-dryer must also be replaced whenever the system is opened. The receiver-dryer should be replaced if moisture indicator (3) is filled with moisture. Moisture indicator (3) will display a pink color or white color if the receiver-dryer is full of moisture.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03863132

In-Line Refrigerant Dryer - Remove and Install

SMCS - 7322-010-QT

Dryer Installation

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that

the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

NOTICE

Never weld of solder any charged components.

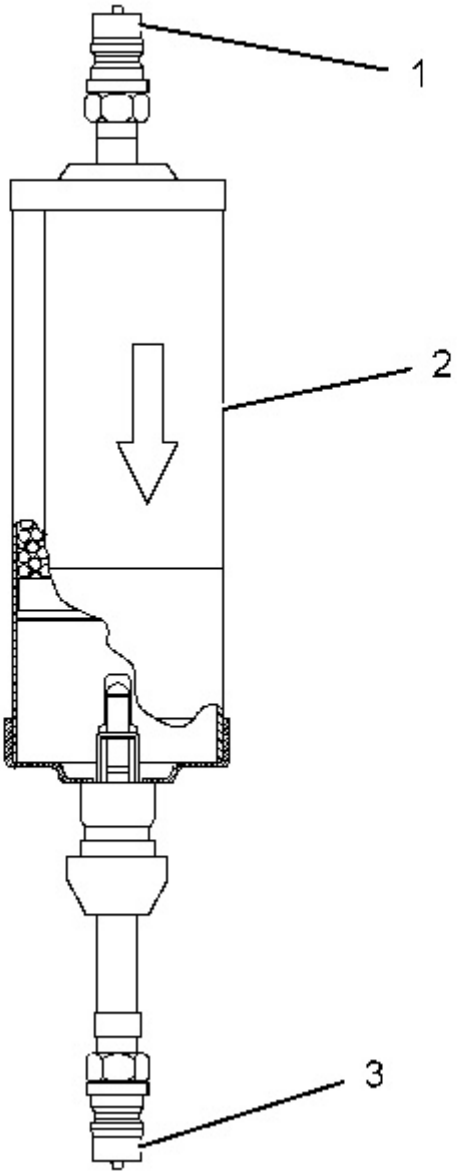


Illustration 1 g01520430

Typical In-Line Dryer with quick disconnects

(1) Inlet hose with air conditioner quick disconnect

(2) Dryer

(3) Outlet hose with air conditioner quick disconnect

Note: Replace dryer (2) annually. Dryer (2) should also be replaced whenever the system is opened.

Disassembly and Assembly

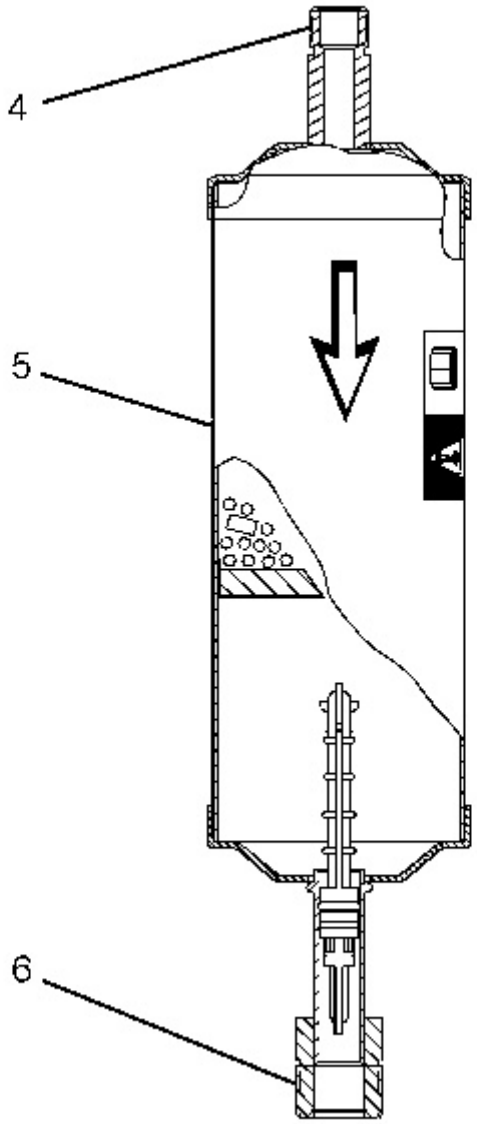


Illustration 2 g01520434

In-line dryer without quick disconnects

(4) Inlet hose without air conditioner quick disconnect

(5) Dryer

(6) Outlet hose without air conditioner quick disconnects

Note: Every two years replace dryer (5). Dryer (5) should also be replaced whenever the system is opened.

Before any service work is performed on the air conditioning system, refer to the Service Manual, SENR5664, "Machine Preparation for Troubleshooting" section in Testing and Adjusting.

Before removing the dryer, perform the following steps in order to properly diagnose the problem

1. Check the following components for blockages:
    - Condenser
    - Evaporator
    - Fresh air filters
2. Check the condition and the tension of the compressor drive belt.
3. Connect a manifold gauge set to the compressor. Refer to Service Manual, SENR5664, "Manifold Gauge Set – Install".
4. Operate the Air conditioning.
    - Operate the engine at 1400 rpm.
    - Place the air conditioning switch in the ON position.
    - Set the blower switch to the HIGH position.
    - Open all of the louvers in the cab.
    - Close the cab doors and close all of the cab windows.
5. Compare the pressures for the manifold gauge to the pressure ranges in Table 1 in order to ensure that the pressures are normal for the current ambient air temperature.

Table 1

Pressure Range [1]		
Ambient Air Temperature C° (F°)	High Pressure Test Fitting kPa (psi) [2]	Low Pressure Test Fitting kPa (psi) [3]
21°C (70°F)	820 to 1300 kPa (120 to 190 psi)	70 to 138 kPa (10 to 20 psi)
27°C (80°F)	950 to 1450 kPa (140 to 210 psi)	70 to 173 kPa (10 to 25 psi)
32°C (90°F)	1175 to 1650 kPa (170 to 240 psi)	105 to 210 kPa (15 to 30 psi)
38°C (100°F)	1300 to 1850 kPa (190 to 270 psi)	105 to 210 kPa (15 to 30 psi)
43°C (110°F)	1450 to 2075 kPa (210 to 300 psi)	105 to 210 kPa (15 to 30 psi)

[1] This table is only for reference.

(2) Pressure may be slightly higher in very humid conditions and lower in very dry conditions.

(3) Pressure before clutch disengagement

6. Check for frost at the dryer outlet.

   Note: Moisture on the drier outlet tube after the orifice is normal and this moisture does not indicate a failure with the dryer. Frost on the drier outlet tube after the orifice is an indicator of a low refrigerant charge.

7. If frost is indicated at the dryer outlet or if pressures are low proceed to Step 8. Otherwise, proceed to Step 15.

8. Recover the refrigerant charge from the machine. Refer to Service Manual, SENR5664, "Refrigerant System Recovery".

9. Record the amount of refrigerant and oil that is recovered from the Air Conditioner system.

   These values will be needed in order to calculate the amount of oil that is needed. Refer to Service Manual, SENR5664, "Refrigerant Compressor Oil - Test" in the Testing and Adjusting Section.

10. If the charge was low, check the system for leaks.

    a. Use an Ultraviolet light and use an electronic leak detector. Ensure that the following items are checked:

       - Quick disconnects which are on the dryer
       - Check the drier swivel nut and tighten the nut to 27 ± 4 N·m (20 ± 3 lb ft).
       - All the connections in the circuit that are O-ring
       - Hoses for rubbing, bulging, and wet spots (oil leaks)

       Note: In order to help reveal leaks, simulate the vibrations which are made by the machine by moving the connections.

11. Recharge the refrigerant. Refer to Service Manual, SENR5664, "Refrigerant System - Charge" in the Testing and Adjusting Section.

12. Retest the system with the engine at 1400 rpm and check for frost at the dryer outlet.

13. Ensure that the pressures are normal for the current ambient temperature.

14. Refer to Table 1 for the pressures which are normal for the current ambient air temperature.

15. If a component is leaking, bill the claim against the leaking component and provide details in the description.

Dryer Removal

If the dryer does not have air conditioner quick Disconnects the refrigerant that is in the system must be recovered. Refer to the Service Manual, SENR5664, "Refrigerant System Recovery" section in Testing and Adjusting before you remove the dryer.

If the dryer has air conditioner quick disconnects use the procedure that follows.

Refer to Service Manual, SENR5664, "Machine Preparation for Disassembly and Assembly" before service is performed on the air conditioning system.

1. Stop the engine for five minutes. This allows the air conditioning system to equalize the pressure.
2. Disconnect the inlet hose from the old dryer.
3. Connect the hose that was disconnected in Step 2 to the inlet on the new dryer.

   Note: For a dryer that has air conditioner quick disconnects, do not add additional oil or refrigerant to the system.
4. Start the engine. Operate the air conditioning system for one minute.
5. With the air conditioning system in operation, disconnect the outlet hose from the old dryer. Disconnect the old dryer.
6. Stop the engine for five minutes. This allows the air conditioning system to equalize pressure.
7. Connect the outlet hose that was disconnected in Step 6 to the new dryer.
8. Mark the new dryer in permanent marker Installed mm/dd/yy. This will assist in future maintenance of the in-line dryer.

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Disassembly and Assembly
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03019201

Refrigerant Orifice Tube Assembly - Remove and Install

SMCS - 7320-010-QT

The orifice tube may be located in the refrigerant line near the evaporator inlet, or in the in-line dryer.

If the orifice tube is located in the refrigerant line near the evaporator inlet use the procedure that follows. If the orifice tube is located in the in-line dryer, refer to Dryer Replacement.

Removing the Orifice Tube

Refer to Safety Requirements before service work is performed on the air conditioning system.

The refrigerant must be recovered before removing the accumulator. Refer to the Service Manual, SENR5664, "Refrigerant Recovery" section in testing and adjusting.

NOTICE

Do not attempt to remove the orifice tube with pliers. Do not twist or rotate the orifice tube in the tube assembly.

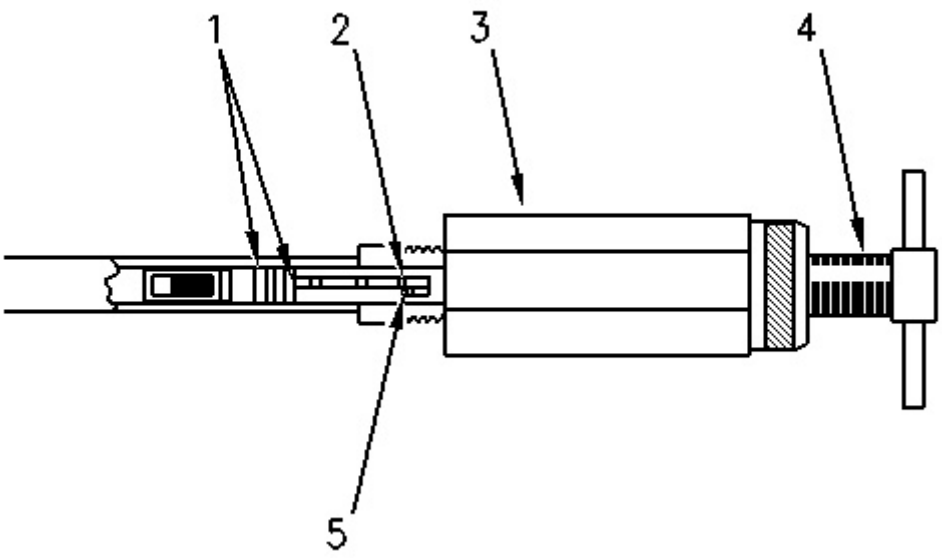


Illustration 1 g00379603

Orifice tube

(1) O-Ring seals

(2) Lugs

(3) Body

(4) Drive screw

(5) Finger lock

1. Disconnect the high side line at the enlarged section of the evaporator inlet port. This will expose the orifice tube for removal.
2. Align the short fingers of the **1U-9890** Orifice Removal Tool with the ribs of the orifice tube. Insert the tool onto the tube until the tool bottoms out.
3. Turn drive screw (4) clockwise. Turn far enough to engage the lugs (2) on the orifice tube in the finger lock (5). The finger lock (5) is part of the removal tool.
4. Hold the drive screw (4) stationary. Thread the body (3) forward until the body makes contact with the inlet port.
5. Continue holding the drive screw stationary, and thread the body forward until the orifice tube becomes free.

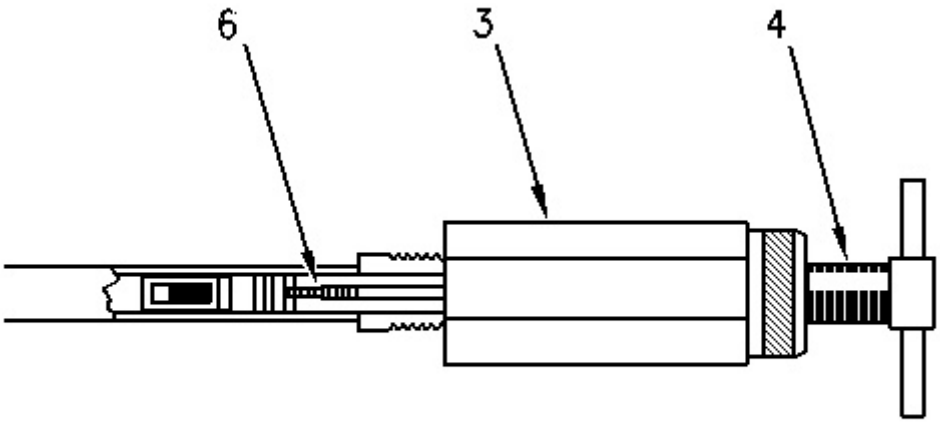


Illustration 2 g00381412

Removing the broken orifice tube

(3) Body

(4) Drive screw

(6) Extractor tip

6. For the removal of the orifice tube assembly, use the extractor tip (6) on **1U-9890** Orifice Removal Tool. Insert the tool into the evaporator inlet tube and thread the tool into the brass center of the orifice tube.
7. Repeat steps 3 and 4.
8. If only the brass center of the orifice tube is removed, thread the tool into the plastic body and repeat step 3 and 4.

Orifice Tube Installation

1. Lubricate the O-Ring on the orifice tube with the proper clean refrigerant oil.
2. Place the orifice tube into the **1U-9890** Orifice Removal Tool. Insert the orifice tube straight into the evaporator inlet tube without twisting until the tube is seated.
3. Disengage the removal tool from the orifice tube.
4. Use a new O-Ring that is lubricated with clean refrigerant oil. Reconnect the high side line at the enlarged section of the evaporator inlet port.
5. Do a leak test. Evacuate the system and recharge the system. Refer to the Service Manual, SENR5664, "Refrigerant Systems-Evacuate" section in testing and adjusting. Also, refer to the Service Manual, SENR5664, "Refrigerant Systems-Charge" section in testing and adjusting.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02869375

Gas Spring Group (Cab)

SMCS - 7301-S3

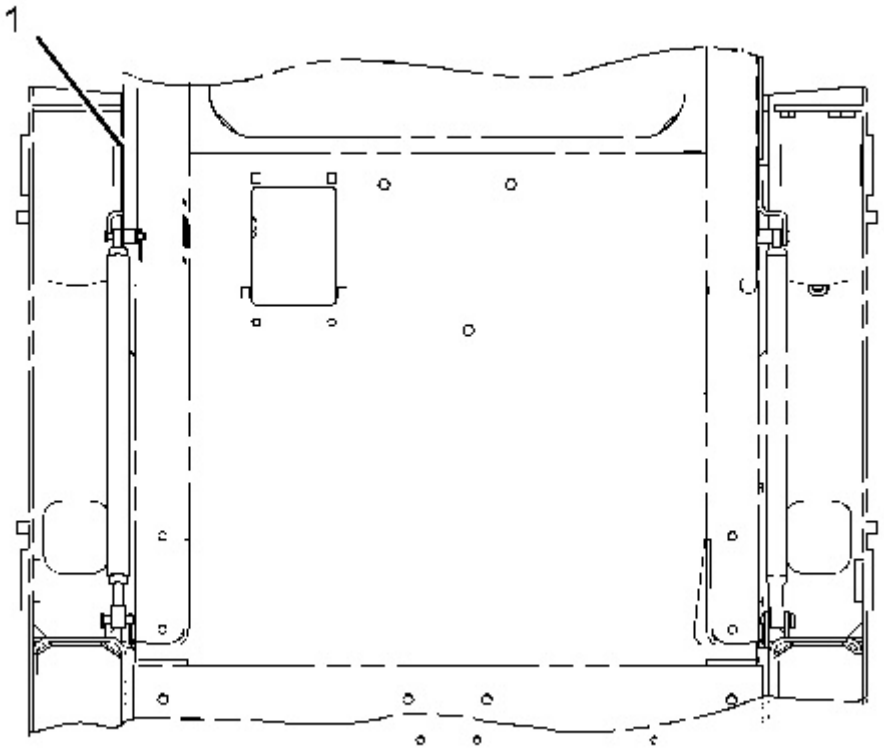


Illustration 1 g01429049

The group comes with one **153-2682** Gas Spring As . Two is the maximum number of springs that are used on the machine. A standard machine configuration for a Skid Steer Loader or a Multi Terrain Loader is equipped with one heavy lift **153-2682** Gas Spring As . The gas spring is mounted on the right hand side of the cab (1) .

Table 1

Needed Springs for the Cab	
Component in the Cab	**Needed Gas Springs**
Seat and mounting group	**153-2682** Gas Spring As
Seat and mounting group Cab door and mounting group	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Cab door and mounting group Lifting group (single point)	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Lifting group (single point)	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Four-point lifting group	**153-2682** Gas Spring As
Seat and mounting group ROPS/FOPS guard	**153-2682** Gas Spring As
Seat and mounting group Four-point lifting group ROPS/FOPS guard	**153-2682** Gas Spring As
Seat and mounting group Lifting group (single point) ROPS/FOPS guard	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Cab door and mounting group Four-point lifting group	**153-2682** Gas Spring As and **153-2683** Gas Spring As

The number of gas springs that are needed depends on the components in the cab assembly. Refer to Table 2 for the components and the needed gas springs. The additional gas spring is mounted on the left hand side of the cab.

Note: The **153-2683** Gas Spring As is included with the cab door group and the lifting group (single point). The **153-2683** Gas Spring As is not included with the four-point lifting group and the ROPS/FOPS guard.

When the following components are installed in the cab, additional lifting assistance may be required:

- A seat and mounting group, a cab door group, and a lifting group (single point)
- A seat and mounting group plus a ROPS/FOPS guard
- A seat and mounting group, a four-point lifting group, and a ROPS/FOPS guard
- A seat and mounting group, a lifting group (single point), and a ROPS/FOPS guard

153-2682 Gas Spring As

Operational temperature range ... -30 to 80 °C (-22 to 176 °F)
Extension force with an extended piston rod ... 2300 ± 115 N (517 ± 26 lb)
Mounted length ... 496 mm (19.5 inch)
Extended length ... 886.5 mm (34.90 inch)

153-2683 Gas Spring As

Operational temperature range ... -30 to 80 °C (-22 to 176 °F)
Extension force with an extended piston rod ... 1500 ± 75 N (337 ± 17 lb)
Mounted length ... 496 mm (19.5 inch)
Extended length ... 886.5 mm (34.90 inch)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02869375

Gas Spring Group (Cab)

SMCS - 7301-S3

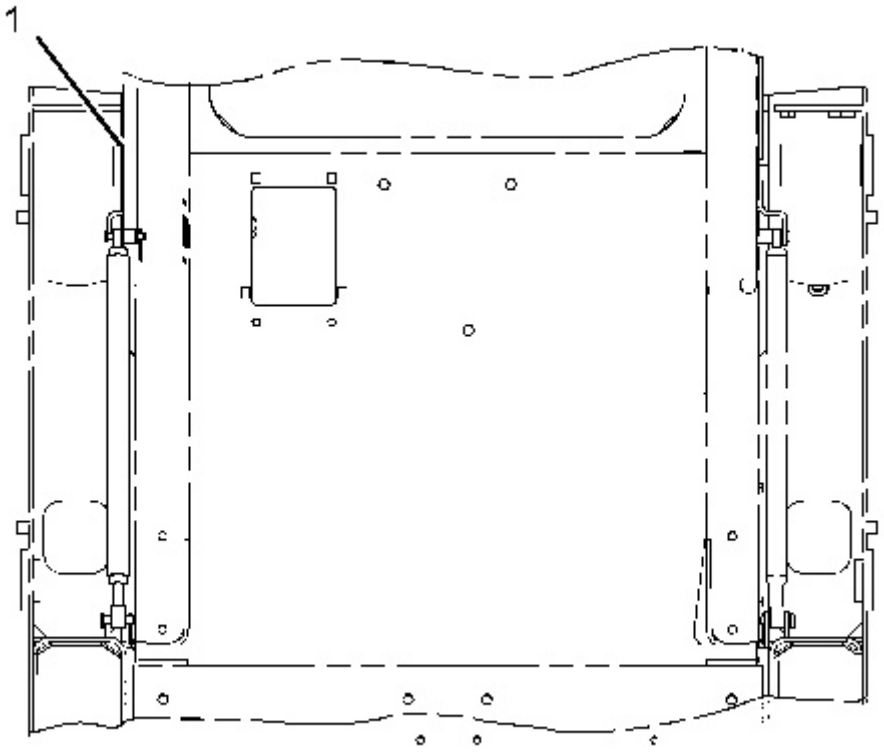


Illustration 1 g01429049

The group comes with one **153-2682** Gas Spring As . Two is the maximum number of springs that are used on the machine. A standard machine configuration for a Skid Steer Loader or a Multi Terrain Loader is equipped with one heavy lift **153-2682** Gas Spring As . The gas spring is mounted on the right hand side of the cab (1) .

Table 1

Needed Springs for the Cab	
Component in the Cab	**Needed Gas Springs**
Seat and mounting group	**153-2682** Gas Spring As
Seat and mounting group Cab door and mounting group	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Cab door and mounting group Lifting group (single point)	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Lifting group (single point)	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Four-point lifting group	**153-2682** Gas Spring As
Seat and mounting group ROPS/FOPS guard	**153-2682** Gas Spring As
Seat and mounting group Four-point lifting group ROPS/FOPS guard	**153-2682** Gas Spring As
Seat and mounting group Lifting group (single point) ROPS/FOPS guard	**153-2682** Gas Spring As and **153-2683** Gas Spring As
Seat and mounting group Cab door and mounting group Four-point lifting group	**153-2682** Gas Spring As and **153-2683** Gas Spring As

The number of gas springs that are needed depends on the components in the cab assembly. Refer to Table 2 for the components and the needed gas springs. The additional gas spring is mounted on the left hand side of the cab.

Note: The **153-2683** Gas Spring As is included with the cab door group and the lifting group (single point). The **153-2683** Gas Spring As is not included with the four-point lifting group and the ROPS/FOPS guard.

When the following components are installed in the cab, additional lifting assistance may be required:

- A seat and mounting group, a cab door group, and a lifting group (single point)
- A seat and mounting group plus a ROPS/FOPS guard
- A seat and mounting group, a four-point lifting group, and a ROPS/FOPS guard
- A seat and mounting group, a lifting group (single point), and a ROPS/FOPS guard

153-2682 Gas Spring As

Operational temperature range ... -30 to 80 °C (-22 to 176 °F)
Extension force with an extended piston rod ... 2300 ± 115 N (517 ± 26 lb)
Mounted length ... 496 mm (19.5 inch)
Extended length ... 886.5 mm (34.90 inch)

153-2683 Gas Spring As

Operational temperature range ... -30 to 80 °C (-22 to 176 °F)
Extension force with an extended piston rod ... 1500 ± 75 N (337 ± 17 lb)
Mounted length ... 496 mm (19.5 inch)
Extended length ... 886.5 mm (34.90 inch)

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i02038431

Cab - Tilt

SMCS - 7301-084

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Procedure to Tilt the Cab

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

WARNING

Do not go beneath cab unless cab is empty and support lever is engaged.

Failure to follow the instructions or heed the warnings could result in injury or death.

Note: Empty the water tank (if equipped) before you tilt the cab.

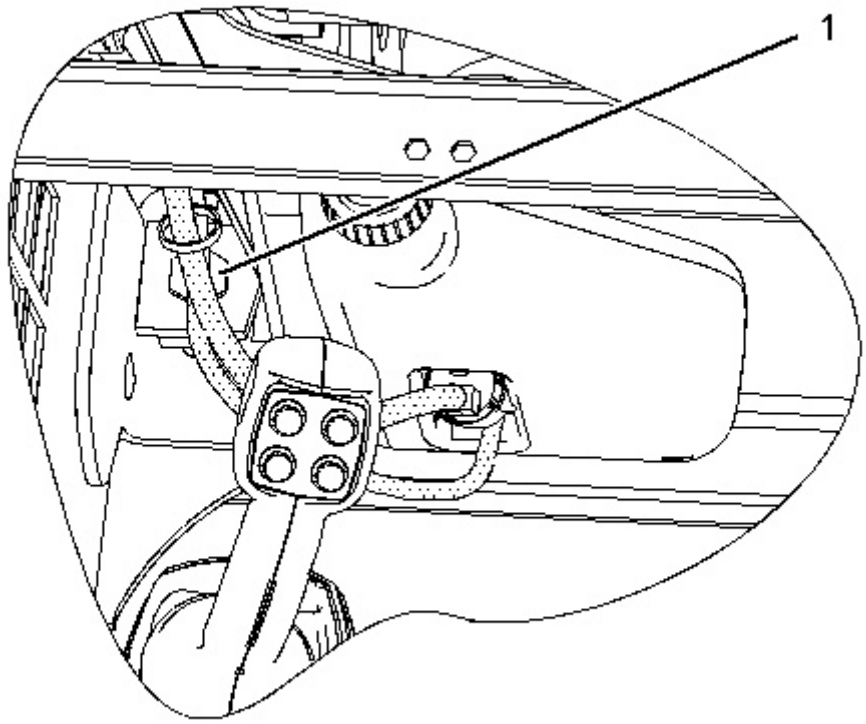


Illustration 1 g01049069

1. Loosen bolt (1) .

   Note: Bolt (1) will be retained in the cab.

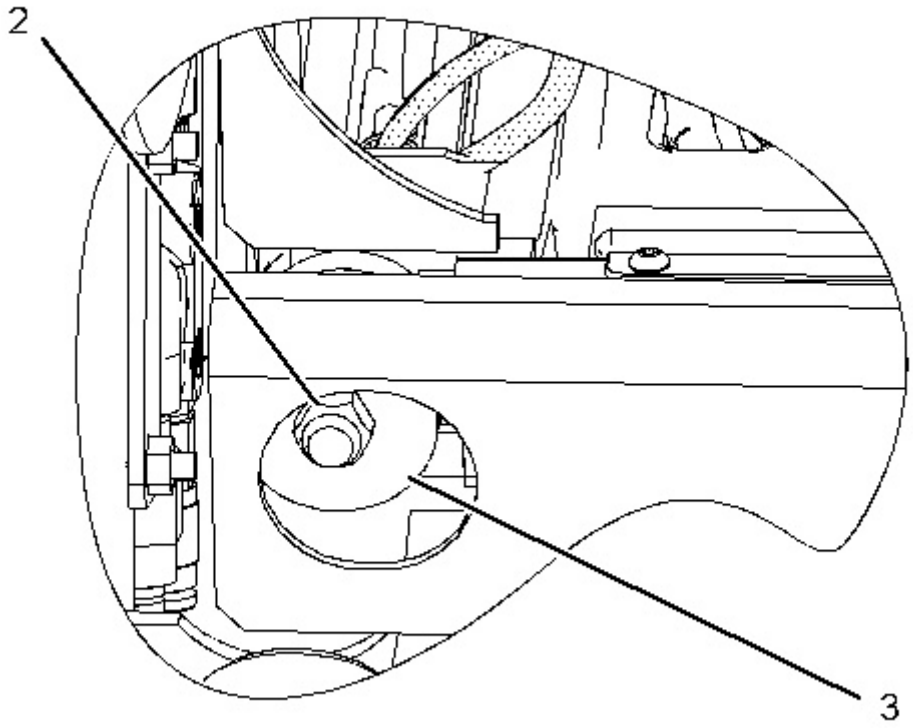


Illustration 2 g01049070

2. Remove nut (2) and large washer (3) from the inside of the cab.
3. Repeat Steps 1 and 2 on the opposite side of the cab.

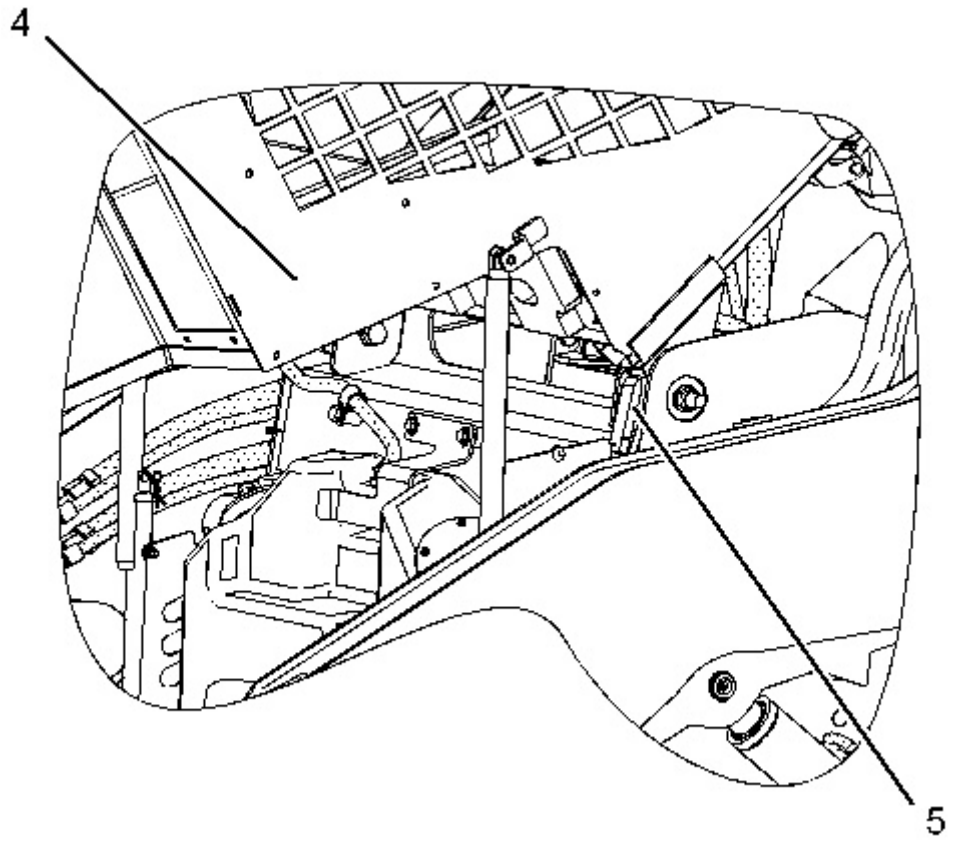


Illustration 3 g01049074

4. Raise cab (4) .



Illustration 4 g00563598

5. Engage cab support lever (5) .

Lower Procedure

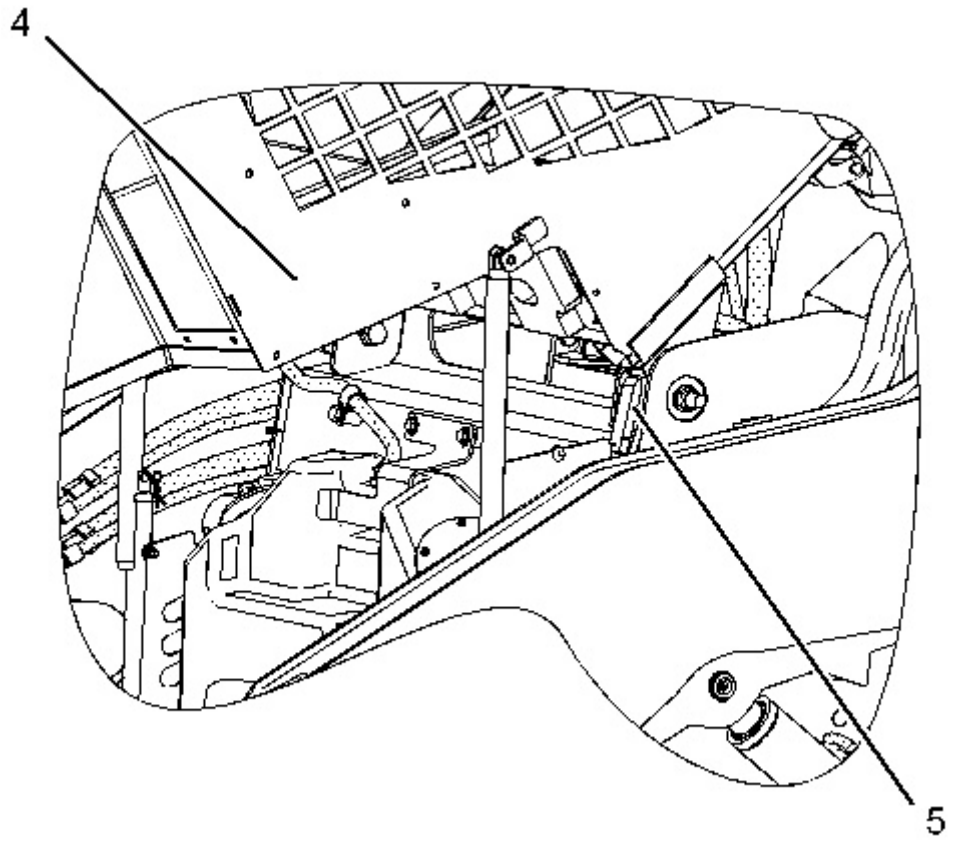


Illustration 5 g01049074



Illustration 6 g00563674

1. Tilt the cab upward.
2. Disengage cab support lever (5) .
3. Lower cab (4) .

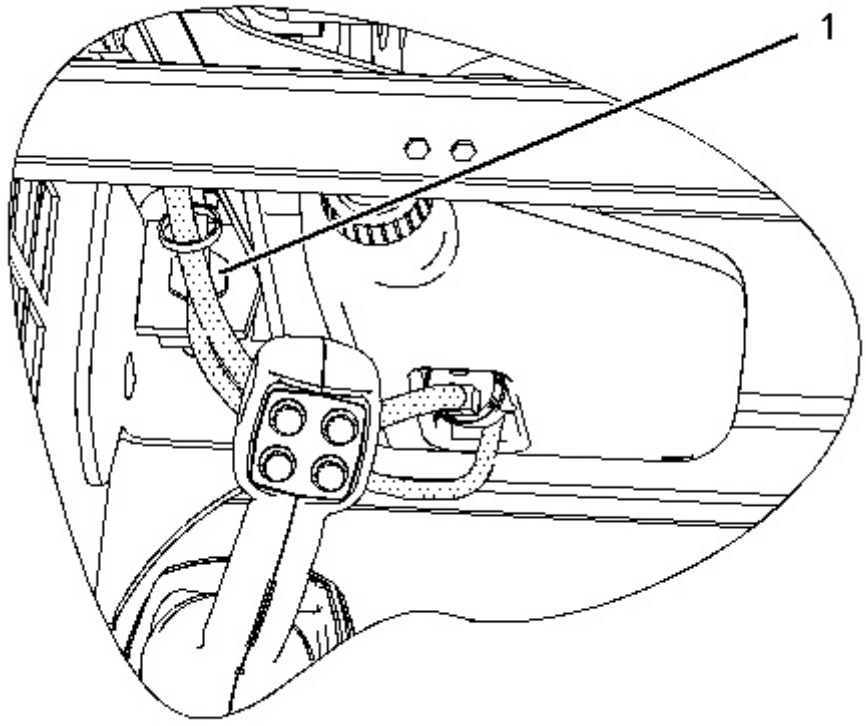


Illustration 7 g01049069

4. Align bolt (1) .

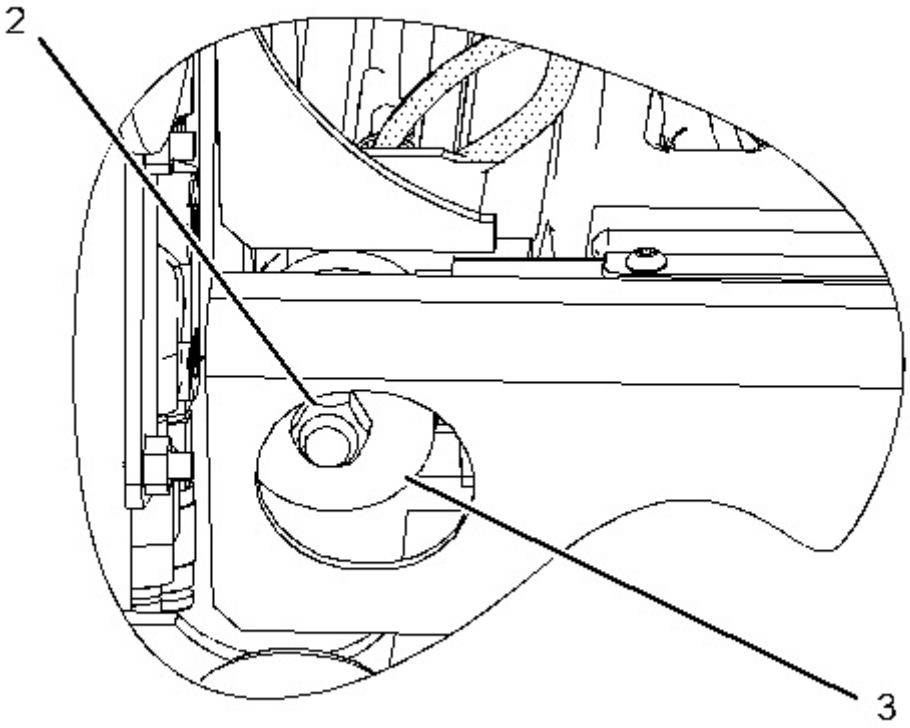


Illustration 8 g01049070

Note: Ensure that the large washer is between the nut and the rubber mounting.

5. Install large washer (3) and nut (2) from the inside of the cab. Tighten the nuts to a torque of 125 ± 10 N·m (92 ± 7 lb ft).

6. Repeat Steps 4 and 5 on the opposite side of the cab.

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i02156046

Cab - Remove

SMCS - 7325-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Description**	**Qty**
A	138-7574	Link Bracket	4

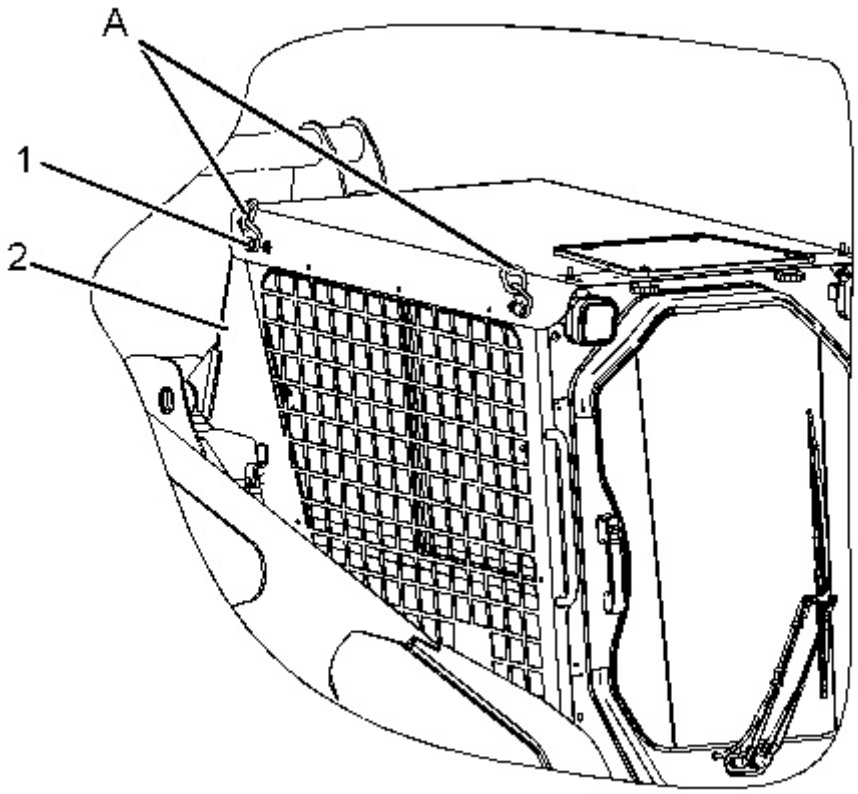


Illustration 1 g01056642

1. Remove bolts (1). Install Tooling (A) onto cab (2). Repeat this step for both sides of the machine.
2. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

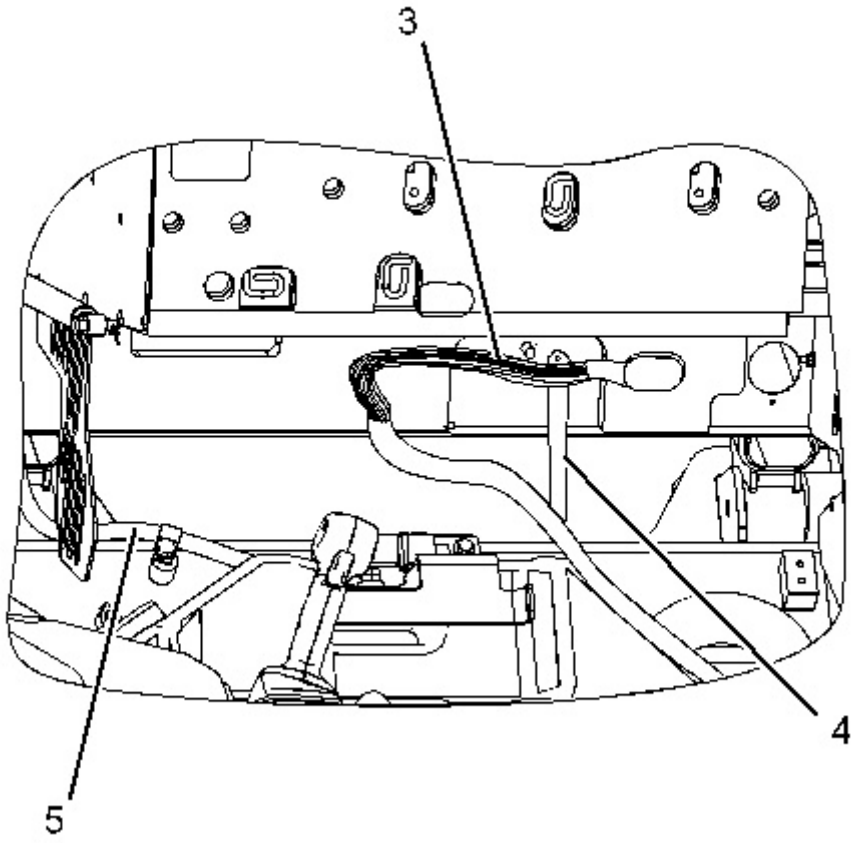


Illustration 2 g01056703

3. Disconnect harness assembly (3). Disconnect ground strap assembly (4). Reposition hose (5) out of the way.
4. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

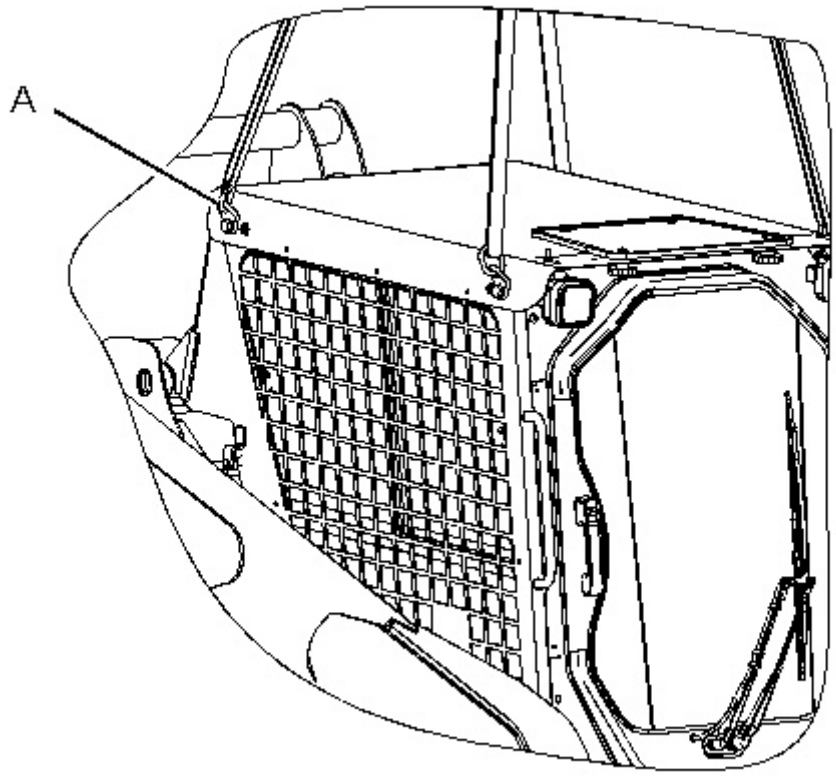


Illustration 3 g01056705

5. Attach a suitable lifting device to Tooling (A), as shown. The weight of the cab is approximately 255 kg (560 lb).
6. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

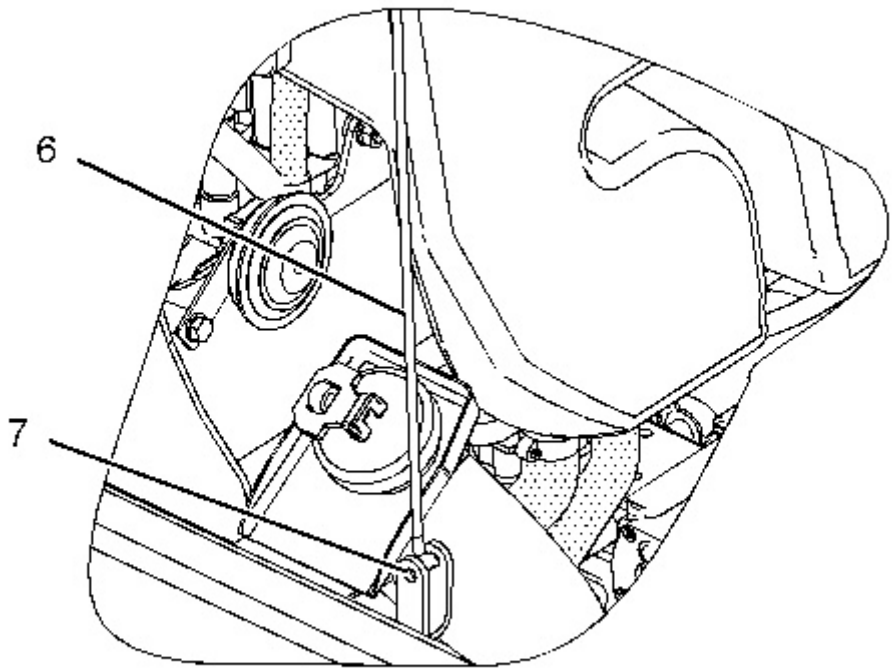


Illustration 4 g01078607

7. Remove pin (7). Position spring (6) out of the way. Repeat this step for the other side of the machine.
8. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

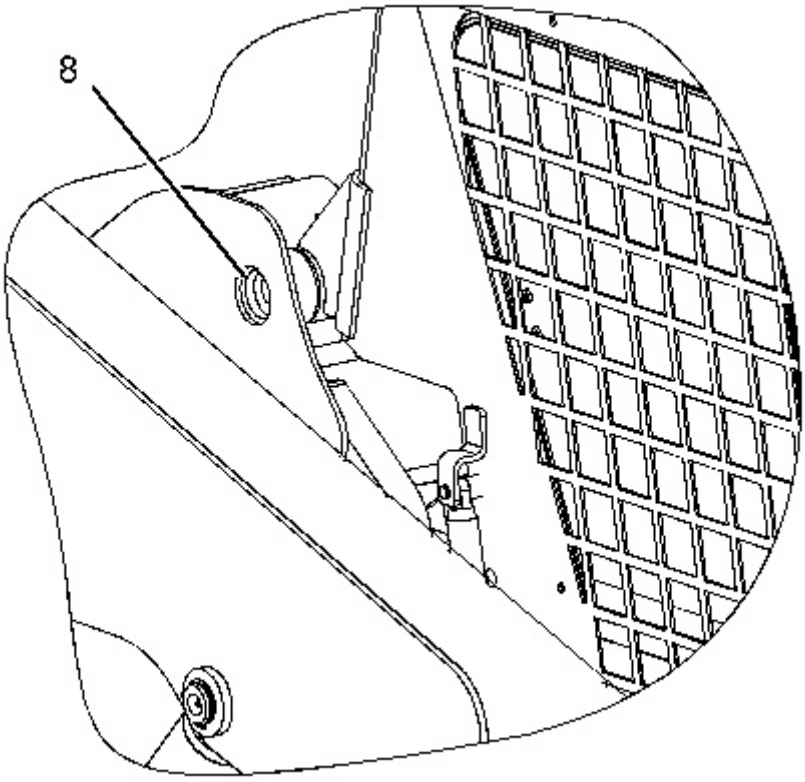


Illustration 5 g01078614

9. Remove bolts (8). Remove the cab.

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02156057

Cab - Install

SMCS - 7325-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

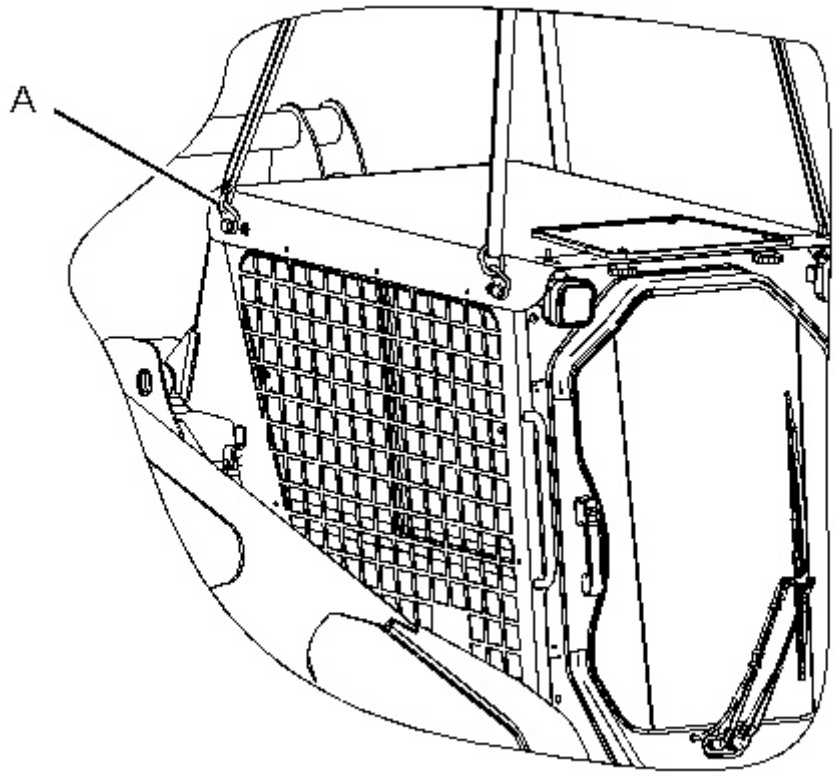


Illustration 1 g01056705

1. Attach a suitable lifting device to Tooling (A), as shown. The weight of the cab is approximately 255 kg (560 lb). Install the cab.

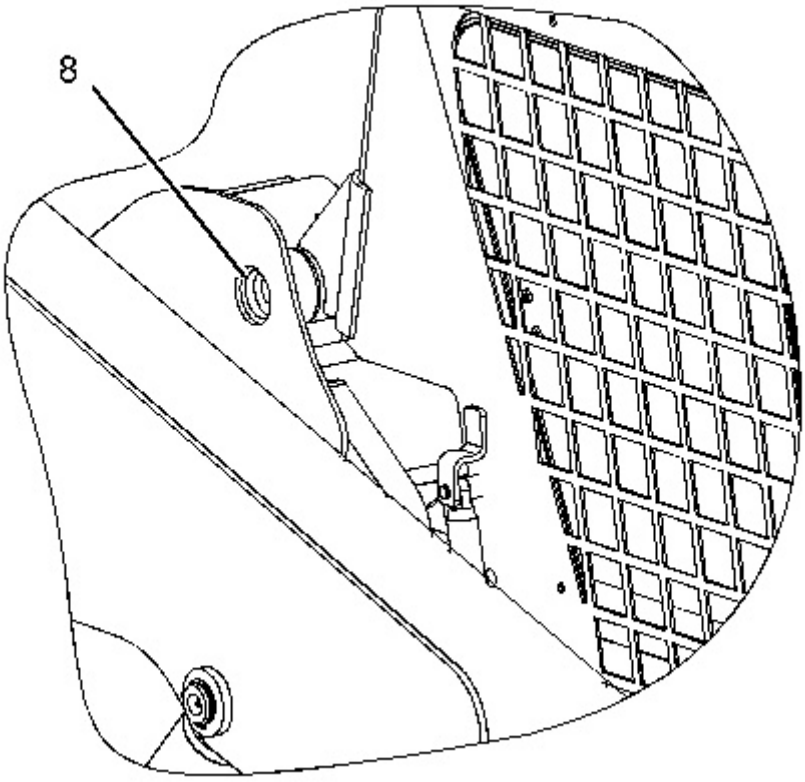


Illustration 2 g01078614

2. Install bolts (8). Tighten bolts (8) to a torque of 55 N·m (40 lb ft). Repeat this step for both sides of the cab.
3. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

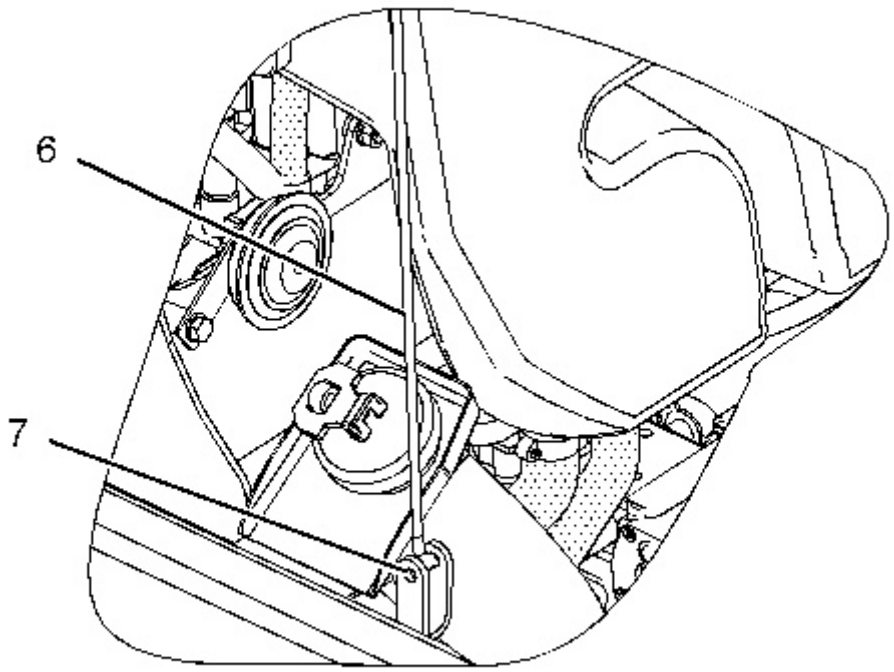


Illustration 3 g01078607

4. Move spring (6) into position. Install pin (7). Repeat this step for the other side of the machine. Remove the suitable lifting device.

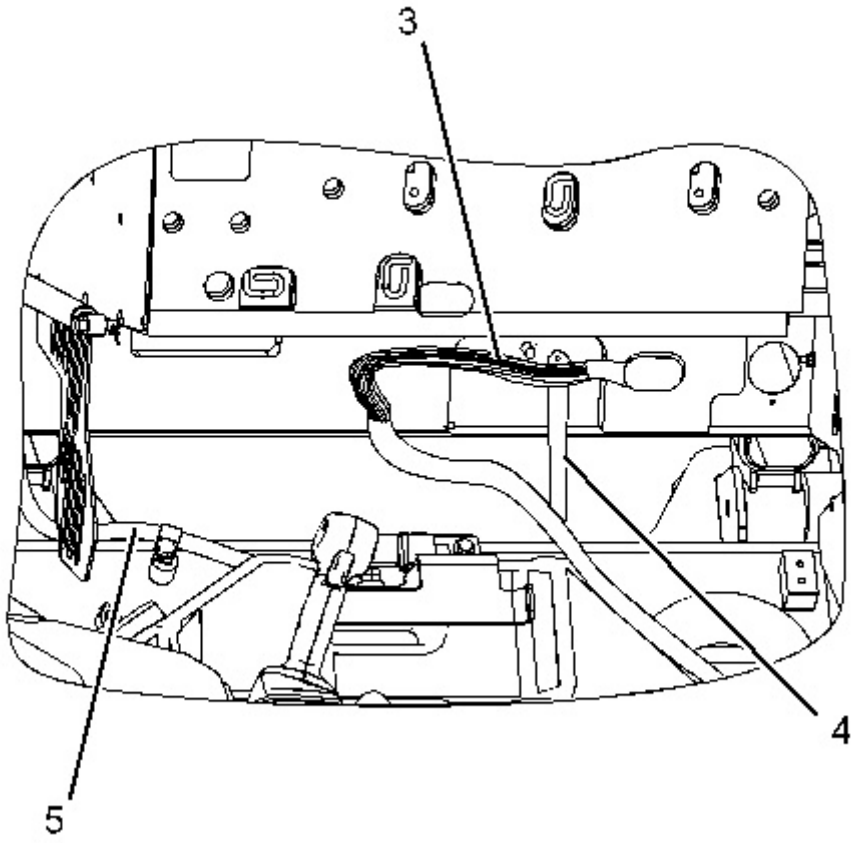


Illustration 4 g01056703

5. Connect harness assembly (3). Connect ground strap assembly (4). Move hose (5) into position.
6. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

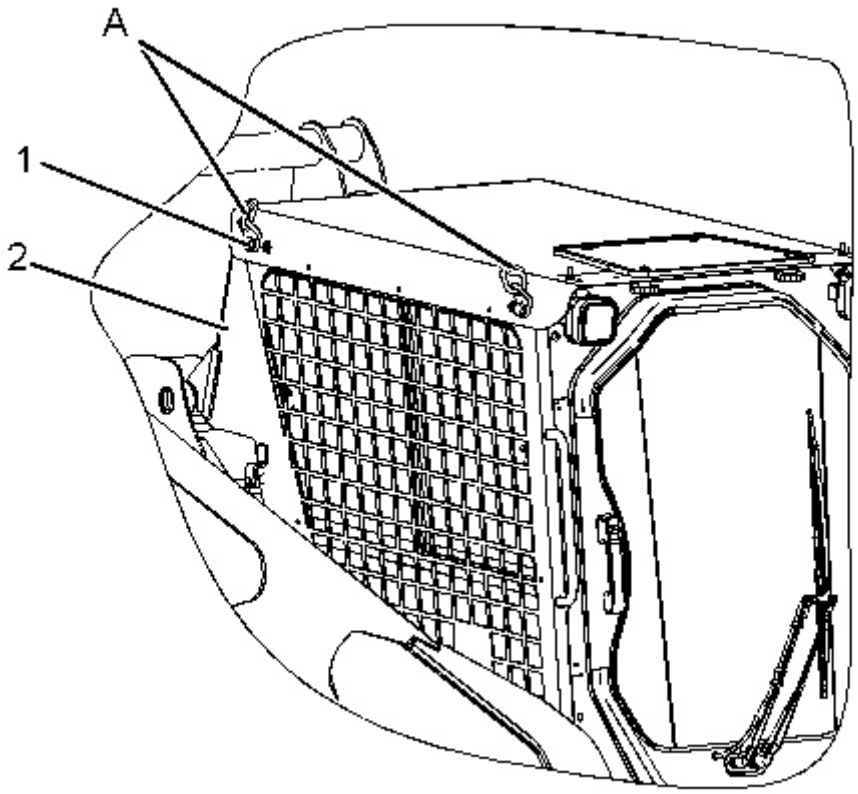


Illustration 5 g01056642

7. Remove bolts (1). Remove Tooling (A) from cab (2). Install bolts (1). Repeat this step for both sides of the machine.

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02038431

Cab - Tilt

SMCS - 7301-084

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Procedure to Tilt the Cab

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

WARNING

Do not go beneath cab unless cab is empty and support lever is engaged.

Failure to follow the instructions or heed the warnings could result in injury or death.

Note: Empty the water tank (if equipped) before you tilt the cab.

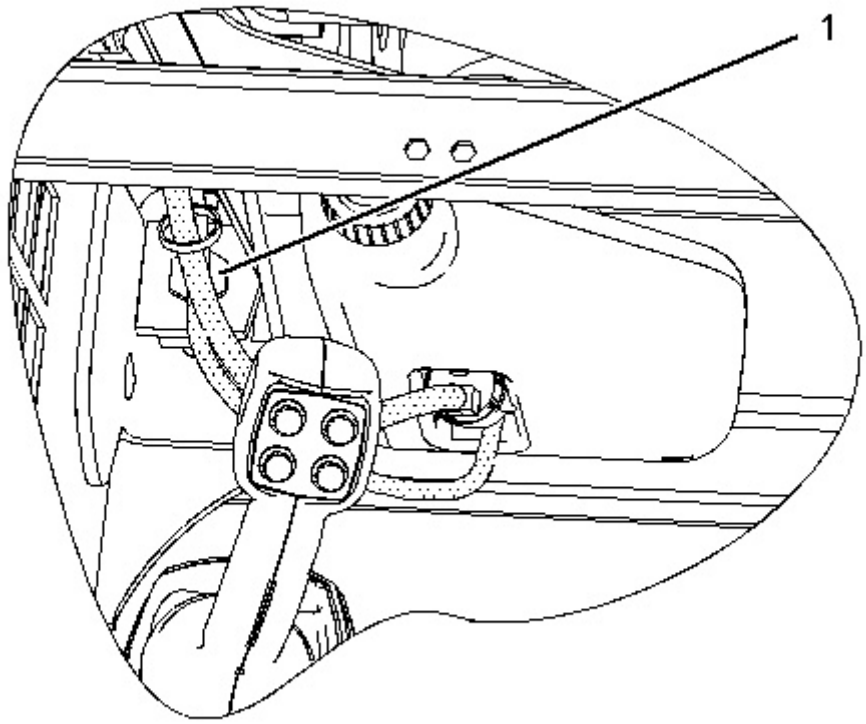


Illustration 1 g01049069

1. Loosen bolt (1) .

   Note: Bolt (1) will be retained in the cab.

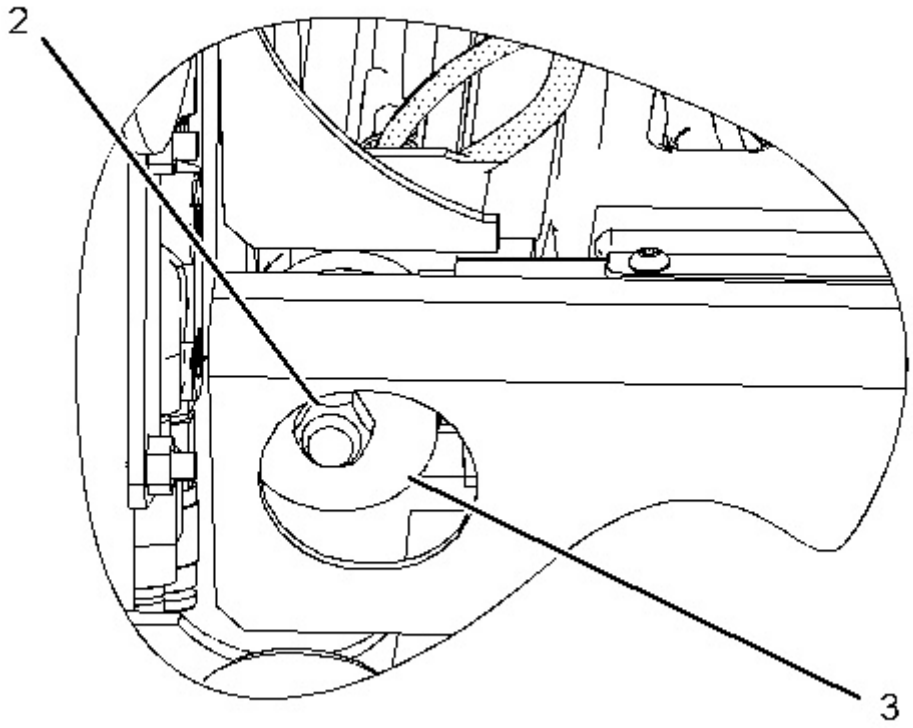


Illustration 2 g01049070

2. Remove nut (2) and large washer (3) from the inside of the cab.
3. Repeat Steps 1 and 2 on the opposite side of the cab.

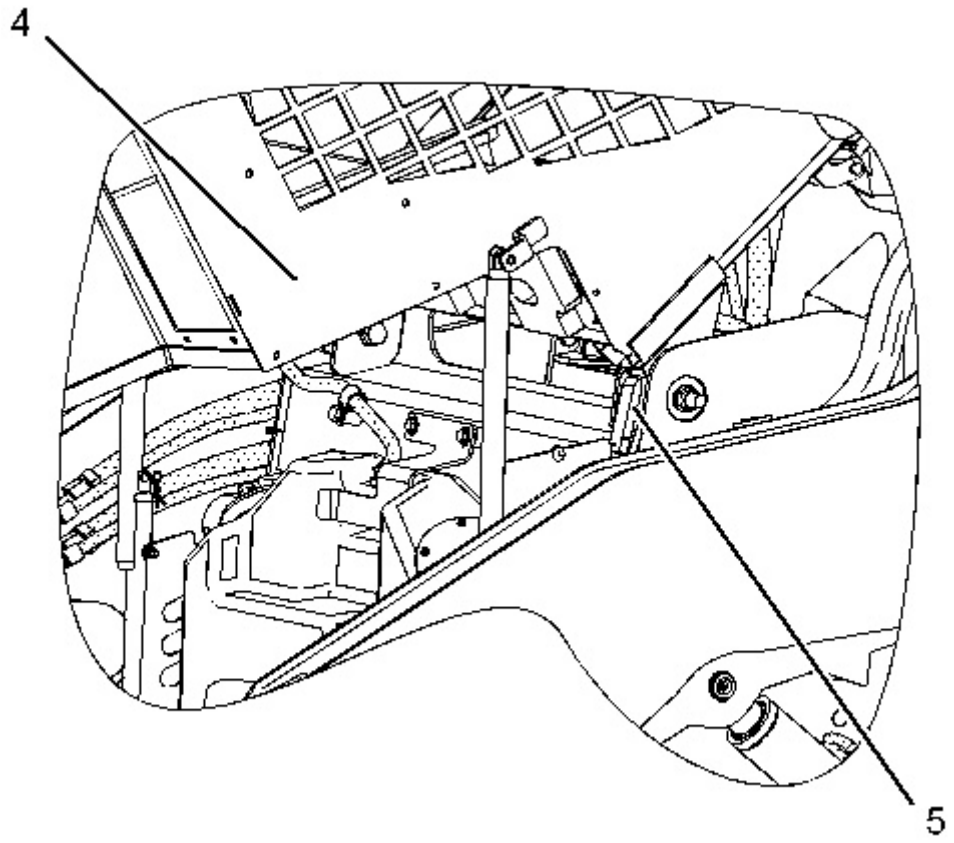


Illustration 3 g01049074

4. Raise cab (4) .



Illustration 4 g00563598

5. Engage cab support lever (5) .

Lower Procedure

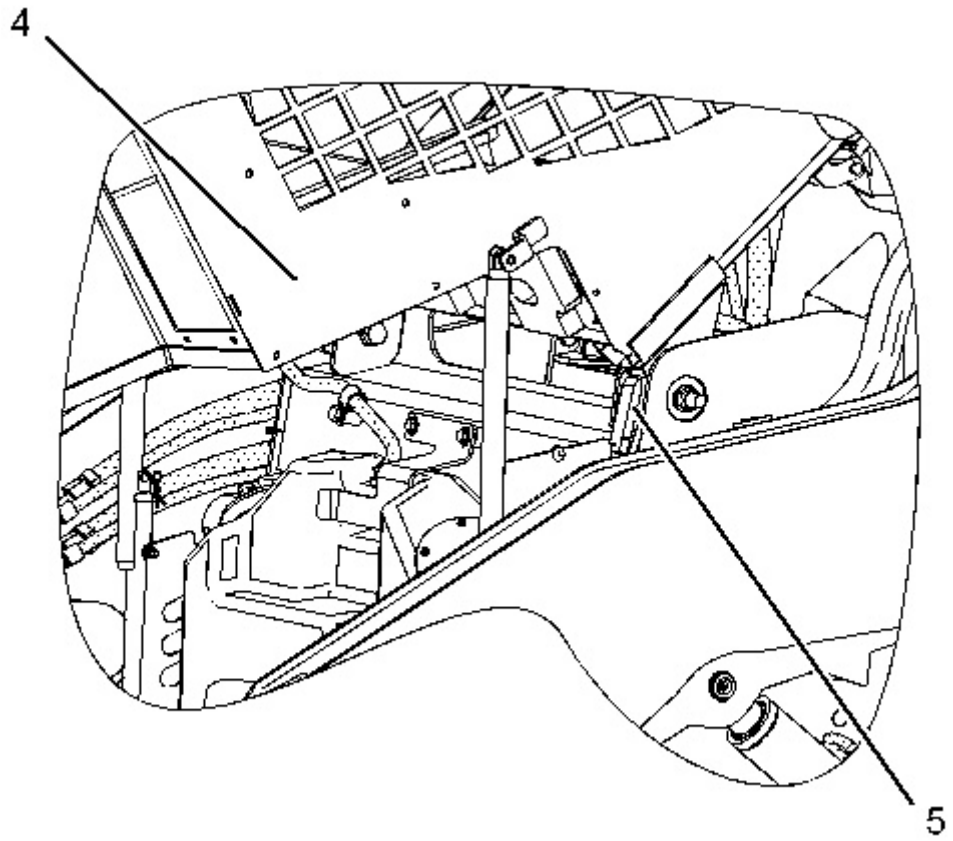


Illustration 5 g01049074



Illustration 6 g00563674

1. Tilt the cab upward.
2. Disengage cab support lever (5) .
3. Lower cab (4) .

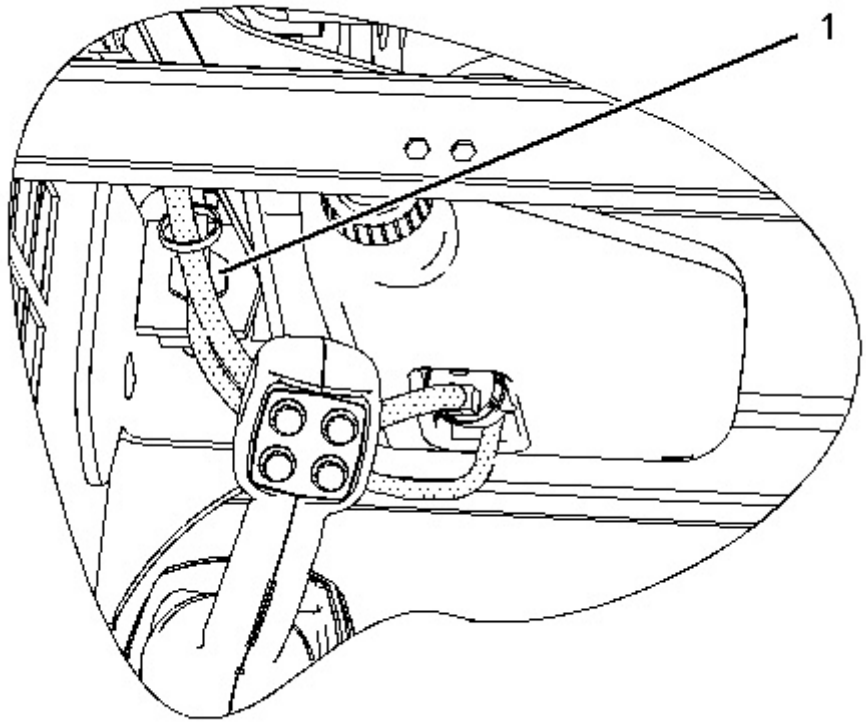


Illustration 7 g01049069

4. Align bolt (1) .

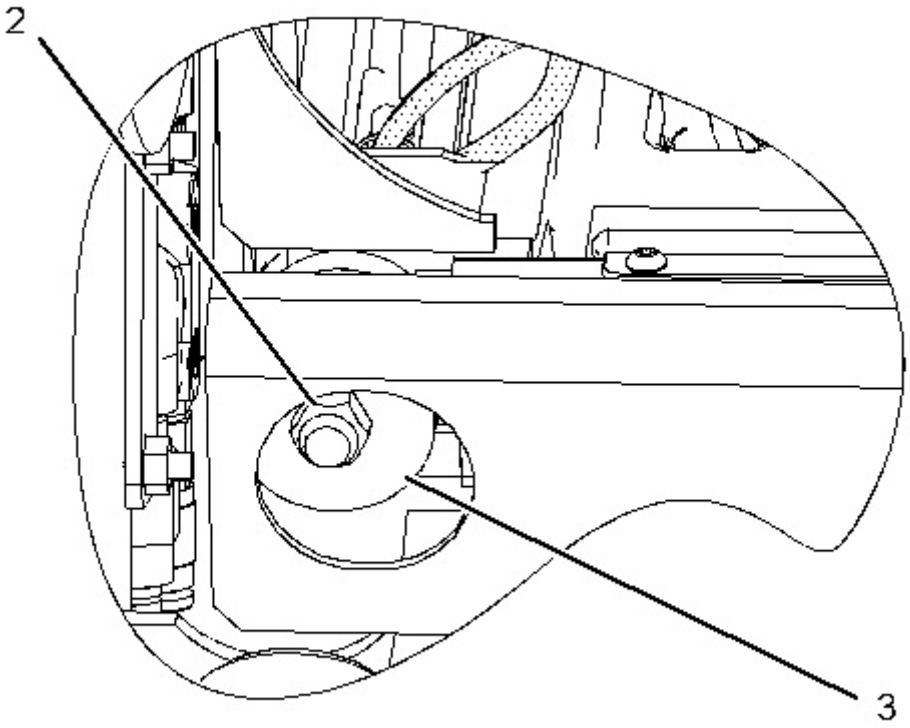


Illustration 8 g01049070

Note: Ensure that the large washer is between the nut and the rubber mounting.

5. Install large washer (3) and nut (2) from the inside of the cab. Tighten the nuts to a torque of 125 ± 10 N·m (92 ± 7 lb ft).

6. Repeat Steps 4 and 5 on the opposite side of the cab.

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Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02038431

Cab - Tilt

SMCS - 7301-084

Procedure to Tilt the Cab

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".

WARNING

Do not go beneath cab unless cab is empty and support lever is engaged.

Failure to follow the instructions or heed the warnings could result in injury or death.

Note: Empty the water tank (if equipped) before you tilt the cab.

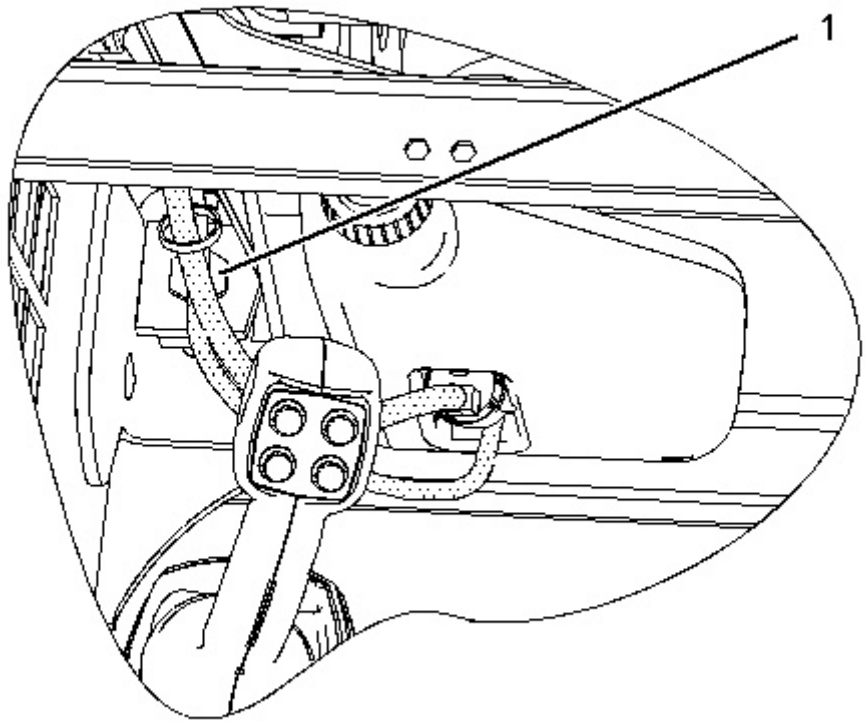


Illustration 1 g01049069

1. Loosen bolt (1) .

   Note: Bolt (1) will be retained in the cab.

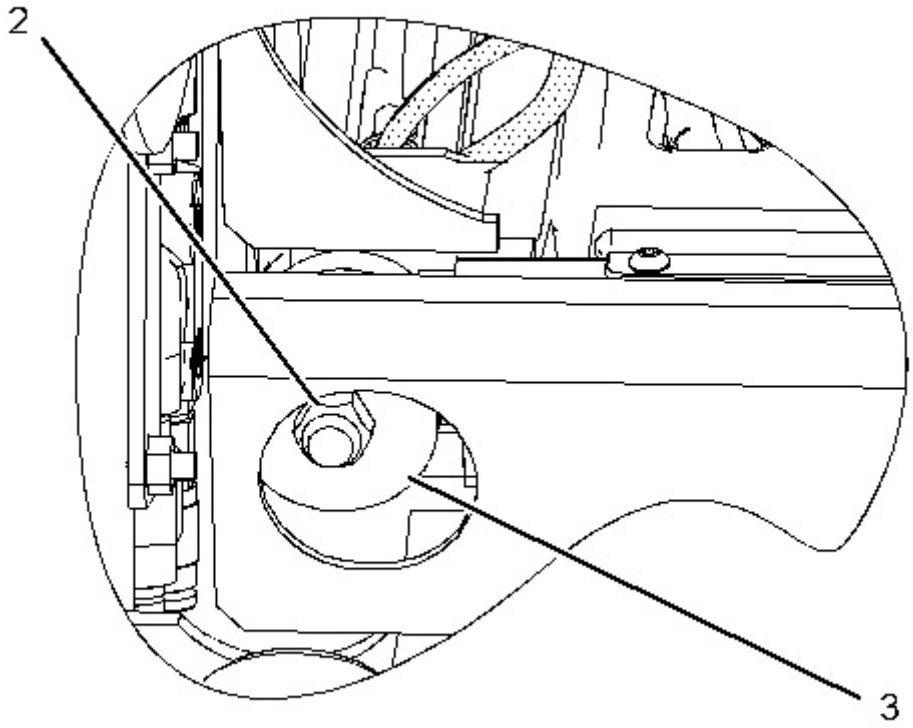


Illustration 2 g01049070

2. Remove nut (2) and large washer (3) from the inside of the cab.
3. Repeat Steps 1 and 2 on the opposite side of the cab.

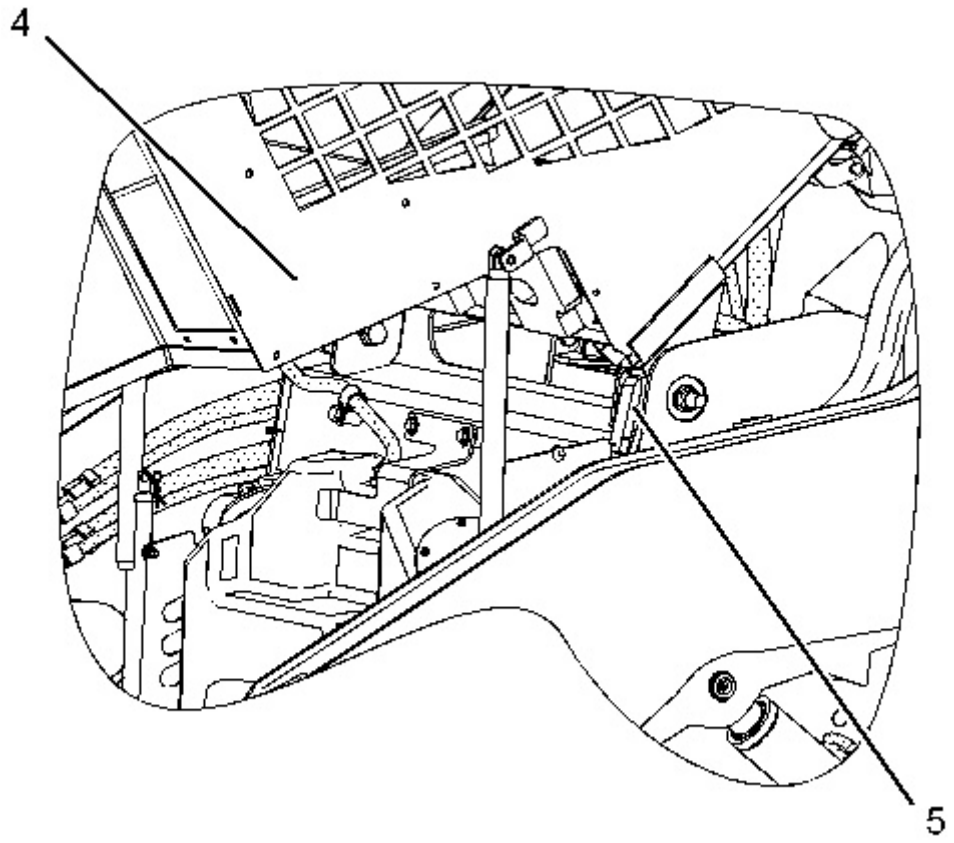


Illustration 3 g01049074

4. Raise cab (4) .



Illustration 4 g00563598

5. Engage cab support lever (5) .

Lower Procedure

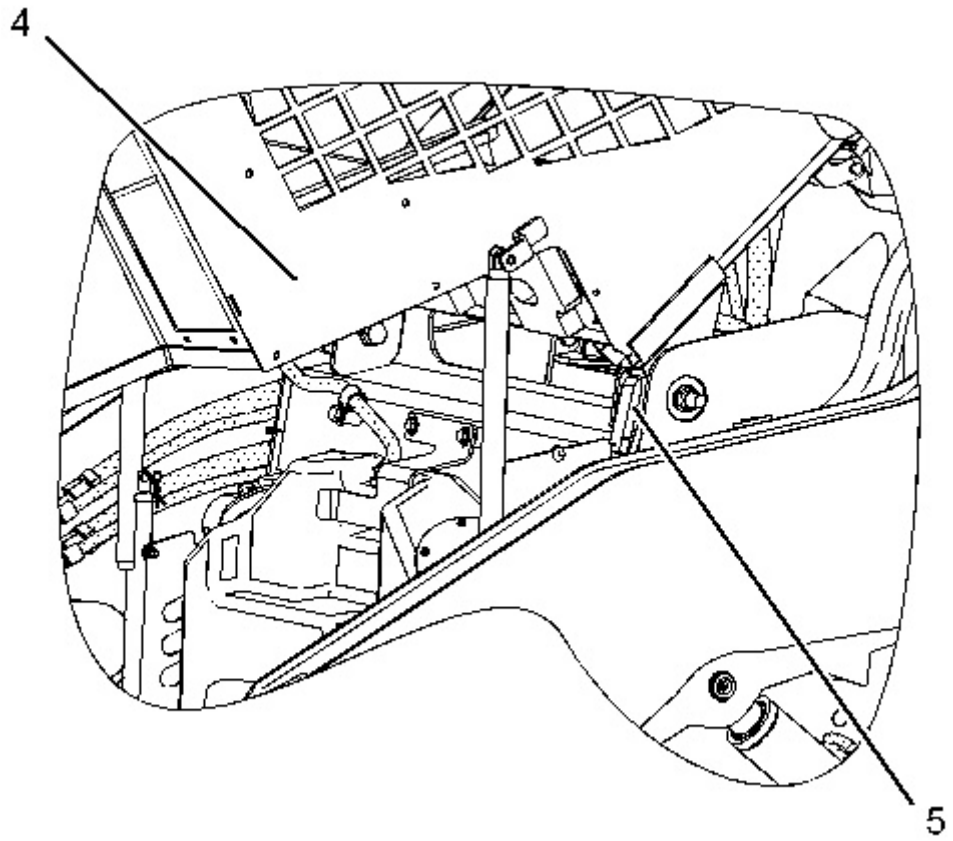


Illustration 5 g01049074



Illustration 6 g00563674

1. Tilt the cab upward.
2. Disengage cab support lever (5) .
3. Lower cab (4) .

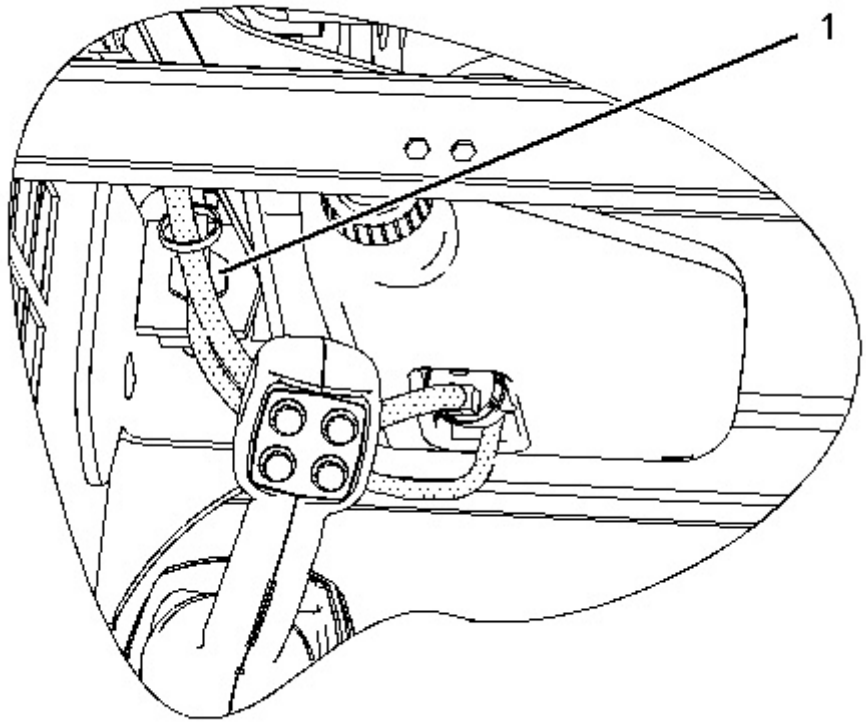


Illustration 7 g01049069

4. Align bolt (1) .

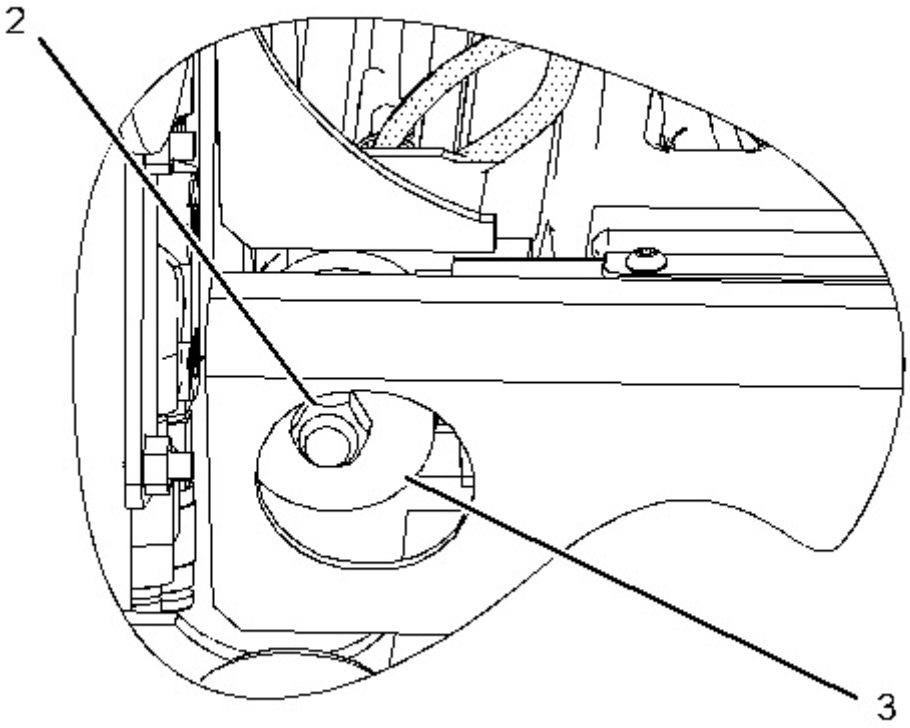


Illustration 8 g01049070

Note: Ensure that the large washer is between the nut and the rubber mounting.

5. Install large washer (3) and nut (2) from the inside of the cab. Tighten the nuts to a torque of 125 ± 10 N·m (92 ± 7 lb ft).

6. Repeat Steps 4 and 5 on the opposite side of the cab.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

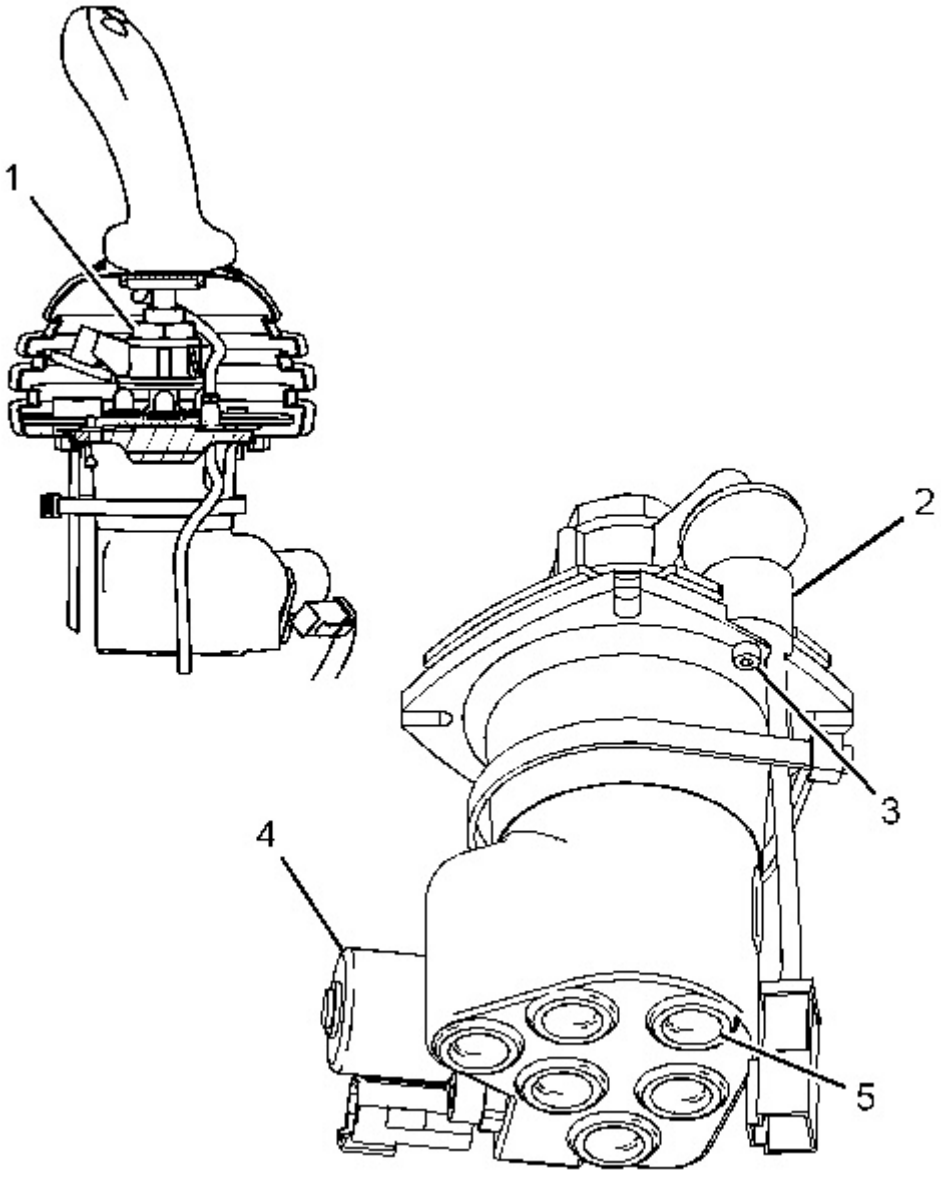


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

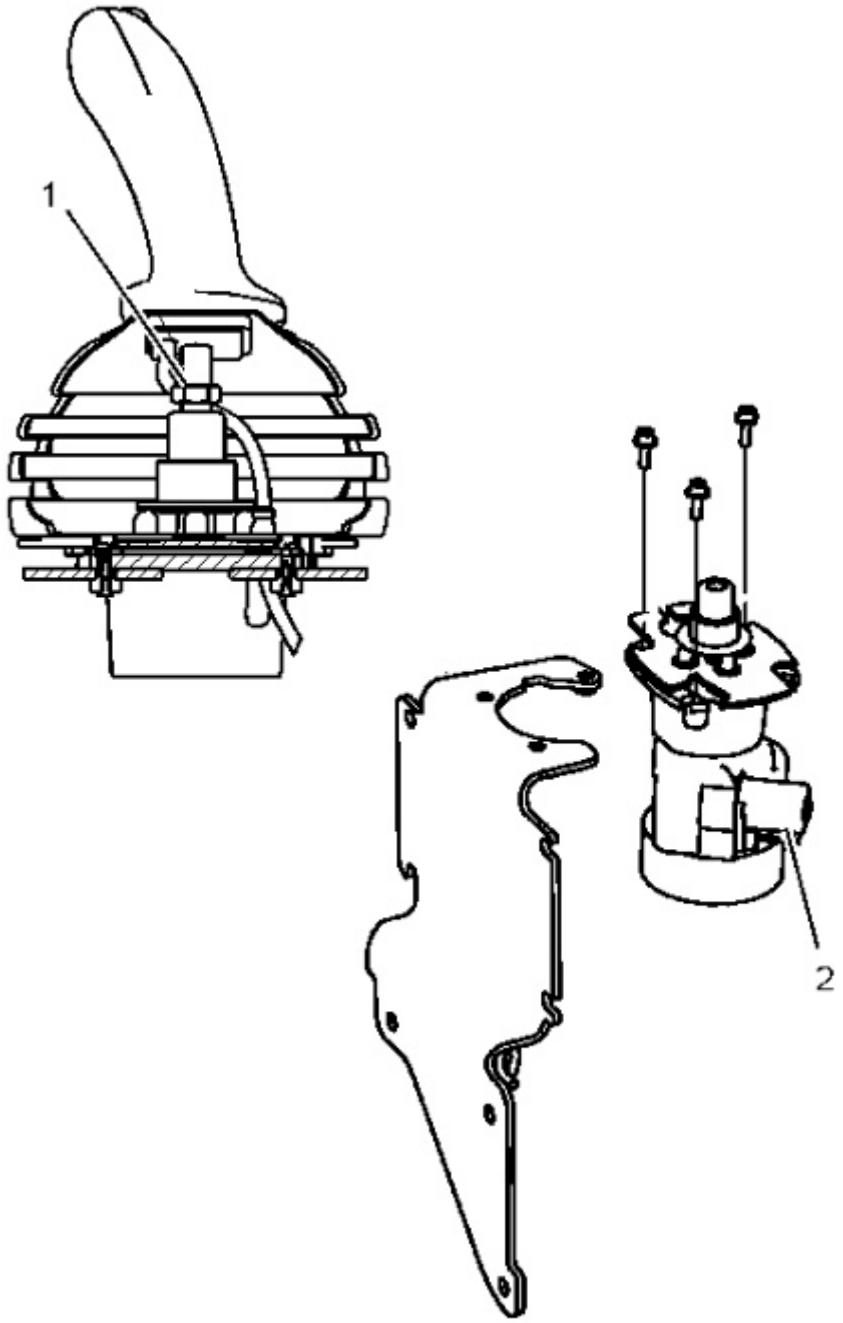


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

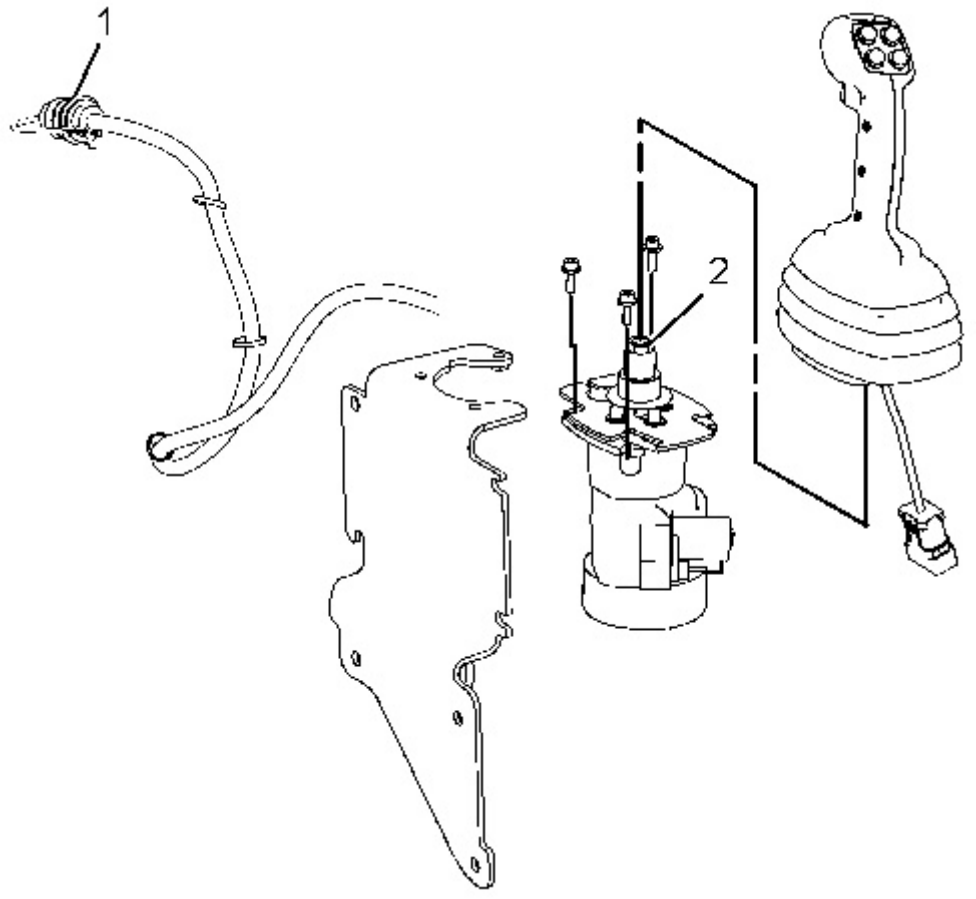


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

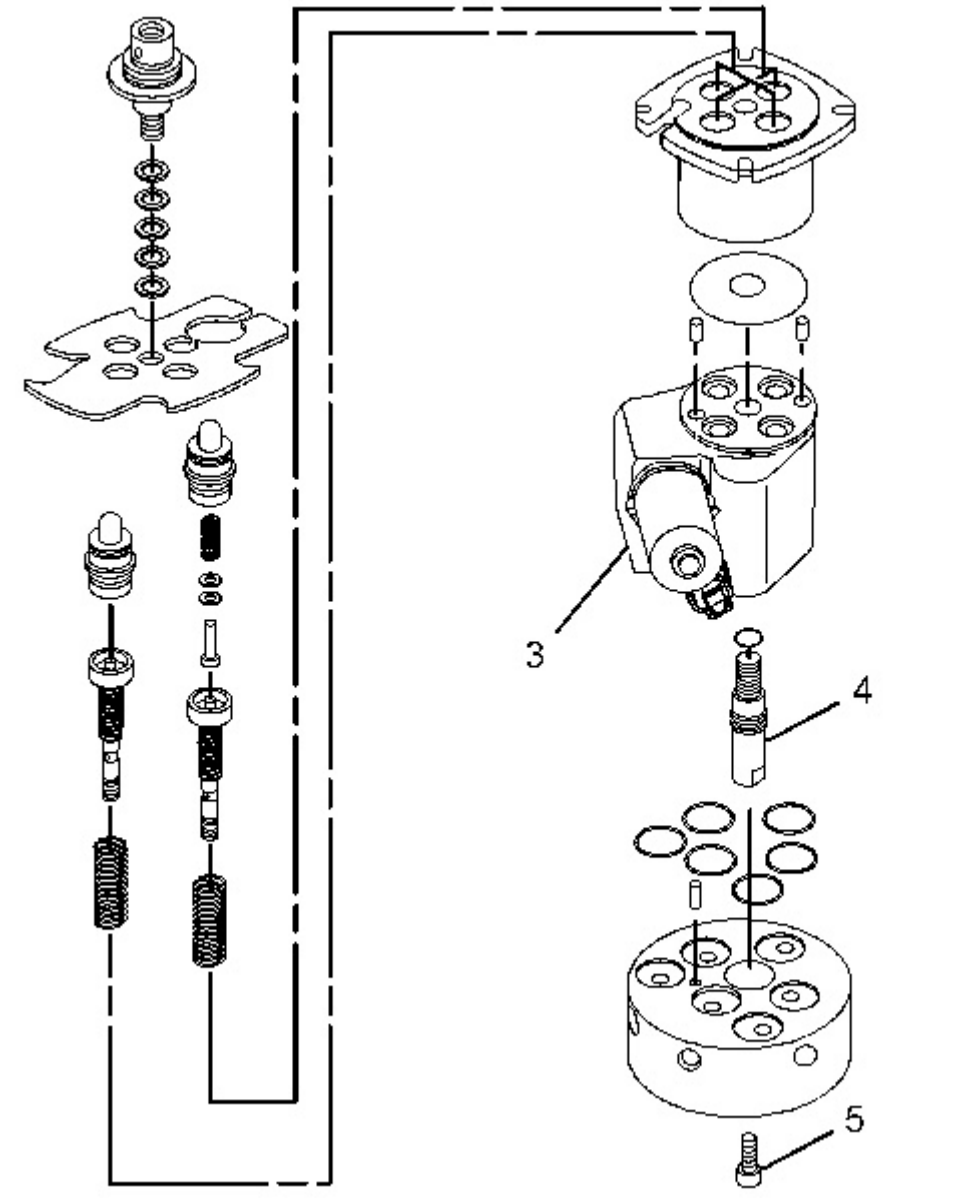


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC

Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

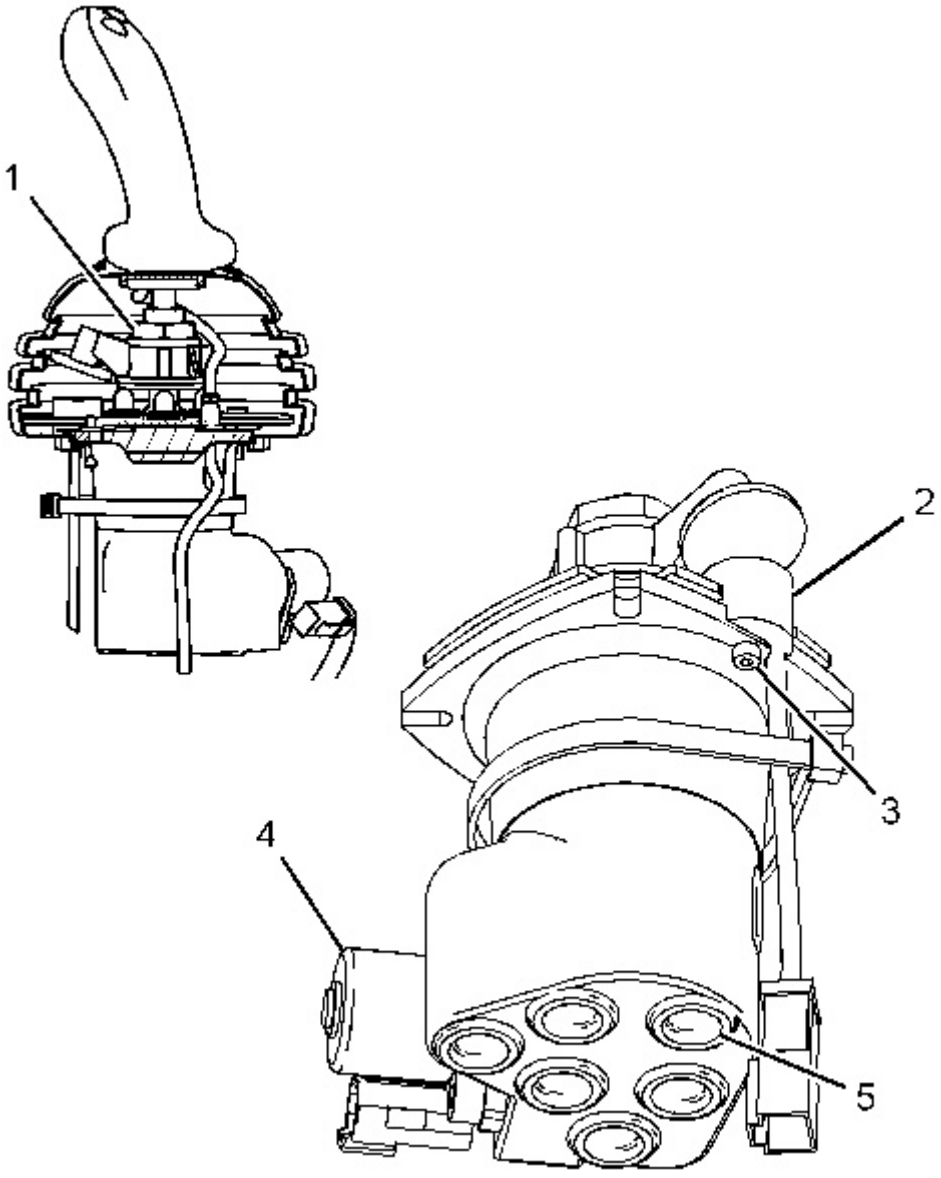


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

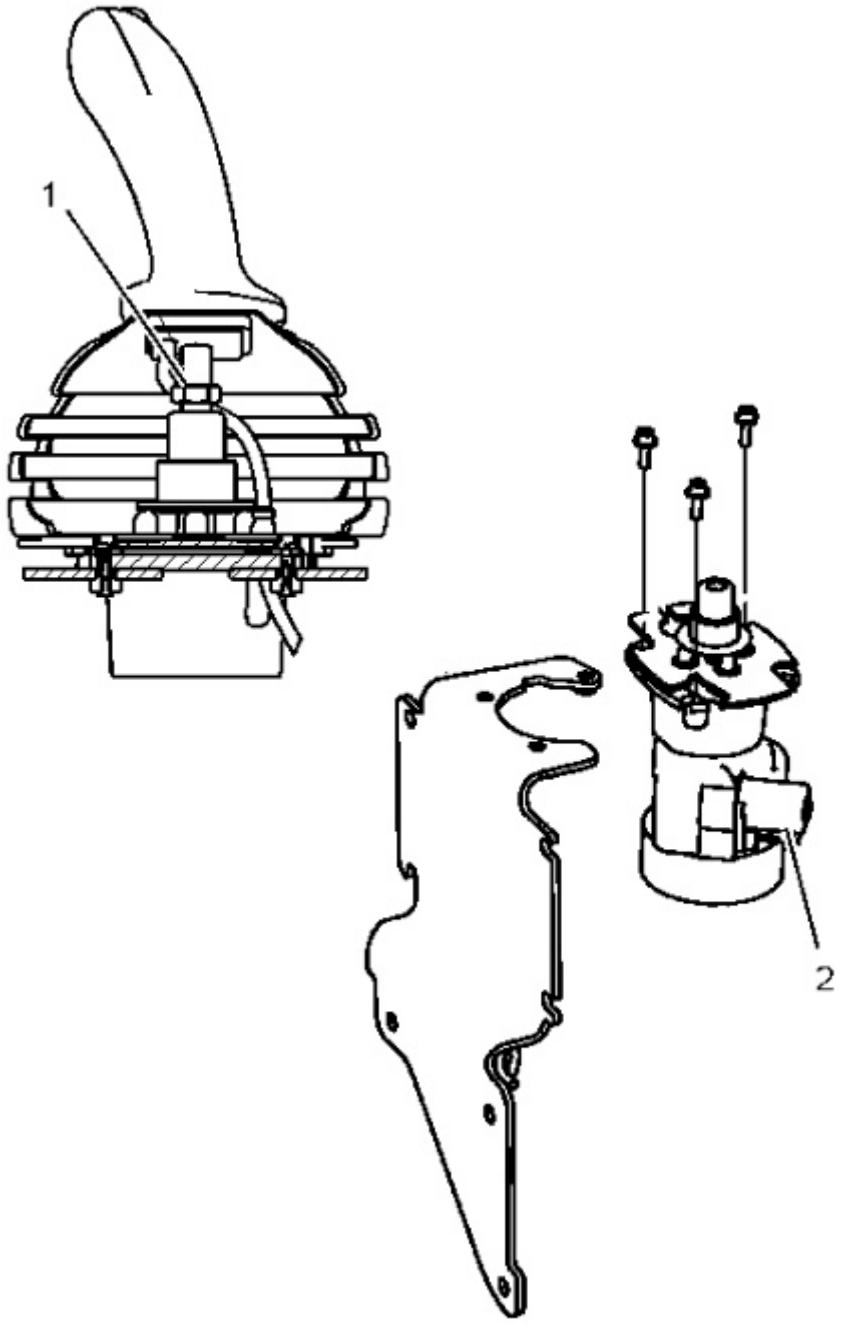


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN6750-UP

S/N - SCP4600-UP

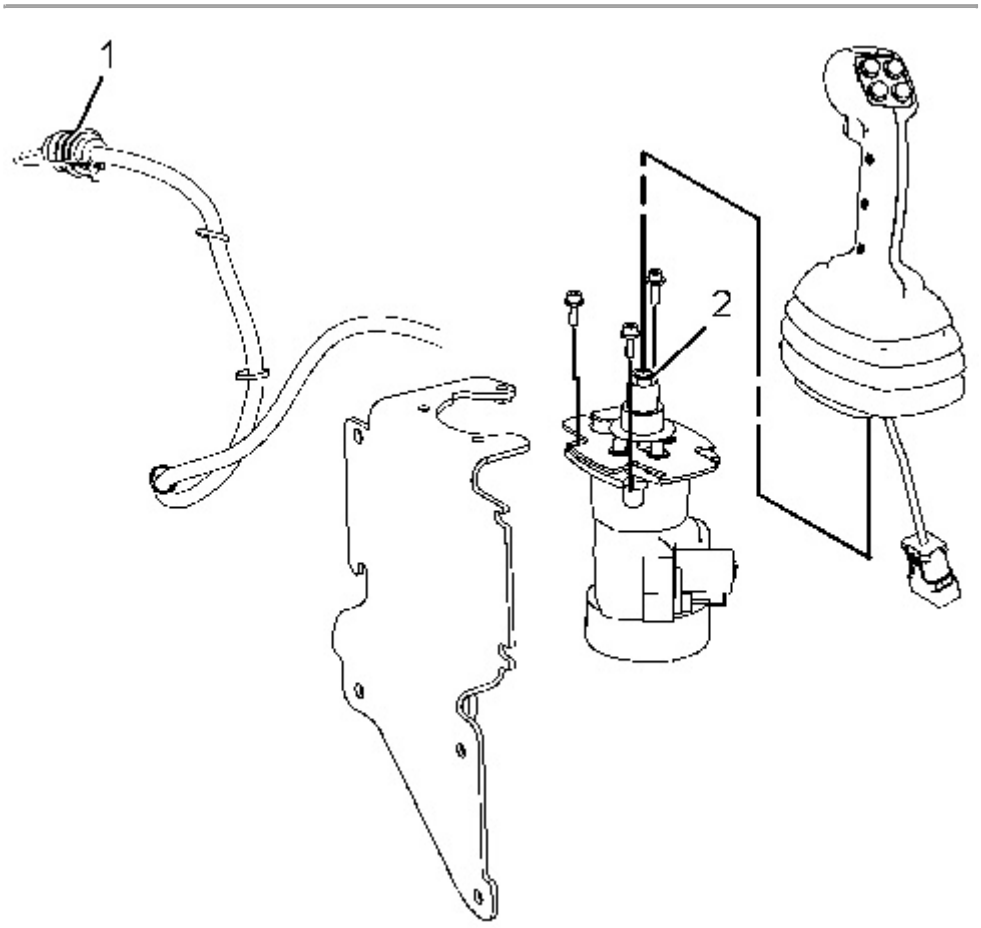


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

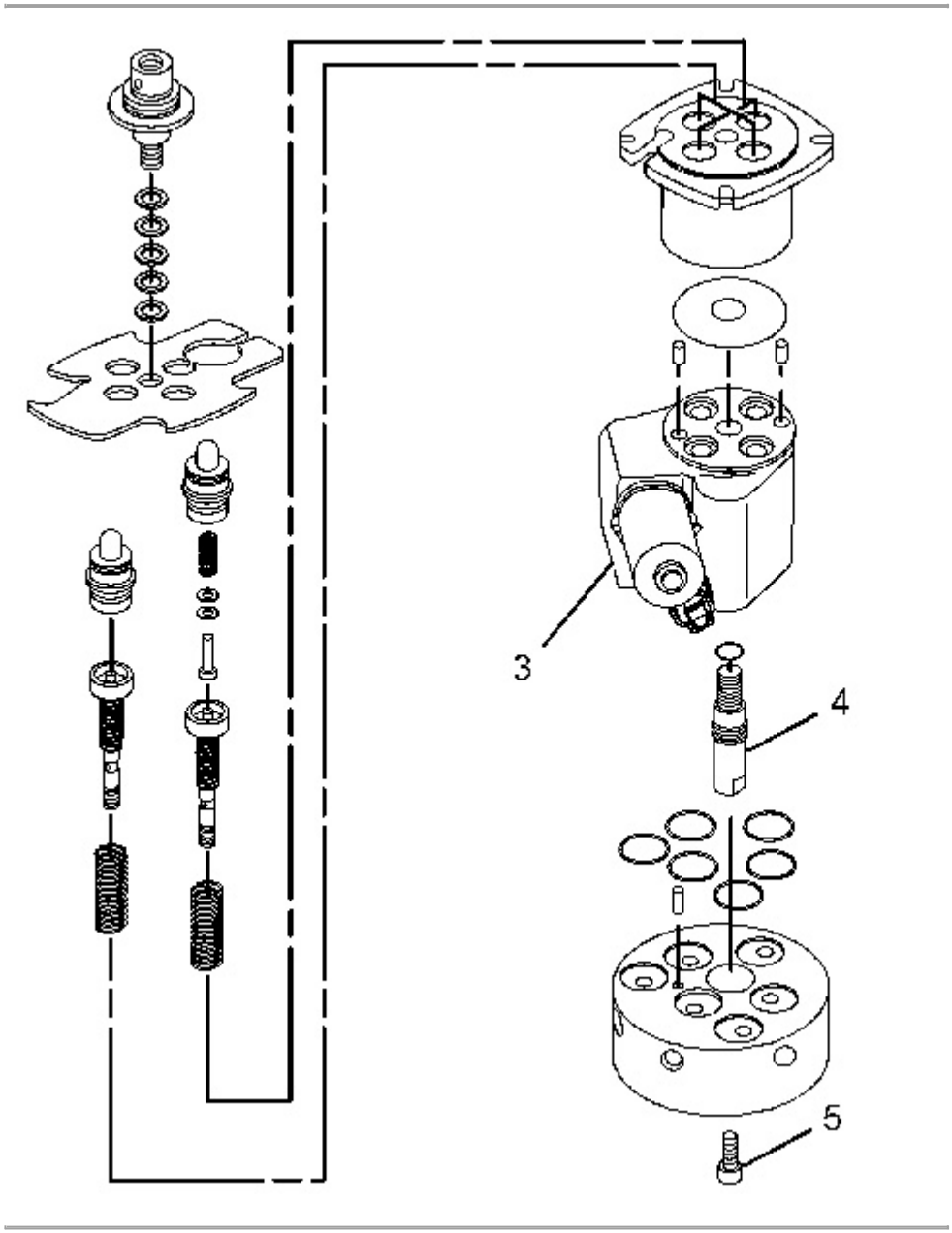


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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i02049704

Pilot Operated Hydraulic Control - Remove

SMCS - 5059-011; 5705-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	6V-9507	Face Seal Plug (9/16 - 18 THD)	5
	6V-9828	Cap As (9/16 - 18 THD)	5
	9U-7071	Tapered Cap/Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

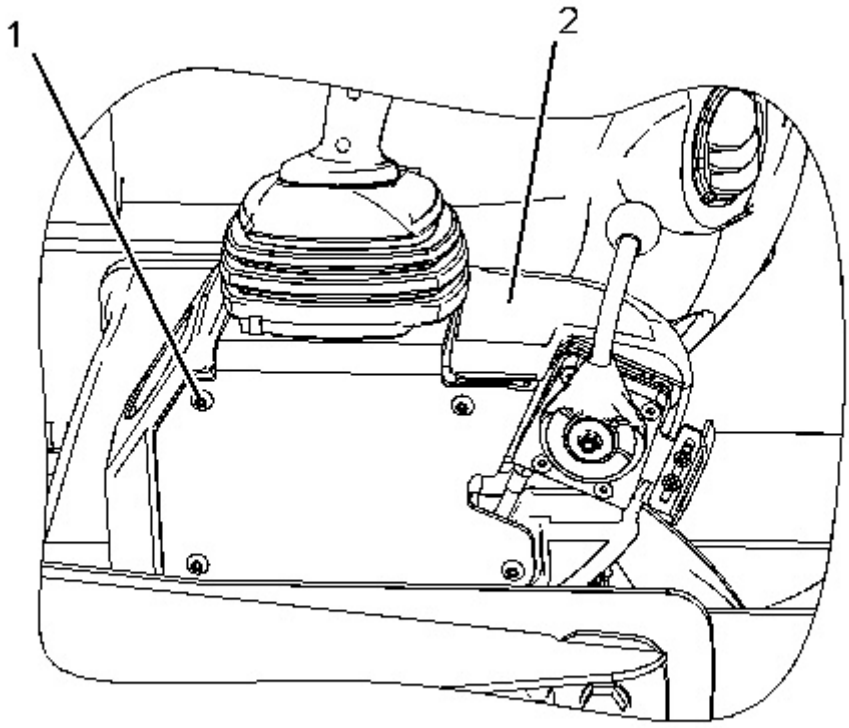


Illustration 1 g01051360

1. Remove screws (1) and remove console (2) .

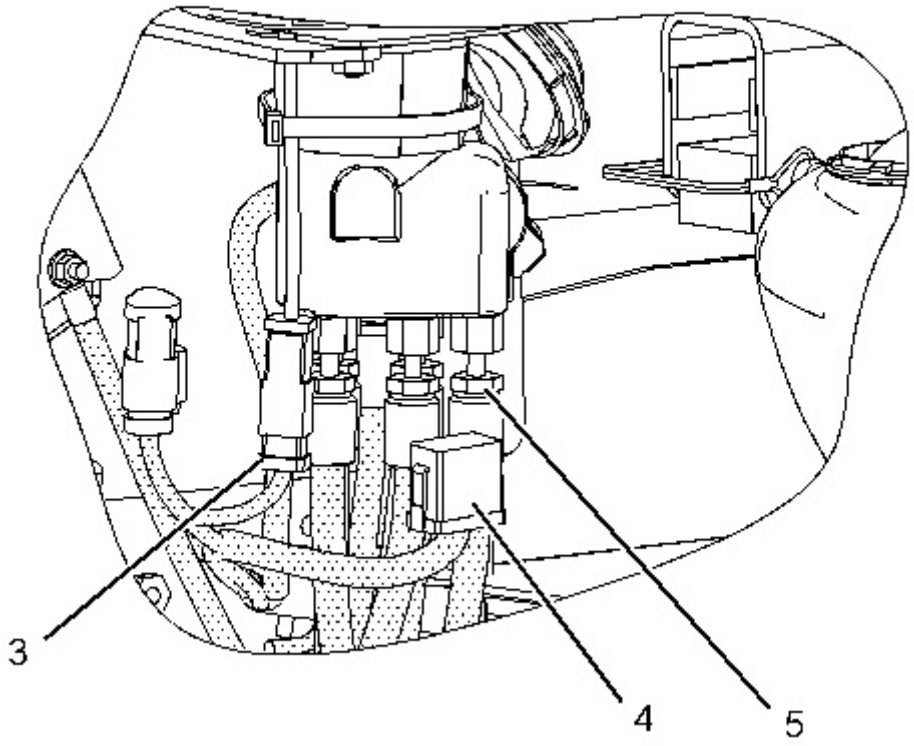


Illustration 2 g01051364

2. Disconnect harness assemblies (3) and (4). Disconnect hose assemblies (5) .

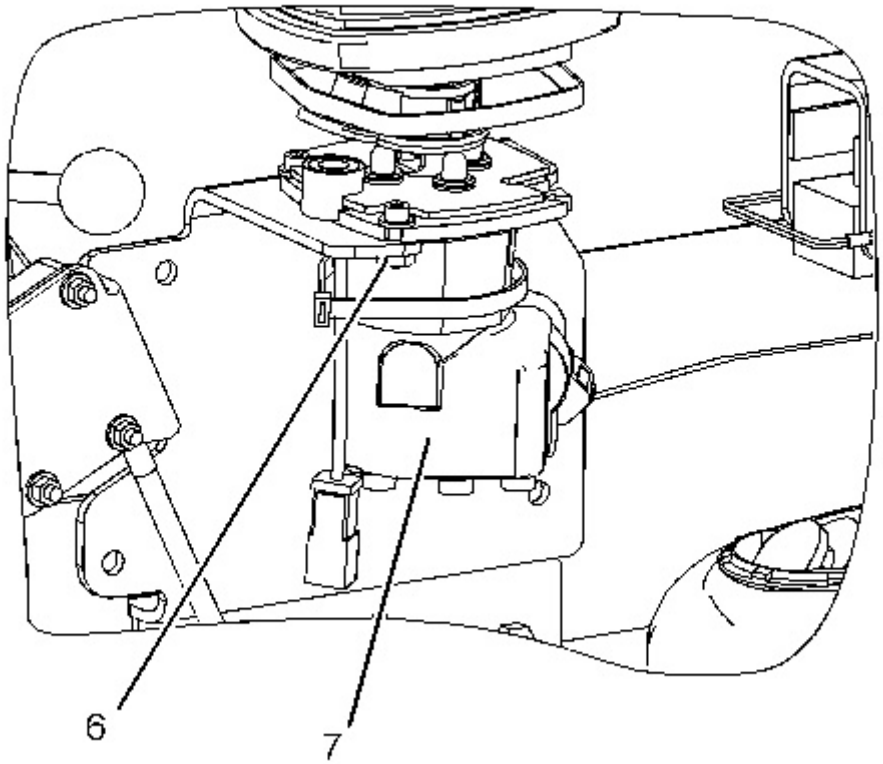


Illustration 3 g01051372

3. Remove bolts (6). Remove pilot operated hydraulic control (7) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117426

Pilot Operated Hydraulic Control - Disassemble

SMCS - 5059-015; 5705-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Remove".

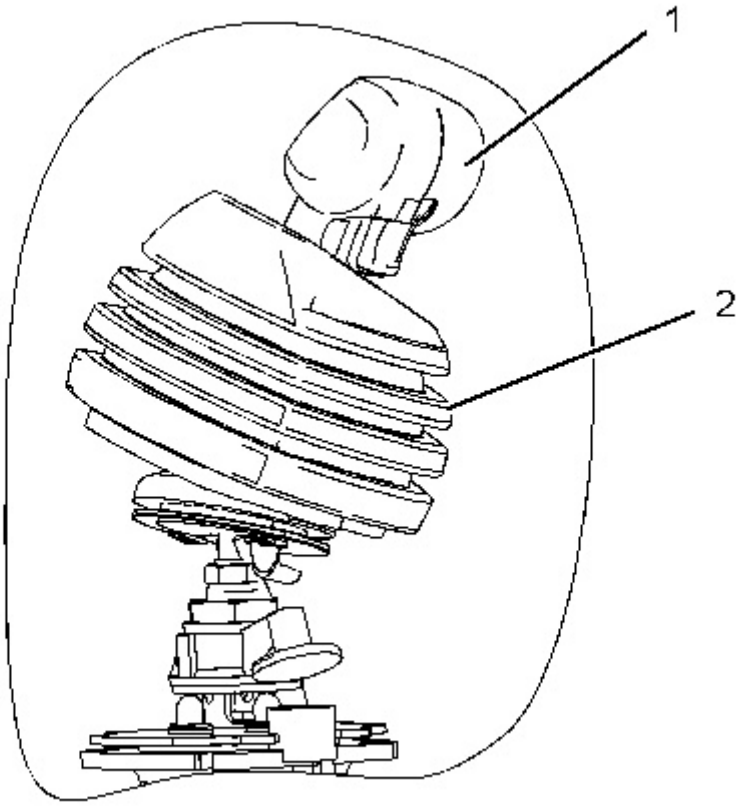


Illustration 1 g01078512

1. Lift rubber boot (2) from the joystick. Remove the screws on the side of joystick handle (1) and remove the joystick handle.

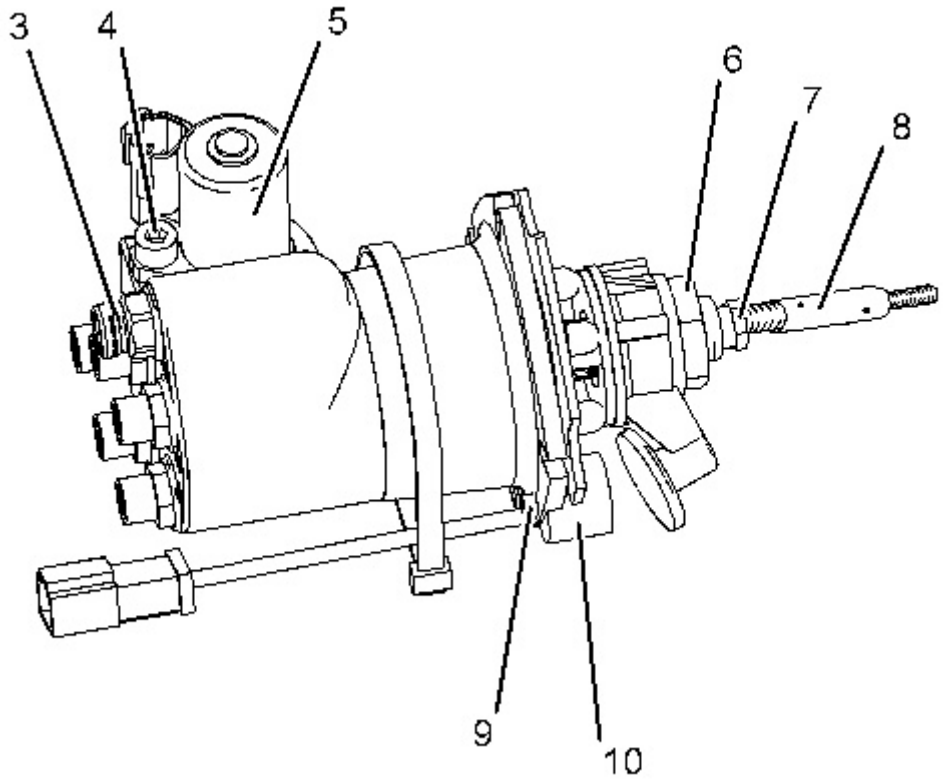


Illustration 2 g01078513

2. Remove fittings (3). Remove bolt (4) and solenoid (5). Remove bolt (9) and coil assembly (10). Note the orientation of nut (6), nut (7) and lever (8) for installation purposes. Loosen nut (7). Remove lever (8). Remove nut (6) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117461

Pilot Operated Hydraulic Control - Assemble

SMCS - 5059-016; 5705-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

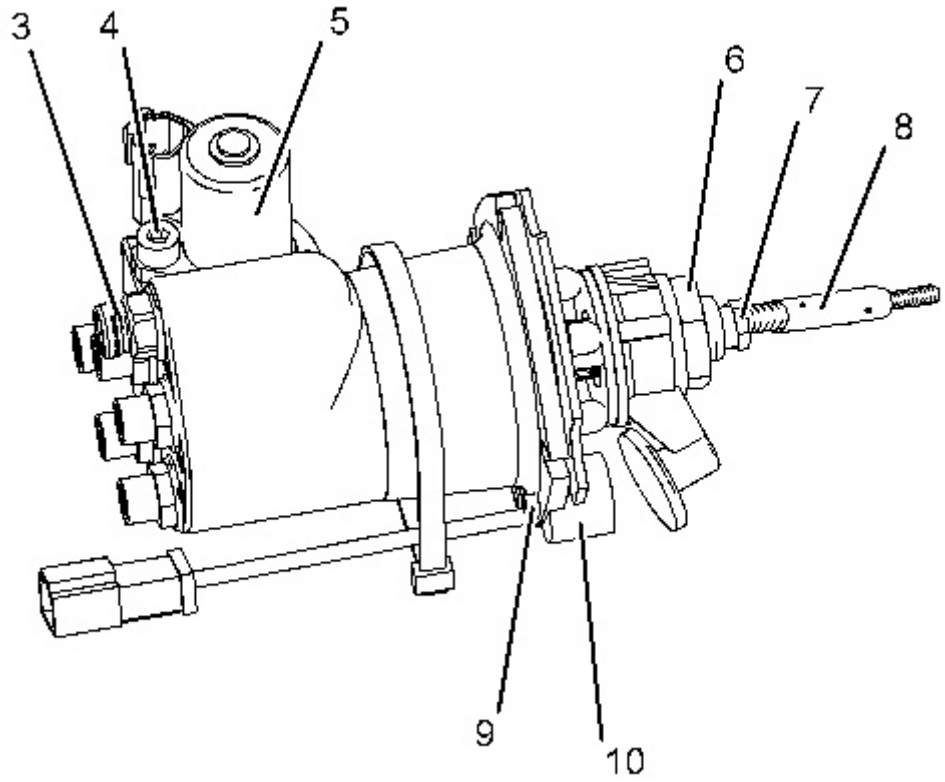


Illustration 1 g01078513

1. Install nut (6). Install lever (8). Tighten nut (7). Install fittings (3). Install solenoid (5) and bolt (4). Install coil assembly (10) and bolt (9).

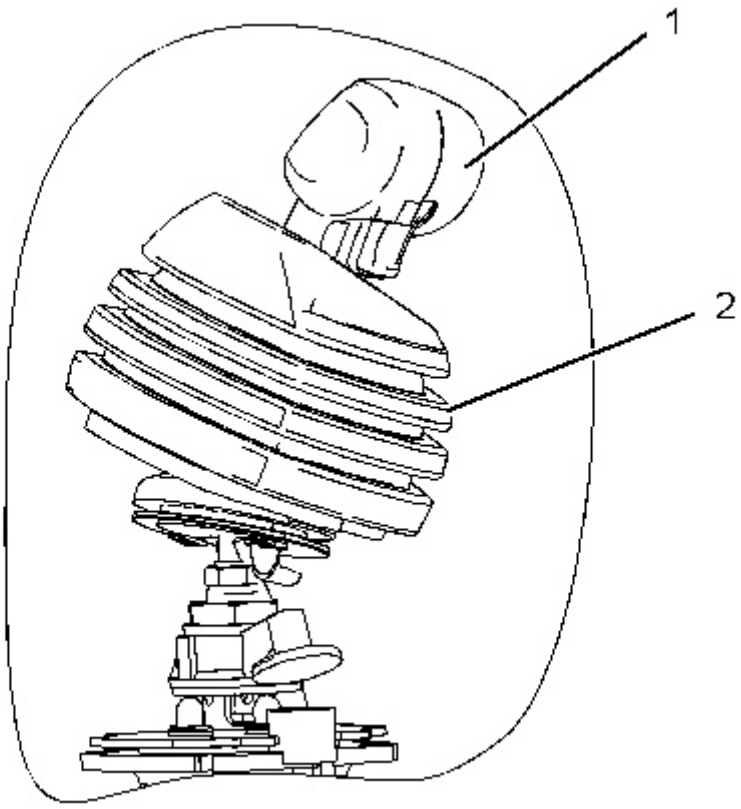


Illustration 2 g01078512

2. Install rubber boot (2) onto the joystick. Install the joystick handle (1). Install the screws on the side of joystick handle.

End By: Install the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Install".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02049737

Pilot Operated Hydraulic Control - Install

SMCS - 5059-012; 5705-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

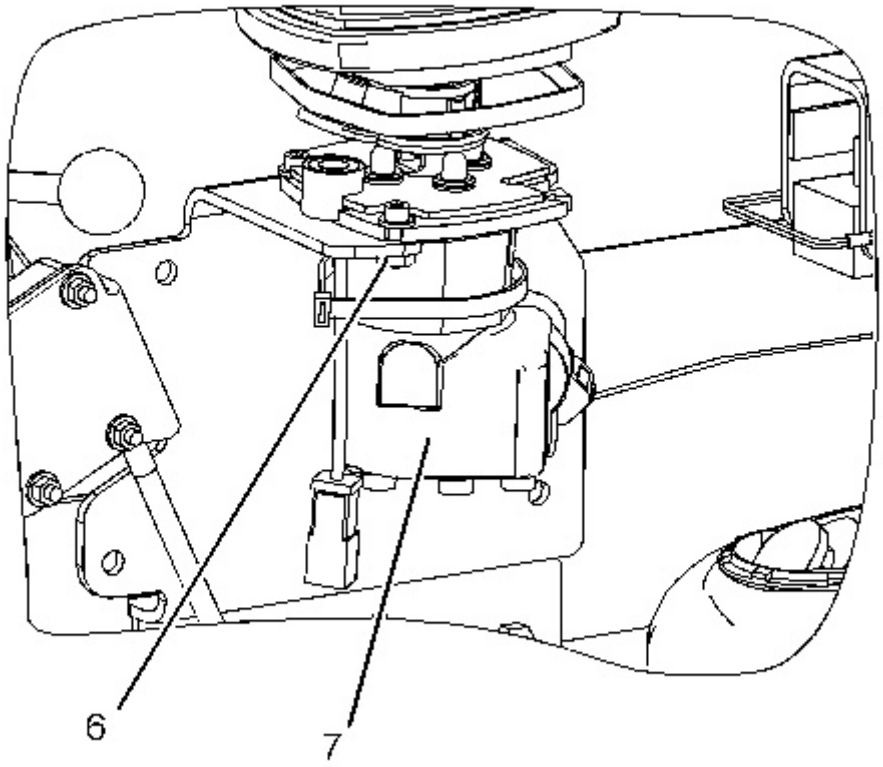


Illustration 1 g01051372

1. Install pilot operated hydraulic control (7). Install bolts (6) .

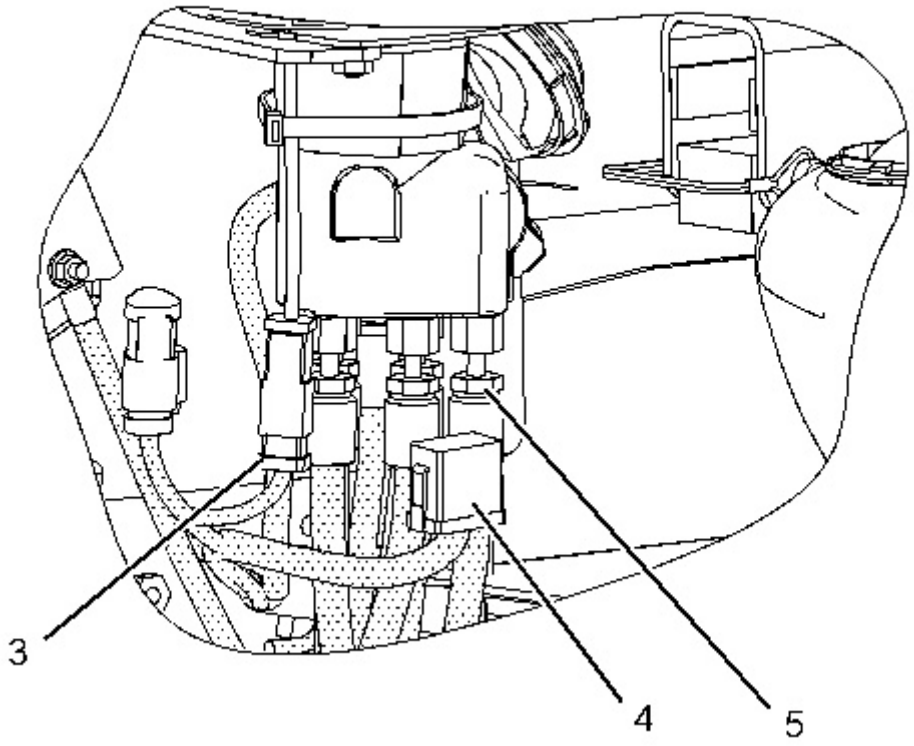


Illustration 2 g01051364

2. Connect harness assemblies (3) and (4). Connect hose assemblies (5) .

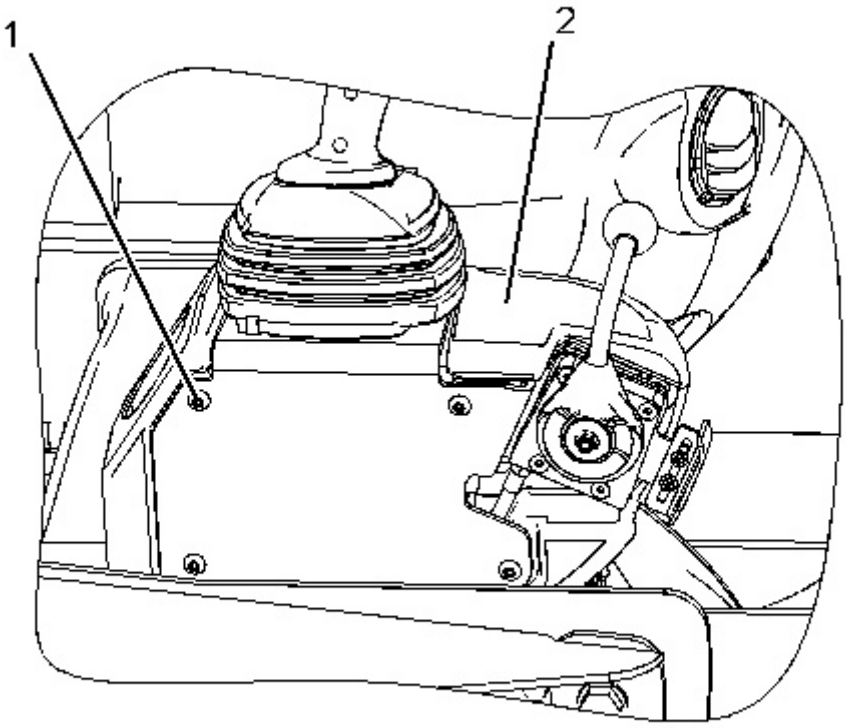


Illustration 3 g01051360

3. Install console (2). Remove screws (1). Tighten the screws (1) to a torque of 2.25 ± .25 N·m (20 ± 2 lb in).

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

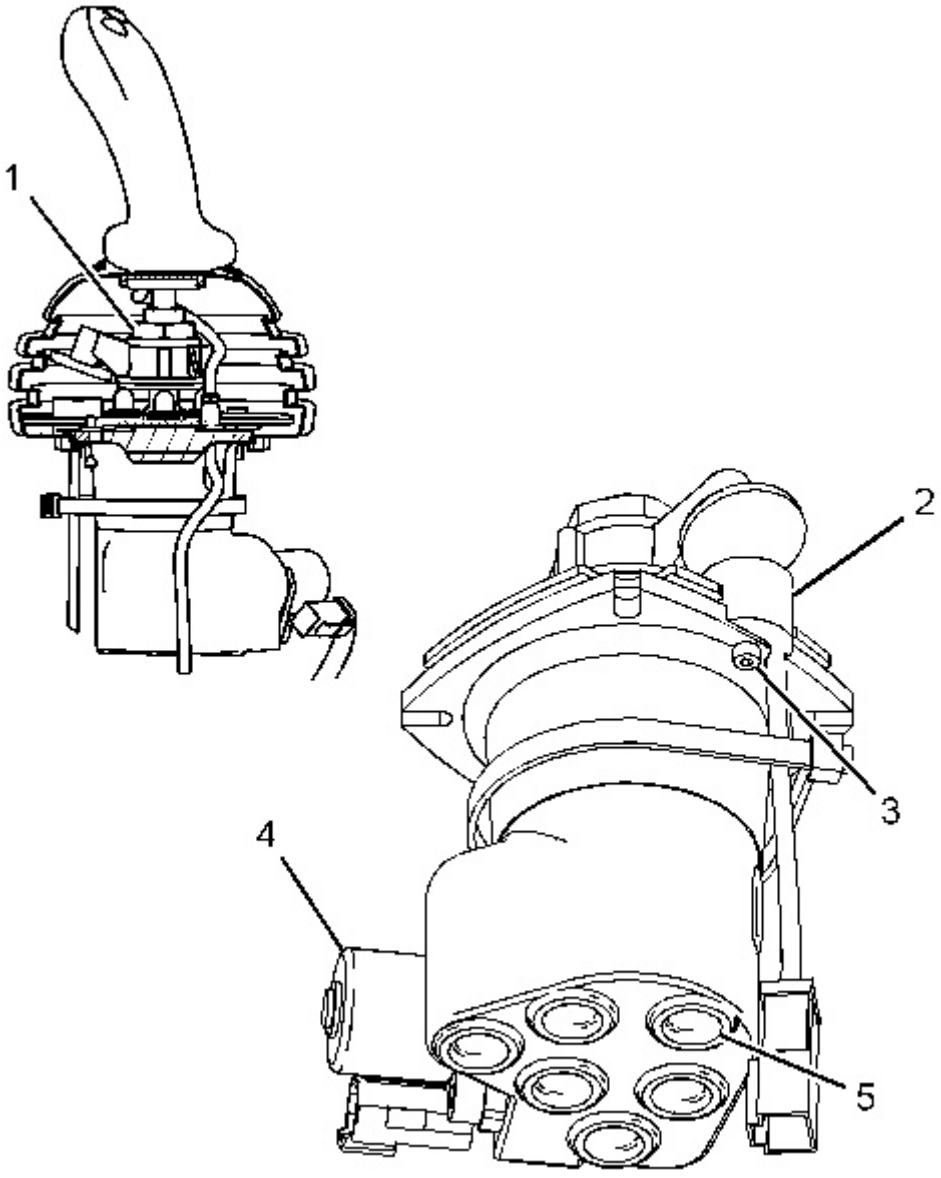


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

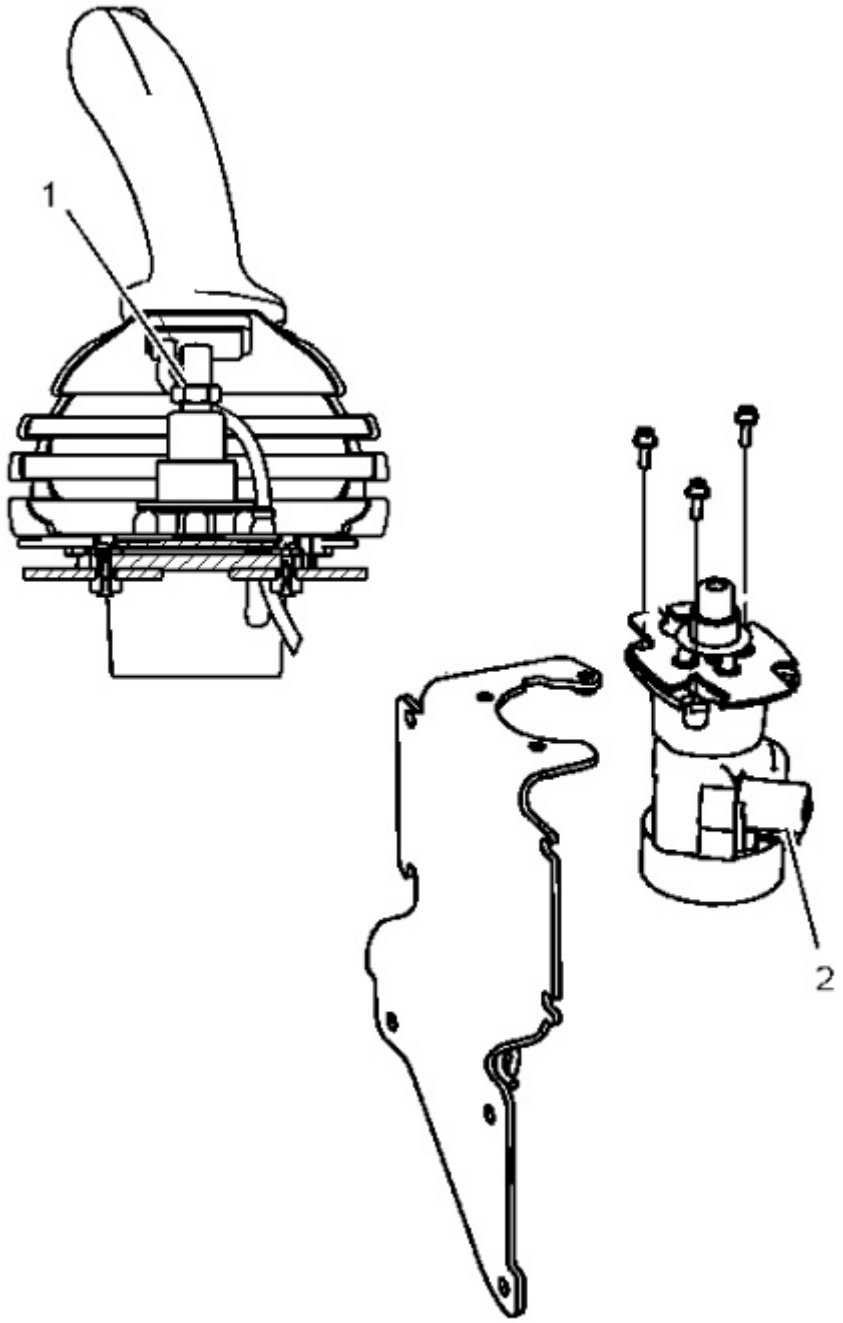


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

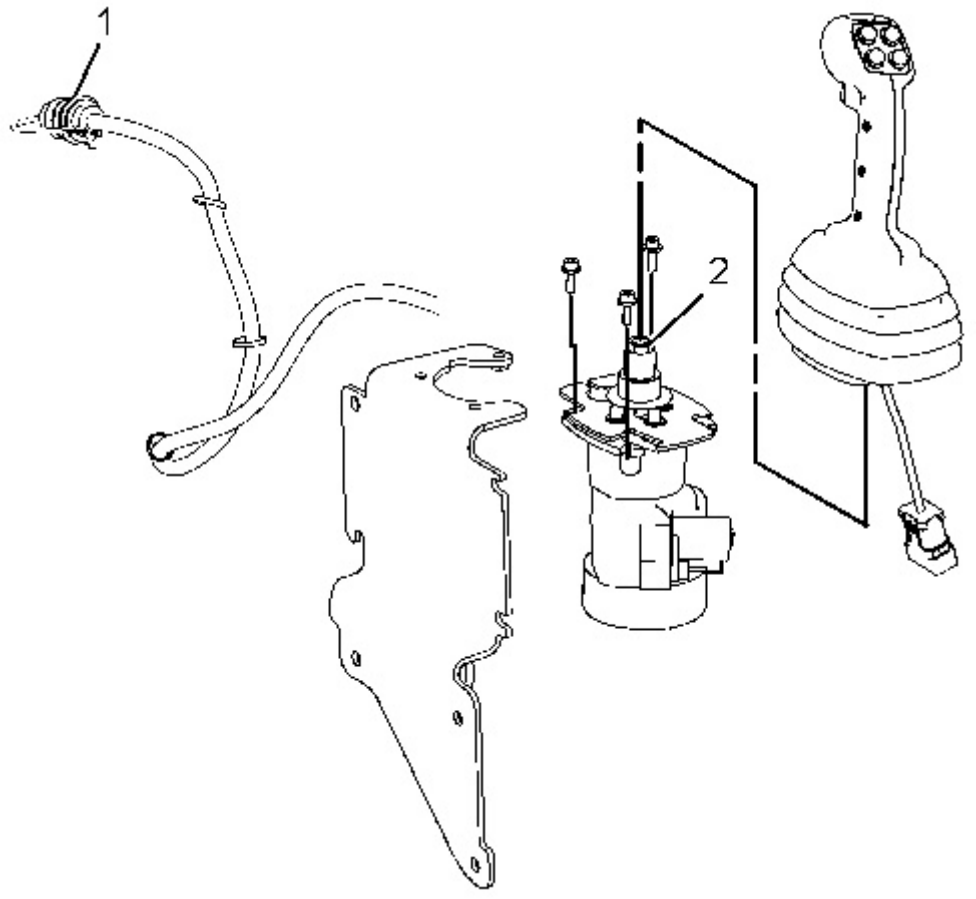


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

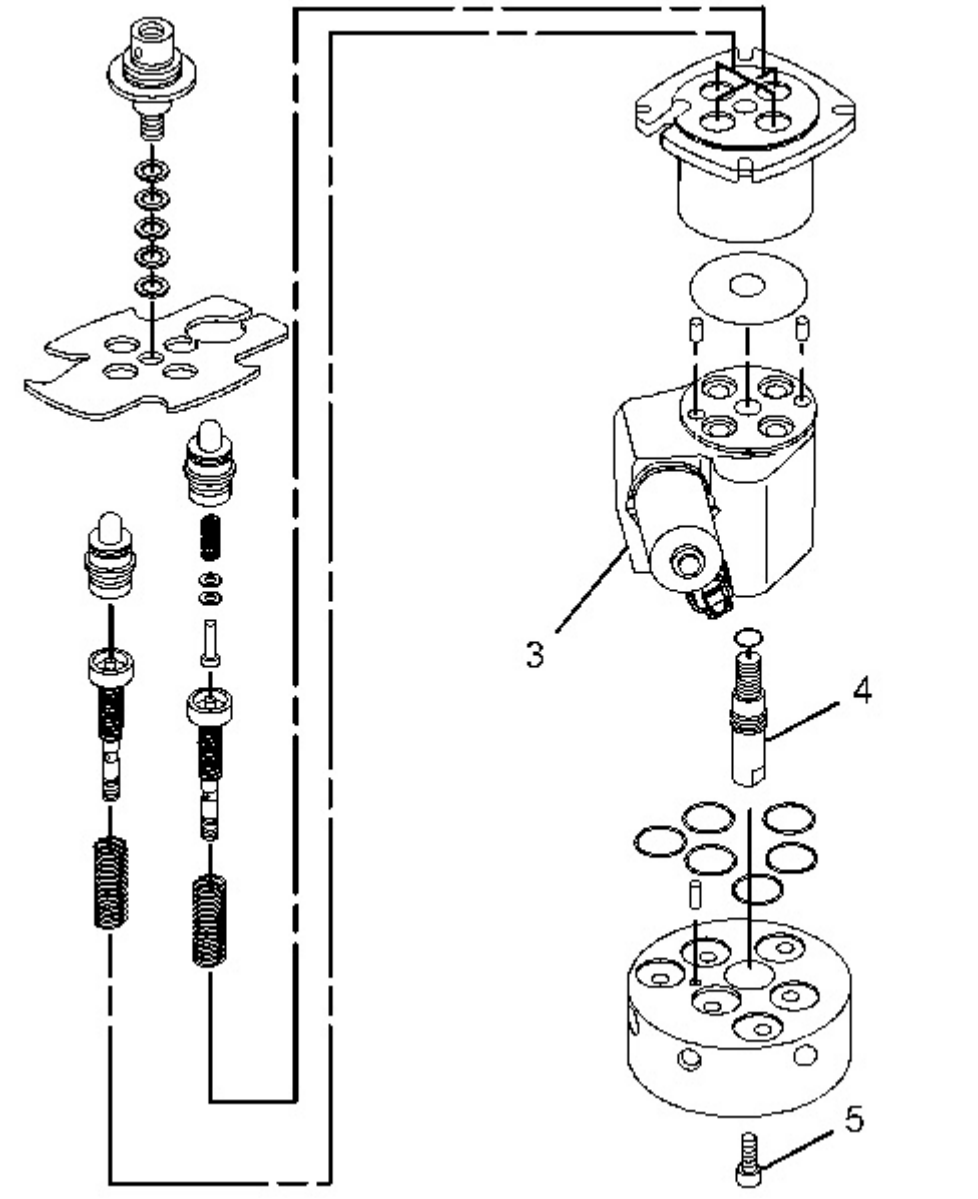


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC

Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

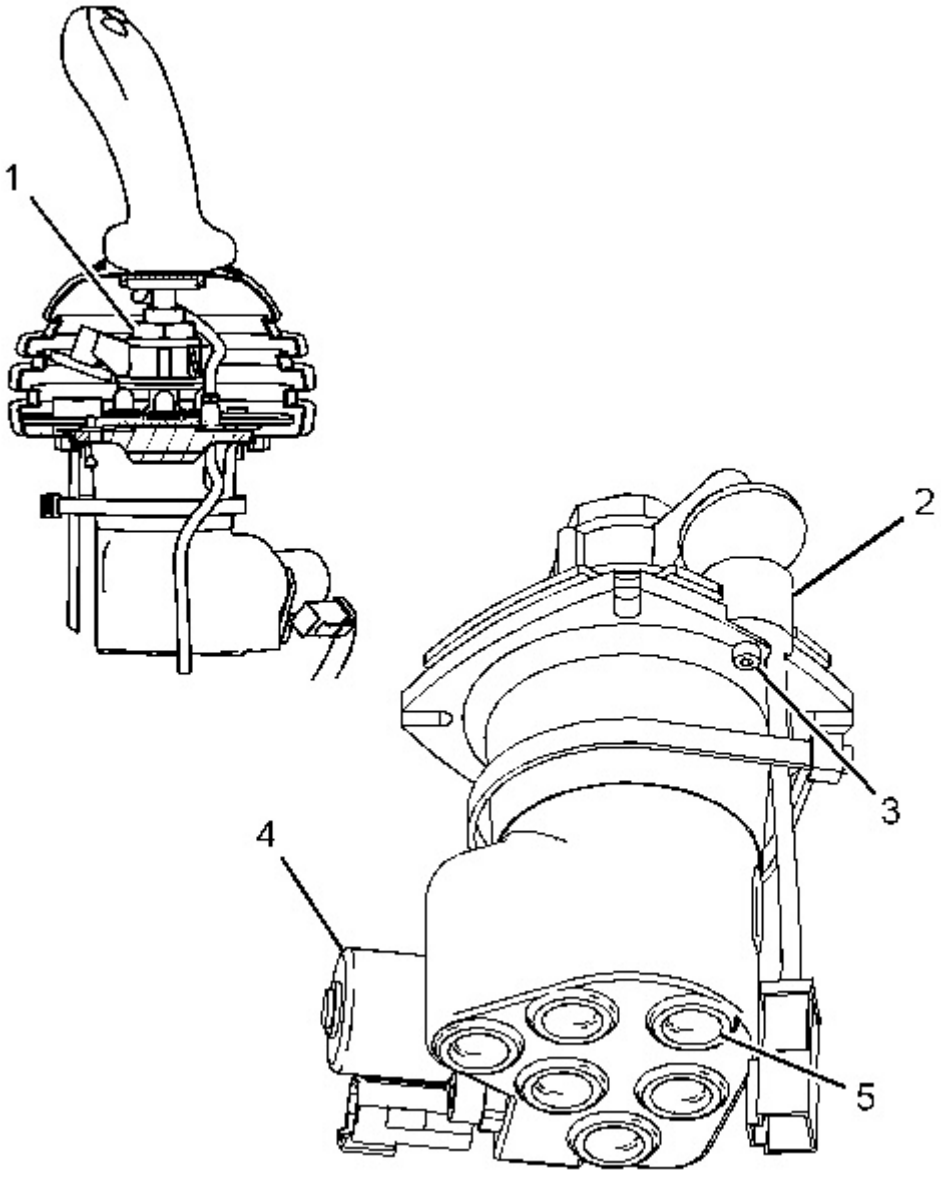


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

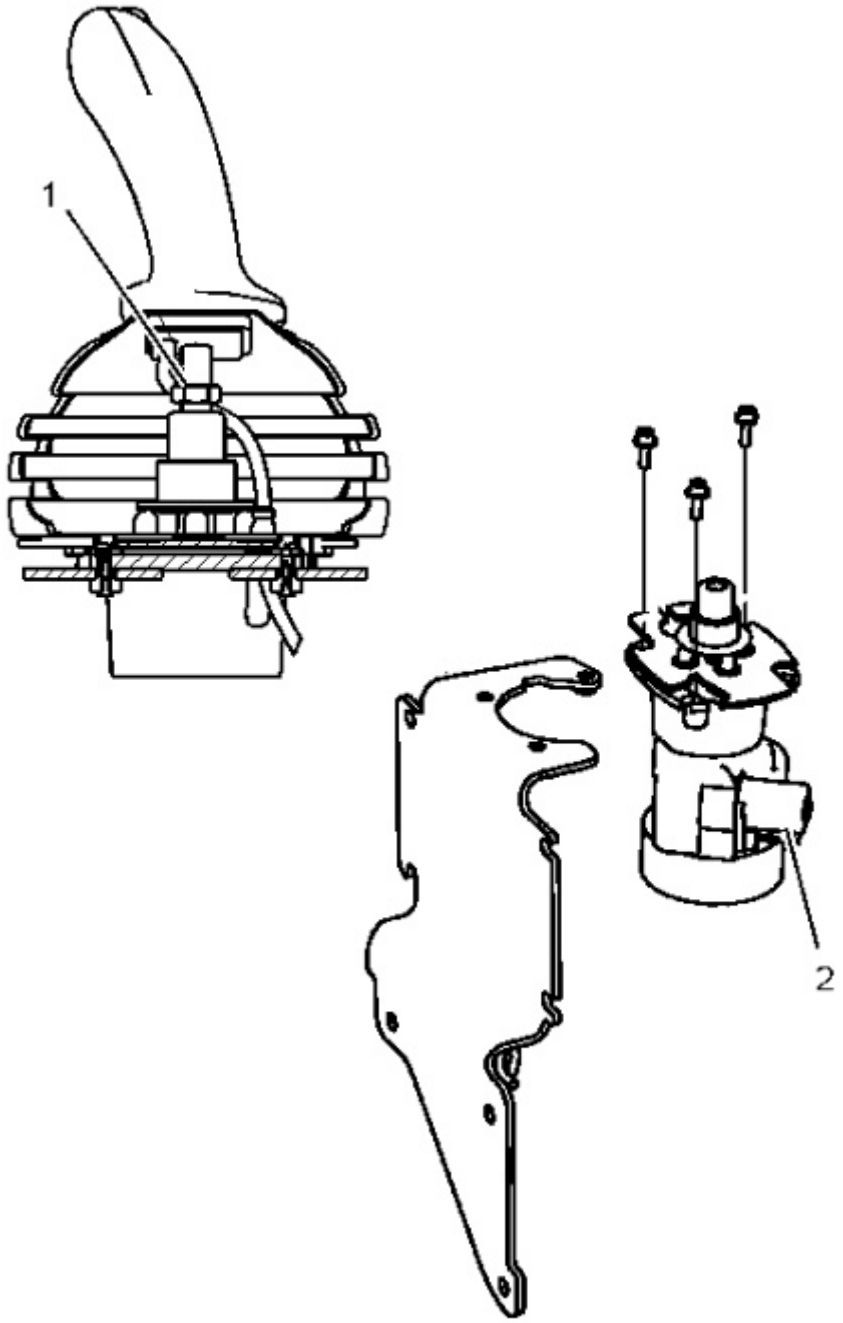


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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i02049704

Pilot Operated Hydraulic Control - Remove

SMCS - 5059-011; 5705-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	6V-9507	Face Seal Plug (9/16 - 18 THD)	5
	6V-9828	Cap As (9/16 - 18 THD)	5
	9U-7071	Tapered Cap/Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

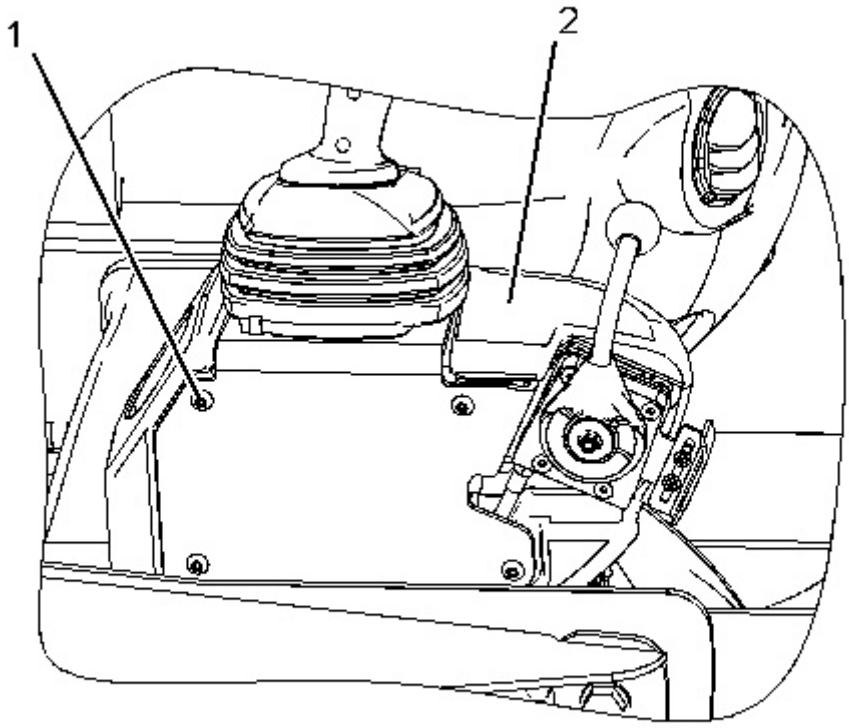


Illustration 1 g01051360

1. Remove screws (1) and remove console (2) .

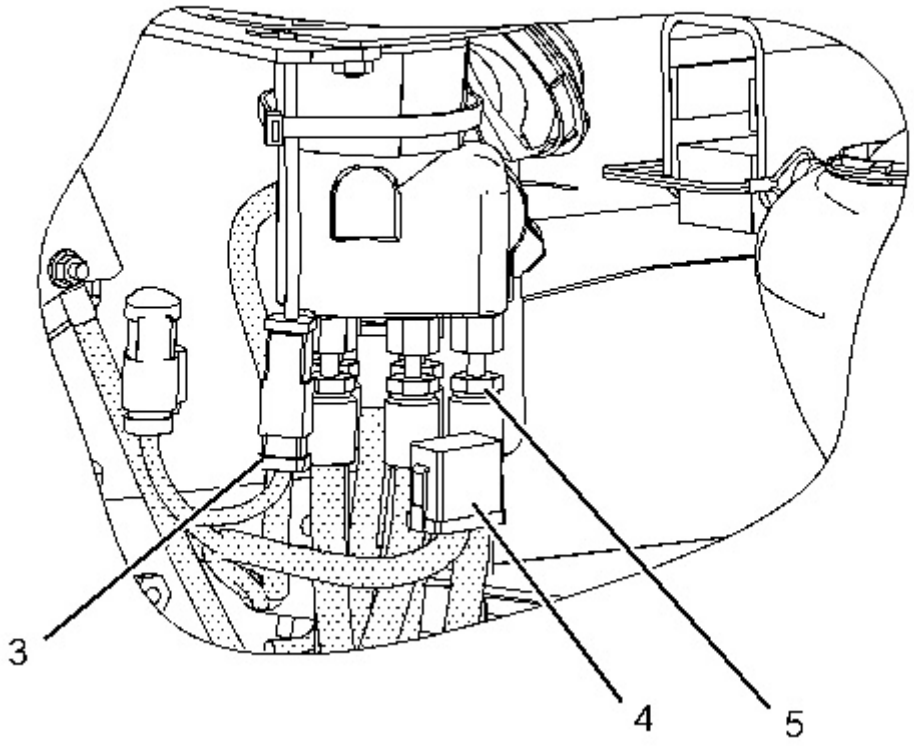


Illustration 2 g01051364

2. Disconnect harness assemblies (3) and (4). Disconnect hose assemblies (5) .

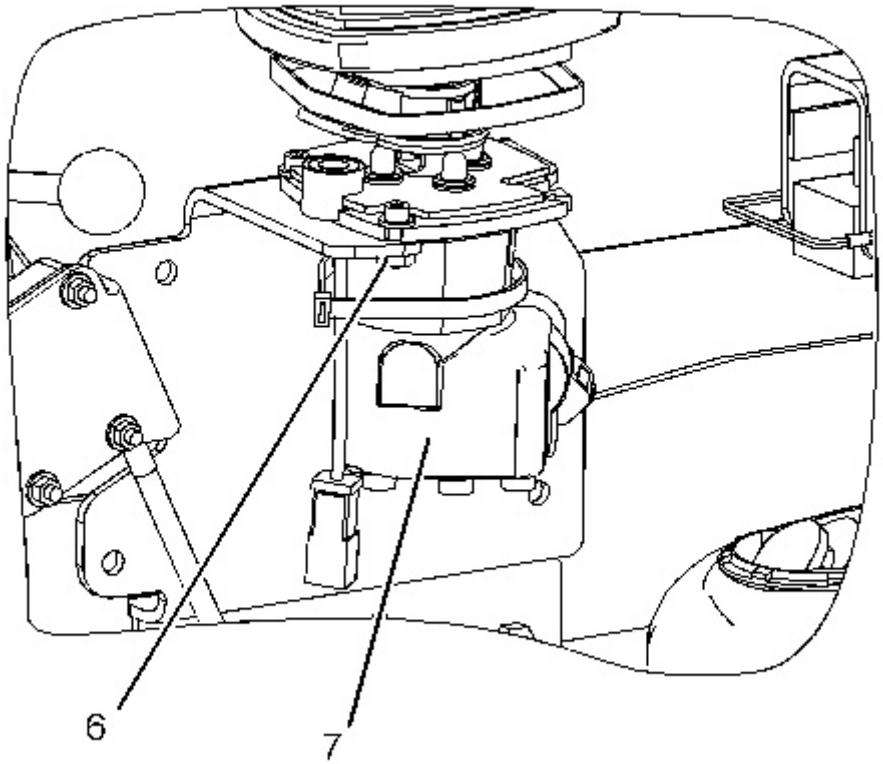


Illustration 3 g01051372

3. Remove bolts (6). Remove pilot operated hydraulic control (7) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117426

Pilot Operated Hydraulic Control - Disassemble

SMCS - 5059-015; 5705-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Remove".

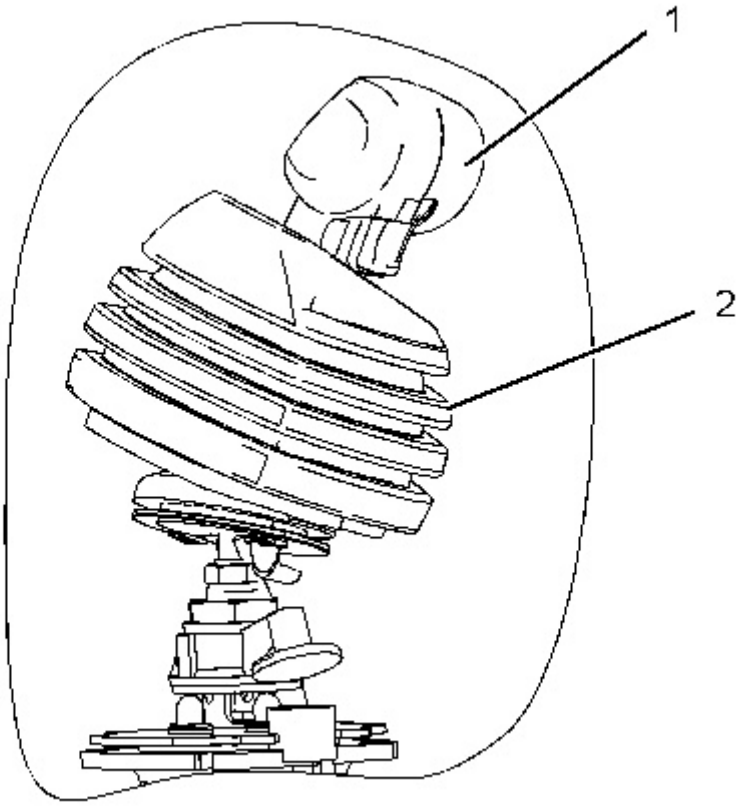


Illustration 1 g01078512

1. Lift rubber boot (2) from the joystick. Remove the screws on the side of joystick handle (1) and remove the joystick handle.

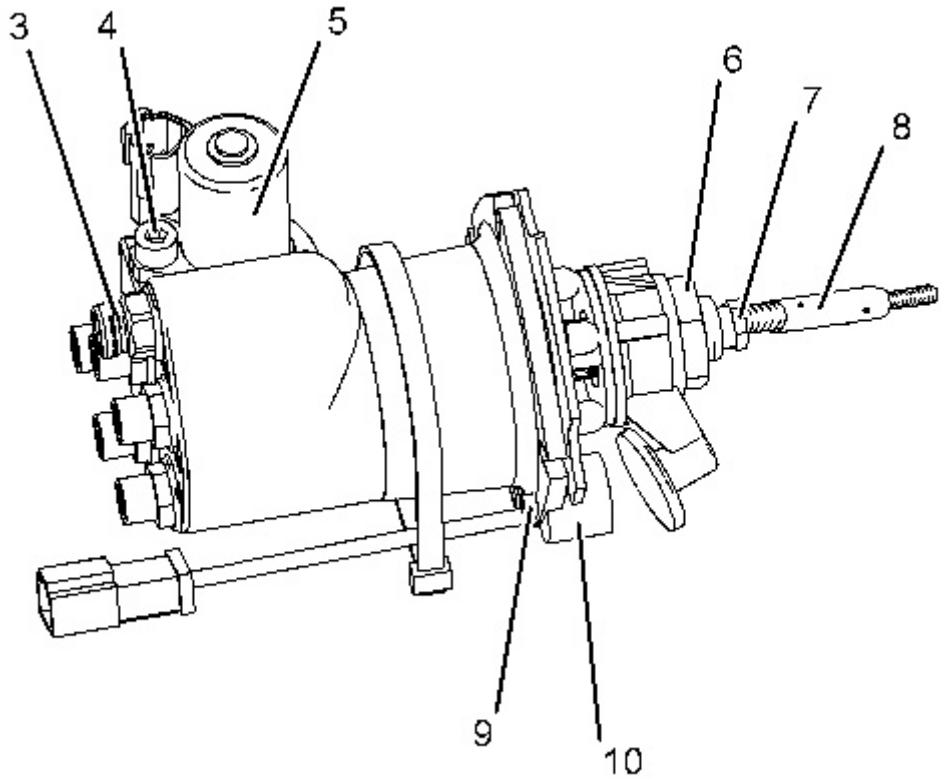


Illustration 2 g01078513

2. Remove fittings (3). Remove bolt (4) and solenoid (5). Remove bolt (9) and coil assembly (10). Note the orientation of nut (6), nut (7) and lever (8) for installation purposes. Loosen nut (7). Remove lever (8). Remove nut (6) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117461

Pilot Operated Hydraulic Control - Assemble

SMCS - 5059-016; 5705-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

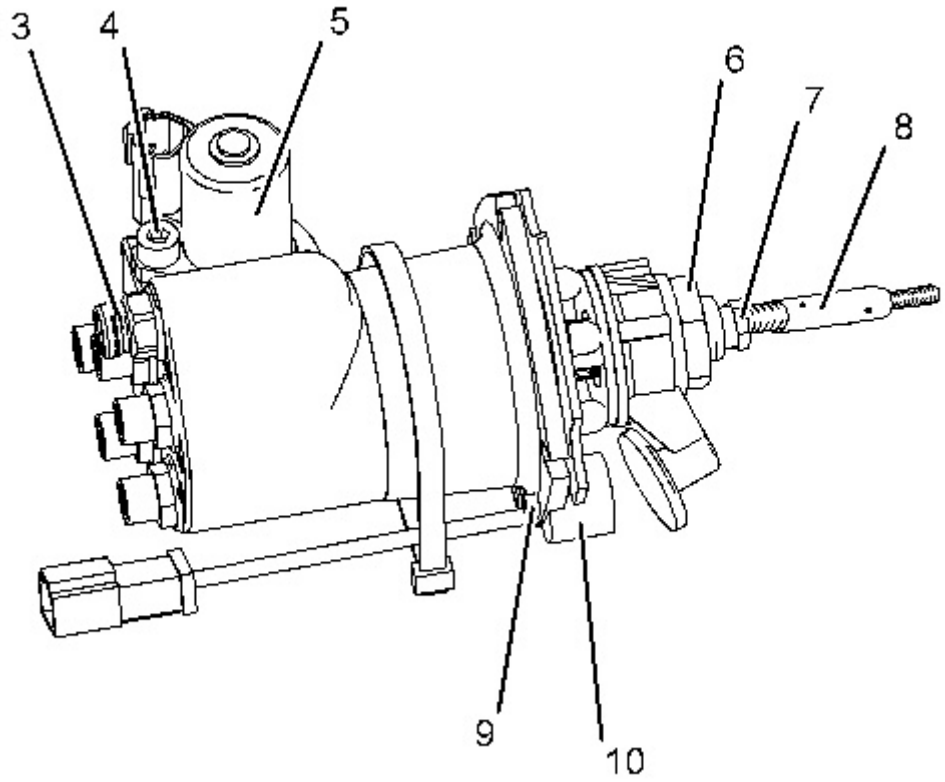


Illustration 1 g01078513

1. Install nut (6). Install lever (8). Tighten nut (7). Install fittings (3). Install solenoid (5) and bolt (4). Install coil assembly (10) and bolt (9).

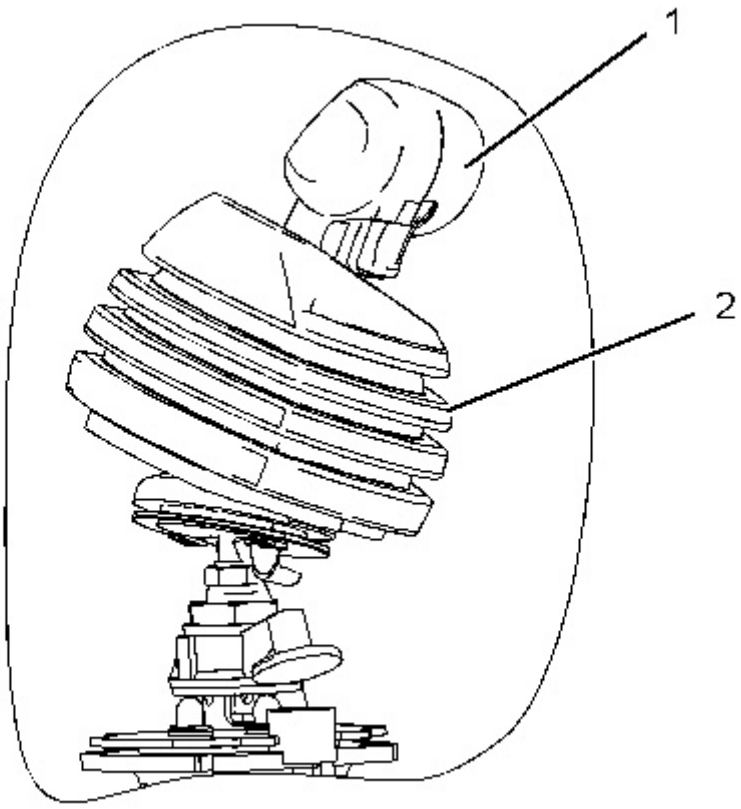


Illustration 2 g01078512

2. Install rubber boot (2) onto the joystick. Install the joystick handle (1). Install the screws on the side of joystick handle.

End By: Install the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Install".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02049737

Pilot Operated Hydraulic Control - Install

SMCS - 5059-012; 5705-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

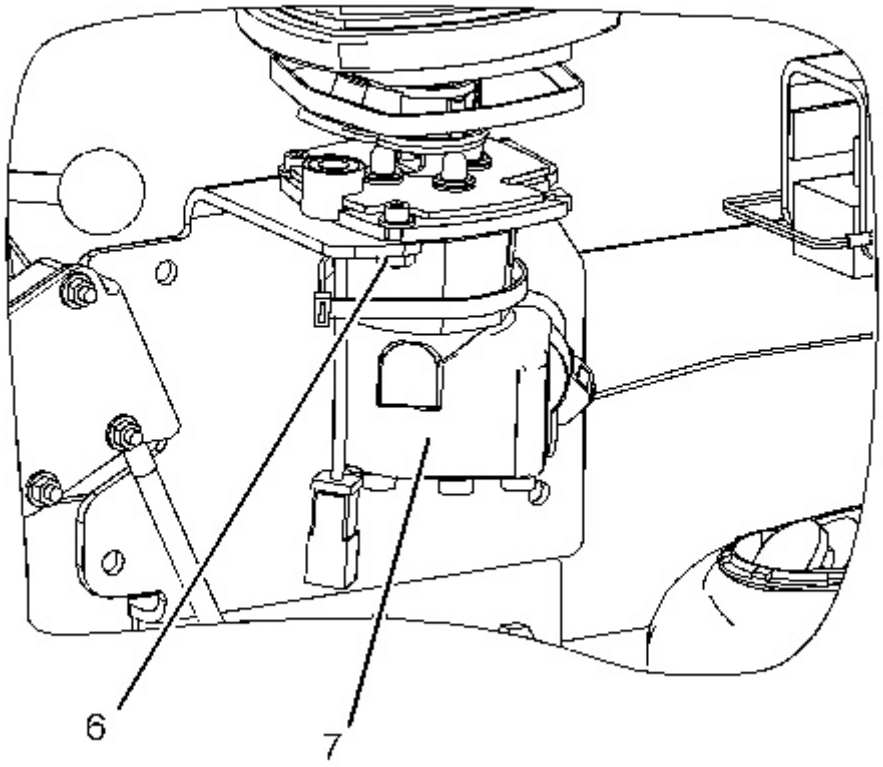


Illustration 1 g01051372

1. Install pilot operated hydraulic control (7). Install bolts (6) .

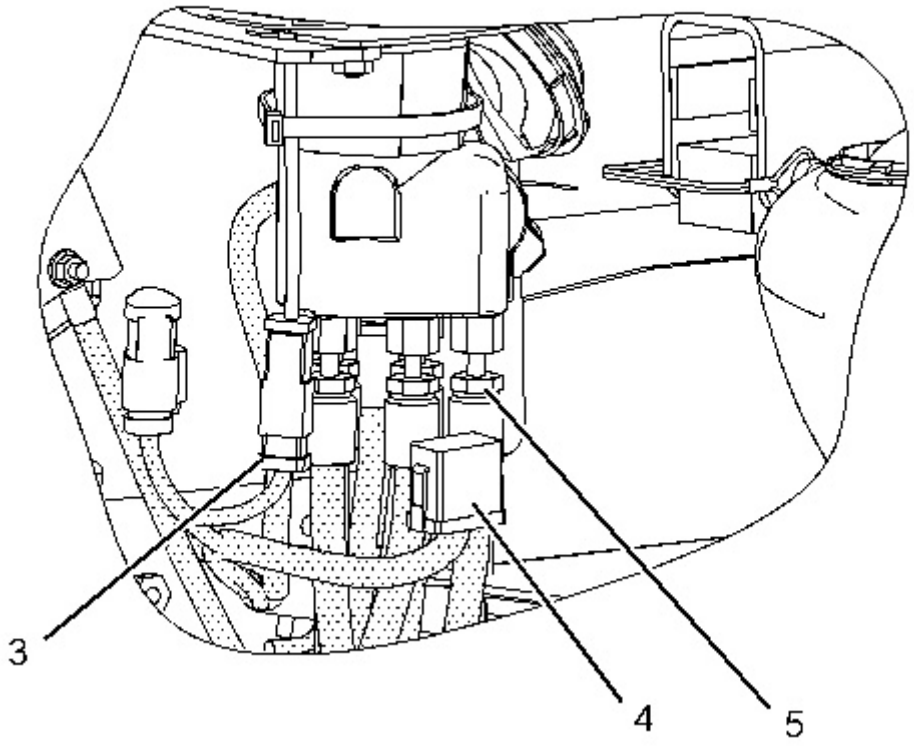


Illustration 2 g01051364

2. Connect harness assemblies (3) and (4). Connect hose assemblies (5) .

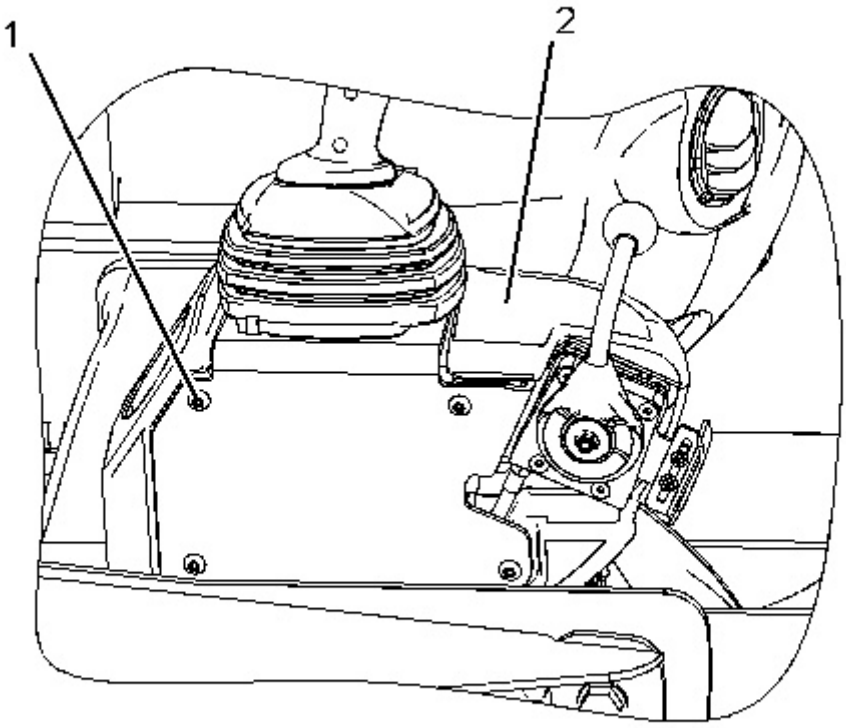


Illustration 3 g01051360

3. Install console (2). Remove screws (1). Tighten the screws (1) to a torque of 2.25 ± .25 N·m (20 ± 2 lb in).

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

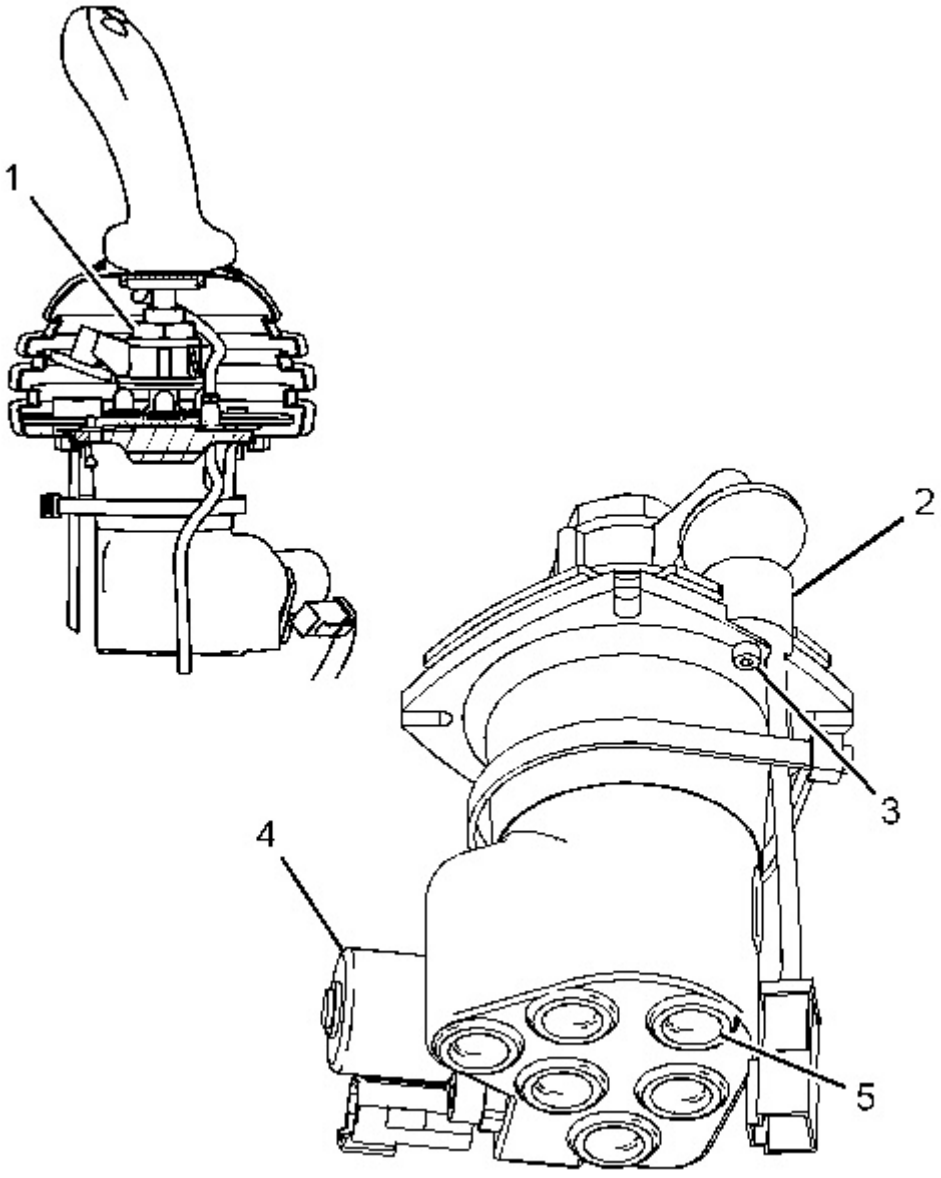


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

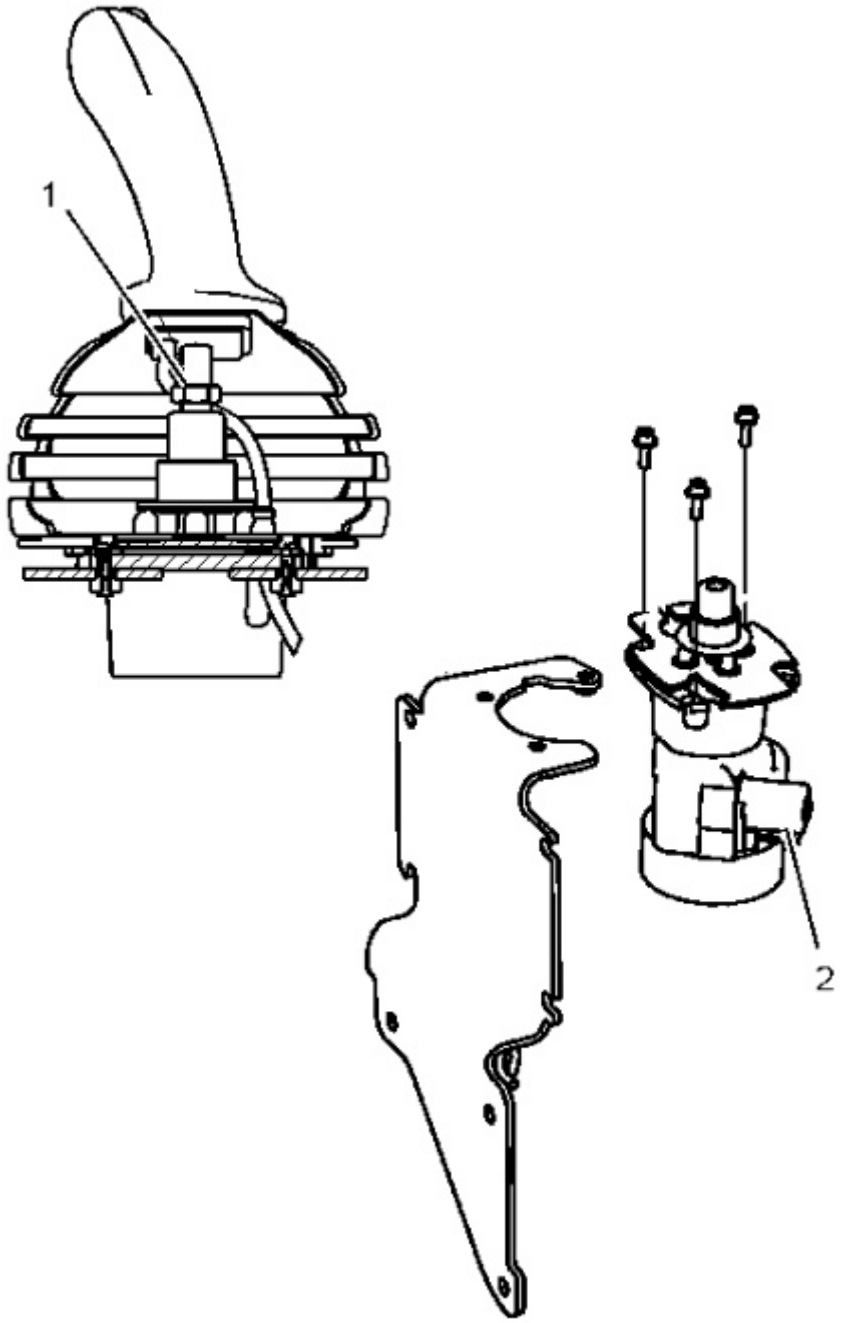


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

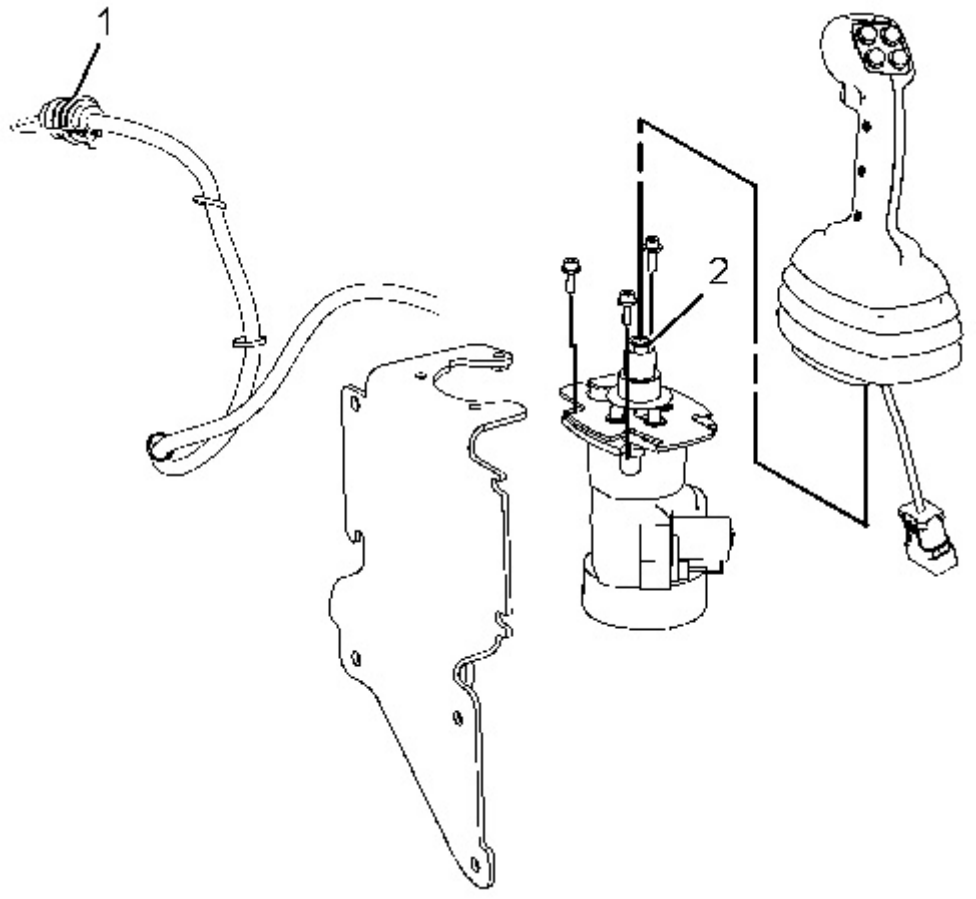


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

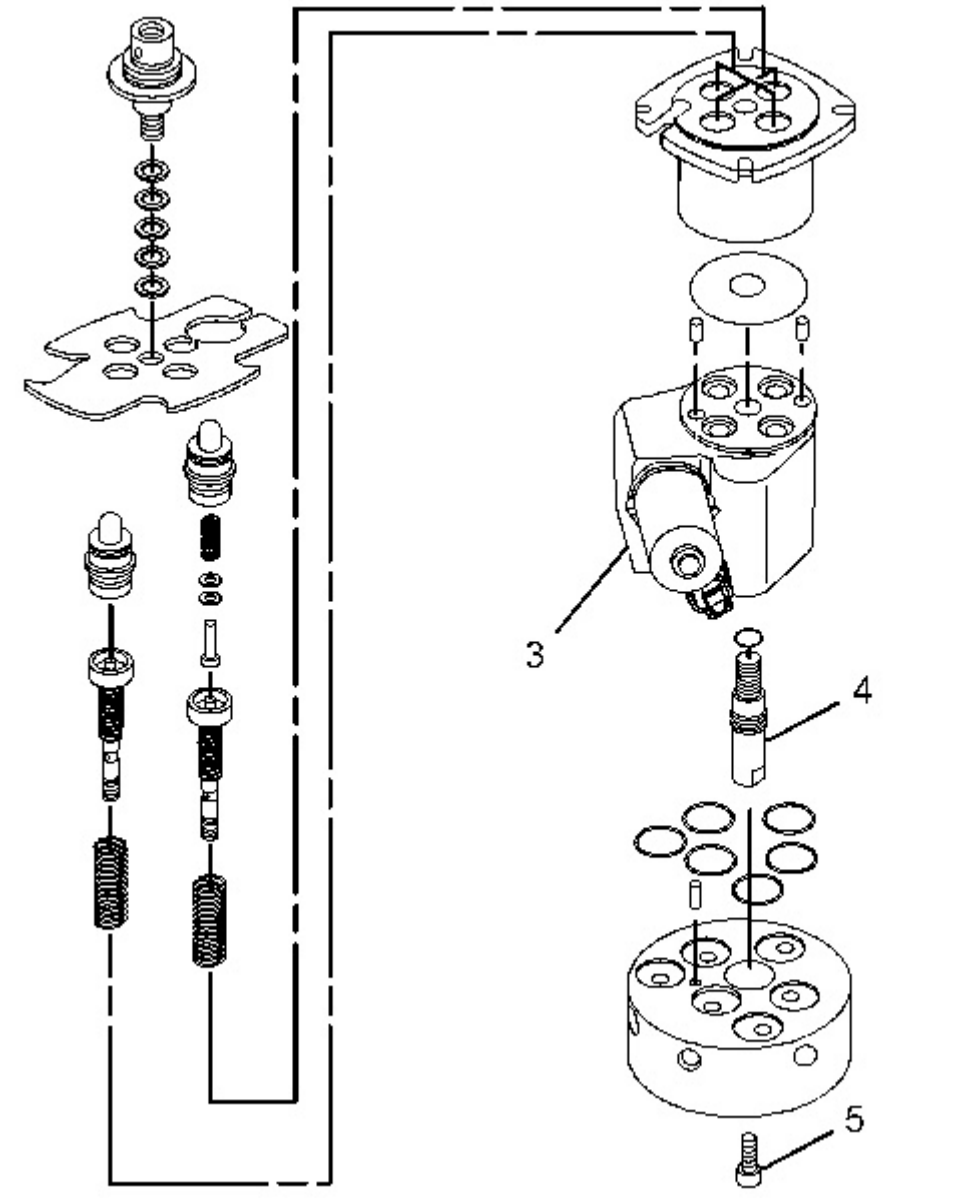


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC

Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

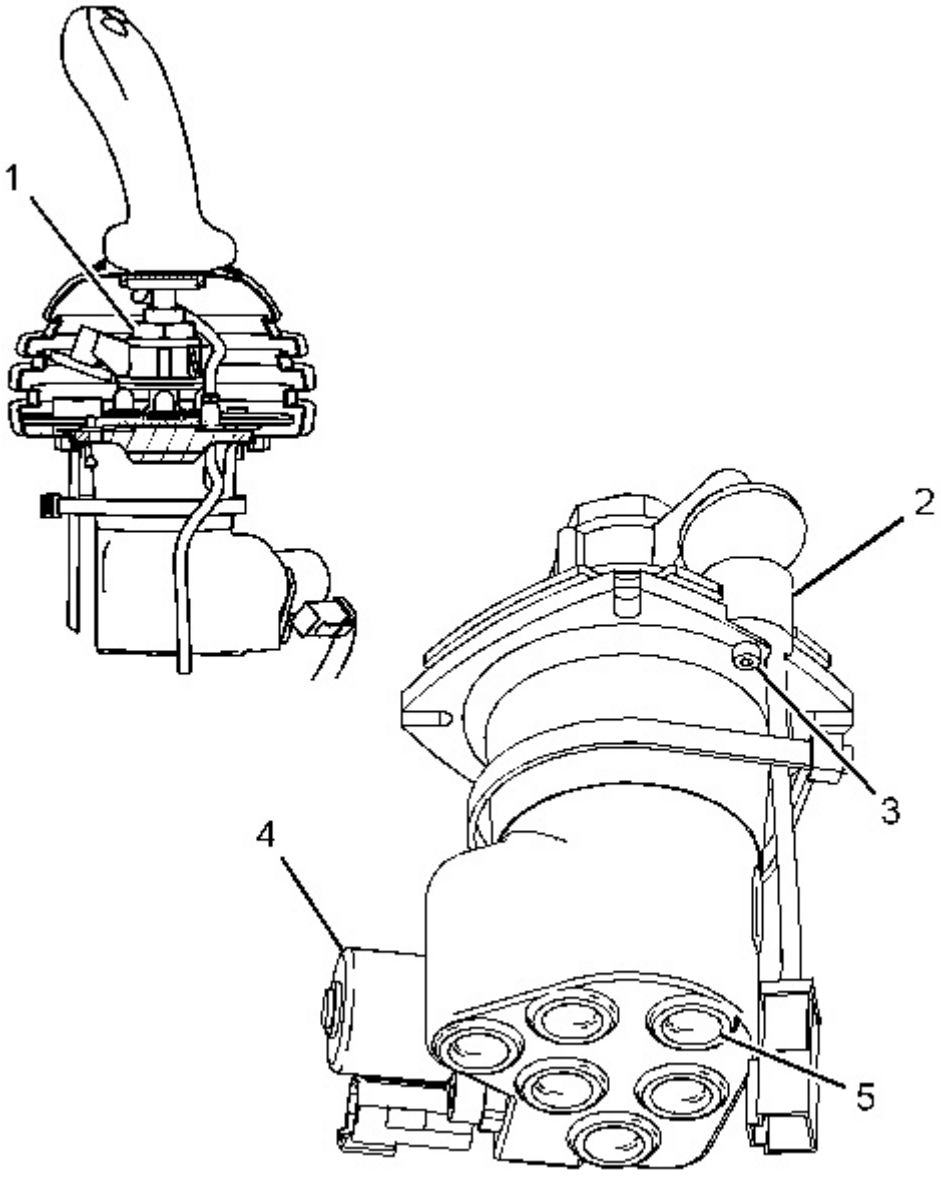


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

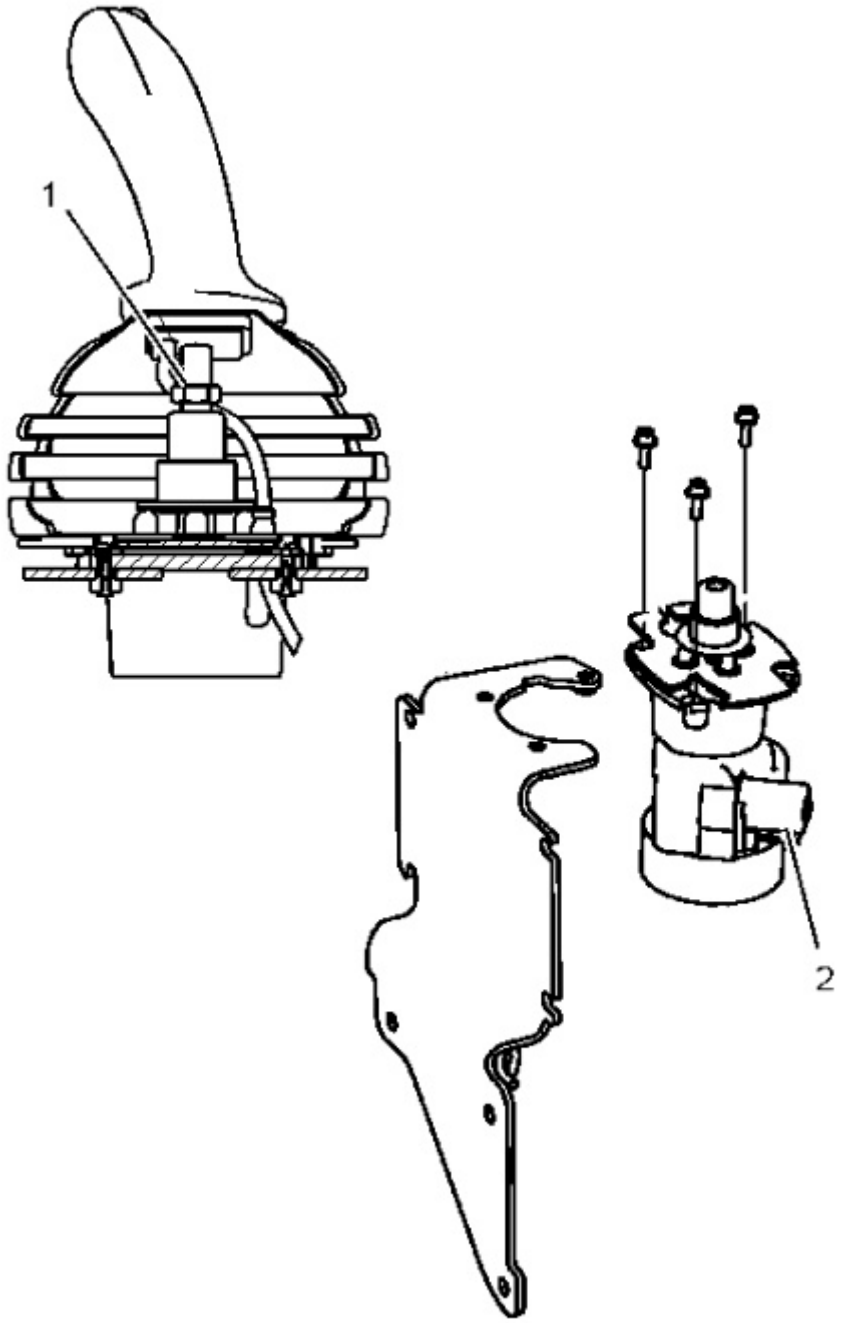


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN6750-UP

S/N - SCP4600-UP

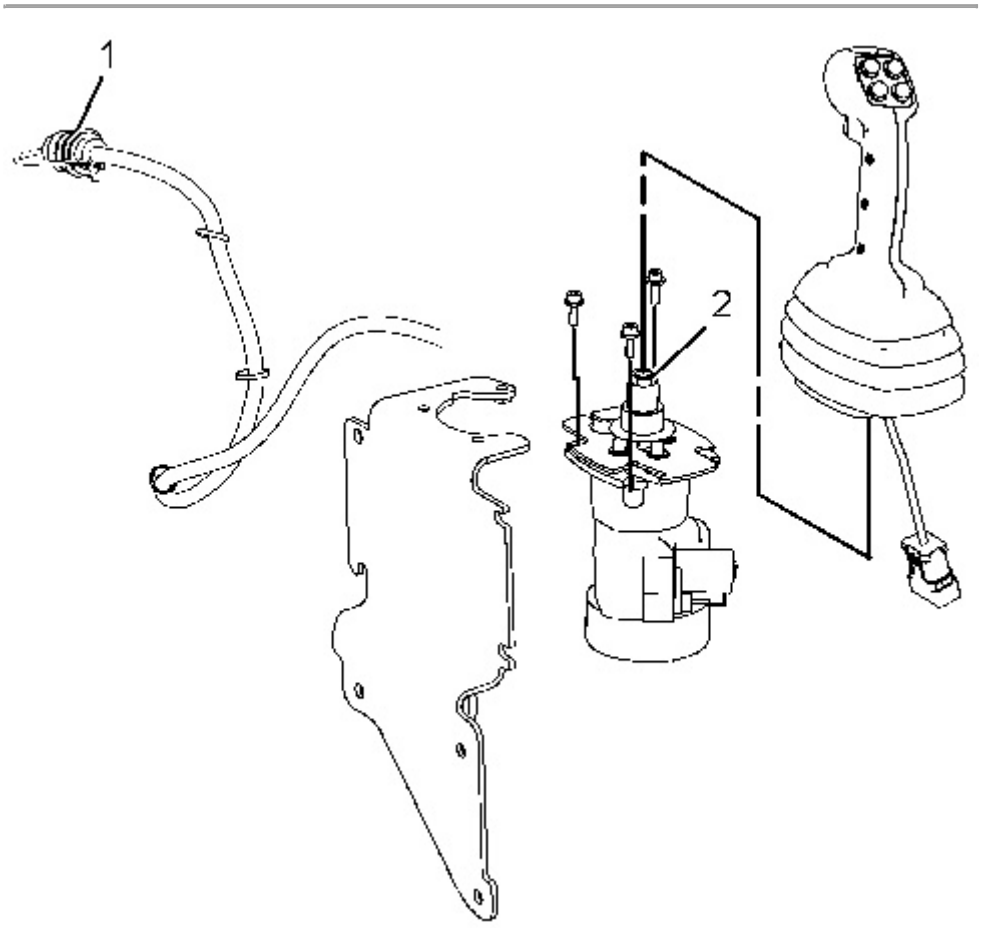


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

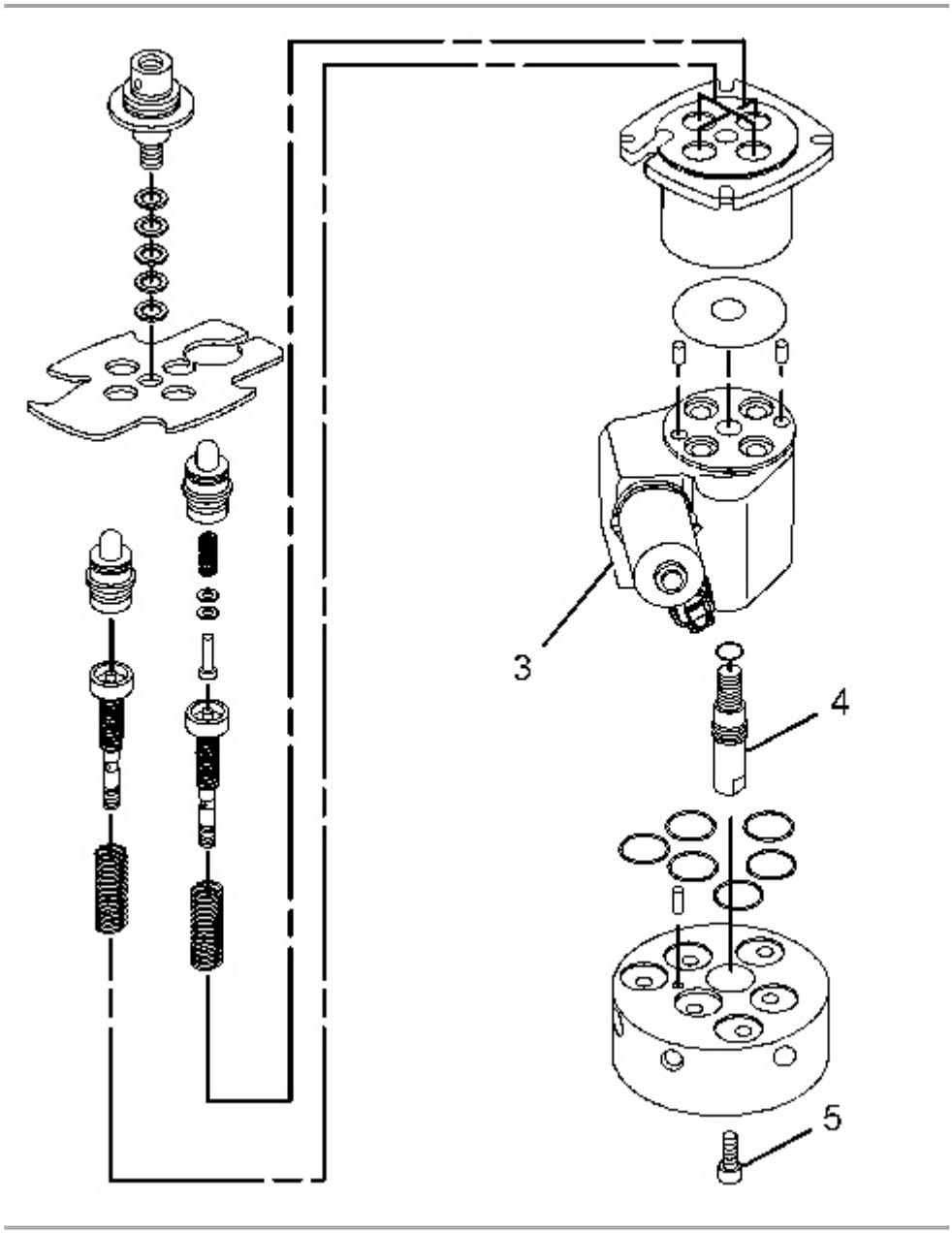


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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i02049704

Pilot Operated Hydraulic Control - Remove

SMCS - 5059-011; 5705-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	6V-9507	Face Seal Plug (9/16 - 18 THD)	5
	6V-9828	Cap As (9/16 - 18 THD)	5
	9U-7071	Tapered Cap/Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

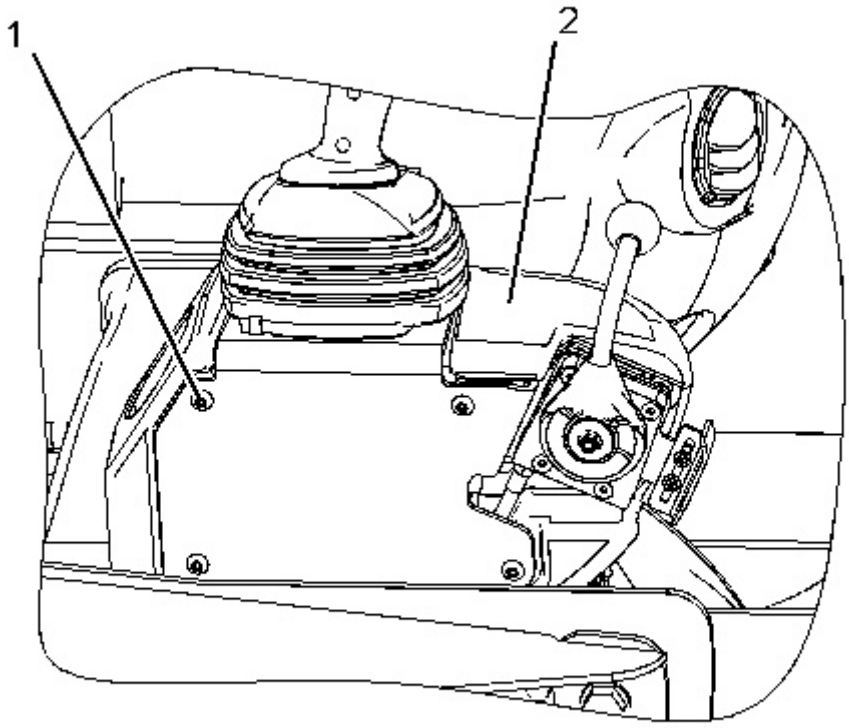


Illustration 1 g01051360

1. Remove screws (1) and remove console (2) .

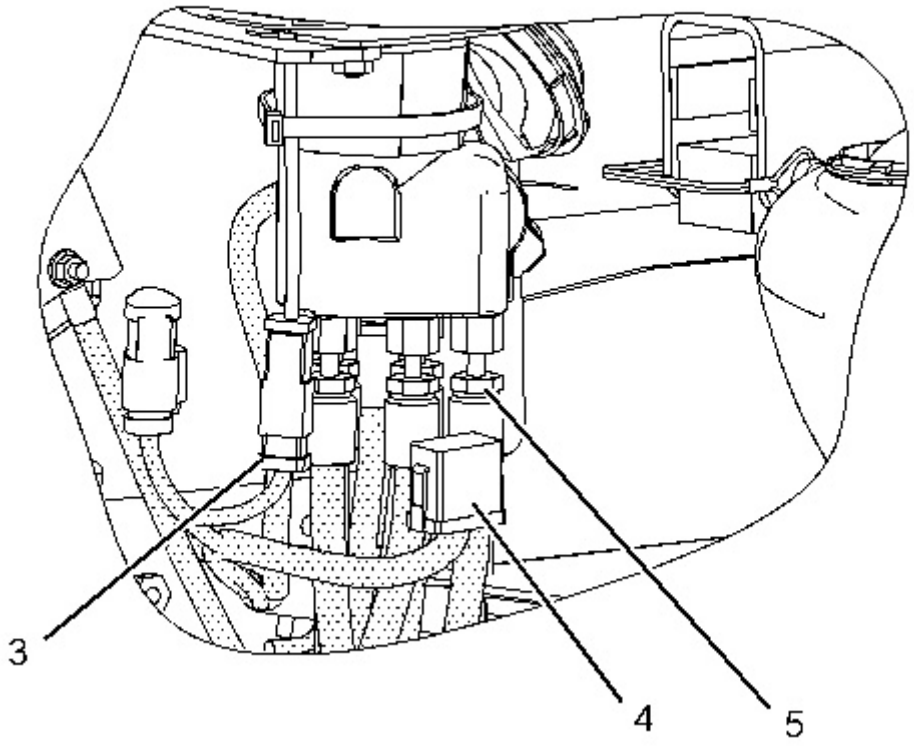


Illustration 2 g01051364

2. Disconnect harness assemblies (3) and (4). Disconnect hose assemblies (5) .

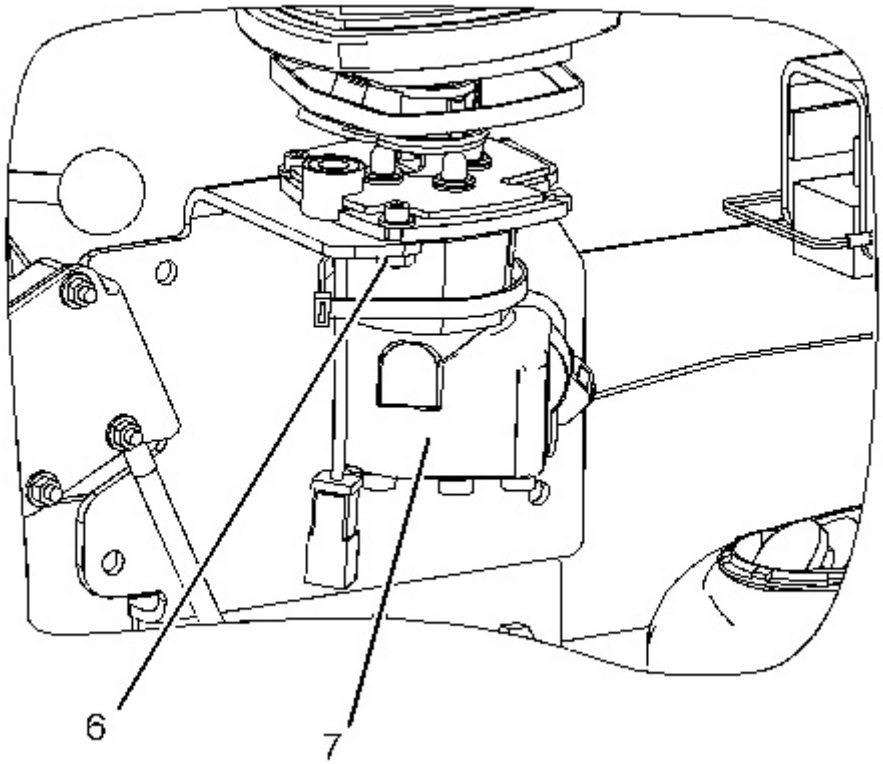


Illustration 3 g01051372

3. Remove bolts (6). Remove pilot operated hydraulic control (7) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117426

Pilot Operated Hydraulic Control - Disassemble

SMCS - 5059-015; 5705-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Remove".

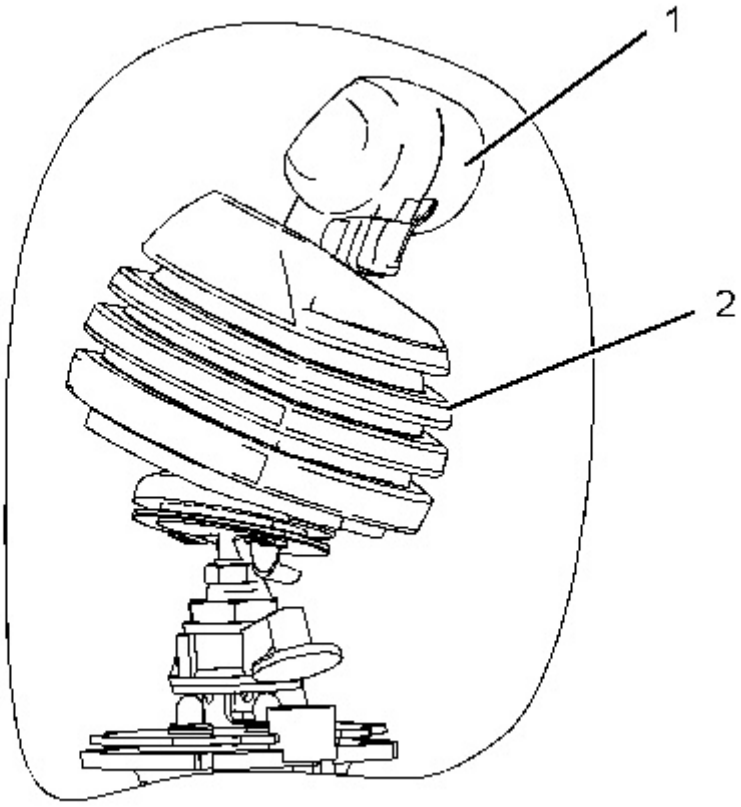


Illustration 1 g01078512

1. Lift rubber boot (2) from the joystick. Remove the screws on the side of joystick handle (1) and remove the joystick handle.

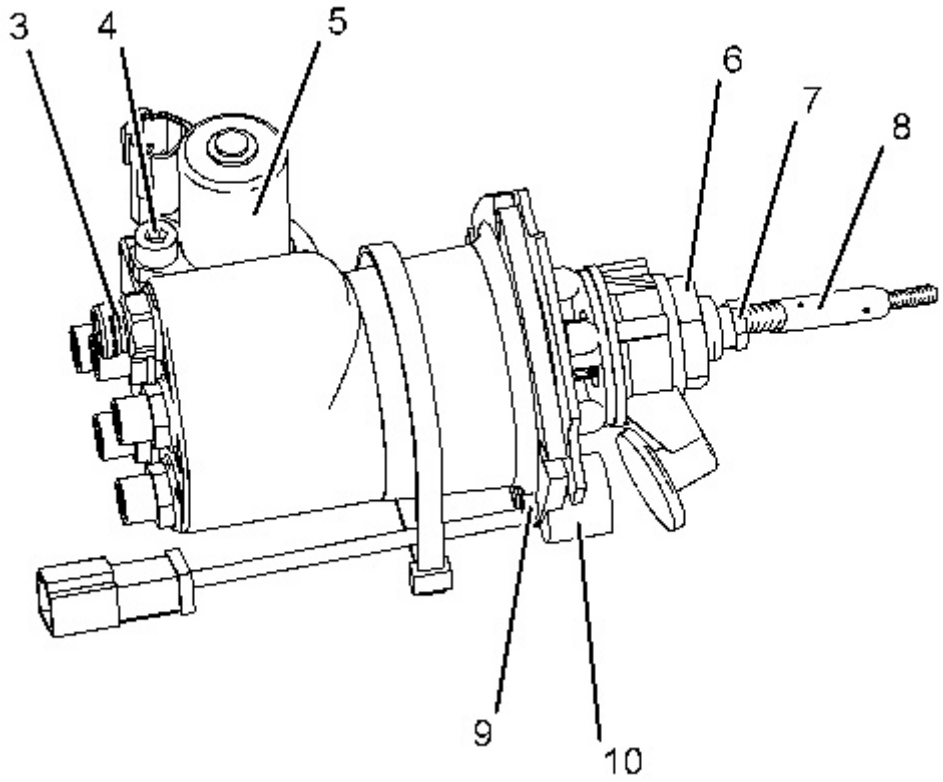


Illustration 2 g01078513

2. Remove fittings (3). Remove bolt (4) and solenoid (5). Remove bolt (9) and coil assembly (10). Note the orientation of nut (6), nut (7) and lever (8) for installation purposes. Loosen nut (7). Remove lever (8). Remove nut (6) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117461

Pilot Operated Hydraulic Control - Assemble

SMCS - 5059-016; 5705-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

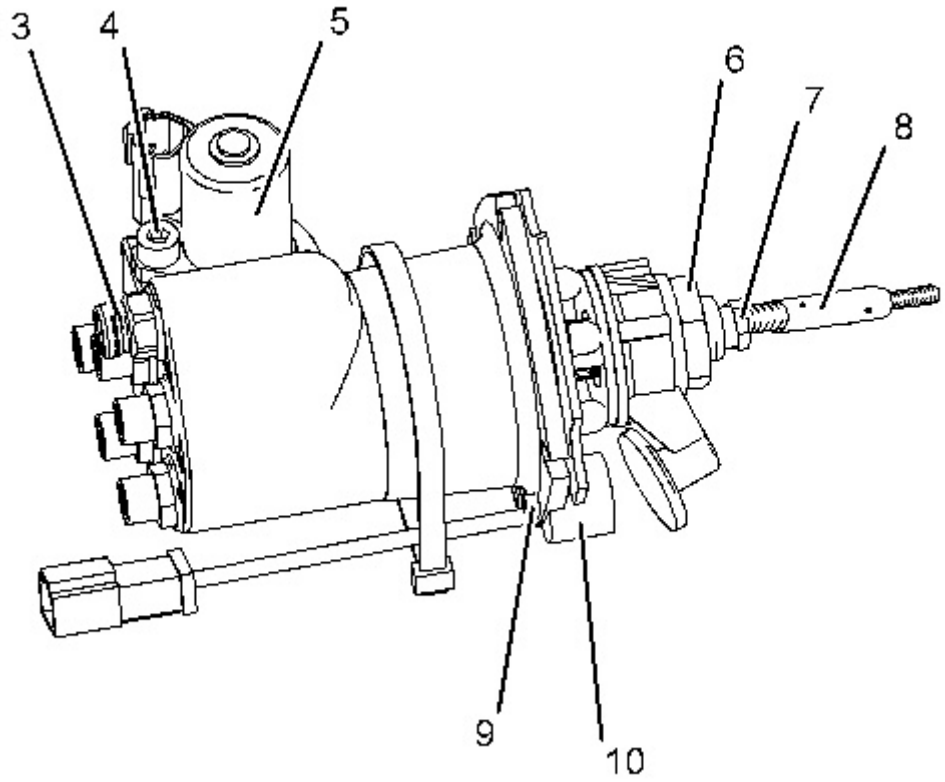


Illustration 1 g01078513

1. Install nut (6). Install lever (8). Tighten nut (7). Install fittings (3). Install solenoid (5) and bolt (4). Install coil assembly (10) and bolt (9).

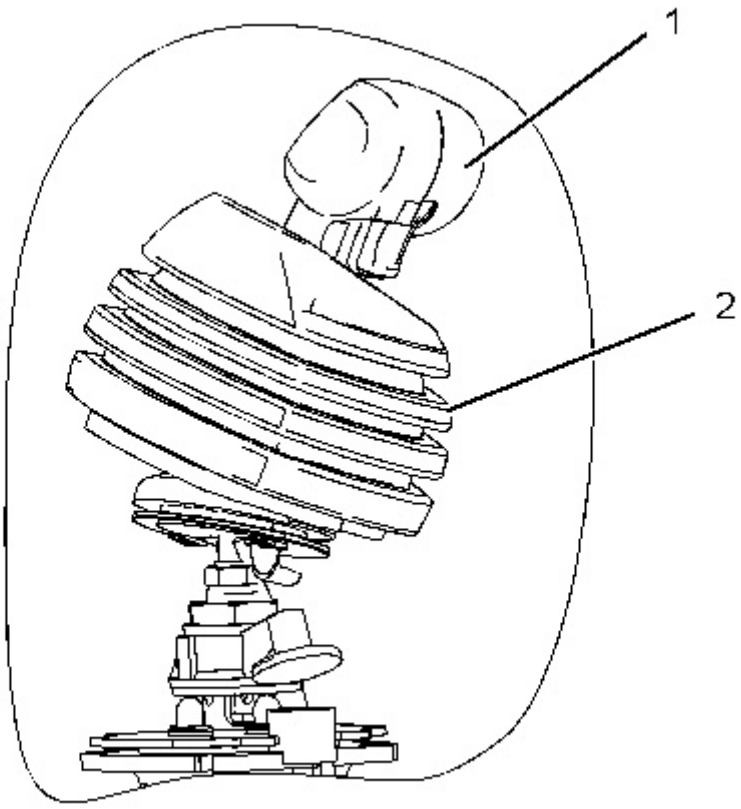


Illustration 2 g01078512

2. Install rubber boot (2) onto the joystick. Install the joystick handle (1). Install the screws on the side of joystick handle.

End By: Install the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Install".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02049737

Pilot Operated Hydraulic Control - Install

SMCS - 5059-012; 5705-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

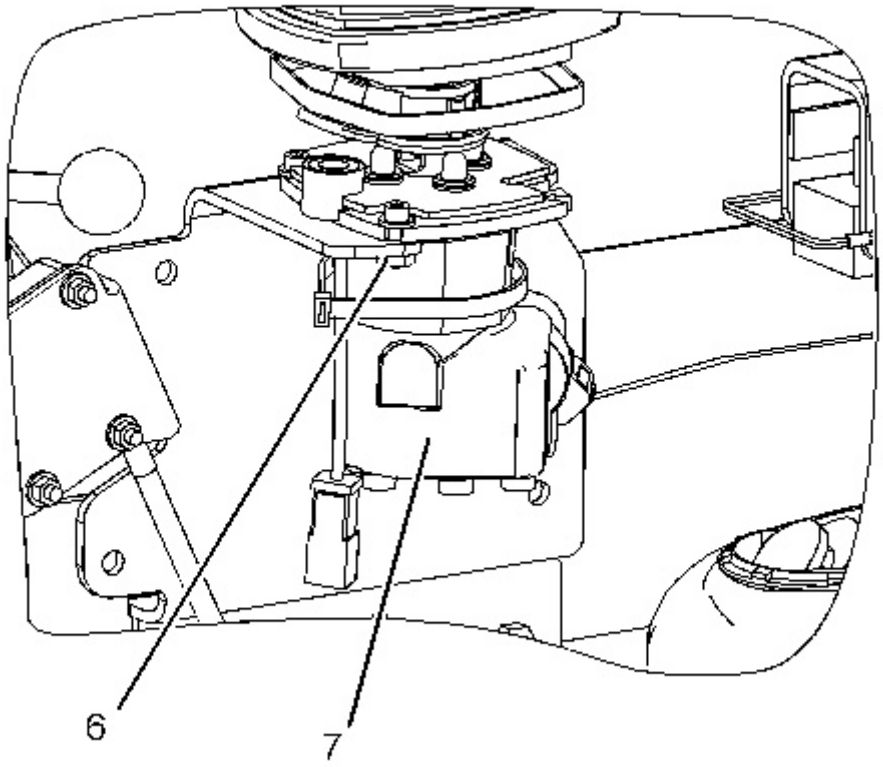


Illustration 1 g01051372

1. Install pilot operated hydraulic control (7). Install bolts (6) .

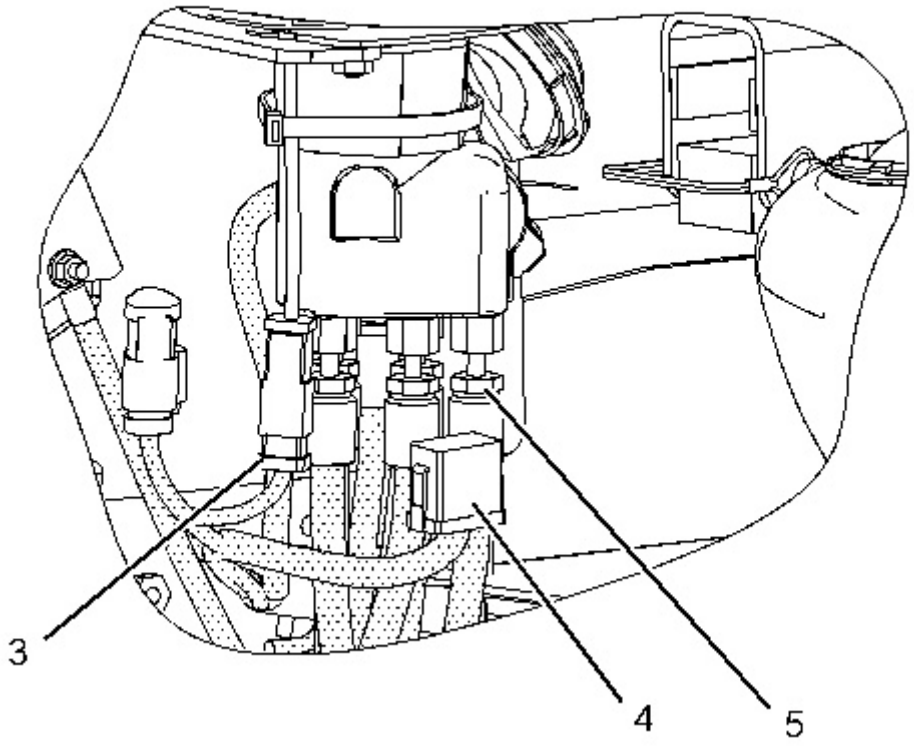


Illustration 2 g01051364

2. Connect harness assemblies (3) and (4). Connect hose assemblies (5) .

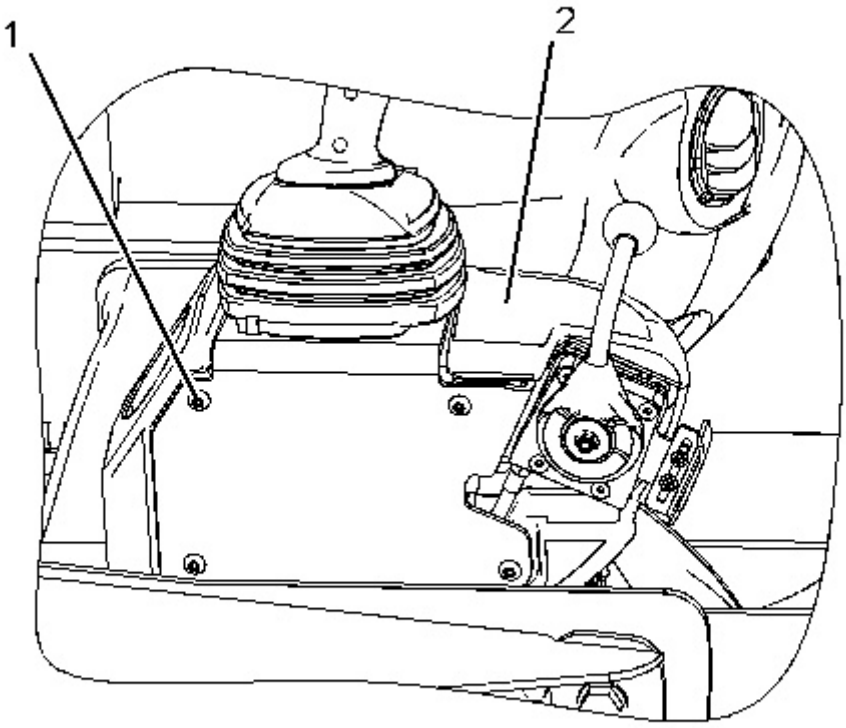


Illustration 3 g01051360

3. Install console (2). Remove screws (1). Tighten the screws (1) to a torque of 2.25 ± .25 N·m (20 ± 2 lb in).

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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i02863376

ROPS Mounting

SMCS - 7266; 7323-MT; 7325-MT

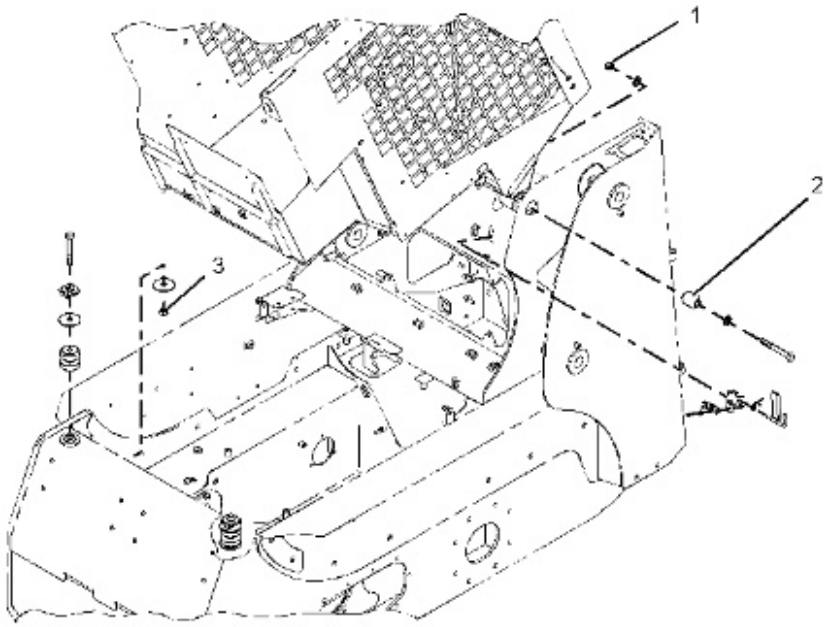


Illustration 1 g01426159

(1) Torque for the two locknuts ... 55 ± 5 N·m (41 ± 4 lb ft)

(2) Apply **5P-3975** Rubber Lubricant to the mount prior to installation.

(3) Torque for the two locknuts ... 125 ± 10 N·m (90 ± 7 lb ft)

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i02863376

ROPS Mounting

SMCS - 7266; 7323-MT; 7325-MT

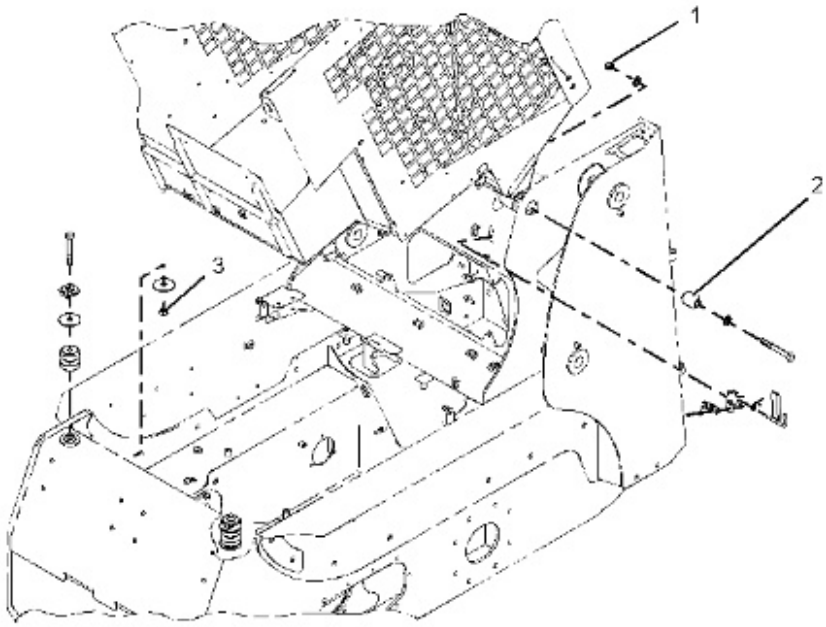


Illustration 1 g01426159

(1) Torque for the two locknuts ... 55 ± 5 N·m (41 ± 4 lb ft)

(2) Apply **5P-3975** Rubber Lubricant to the mount prior to installation.

(3) Torque for the two locknuts ... 125 ± 10 N·m (90 ± 7 lb ft)

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02156067

Seat - Remove and Install

SMCS - 7312-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Start By:

A. Raise the cab upward. Refer to Disassembly and Assembly Manual, "Cab - Tilt".

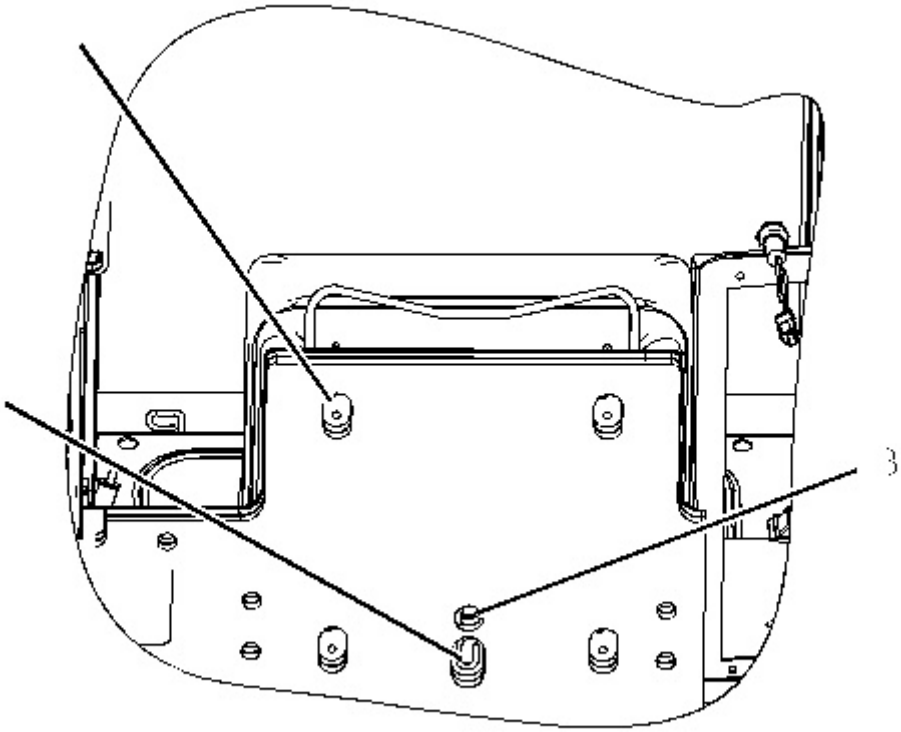


Illustration 1 g01049942

1. Remove nuts (1) .
2. Disconnect harness assembly (2) .
3. Remove grommet (3) .

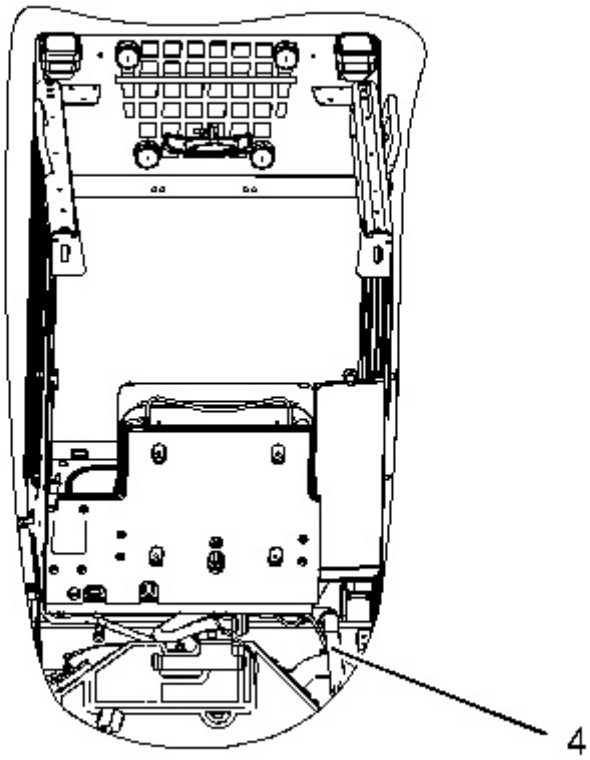


Illustration 2 g01049944

4. Disengage cab support (4) and lower the cab.

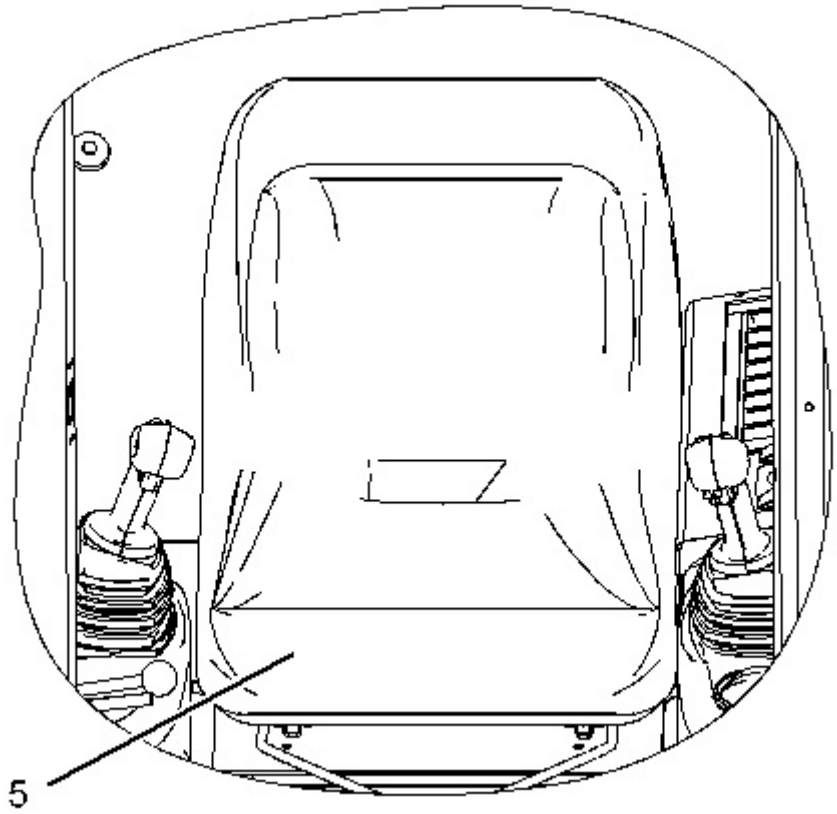


Illustration 3 g01093474

5. Use two people to remove seat (5). The weight of seat (5) is approximately 24 kg (53 lb).

Note: For additional information concerning the seat, refer to Service Manual, SENR6615, "Contour Series Seat".

Installation Procedure

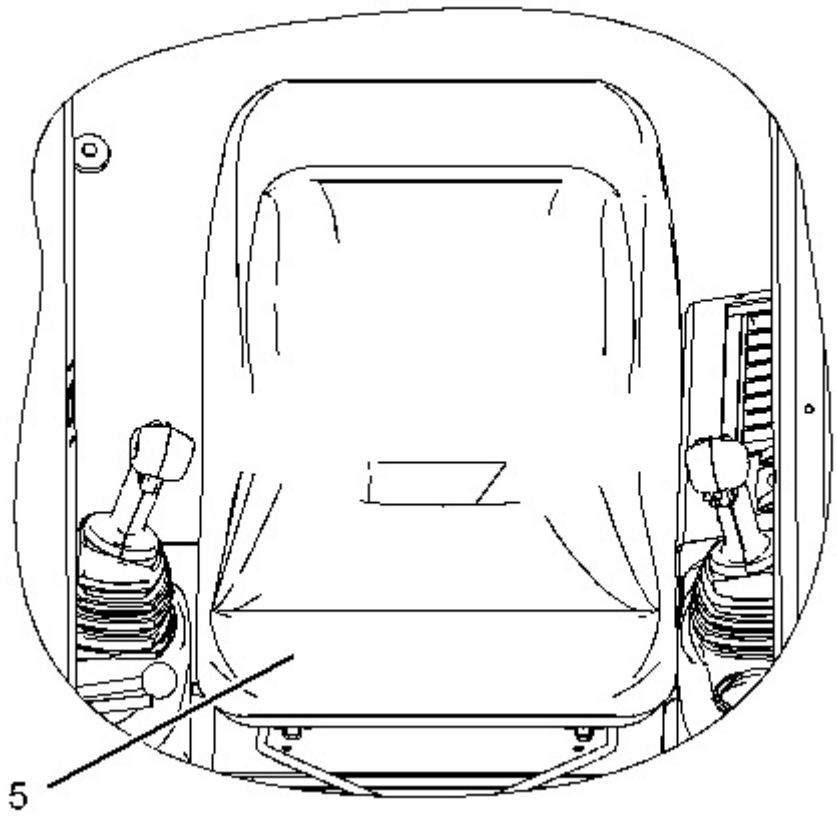


Illustration 4 g01093474

1. Use two people to position seat (5). The weight of seat (5) is approximately 24 kg (53 lb).

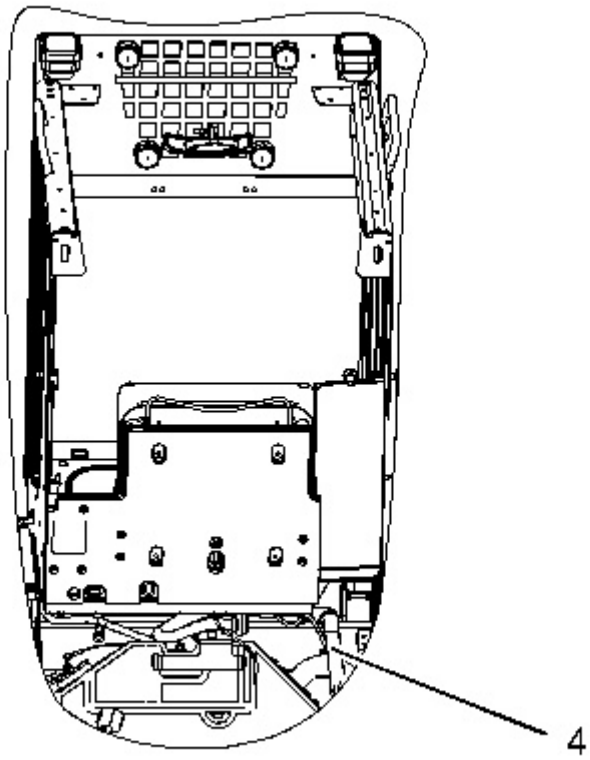


Illustration 5 g01049944

2. Raise the cab and engage cab support (4) .

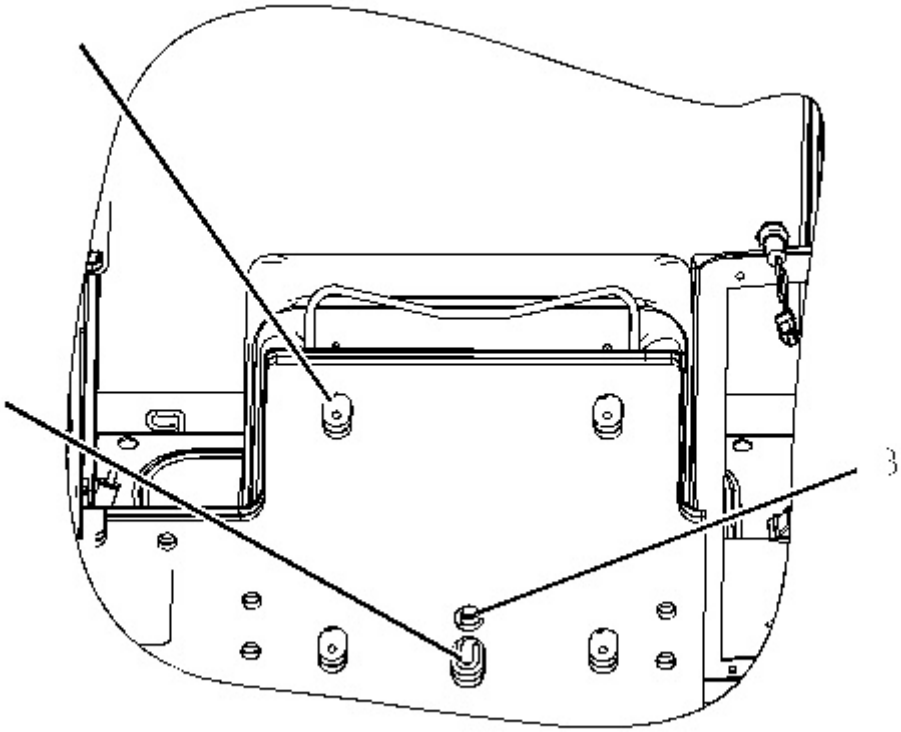


Illustration 6 g01049942

3. Install nuts (1) .
4. Install grommet (3) .
5. Connect harness assembly (2) .

End By: Lower the cab. Refer to Disassembly and Assembly Manual, "Cab - Tilt".

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02934824

Hydrostatic System

SMCS - 4350

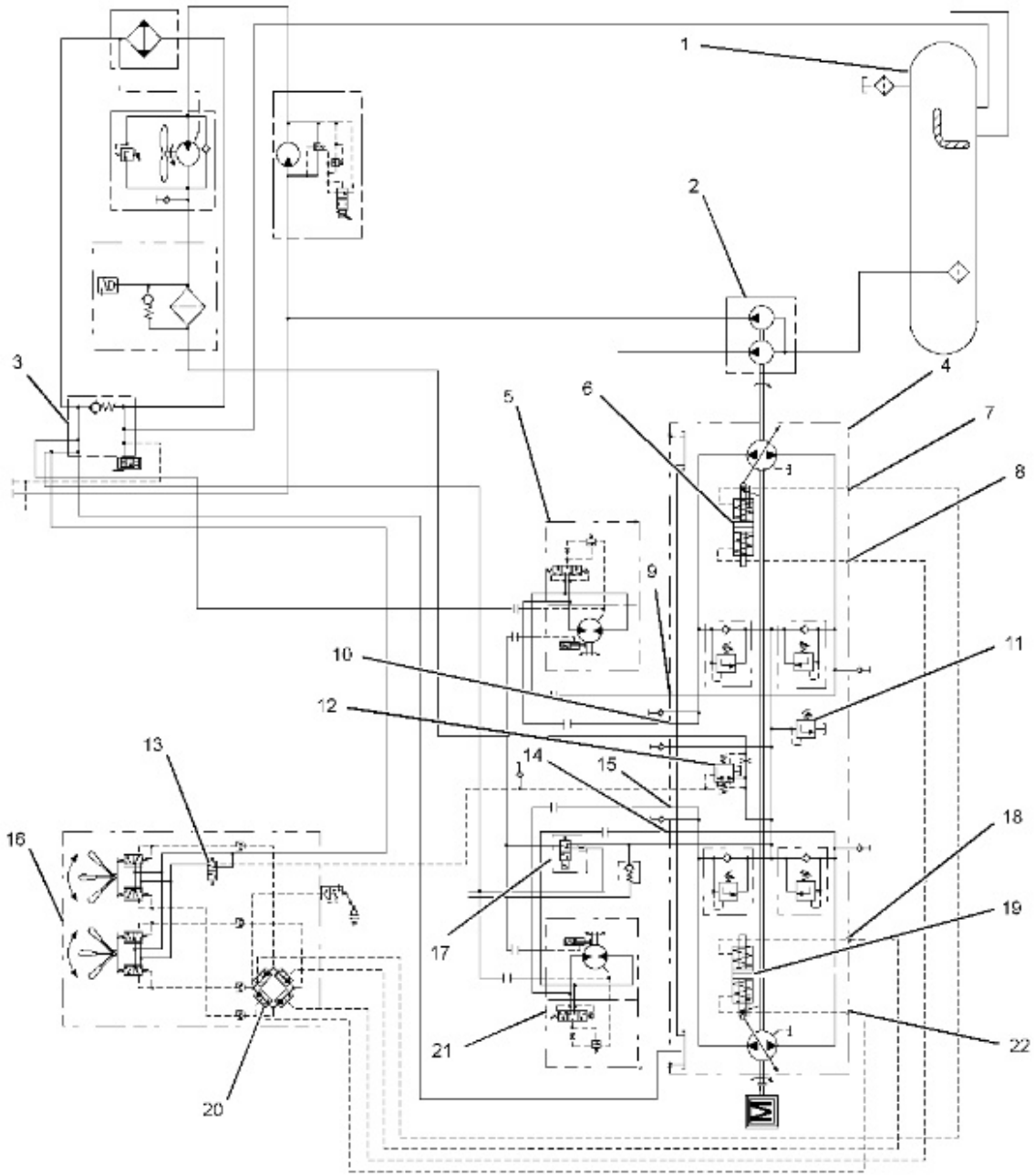


Illustration 1 g01454966

Hydraulic Schematic Single Speed

(1) Hydraulic Tank Group

(2) Gear Pump (charge oil, implement, air conditioner and fan drive)

(3) Return Manifold Group

(4) Piston Pump (hydrostatic system)

(5) Piston Motor Group (hydrostatic right side)

(6) Pump actuator group (hydrostatic right side)

(7) "X3" Pilot pressure port (hydrostatic right side)

(8) "X4" Pilot pressure port (hydrostatic right side)

(9) High pressure port for the "A" loop

(10) High pressure port for the "B" loop

(11) Relief Valve (Charge oil)

(12) Speed Sensing Valve Group

(13) Solenoid Valve Group (hydrostatic system)

(14) High pressure port for the "A" loop

(15) High pressure port for the "B" loop

(16) Pilot Valve (hydrostatic system)

(17) Solenoid Valve and Mounting Group (parking brake)

(18) "X4" Pilot pressure port (hydrostatic left side)

(19) Pump actuator group (hydrostatic left side)

(20) Resolver network

(21) Piston Motor Group (hydrostatic left side)

(22) "X3" Pilot pressure port (hydrostatic left side)

The hydrostatic system is a closed loop. The hydrostatic system is made up of the following main components: Hydraulic Tank Group (1), Gear Pump (charge oil, implement, air conditioner and fan drive) (2), Piston Pump (hydrostatic system) (4), Piston Motor Group (hydrostatic right side) (5) and Piston Motor Group (hydrostatic left side) (21) .

The oil that flows from the Piston Pump (hydrostatic system) to the Piston Motor Groups (hydrostatic system) flows in a continuous loop. The oil then returns to the Piston Pump (hydrostatic system). The hydrostatic system is kept full of oil by the charge system. The forward section of the Gear Pump (charge oil, implement, air conditioner and fan drive) supplies both sections of the Piston Pump (hydrostatic system) with charge oil.

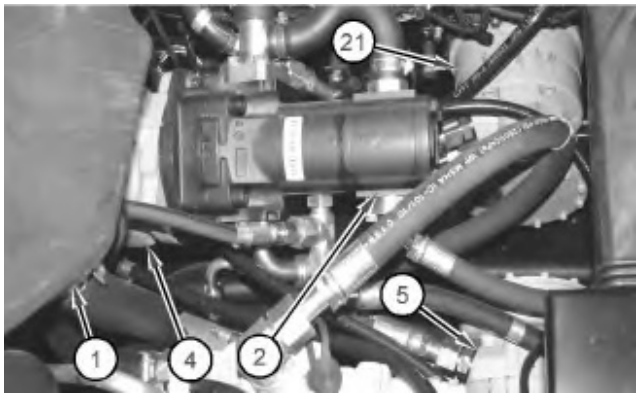


Illustration 2 g01038745

Hydrostatic System Components

(1) Hydraulic Tank Group

(2) Gear Pump (charge oil, implement, air conditioner and fan drive)

(4) Piston Pump (hydrostatic system)

(5) Piston Motor Group (hydrostatic right side)

(21) Piston Motor Group (hydrostatic left side)

Pilot oil flows from the Pilot Valve (hydrostatic system) (16) to the pilot pressure ports (7), (8), (18), and (22) that are on the Piston Pump (hydrostatic system). The pilot oil causes the pump actuator groups (6) and (19) in the Piston Pump (hydrostatic system) to move the swashplates. This causes the Piston Pump (hydrostatic system) to pump oil to the Piston Motor Groups (5) and (21) .

When the Piston Pump (hydrostatic system) is in the NEUTRAL position only charge pressure will flow out of "A" loop port (9) and "B" loop port (10) .

In the NEUTRAL position, no high pressure oil flow is provided to the piston motors. The hydrostatic system oil pressure will be equal to the charge oil pressure.

If the travel control lever is pushed to the FORWARD position, the Pilot Valve (hydrostatic system) (16) opens a path for the oil to flow to the pump actuator group (hydrostatic right side) (6) and the pump actuator group (hydrostatic left side) (19). The oil that flows into the "X 4" pilot pressure port (hydrostatic right side) (8) causes the actuator piston (6) to shift upward. The pilot oil also flows into the "X 4" pilot pressure port (hydrostatic left side) (18). The pilot oil that flows into the "X 4" pilot pressure port (hydrostatic left side) (18) causes the actuator piston (19) to shift downward. The movement of the actuators causes the swashplates to move. Movement of the swashplate will cause piston pump (4) to upstroke. The flow of the oil out of the "B" ports (10) and (15) that are in the Piston Pump (hydrostatic system) (4) increases. Refer to the Systems Operation, RENR4866, "Pilot Hydraulic System" for additional information about the pilot valve. Refer to Systems Operation, RENR4866, "Piston Pump (Hydrostatic System)" for additional information about the piston pump.

The oil that flows out of "B" ports (10) and (15) causes Piston Motor Groups (5) and (21) to rotate. The shafts of the Piston Motor Groups will turn at a rate that is determined by the amount of oil that is flowing to the Piston Motor Groups. If the travel control lever is moved further into the FORWARD position, the swashplates will move further. This causes the Piston Pump to pump oil to the Piston Motor Groups at a greater flow rate. If the flow rate is greater, the shafts of the motors will turn faster. Refer to Systems Operation, RENR4866, "Piston Motor Group" for additional information.

The oil that is flowing from the Piston Motor Groups is at a lower pressure. The lower pressure oil returns to the Piston Pump (hydrostatic system) through high pressure ports for the "A" loops (9) and (14). Any oil that is lost from the "A" or "B" loops is replaced by charge oil.

Reference

Two Speed Function

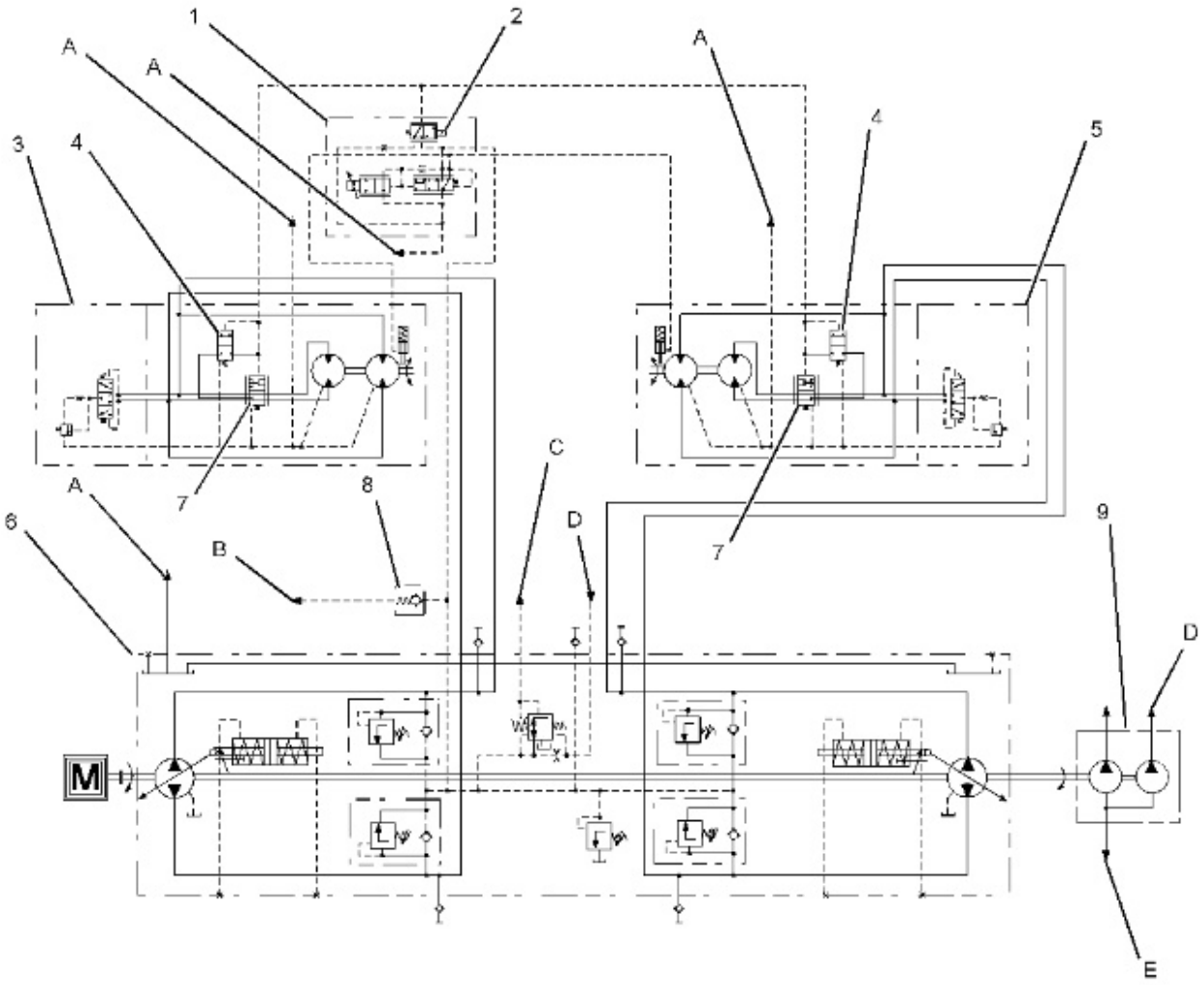


Illustration 3 g01454989

Hydraulic Schematic for the Two Speed

(1) Solenoid Valve and Mounting Group (parking brake)

(2) Solenoid Valve Group (two speed control)

(3) Piston Motor Group (hydrostatic left side)

(4) Control valve (charge oil)

(5) Piston Motor Group (hydrostatic right side)

(6) Piston Pump (hydrostatic system)

(7) Speed selector valve

(8) Check valve

(9) Gear Pump (charge oil, implement, air conditioner and fan drive)

(A) Line to the Return Manifold Group

(B) Line to the Control Valve (work tool)

(C) Pilot oil line from the Speed Sensing Valve Group

(D) Charge oil line from the Gear Pump (charge oil, implement, air conditioner and fan drive)

(E) Line to the Hydraulic Tank Group

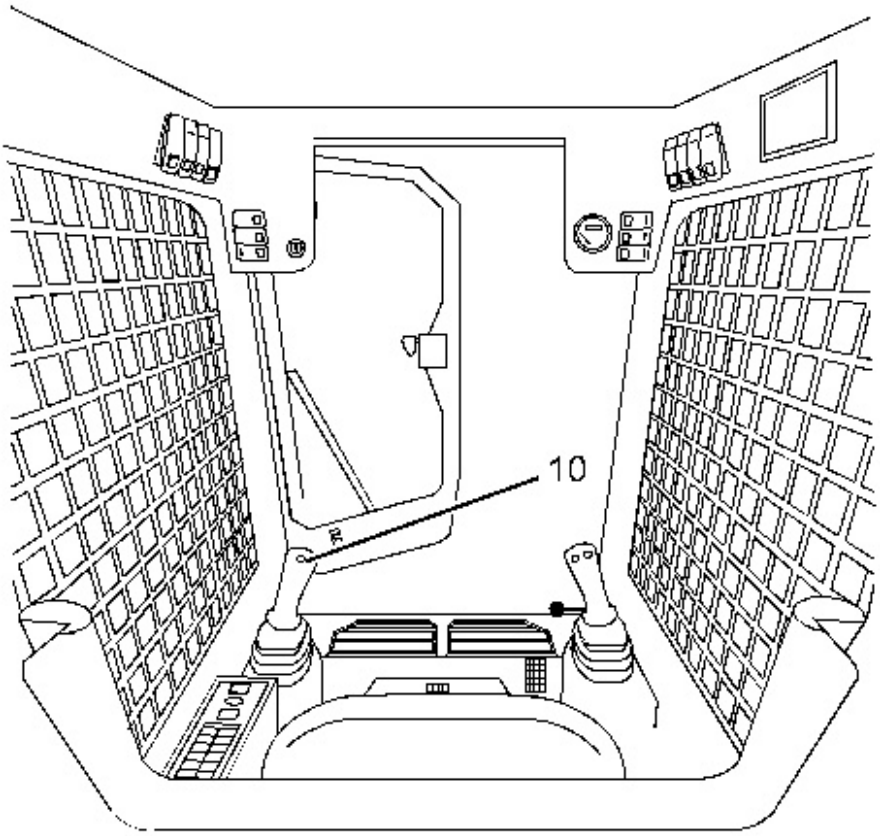


Illustration 4 g01454999

Travel control lever

(10) Travel control lever

If the machine is equipped with two speed capability, the machine can be switched to rabbit mode. A control switch is mounted on the travel control lever (10) which activates the two speed function.

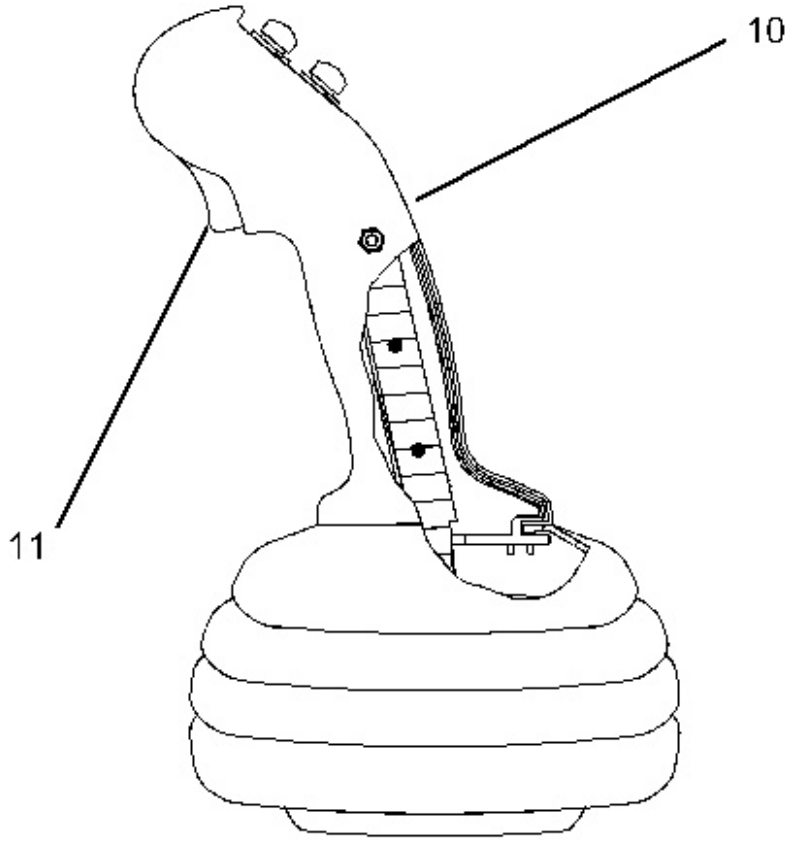


Illustration 5 g01039914

Two speed control switch

(10) Travel control lever

(11) Two speed control switch

The two speed control switch (11) is a toggle switch. Press the button once in order to activate the rabbit mode. Press the switch again in order to deactivate the rabbit mode and return to the normal mode. When the machine is in normal mode, the hydrostatic system functions in the same manner as the machines that are equipped with the standard piston motors. Refer to the Operation and Maintenance Manual, SEBU7731, "Operator Controls (Joystick Controls)" for additional information.

When the operator presses the two speed control switch (11) in order to activate the rabbit mode, the switch sends an electrical signal to the Solenoid Valve Group (two speed control) (2). Since the solenoid in the Solenoid Valve Group (two speed control) is now energized the spool that is part of the Solenoid Valve Group (two speed control) shifts to the left. When the spool is shifted to the left the spool will allow charge oil to flow to the speed selector valve (7) that is a part of Piston Motor

Group (hydrostatic left side) (3) and the speed selector valve (7) that is a part of Piston Motor Group (hydrostatic right side) (5) .

The charge oil pressure is greater than the force of the spring that is positioning the speed selector valves. The charge oil pressure forces the selector valves to shift downward.

When the speed selector valves are shifted downward, the speed selector valves will block the flow of high pressure oil to half of the pistons in the motors. These pistons will then freewheel as the motor shaft spins. Since only half of the pistons receive flow, oil can fill the cylinders for the pistons faster. This causes the motor shaft to rotate faster. The output torque of the motor will decrease with the increase in speed.

The charge oil pressure also overcomes the force of the spring that is a part of each of the control valves (charge oil) (4). The charge oil pressure causes each of the control valves (charge oil) that are a part of each piston motor to shift downward. This allows a constant flow of charge oil to the motor which will keep the pistons in the motor that are freewheeling seated against the cam ring. This keeps the pistons from sliding while the motor is operating at a higher speed. Refer to the Systems Operation, RENR4866, "Piston Motor Group (Hydrostatic system)" for additional information.

When the machine is first started, the machine is automatically reset to the normal mode.

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02935162

Piston Pump (Hydrostatic)

SMCS - 5070

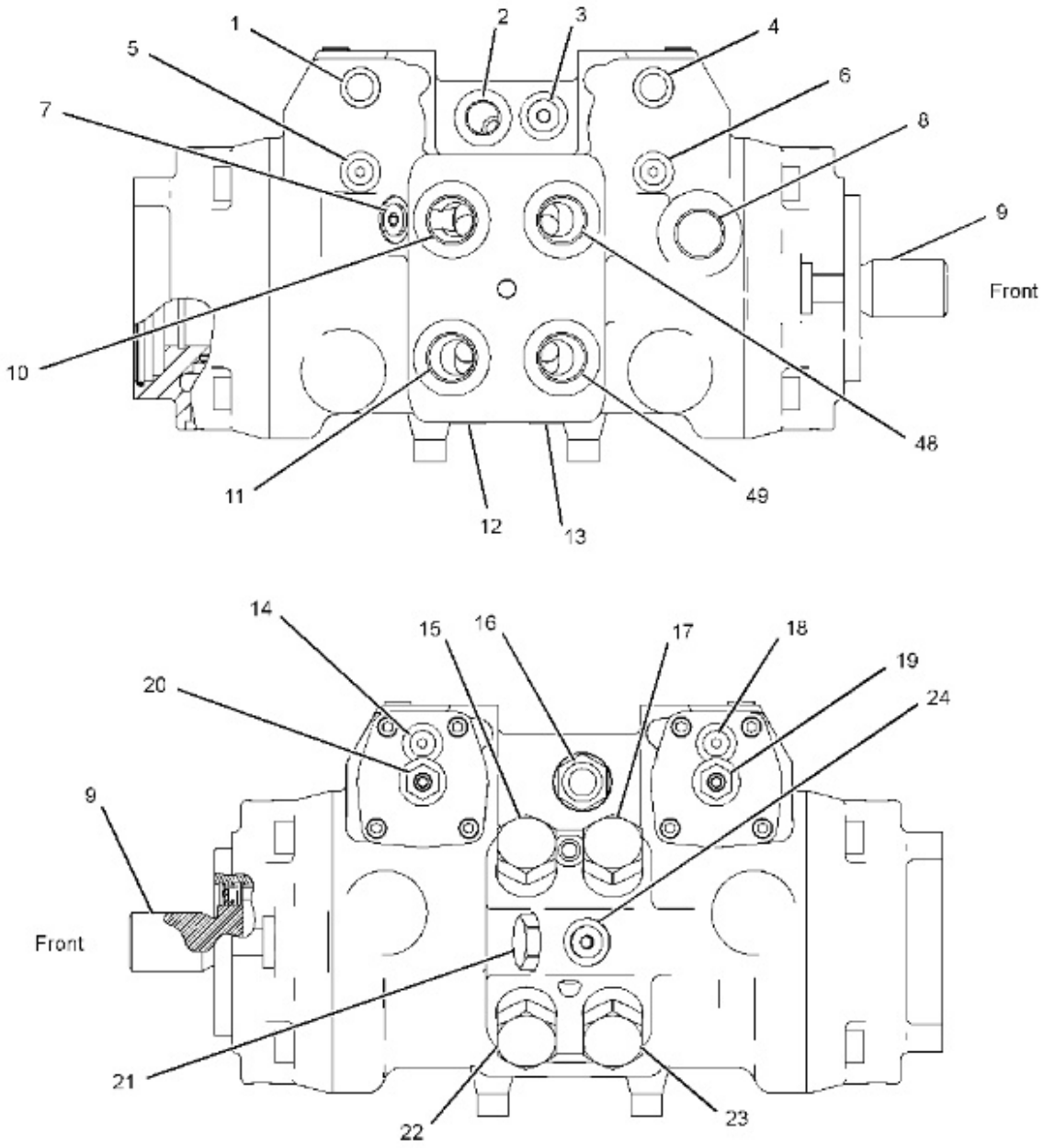


Illustration 1 g01455755

Piston Pump (hydrostatic system)

(1) Adjustment for the maximum displacement (rear pump section)

(2) Inlet port for the charge oil

(3) Gauge port for the "B" loop (front pump section)

(4) Adjustment for the maximum displacement (front pump section)

(5) "X 3" Pilot pressure port

(6) "X 3" Pilot pressure port

(7) Gauge port for the "B" loop (rear pump section)

(8) Port for the case drain

(9) Input shaft

(10) Port for the high pressure oil for the "B" loop to Port A on the right drive motor

(11) Port for the high pressure oil for the "A" loop to Port B on the right drive motor

(12) Gauge port for the "A" loop (rear pump section)

(13) Gauge port for the "A" loop (front pump section)

(14) "X 4" Pilot pressure port

(15) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (front pump section)

(16) Speed Sensing Valve Group

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(18) "X 4" Pilot pressure port

(19) Mechanical adjustment for the pump null (rear pump section)

(20) Mechanical adjustment for the pump null (front pump section)

(21) Relief Valve (Charge oil)

(22) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (front pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

(24) Gauge port for the charge oil

(48) Port for the high pressure oil for the "B" loop to Port B on the left drive motor

(49) Port for the high pressure oil for the "A" loop to Port A on the left drive motor

The Piston Pump (hydrostatic system) operates in a closed loop system. The standard single speed Piston Pump (hydrostatic system) is a variable displacement piston pump. The pump is driven from the engine flywheel by a coupling that is splined to the input shaft (9) .

The Piston Pump (hydrostatic system) consists of two separate pumps. The two pumps are contained in one housing. The following main components are located on the outside of the Piston Pump (hydrostatic system): Input shaft (9), Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (front pump section) (15), Speed Sensing Valve Group (16), Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section) (17), Relief Valve (Charge oil) (21), Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (front pump section) (22) and Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section) (23) .

The pilot pressure ports (5), (6), (14) and (18) are connected to the Pilot Valve (hydrostatic system). Gauge ports (3), (7), (12) and (13) are equipped with pressure taps in order to test the oil pressure in the "A" and "B" high pressure loops. Gauge port (24) is equipped with a pressure tap in order to test the oil pressure in the charge oil circuit.

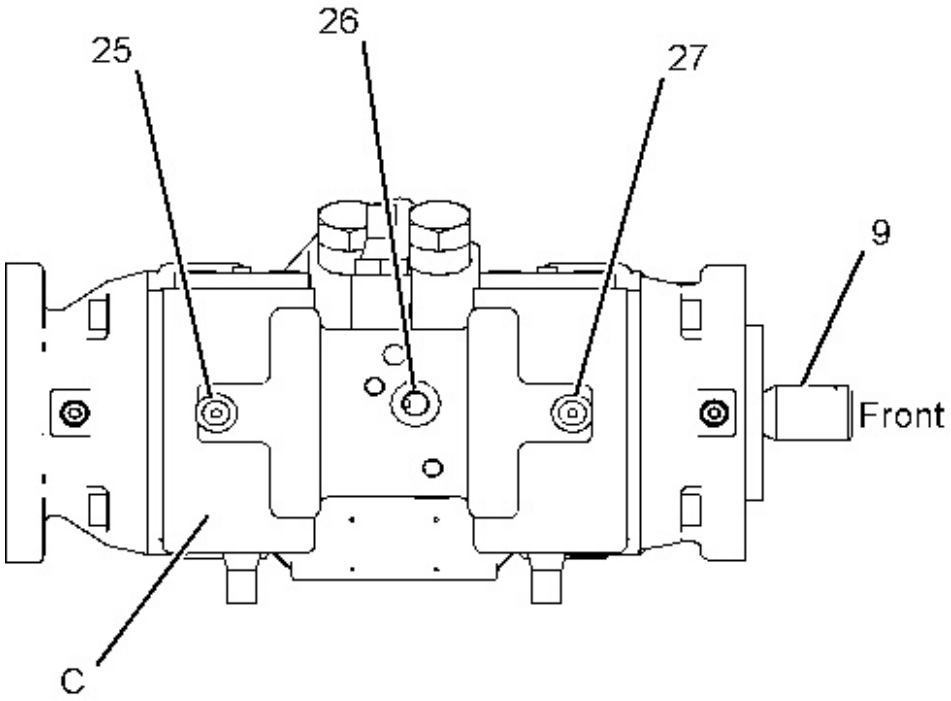


Illustration 2 g01455768

Piston Pump (hydrostatic system)

(9) Input shaft

(25) Port for testing case drain pressure (rear pump section)

(26) Port for testing the speed sensing pressure

(27) Port for testing case drain pressure (front pump section)

(C) Top side of the Piston Pump (hydrostatic system)

Test the oil pressure in the Speed Sensing Valve Group oil circuit at location (26). Test the oil pressure for the rear pump case drain at location (25). Test the oil pressure for the front pump case drain at location (27).

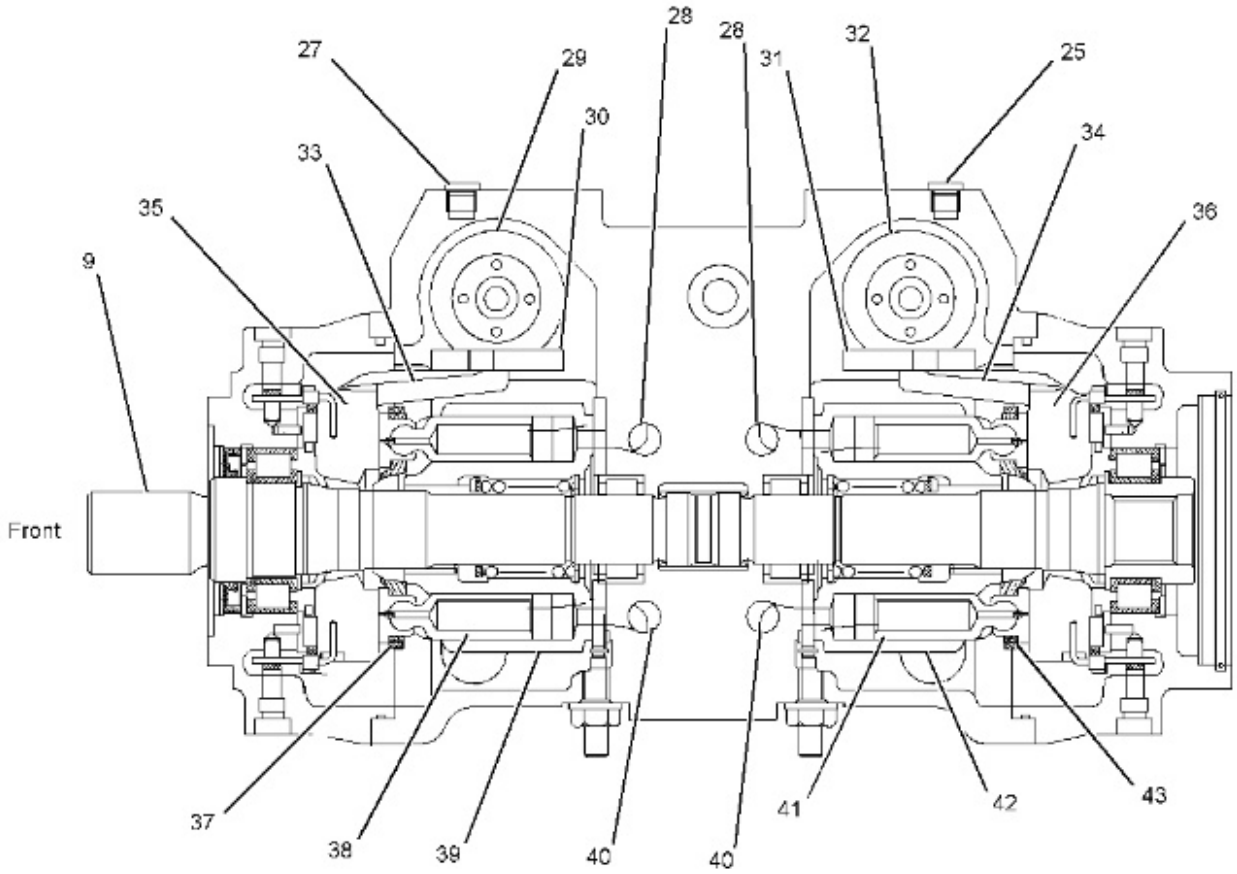


Illustration 3 g01455769

Cutaway of the Piston Pump (hydrostatic system)

(9) Input shaft

(25) Port for testing case drain pressure (rear pump section)

(27) Port for testing case drain pressure (front pump section)

(28) Passages to ports "B"

(29) Actuator group (front pump section)

(30) Slider (front pump section)

(31) Slider (rear pump section)

(32) Actuator group (rear pump section)

(33) Control arm for the swashplate (front pump section)

(34) Control arm for the swashplate (rear pump section)

(35) Swashplate (front pump section)

(36) Swashplate (rear pump section)

(37) Retraction plate (front pump section)

(38) Piston (front pump section)

(39) Rotating group (front pump section)

(40) Passages to ports "A"

(41) Piston (rear pump section)

(42) Rotating group (rear pump section)

(43) Retraction plate (rear pump section)

The following main components of the Piston Pump (hydrostatic system) are located internally: two actuator groups (29) and (32), input shaft (9) and two rotating groups (39) and (42). Each rotating group consists of the following components: swashplates (35) or (36), control arms for the swashplates (33) or (34), pistons (38) or (41), retraction plates (37) or (43) and one cylinder barrel in each rotating group.

The pilot pressure ports (5), (6), (14) and (18) are used to control the angle of the swashplates (35) and (36). The angle of the swashplates combine with the engine rpm in order to control the output from each of the pump sections. The pilot oil that flows to the pilot pressure ports first flows through the resolver network that is a part of the Pilot Valve (hydrostatic system). Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

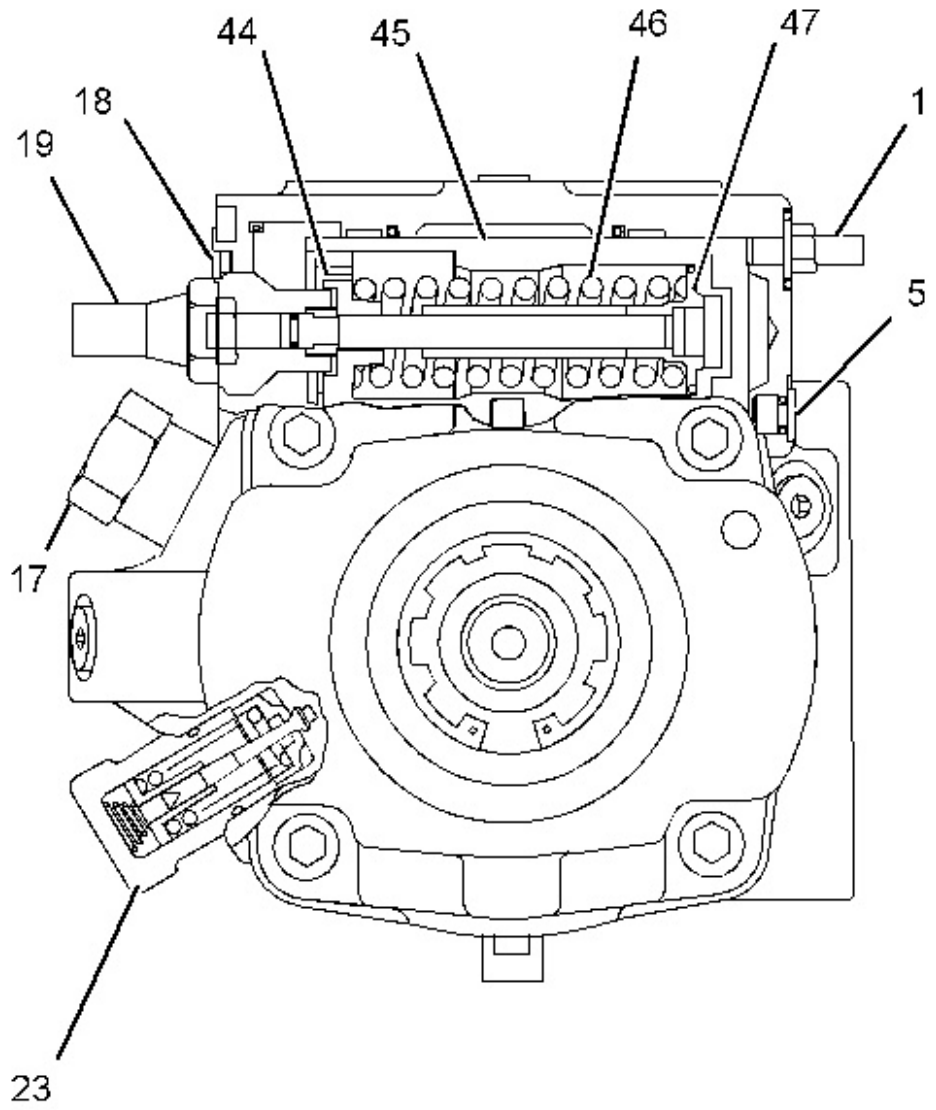


Illustration 4 g01455775

Actuator group (front pump section)

(1) Adjustment for the maximum displacement (rear pump section)

(5) "X 3" Pilot pressure port (hydrostatic right side)

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(18) "X 4" Pilot pressure port (hydrostatic right side)

(19) Mechanical adjustment for the pump null (rear pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

(44) Spring collar

(45) Actuator piston

(46) Spring

(47) Spring collar

The input shaft (9) for the rotating groups (39) and (42) consists of two shafts that are splined together between the two rotating groups. Swashplates (35) and (36) can operate independently. The rotating group (front pump section) (39) supplies high pressure oil to the Piston Motor Group (hydrostatic left side). The rotating group (rear pump section) (42) supplies high pressure oil to the Piston Motor Group (hydrostatic right side). For the following example of the operation of the pump, the rotating group (rear pump section) (42) will be used. The rotating group (front pump section) (39) will operate in the same manner.

When the operator moves the travel control lever to the FORWARD position, pilot oil flows out of the Pilot Valve (hydrostatic system) and into "X 4" Pilot pressure port (hydrostatic right side) (18). The pressure of the pilot oil that is flowing into pilot pressure port (18) causes the actuator piston (45) to overcome the force of spring (46). When the actuator piston overcomes the force of the spring, the piston moves to the right.

The movement of the piston to the right causes the slider (rear pump section) (31) to move the control arm for the swashplate (rear pump section) (34). The movement of the control arm increases the angle of the swashplate (rear pump section) (36). Half of the pistons in the cylinder barrel pull oil into the rotating group as the pistons rotate around the swashplate. The oil enters the Piston Pump (hydrostatic system) through ports "A". The oil flows into the rotating groups through passages to ports "A" (40). The other half of the pistons push oil out of the rotating group as the pistons rotate around the swashplate. The oil exits the rotating group through passages to ports "B" (28). As the angle of the swashplate increases, the output of the oil also increases.

When the operator moves the travel control lever to the BACKWARD position, pilot oil flows out of the Pilot Valve (hydrostatic system) and into "X 3" Pilot pressure port (hydrostatic right side) (5). The pressure of the pilot oil that is flowing into pilot pressure port (5) causes the actuator piston (45) to overcome the force of spring (46). When the actuator piston overcomes the force of the spring, the piston moves to the left.

The movement of the piston to the left causes the slider (rear pump section) (31) to move the control arm for the swashplate (rear pump section) (34). The movement of the control arm increases the angle of the swashplate (rear pump section) (36). Half of the pistons in the cylinder barrel pull oil into the rotating group as the pistons rotate around the swashplate. The oil enters the Piston Pump (hydrostatic system) through ports "B". The oil flows into the rotating groups through passages to ports "B" (28). The other half of the pistons push oil out of the rotating group as the pistons rotate

around the swashplate. The oil exits the rotating group through passages to ports "A" (40). As the angle of the swashplate increases, the output of the oil also increases.

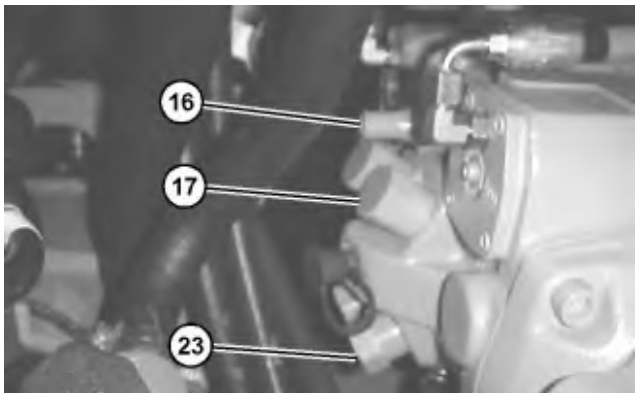


Illustration 5 g01041089

(16) Speed Sensing Valve Group

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

The Speed Sensing Valve Group (16) senses the change in the flow of oil from the Gear Pump (charge oil, implement, air conditioner, and fan drive) as the engine speed changes. An orifice in the Speed Sensing Valve Group creates a pressure differential within the valve. The valve uses the pressure differential to route more flow or less flow to the Pilot Valve (hydrostatic system) in order to control the Piston Pump (hydrostatic system). An increase in the pressure differential will cause more oil to flow to the Pilot Valve (hydrostatic system). The Pilot Valve (hydrostatic system) uses this oil to control the swashplates in the Piston Pump (hydrostatic system).

The Pilot Valve (hydrostatic system) will not function unless the interlock system is energized. The Solenoid Valve Group (hydrostatic system), that is a part of the Pilot Valve (hydrostatic system), must be energized in order for the pilot oil to flow. The Solenoid Valve Group (hydrostatic system) must be energized in order for the Pilot Valve (hydrostatic system) to be functional. Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

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Piston Motor (Hydrostatic)

SMCS - 5058

Piston Motor Group (Hydrostatic System)

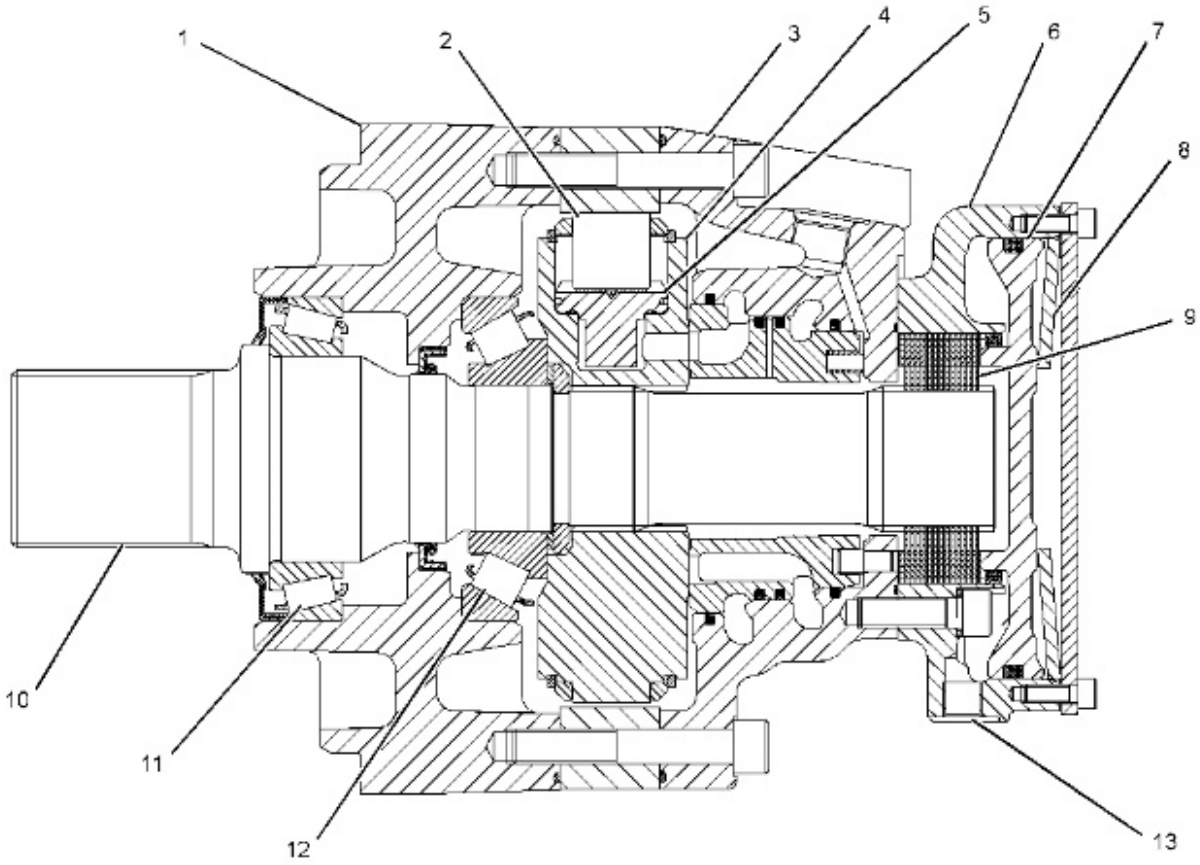


Illustration 1 g01455785

Piston Motor Group (hydrostatic system)

(1) Shaft housing

(2) Roller

(3) Rotor housing

(4) Rotor

(5) Piston assembly

(6) Brake housing

(7) Brake piston

(8) Belleville washer

(9) Brake disc pack

(10) Shaft

(11) Roller bearing

(12) Roller bearing

(13) Port for the brake release

The Piston Motor Group (hydrostatic system) is of a radial piston type. The Piston Motor Group (hydrostatic system) that is standard equipment for the machine is a motor that is single speed. The Piston Motor Group (hydrostatic system) consists of three sections. These sections are the shaft housing (1), the rotor housing (3) and the brake housing (6). Rotor (4) is connected to shaft (10) by splines. Brake disc pack (9) is engaged by brake piston (7) and belleville washer (8) when there is no hydraulic oil pressure. When there is hydraulic oil pressure, the oil pressure forces brake piston (7) against belleville washer (8). This allows brake disc pack (9) to disengage.

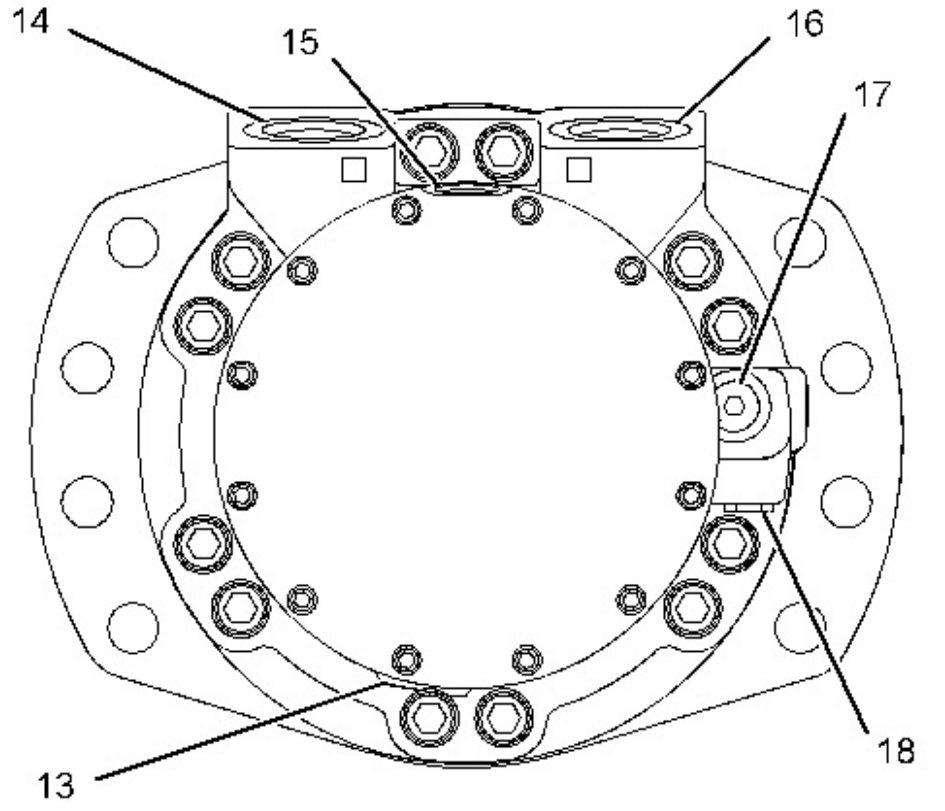


Illustration 2 g01455789

(13) Port for the brake release

(14) Port for the "A" or "B" high pressure loop

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(17) Flushing valve

(18) Regulator valve

The hydraulic oil that flows from the Piston Pump (hydrostatic system) flows into ports (14) and (16). One port will receive the high pressure oil and the other port will be the low pressure oil that is in the return loop. The port that receives the high pressure oil is determined by the desired direction of travel of the machine and the rotation of the motor. The direction of rotation is different for each motor. The motor that is on the right side of the machine will rotate in the opposite direction as the motor that is on the left side. For the following example of the operation of the motor, port (16) is considered to be the high pressure port.

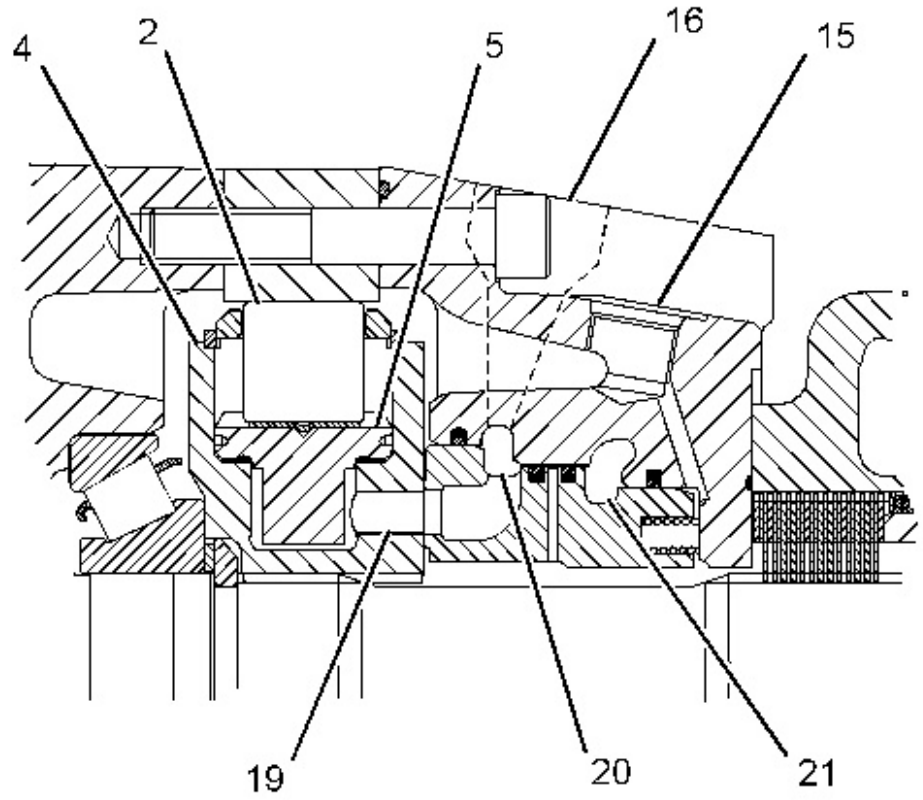


Illustration 3 g01455793

(2) Roller

(4) Rotor

(5) Piston assembly

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(19) Exposed port

(20) Annular passages for port (16)

(21) Annular passages for port (14)

The high pressure hydraulic oil flows through the port (16) and into the annular passage (20). The hydraulic oil then flows through the exposed ports (19). The exposed ports are part of the rotor (4). The hydraulic oil flows through the exposed ports into the cavity that is below the piston assemblies (5).

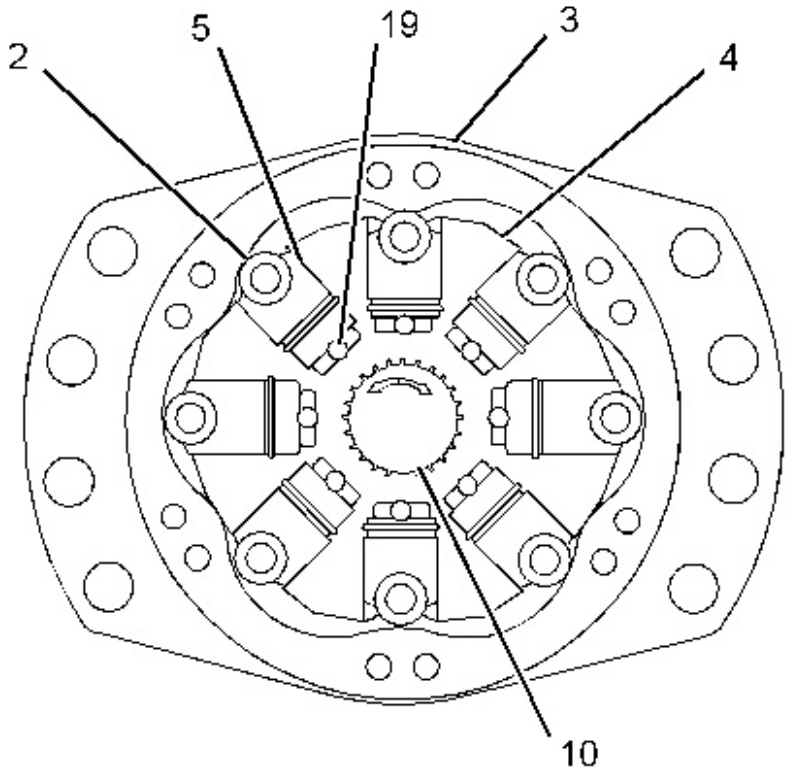


Illustration 4 g01455796

(2) Roller

(3) Rotor housing

(4) Rotor

(5) Piston assembly

(10) Shaft

(19) Exposed port

As the oil pressure in the cavity increases, the piston assembly (5) is forced outward. As the piston assembly is forced outward, the piston rollers (2) roll on the inner diameter of the rotor housing (3). The inner diameter of the rotor housing (3) has a wavy shape. As the piston rollers move along the inner diameter of the rotor housing, the piston rollers follow the wavy inner diameter which causes the rotor to turn.

Because the rotor is connected to the shaft (10) by splines, the rotor turns the shaft. As the rotor turns, the previously exposed ports (19) are covered and the previously covered ports are exposed. The fully extended piston assembly next passes over an exposed port.

As the piston rollers follow the inner diameter of the rotor housing, the rollers force the piston assembly toward the shaft (10). The hydraulic oil that is in the cavity is forced through the exposed port by the inward motion of the piston assembly. The hydraulic oil then returns to an annular passage (21). The oil then flows out of the port (14). This oil is the low pressure loop.

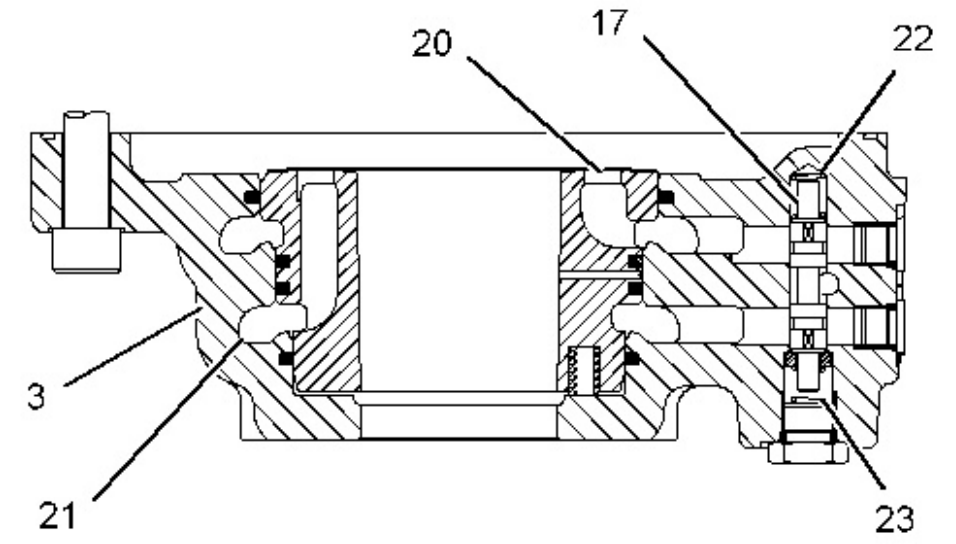


Illustration 5 g01455799

(3) Rotor housing

(17) Flushing valve

(20) Annular passages for port (13)

(21) Annular passages for port (15)

(22) Spring

(23) Spring

The port (15) provides a case drain for the oil that leaks past the piston assemblies and from the flushing valve (17). The flushing valve is a shuttle valve that provides a means for the oil for the hydrostatic loop to flow to the hydraulic oil cooler in order to cool the motor. The flushing valve also provides a means to flush harmful particles from the motor.

The oil that flows through the flushing valve flows from the low pressure side of the drive loop. When the oil pressure in the annular passage (20) increases, the oil pressure acts against the spool for flushing valve (17). The oil pressure overcomes the force of the spring (23). The oil pressure forces the spool to shift downward. When the spool shifts downward the spool opens a path to the Return Manifold Group for the oil that is in annular passage (21).

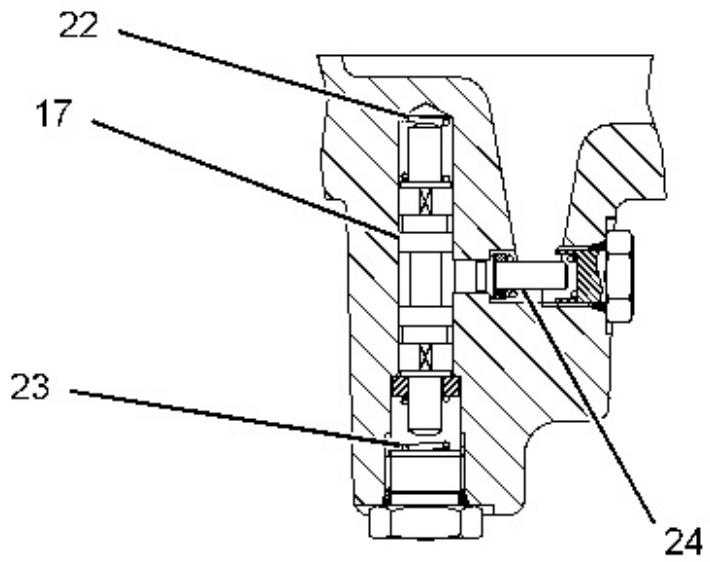


Illustration 6 g01455810

(17) Flushing valve

(22) Spring

(23) Spring

(24) Regulator valve

The oil from the annular passage (21) flows past the spool (17) to the regulator valve (24). The pressure of the oil from the annular passage (21) forces the regulator valve (24) to open.

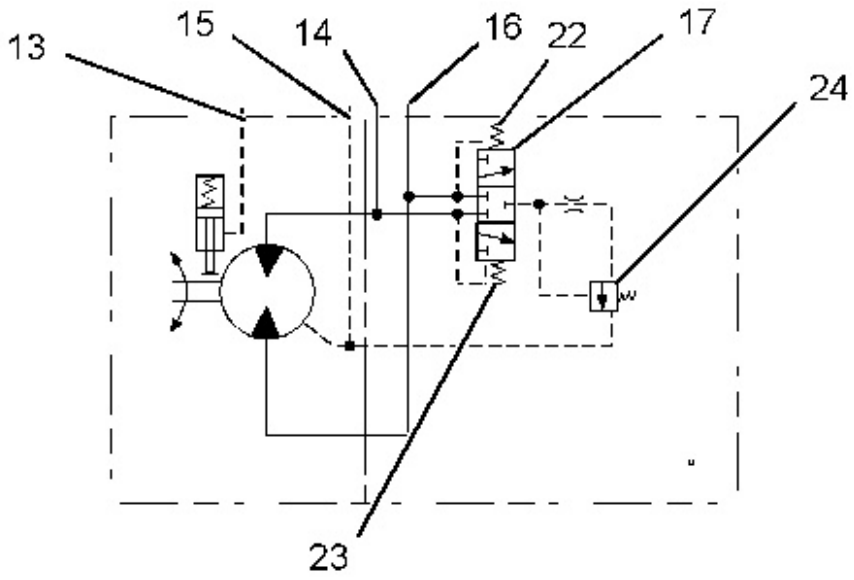


Illustration 7 g01455816

(13) Port for the brake release

(14) Port for the "A" or "B" high pressure loop

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(17) Flushing valve

(22) Spring

(23) Spring

(24) Regulator valve

The oil flows past the regulator valve (24) and out of port (14). The oil then flows to the Return Manifold Group. The oil then flows through the oil cooler. Then, the oil returns to the hydraulic oil tank.

If the oil pressure in the annular passage (14) increases, the oil pressure acts against the spool for flushing valve (17). The oil pressure overcomes the force of the spring (22). The oil pressure forces the spool (17) to shift upward. When the spool shifts upward, the spool opens a path to the Return Manifold Group for the oil that is in annular passage (20) .

The oil from the annular passage (20) flows past the spool (17) to the regulator valve (24). The pressure of the oil from the annular passage (20) forces the regulator valve (24) to open.

The oil flows past the regulator valve (24) and out of the port (16). The oil then flows to the Return Manifold Group. The oil then flows through the oil cooler. Then, the oil returns to the hydraulic oil tank.

Piston Motor Group (Two Speed)

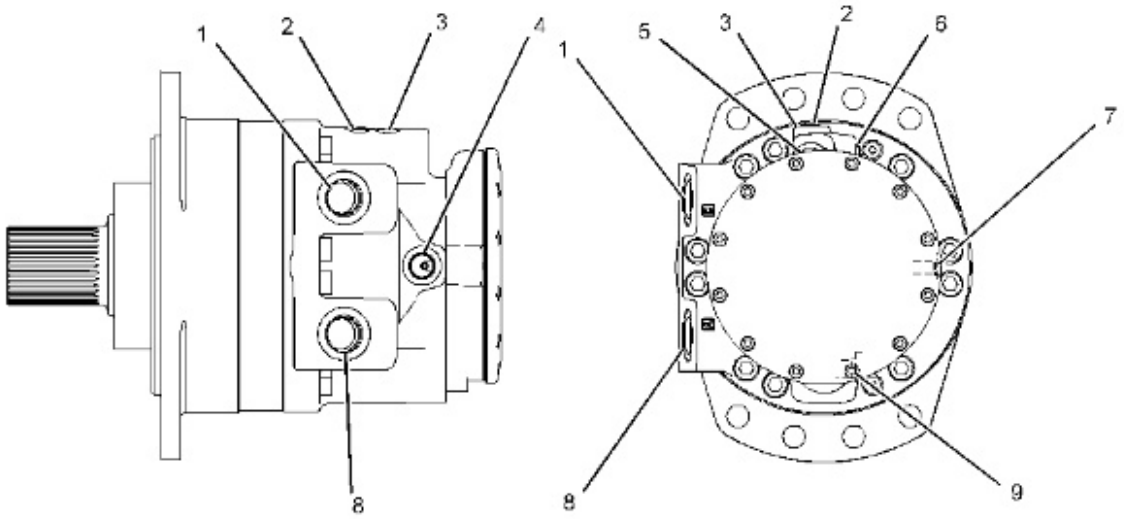


Illustration 8 g01455828

(1) Port for the "A" or "B" high pressure loop

(2) Control valve (charge oil)

(3) Speed selector valve

(4) Port for the motor case drain

(5) Flushing valve

(6) Regulator valve

(7) Port for the brake release

(8) Port for the "A" or "B" high pressure loop

(9) Port for the two speed control

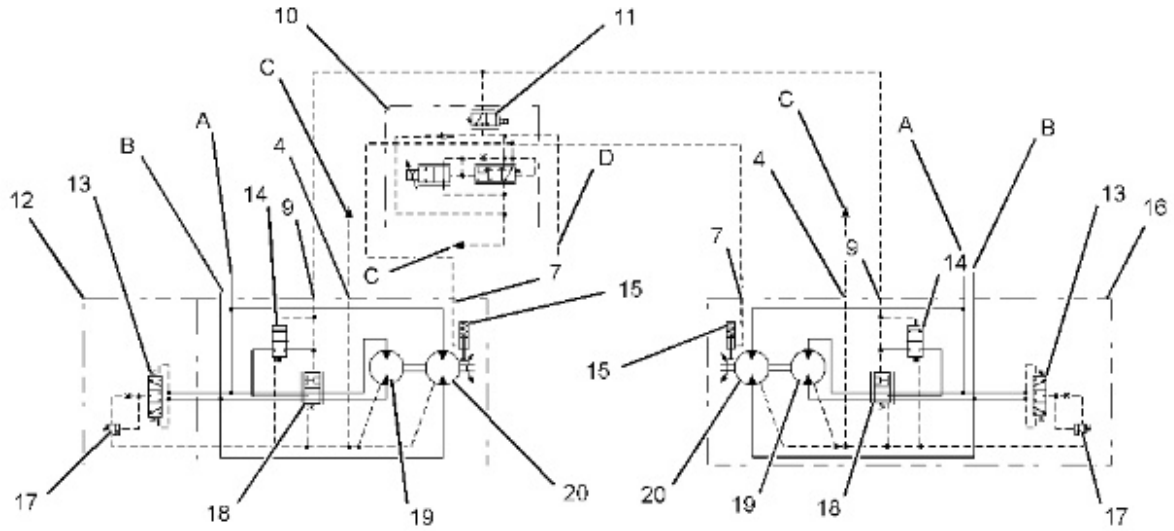


Illustration 9 g01455838

Hydraulic Schematic for the Two Speed

(4) Port for the motor case drain

(7) Port for the brake release

(9) Port for the two speed control

(10) Solenoid Valve and Mounting Group (parking brake)

(11) Solenoid Valve Group (two speed control)

(12) Piston Motor Group (hydrostatic left side)

(13) Flushing valve

(14) Control valve (charge oil)

(15) Parking brake

(16) Piston Motor Group (hydrostatic right side)

(17) Regulator valve

(18) Speed selector valve

(19) Cylinders in the motor that do not receive oil

(20) Cylinders in the motor that receive oil

(A) High pressure line for the "A" loop

(B) High pressure line for the "B" loop

(C) Line to the Return Manifold Group

(D) Oil line from the Gear Pump (charge oil, implement, air conditioner and fan drive)

If the Piston Motor Group (two speed) is not in the rabbit mode, the motor operates in the same manner as the standard piston motor. Refer to " Piston Motor Group (Hydrostatic System)" for additional information.

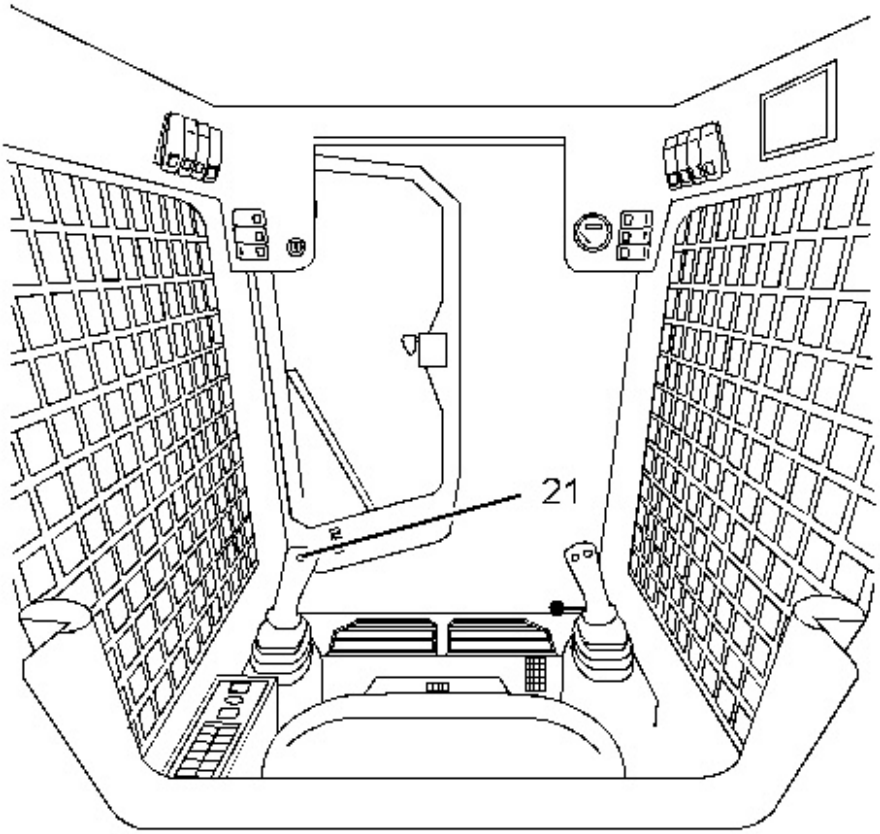


Illustration 10 g01455922

Travel control lever

(21) Travel control lever

When the machine is equipped with two speed capability, the machine can be switched to rabbit mode. A control switch is mounted on the travel control lever (21) which activates the two speed function.

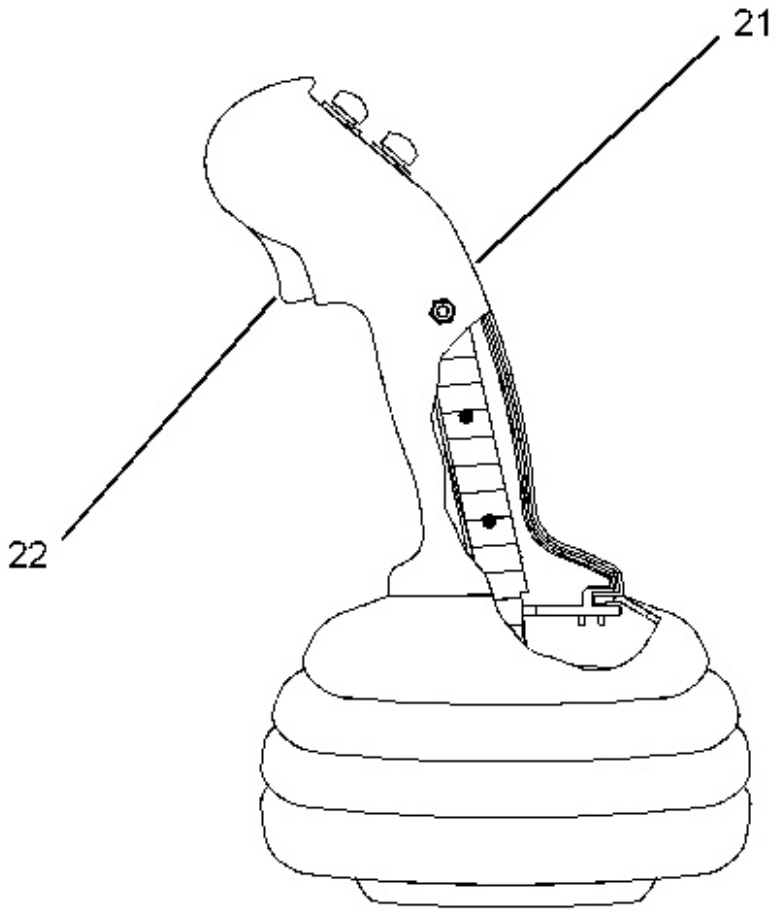


Illustration 11 g01455935

Two speed control switch

(21) Travel control lever

(22) Two speed control switch

The two speed control switch (22) is a toggle switch. Press the button once in order to activate the rabbit mode. Press the switch again in order to deactivate the rabbit mode and return to the normal mode. When the machine is in the normal mode, the hydrostatic system functions in the same manner as the machines that are equipped with the standard piston motors. Refer to the Operation and Maintenance Manual, "Operator Controls (Joystick Controls)" for additional information.

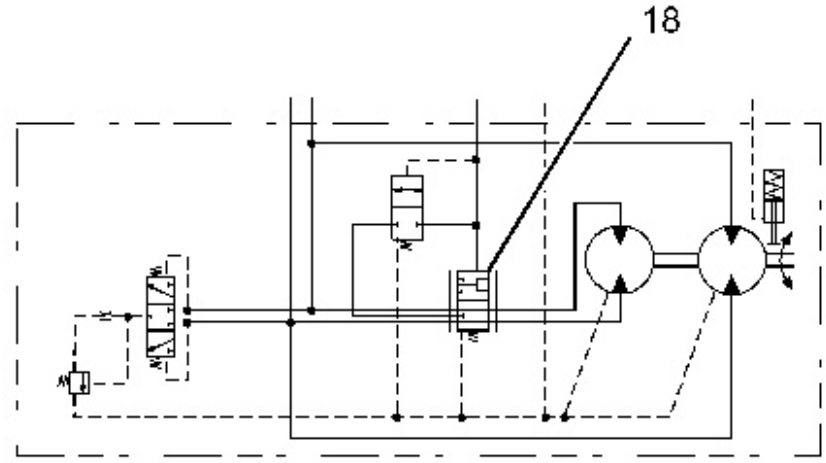


Illustration 12 g01455947

(18) Speed selector valve

When the operator presses the two speed control switch (22) in order to activate the rabbit mode, the switch sends an electrical signal to the Solenoid Valve Group (two speed control) (11). Since the solenoid in the Solenoid Valve Group (two speed control) is now energized the spool that is part of the Solenoid Valve Group (two speed control) shifts to the left. When the spool is shifted to the left the spool will allow charge oil to flow to the port that is for the two speed control (9). The oil then flows to the speed selector valve (18) that is a part of the Piston Motor Group (hydrostatic left side) (12) and the speed selector valve (18) that is a part of the Piston Motor Group (hydrostatic right side) (16) .

When the charge oil pressure is greater than the force of the spring that is positioning the speed selector valves, the charge oil pressure forces the selector valves to shift downward. When the speed selector valves are shifted downward, the speed selector valves will block the flow of high pressure oil from port (A) or (B) to half of the pistons in the motors. The cylinders that do not receive oil (19) will then freewheel as the motor shaft spins. Because only half of the pistons receive oil flow, the oil can fill the cylinders faster. This causes the motor shaft to rotate faster. The output torque of the motor will decrease with the increase in speed.

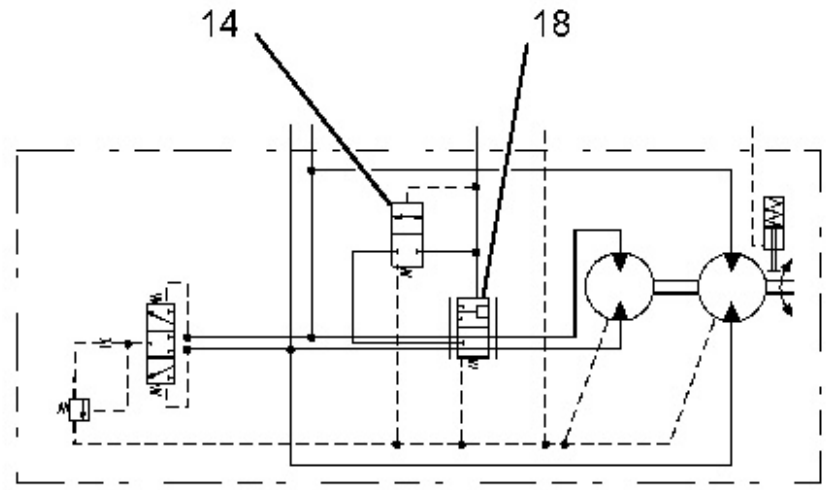


Illustration 13 g01455950

(14) Control valve (charge oil)

(18) Speed selector valve

When the charge oil pressure becomes large, the charge oil pressure also overcomes the force of the spring that is a part of each of the control valves (charge oil) (14). The charge oil pressure causes each of the control valves (charge oil) that are a part of each piston motor to shift downward. When the control valve (charge oil) shifts downward, the control valve allows a constant flow of charge oil to the motor which will keep the pistons in the motor that are freewheeling seated against the cam ring. This keeps the pistons from sliding while the motor is operating at a higher speed.

When the machine is first started, the machine is automatically reset to the normal mode.

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Systems Operation
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4866-01 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02050002

Tandem Drive and Axle

SMCS - 3007

Tandem Drive

The tandem drive consists of the following major components:

- Drive chains
- Drive sprockets
- Axles
- Mounting hardware

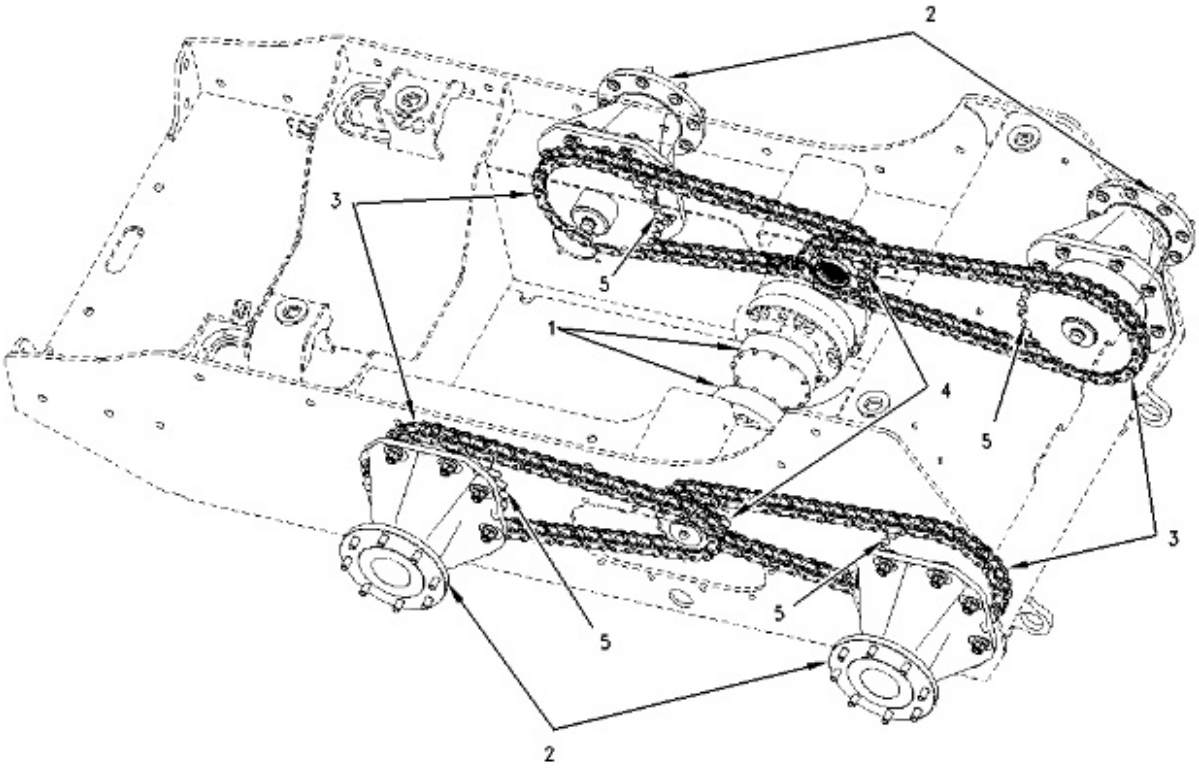


Illustration 1 g00597550

(1) Piston motors (hydrostatic)

(2) Axles

(3) Drive chains

(4) Drive sprockets

(5) Axle sprockets

The tandem drive transfers mechanical power from the piston motors (hydrostatic) (1) to the axles (2) through the chains (3). Torque and speed from each motor is transferred to the chains by double drive sprockets (4). Drive sprockets (4) are not as large as axle sprockets (5). Torque multiplication is created in the tandem drive system because a small gear drives a larger gear.

The inboard chains drive a single sprocket at the front axles. The outboard chains drive a single sprocket (5) at the rear axles.

The chains (3) are high strength drive chains. Lubrication is supplied by an oil bath of "10W30" oil in each drive chain box. The chains are dipped at the bottom of the axle sprockets as the chains rotate.

As running time is accumulated on the drive train, the chains will elongate due to wear in the chain links. Adjustment slots are provided in the axle. Refer to Operation and Maintenance Manual, SEBU7731, "Drive Chain Tension - Check/Adjust" for the proper adjustment procedure for the chains.

The teeth on the sprockets are heat treated in order to provide resistance to surface wear. The axle sprockets (5) are attached to the spindles by internal splines, a hardened washer, and a bolt. The double drive sprockets (4) are attached to the hydraulic motors by internal splines, a retainer, and a bolt.

Axle

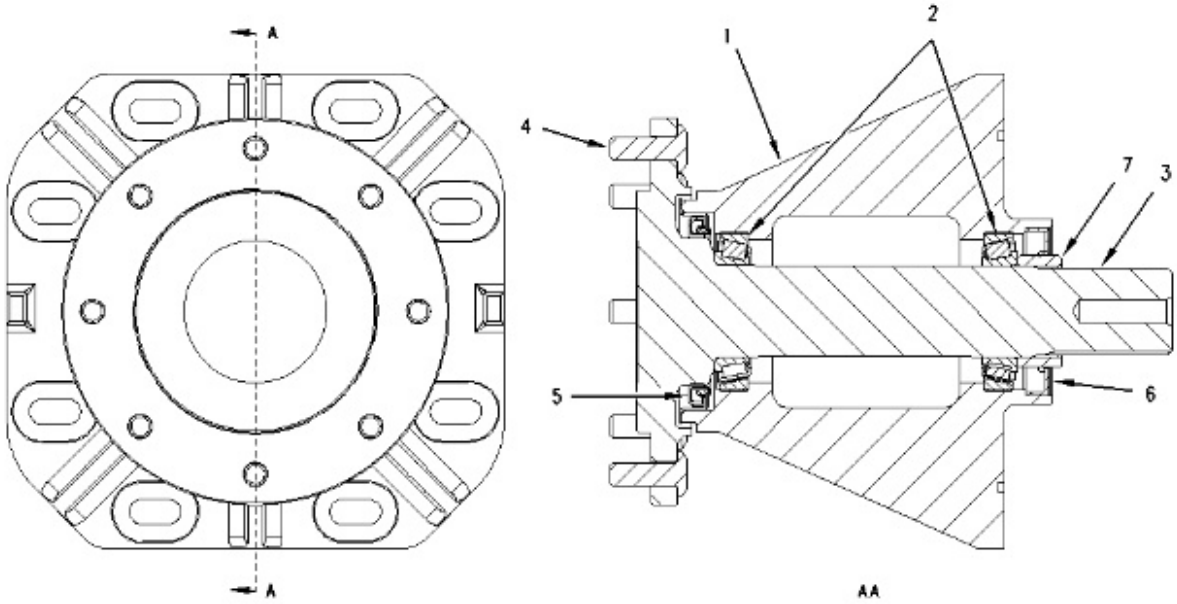


Illustration 2 g00598054

(1) Housing

(2) Roller bearing cup and cone

(3) Spindle

(4) Stud

(5) Seal

(6) Seal

(7) Spacer

The axle consists of the following components:

- housing
- spindle
- two grease seals
- bearing spacer

- two tapered roller bearings

The spindle flange provides a protective lip for hard objects and the flange provides a mounting for the wheel rims.

Bearing grease is retained by the two grease seals (5) and (6) and the bearing spacer (7). The inside lip seal (6) sits on the bearing spacer. The inside lip seal separates the grease for the axle bearing and the oil that is in the drive chain box. The outer seal (5) features sealing elements that are resistant to contamination in addition to an internal grease seal.

Two identical tapered roller bearings support the spindle at each end of the axle housing.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
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i02093443

Pilot Valve (Joystick)

SMCS - 5059; 5705

There are two pilot valves on the machine. The two pilot valves get hydraulic oil from separate circuits. Hydraulic oil for both circuits comes from the gear pump.

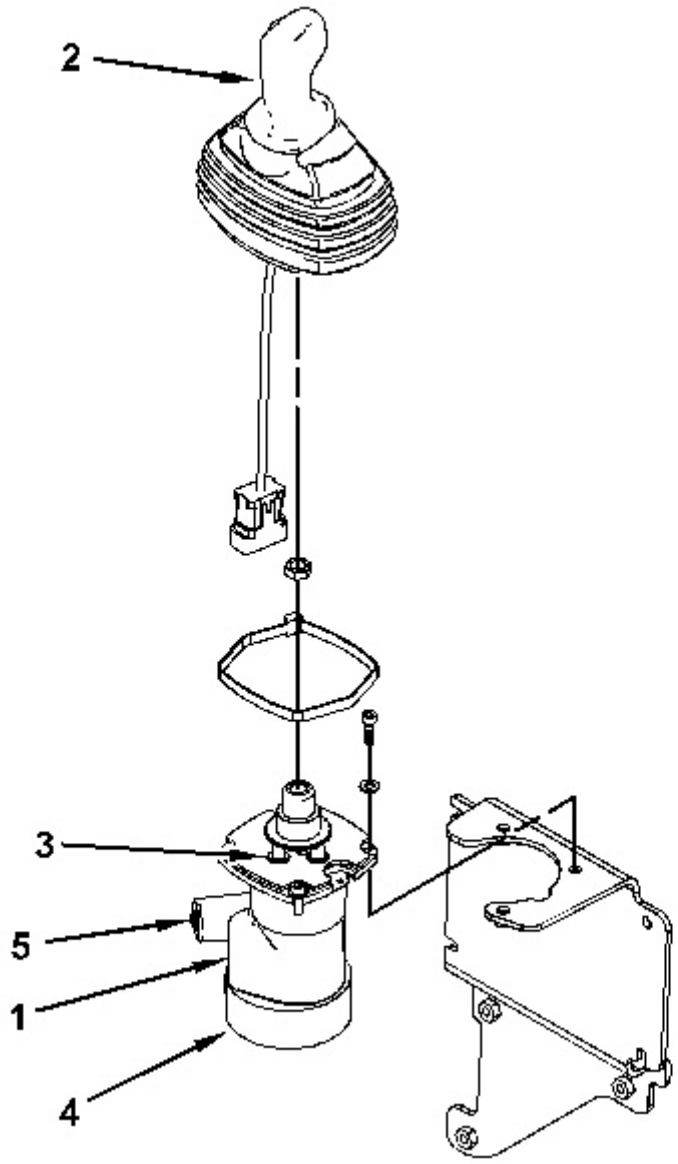


Illustration 1 g01056035

(1) Pilot valve

(2) Control lever

(3) Plungers

(4) Resolver block

(5) Solenoid valve (hydrostatic)

The first pilot valve (1) controls the motion of the machine. The control lever (2) is moved to a desired position. The plungers (3) for the pilot valve are moved by the control lever. The plungers direct the oil flow to the resolver block (4). The resolver block directs the hydraulic oil to the actuator pistons for the piston pump (hydrostatic). The solenoid valve (hydrostatic) (5) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

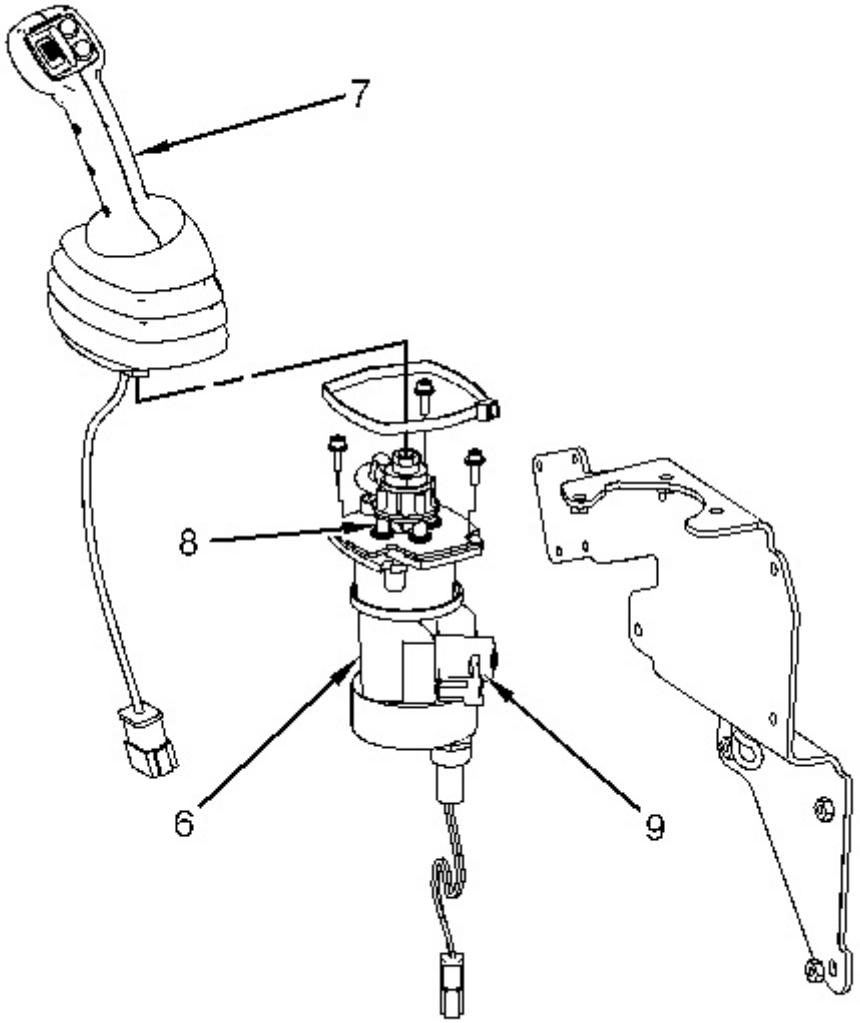


Illustration 2 g01056040

(6) Pilot valve

(7) Control lever

(8) Plungers

(9) Solenoid valve (work tool)

The second pilot valve (6) controls the motion of the work tool. The control lever (7) is moved to a desired position. The plungers (8) for the pilot valve direct the pilot hydraulic oil to the respective spool in the control valve (work tool). The work tool reacts accordingly. The solenoid valve (work tool) (9) is an interlock solenoid. The solenoid must be energized in order for oil to flow to the pilot valve. Refer to the Systems Operation, "General Information" for more information on the interlock system.

The control levers on both pilot valves are spring centered. When the levers are released from any position except for the FLOAT position, the levers will return to the NEUTRAL position. The FLOAT position has a detent that keeps the pilot valve for the work tool in the FLOAT position until you move the lever. Then, the pilot valve will return to the NEUTRAL position.

Refer to the Operation and Maintenance Manual, "Operator Controls - Joystick Controls" for more information on the pilot operated hydraulic controls.

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Systems Operation
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i02933477

Hydrostatic System

SMCS - 4350

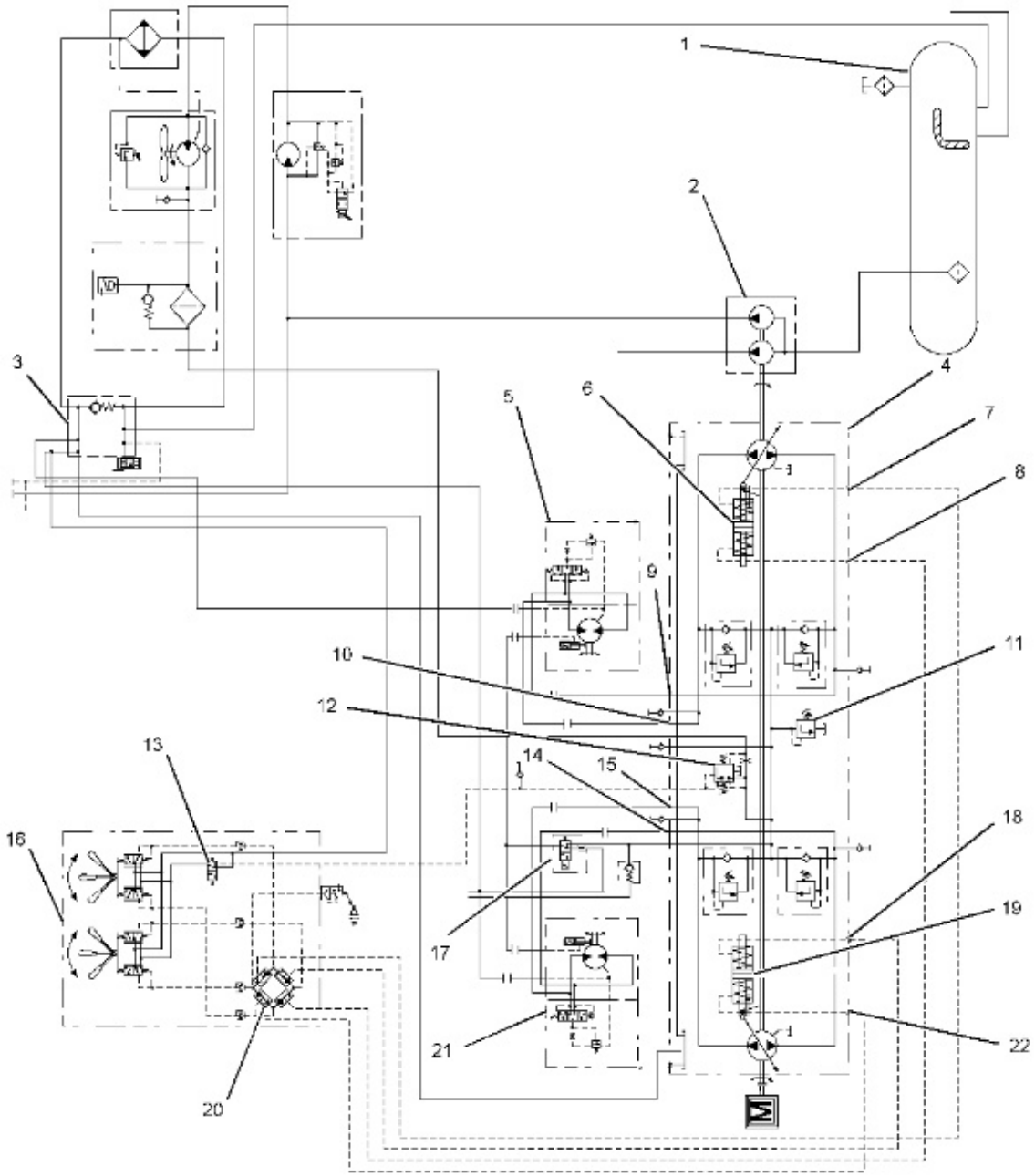


Illustration 1 g01454966

Hydraulic Schematic Single Speed

(1) Hydraulic Tank Group

(2) Gear Pump (charge oil, implement, air conditioner and fan drive)

(3) Return Manifold Group

(4) Piston Pump (hydrostatic system)

(5) Piston Motor Group (hydrostatic right side)

(6) Pump actuator group (hydrostatic right side)

(7) "X3" Pilot pressure port (hydrostatic right side)

(8) "X4" Pilot pressure port (hydrostatic right side)

(9) High pressure port for the "A" loop

(10) High pressure port for the "B" loop

(11) Relief Valve (Charge oil)

(12) Speed Sensing Valve Group

(13) Solenoid Valve Group (hydrostatic system)

(14) High pressure port for the "A" loop

(15) High pressure port for the "B" loop

(16) Pilot Valve (hydrostatic system)

(17) Solenoid Valve and Mounting Group (parking brake)

(18) "X4" Pilot pressure port (hydrostatic left side)

(19) Pump actuator group (hydrostatic left side)

(20) Resolver network

(21) Piston Motor Group (hydrostatic left side)

(22) "X3" Pilot pressure port (hydrostatic left side)

The hydrostatic system is a closed loop. The hydrostatic system is made up of the following main components: Hydraulic Tank Group (1), Gear Pump (charge oil, implement, air conditioner and fan drive) (2), Piston Pump (hydrostatic system) (4), Piston Motor Group (hydrostatic right side) (5) and Piston Motor Group (hydrostatic left side) (21) .

The oil that flows from the Piston Pump (hydrostatic system) to the Piston Motor Groups (hydrostatic system) flows in a continuous loop. The oil then returns to the Piston Pump (hydrostatic system). The hydrostatic system is kept full of oil by the charge system. The forward section of the Gear Pump (charge oil, implement, air conditioner and fan drive) supplies both sections of the Piston Pump (hydrostatic system) with charge oil.

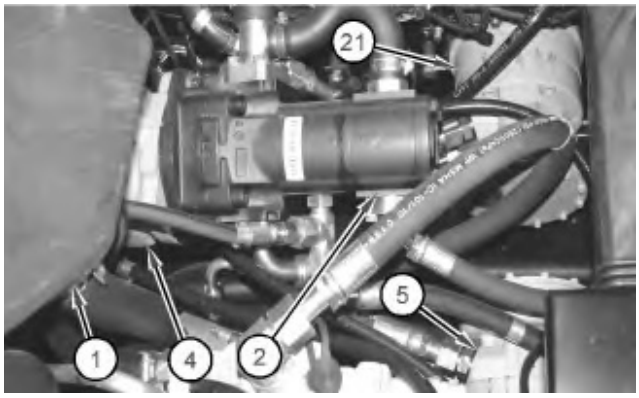


Illustration 2 g01038745

Hydrostatic System Components

(1) Hydraulic Tank Group

(2) Gear Pump (charge oil, implement, air conditioner and fan drive)

(4) Piston Pump (hydrostatic system)

(5) Piston Motor Group (hydrostatic right side)

(21) Piston Motor Group (hydrostatic left side)

Pilot oil flows from the Pilot Valve (hydrostatic system) (16) to the pilot pressure ports (7), (8), (18), and (22) that are on the Piston Pump (hydrostatic system). The pilot oil causes the pump actuator groups (6) and (19) in the Piston Pump (hydrostatic system) to move the swashplates. This causes the Piston Pump (hydrostatic system) to pump oil to the Piston Motor Groups (5) and (21) .

When the Piston Pump (hydrostatic system) is in the NEUTRAL position only charge pressure will flow out of "A" loop port (9) and "B" loop port (10) .

In the NEUTRAL position, no high pressure oil flow is provided to the piston motors. The hydrostatic system oil pressure will be equal to the charge oil pressure.

If the travel control lever is pushed to the FORWARD position, the Pilot Valve (hydrostatic system) (16) opens a path for the oil to flow to the pump actuator group (hydrostatic right side) (6) and the pump actuator group (hydrostatic left side) (19). The oil that flows into the "X 4" pilot pressure port (hydrostatic right side) (8) causes the actuator piston (6) to shift upward. The pilot oil also flows into the "X 4" pilot pressure port (hydrostatic left side) (18). The pilot oil that flows into the "X 4" pilot pressure port (hydrostatic left side) (18) causes the actuator piston (19) to shift downward. The movement of the actuators causes the swashplates to move. Movement of the swashplate will cause piston pump (4) to upstroke. The flow of the oil out of the "B" ports (10) and (15) that are in the Piston Pump (hydrostatic system) (4) increases. Refer to the Systems Operation, "Pilot Hydraulic System" for additional information about the pilot valve. Refer to Systems Operation, "Piston Pump (Hydrostatic System)" for additional information about the piston pump.

The oil that flows out of "B" ports (10) and (15) causes Piston Motor Groups (5) and (21) to rotate. The shafts of the Piston Motor Groups will turn at a rate that is determined by the amount of oil that is flowing to the Piston Motor Groups. If the travel control lever is moved further into the FORWARD position, the swashplates will move further. This causes the Piston Pump to pump oil to the Piston Motor Groups at a greater flow rate. If the flow rate is greater, the shafts of the motors will turn faster. Refer to Systems Operation, "Piston Motor Group" for additional information.

The oil that is flowing from the Piston Motor Groups is at a lower pressure. The lower pressure oil returns to the Piston Pump (hydrostatic system) through high pressure ports for the "A" loops (9) and (14). Any oil that is lost from the "A" or "B" loops is replaced by charge oil.

Reference

Two Speed Function

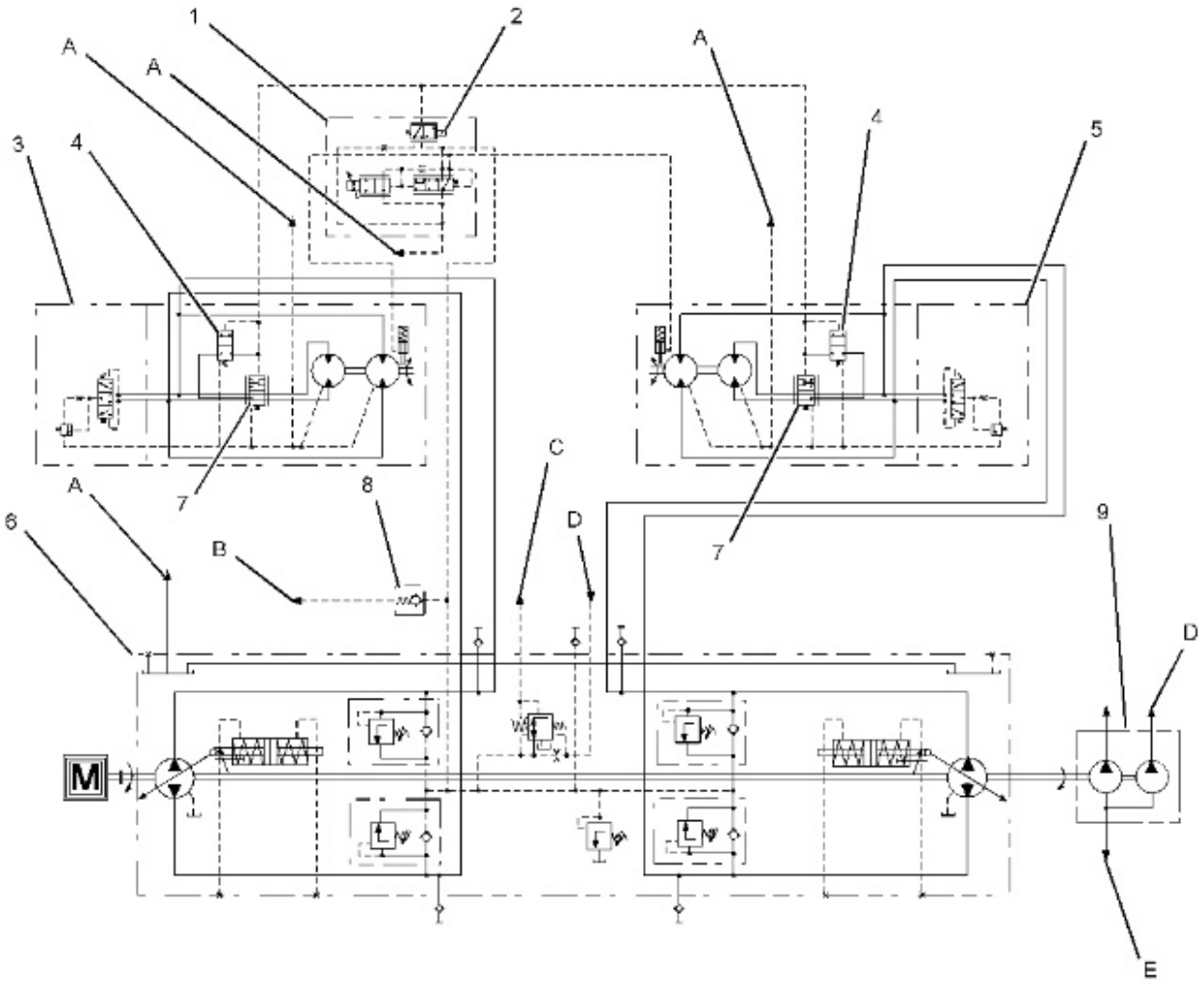


Illustration 3 g01454989

Hydraulic Schematic for the Two Speed

(1) Solenoid Valve and Mounting Group (parking brake)

(2) Solenoid Valve Group (two speed control)

(3) Piston Motor Group (hydrostatic left side)

(4) Control valve (charge oil)

(5) Piston Motor Group (hydrostatic right side)

(6) Piston Pump (hydrostatic system)

(7) Speed selector valve

(8) Check valve

(9) Gear Pump (charge oil, implement, air conditioner and fan drive)

(A) Line to the Return Manifold Group

(B) Line to the Control Valve (work tool)

(C) Pilot oil line from the Speed Sensing Valve Group

(D) Charge oil line from the Gear Pump (charge oil, implement, air conditioner and fan drive)

(E) Line to the Hydraulic Tank Group

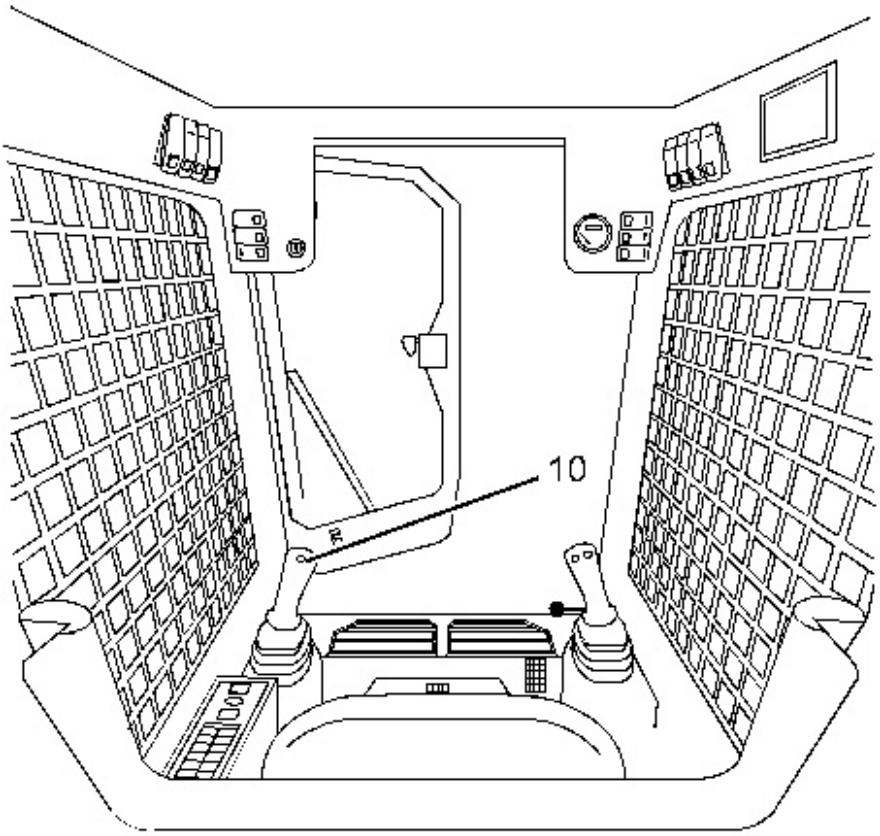


Illustration 4 g01454999

Travel control lever

(10) Travel control lever

If the machine is equipped with two speed capability, the machine can be switched to rabbit mode. A control switch is mounted on the travel control lever (10) which activates the two speed function.

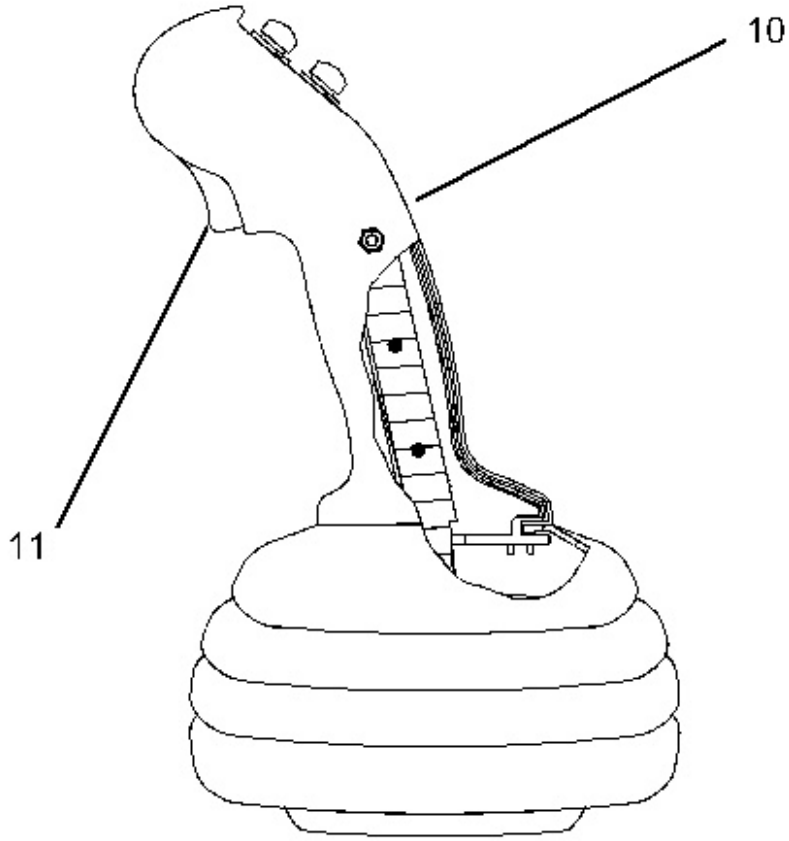


Illustration 5 g01039914

Two speed control switch

(10) Travel control lever

(11) Two speed control switch

The two speed control switch (11) is a toggle switch. Press the button once in order to activate the rabbit mode. Press the switch again in order to deactivate the rabbit mode and return to the normal mode. When the machine is in normal mode, the hydrostatic system functions in the same manner as the machines that are equipped with the standard piston motors. Refer to the Operation and Maintenance Manual, "Operator Controls (Joystick Controls)" for additional information.

When the operator presses the two speed control switch (11) in order to activate the rabbit mode, the switch sends an electrical signal to the Solenoid Valve Group (two speed control) (2). Since the solenoid in the Solenoid Valve Group (two speed control) is now energized the spool that is part of the Solenoid Valve Group (two speed control) shifts to the left. When the spool is shifted to the left the spool will allow charge oil to flow to the speed selector valve (7) that is a part of Piston Motor

Group (hydrostatic left side) (3) and the speed selector valve (7) that is a part of Piston Motor Group (hydrostatic right side) (5) .

The charge oil pressure is greater than the force of the spring that is positioning the speed selector valves. The charge oil pressure forces the selector valves to shift downward.

When the speed selector valves are shifted downward, the speed selector valves will block the flow of high pressure oil to half of the pistons in the motors. These pistons will then freewheel as the motor shaft spins. Since only half of the pistons receive flow, oil can fill the cylinders for the pistons faster. This causes the motor shaft to rotate faster. The output torque of the motor will decrease with the increase in speed.

The charge oil pressure also overcomes the force of the spring that is a part of each of the control valves (charge oil) (4). The charge oil pressure causes each of the control valves (charge oil) that are a part of each piston motor to shift downward. This allows a constant flow of charge oil to the motor which will keep the pistons in the motor that are freewheeling seated against the cam ring. This keeps the pistons from sliding while the motor is operating at a higher speed. Refer to the Systems Operation, "Piston Motor Group (Hydrostatic system)" for additional information.

When the machine is first started, the machine is automatically reset to the normal mode.

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Systems Operation
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i02935162

Piston Pump (Hydrostatic)

SMCS - 5070

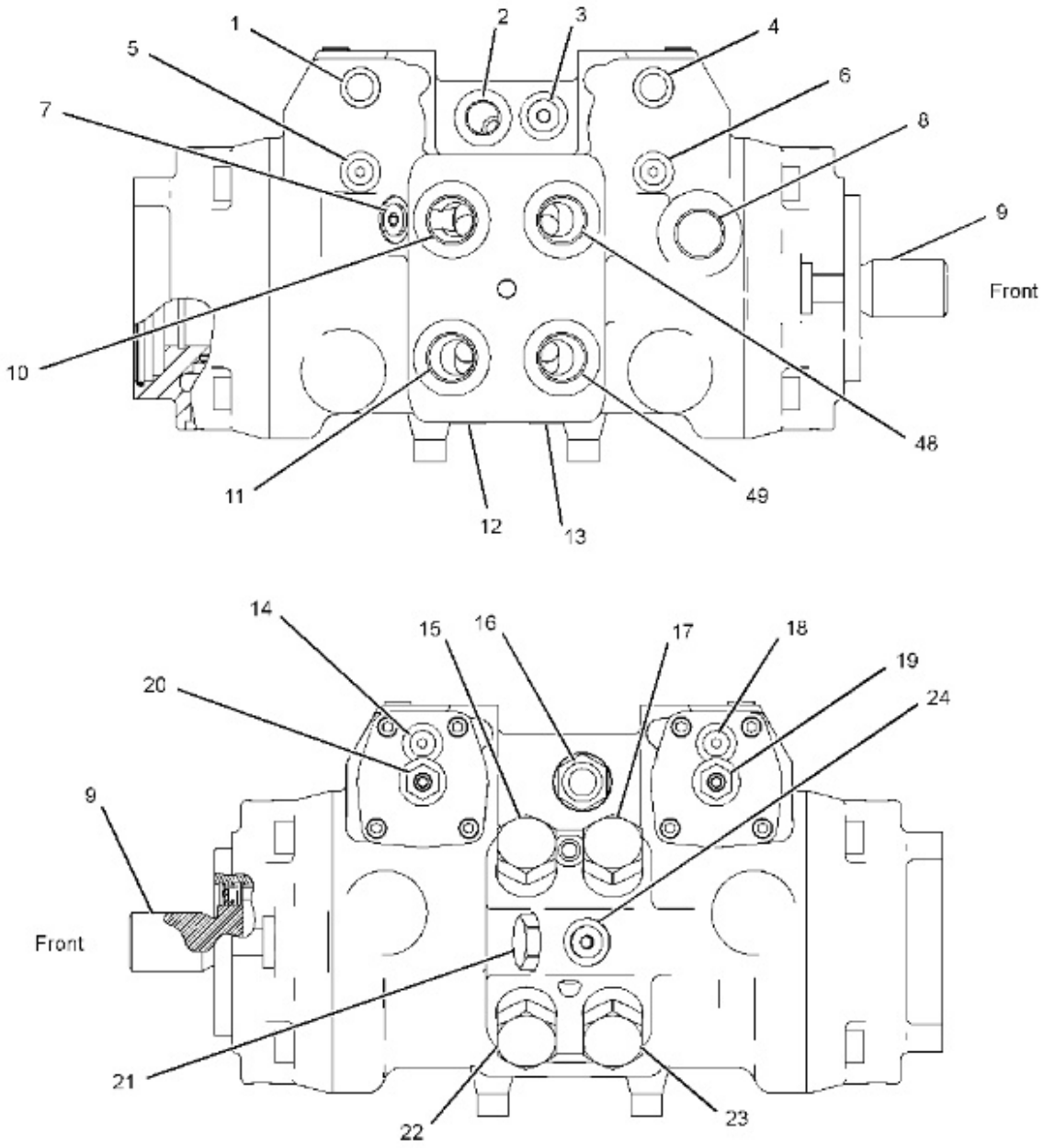


Illustration 1 g01455755

Piston Pump (hydrostatic system)

(1) Adjustment for the maximum displacement (rear pump section)

(2) Inlet port for the charge oil

(3) Gauge port for the "B" loop (front pump section)

(4) Adjustment for the maximum displacement (front pump section)

(5) "X 3" Pilot pressure port

(6) "X 3" Pilot pressure port

(7) Gauge port for the "B" loop (rear pump section)

(8) Port for the case drain

(9) Input shaft

(10) Port for the high pressure oil for the "B" loop to Port A on the right drive motor

(11) Port for the high pressure oil for the "A" loop to Port B on the right drive motor

(12) Gauge port for the "A" loop (rear pump section)

(13) Gauge port for the "A" loop (front pump section)

(14) "X 4" Pilot pressure port

(15) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (front pump section)

(16) Speed Sensing Valve Group

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(18) "X 4" Pilot pressure port

(19) Mechanical adjustment for the pump null (rear pump section)

(20) Mechanical adjustment for the pump null (front pump section)

(21) Relief Valve (Charge oil)

(22) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (front pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

(24) Gauge port for the charge oil

(48) Port for the high pressure oil for the "B" loop to Port B on the left drive motor

(49) Port for the high pressure oil for the "A" loop to Port A on the left drive motor

The Piston Pump (hydrostatic system) operates in a closed loop system. The standard single speed Piston Pump (hydrostatic system) is a variable displacement piston pump. The pump is driven from the engine flywheel by a coupling that is splined to the input shaft (9) .

The Piston Pump (hydrostatic system) consists of two separate pumps. The two pumps are contained in one housing. The following main components are located on the outside of the Piston Pump (hydrostatic system): Input shaft (9), Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (front pump section) (15), Speed Sensing Valve Group (16), Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section) (17), Relief Valve (Charge oil) (21), Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (front pump section) (22) and Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section) (23) .

The pilot pressure ports (5), (6), (14) and (18) are connected to the Pilot Valve (hydrostatic system). Gauge ports (3), (7), (12) and (13) are equipped with pressure taps in order to test the oil pressure in the "A" and "B" high pressure loops. Gauge port (24) is equipped with a pressure tap in order to test the oil pressure in the charge oil circuit.

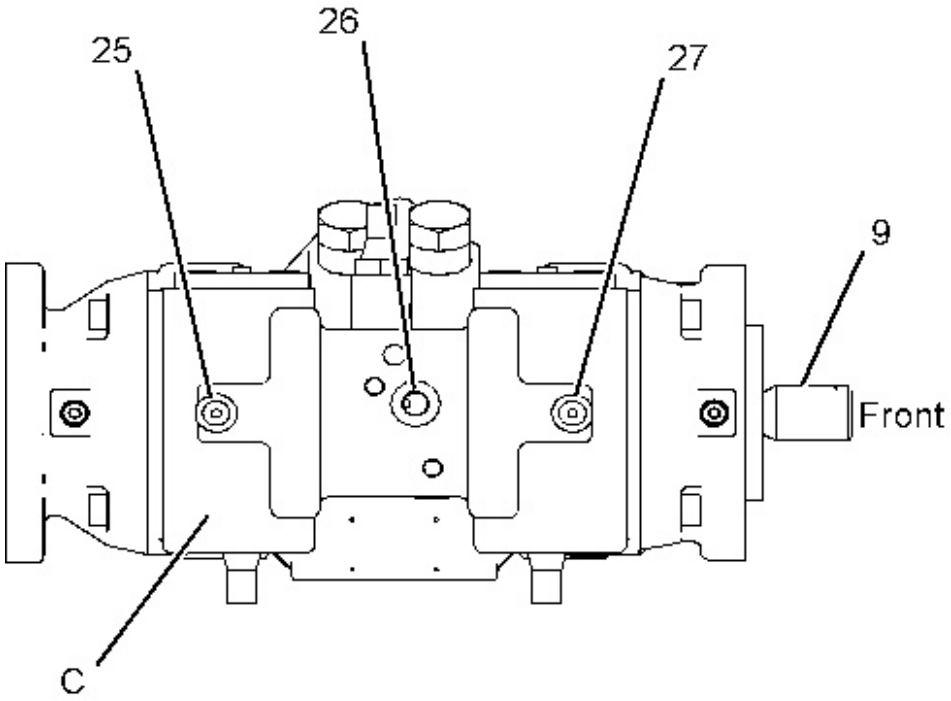


Illustration 2 g01455768

Piston Pump (hydrostatic system)

(9) Input shaft

(25) Port for testing case drain pressure (rear pump section)

(26) Port for testing the speed sensing pressure

(27) Port for testing case drain pressure (front pump section)

(C) Top side of the Piston Pump (hydrostatic system)

Test the oil pressure in the Speed Sensing Valve Group oil circuit at location (26). Test the oil pressure for the rear pump case drain at location (25). Test the oil pressure for the front pump case drain at location (27).

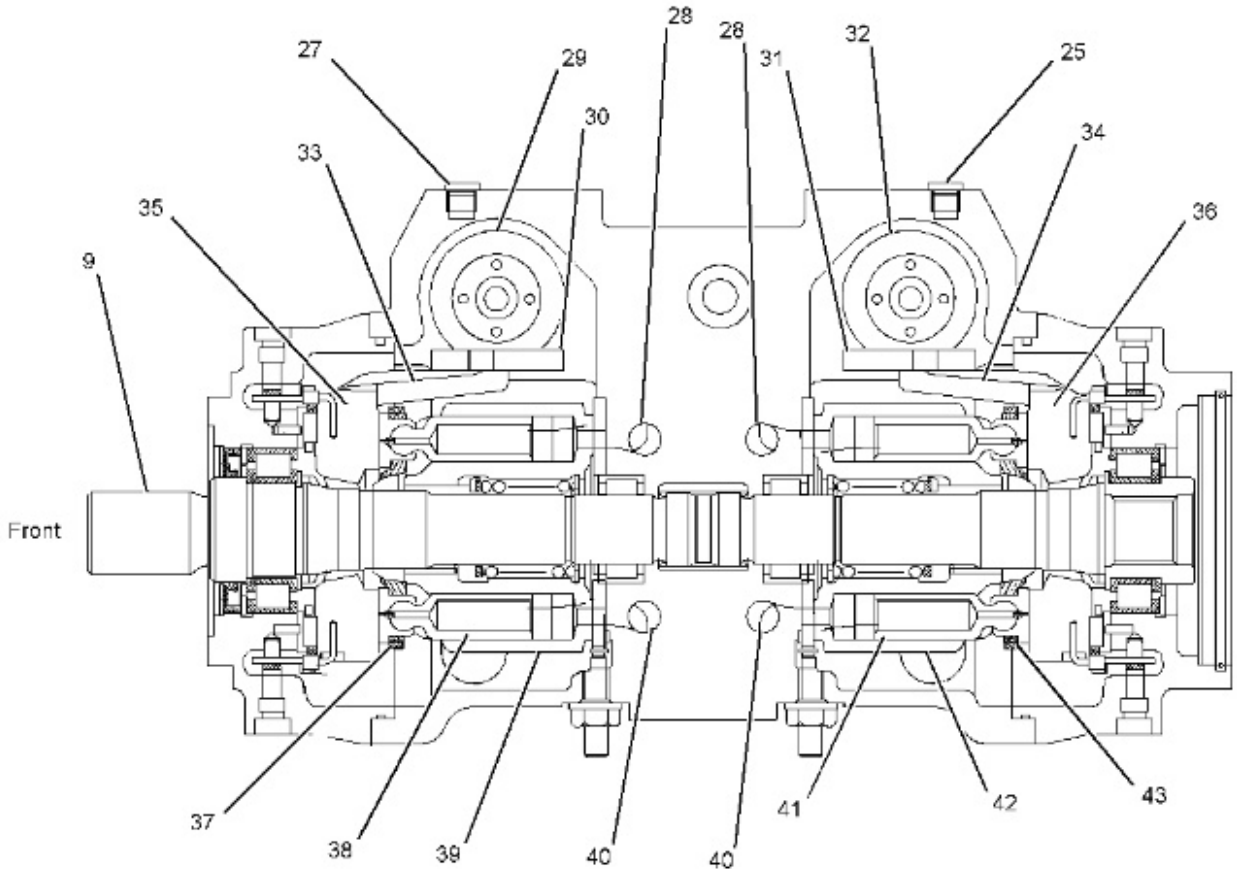


Illustration 3 g01455769

Cutaway of the Piston Pump (hydrostatic system)

(9) Input shaft

(25) Port for testing case drain pressure (rear pump section)

(27) Port for testing case drain pressure (front pump section)

(28) Passages to ports "B"

(29) Actuator group (front pump section)

(30) Slider (front pump section)

(31) Slider (rear pump section)

(32) Actuator group (rear pump section)

(33) Control arm for the swashplate (front pump section)

(34) Control arm for the swashplate (rear pump section)

(35) Swashplate (front pump section)

(36) Swashplate (rear pump section)

(37) Retraction plate (front pump section)

(38) Piston (front pump section)

(39) Rotating group (front pump section)

(40) Passages to ports "A"

(41) Piston (rear pump section)

(42) Rotating group (rear pump section)

(43) Retraction plate (rear pump section)

The following main components of the Piston Pump (hydrostatic system) are located internally: two actuator groups (29) and (32), input shaft (9) and two rotating groups (39) and (42). Each rotating group consists of the following components: swashplates (35) or (36), control arms for the swashplates (33) or (34), pistons (38) or (41), retraction plates (37) or (43) and one cylinder barrel in each rotating group.

The pilot pressure ports (5), (6), (14) and (18) are used to control the angle of the swashplates (35) and (36). The angle of the swashplates combine with the engine rpm in order to control the output from each of the pump sections. The pilot oil that flows to the pilot pressure ports first flows through the resolver network that is a part of the Pilot Valve (hydrostatic system). Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

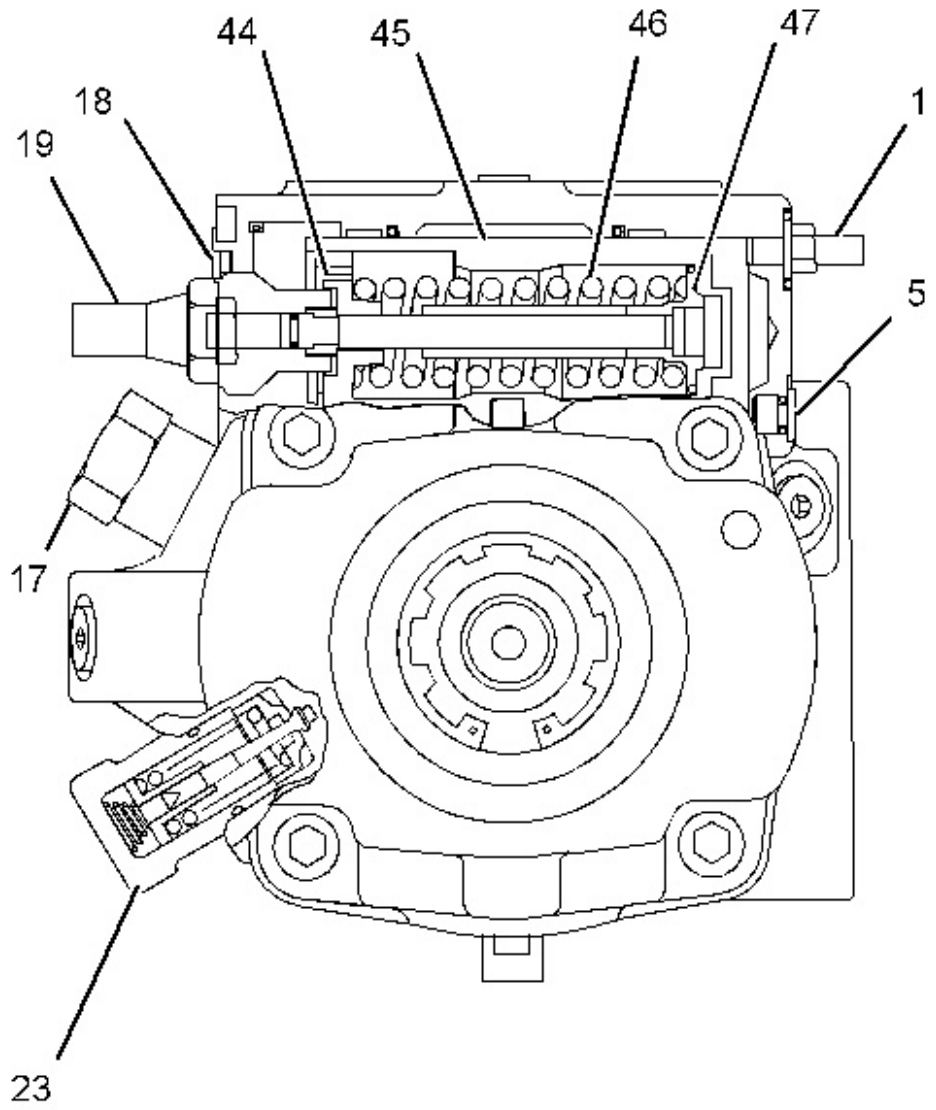


Illustration 4 g01455775

Actuator group (front pump section)

(1) Adjustment for the maximum displacement (rear pump section)

(5) "X 3" Pilot pressure port (hydrostatic right side)

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(18) "X 4" Pilot pressure port (hydrostatic right side)

(19) Mechanical adjustment for the pump null (rear pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

(44) Spring collar

(45) Actuator piston

(46) Spring

(47) Spring collar

The input shaft (9) for the rotating groups (39) and (42) consists of two shafts that are splined together between the two rotating groups. Swashplates (35) and (36) can operate independently. The rotating group (front pump section) (39) supplies high pressure oil to the Piston Motor Group (hydrostatic left side). The rotating group (rear pump section) (42) supplies high pressure oil to the Piston Motor Group (hydrostatic right side). For the following example of the operation of the pump, the rotating group (rear pump section) (42) will be used. The rotating group (front pump section) (39) will operate in the same manner.

When the operator moves the travel control lever to the FORWARD position, pilot oil flows out of the Pilot Valve (hydrostatic system) and into "X 4" Pilot pressure port (hydrostatic right side) (18). The pressure of the pilot oil that is flowing into pilot pressure port (18) causes the actuator piston (45) to overcome the force of spring (46). When the actuator piston overcomes the force of the spring, the piston moves to the right.

The movement of the piston to the right causes the slider (rear pump section) (31) to move the control arm for the swashplate (rear pump section) (34). The movement of the control arm increases the angle of the swashplate (rear pump section) (36). Half of the pistons in the cylinder barrel pull oil into the rotating group as the pistons rotate around the swashplate. The oil enters the Piston Pump (hydrostatic system) through ports "A". The oil flows into the rotating groups through passages to ports "A" (40). The other half of the pistons push oil out of the rotating group as the pistons rotate around the swashplate. The oil exits the rotating group through passages to ports "B" (28). As the angle of the swashplate increases, the output of the oil also increases.

When the operator moves the travel control lever to the BACKWARD position, pilot oil flows out of the Pilot Valve (hydrostatic system) and into "X 3" Pilot pressure port (hydrostatic right side) (5). The pressure of the pilot oil that is flowing into pilot pressure port (5) causes the actuator piston (45) to overcome the force of spring (46). When the actuator piston overcomes the force of the spring, the piston moves to the left.

The movement of the piston to the left causes the slider (rear pump section) (31) to move the control arm for the swashplate (rear pump section) (34). The movement of the control arm increases the angle of the swashplate (rear pump section) (36). Half of the pistons in the cylinder barrel pull oil into the rotating group as the pistons rotate around the swashplate. The oil enters the Piston Pump (hydrostatic system) through ports "B". The oil flows into the rotating groups through passages to ports "B" (28). The other half of the pistons push oil out of the rotating group as the pistons rotate

around the swashplate. The oil exits the rotating group through passages to ports "A" (40). As the angle of the swashplate increases, the output of the oil also increases.

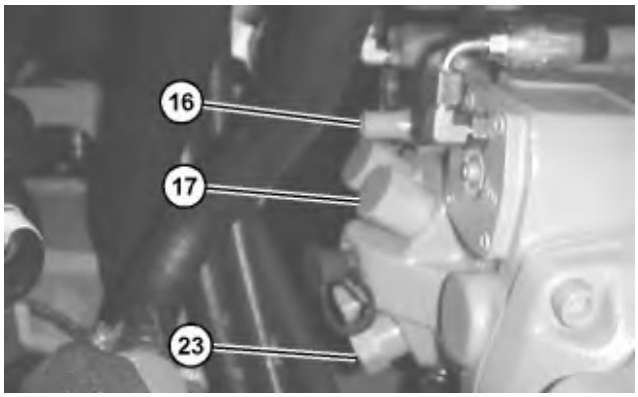


Illustration 5 g01041089

(16) Speed Sensing Valve Group

(17) Relief Valve Assembly (Crossover and makeup valves) for the "B" loop (rear pump section)

(23) Relief Valve Assembly (Crossover and makeup valves) for the "A" loop (rear pump section)

The Speed Sensing Valve Group (16) senses the change in the flow of oil from the Gear Pump (charge oil, implement, air conditioner, and fan drive) as the engine speed changes. An orifice in the Speed Sensing Valve Group creates a pressure differential within the valve. The valve uses the pressure differential to route more flow or less flow to the Pilot Valve (hydrostatic system) in order to control the Piston Pump (hydrostatic system). An increase in the pressure differential will cause more oil to flow to the Pilot Valve (hydrostatic system). The Pilot Valve (hydrostatic system) uses this oil to control the swashplates in the Piston Pump (hydrostatic system).

The Pilot Valve (hydrostatic system) will not function unless the interlock system is energized. The Solenoid Valve Group (hydrostatic system), that is a part of the Pilot Valve (hydrostatic system), must be energized in order for the pilot oil to flow. The Solenoid Valve Group (hydrostatic system) must be energized in order for the Pilot Valve (hydrostatic system) to be functional. Refer to the Systems Operation, "Pilot Hydraulic System" for additional information.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i02935514

Piston Motor (Hydrostatic)

SMCS - 5058

Piston Motor Group (Hydrostatic System)

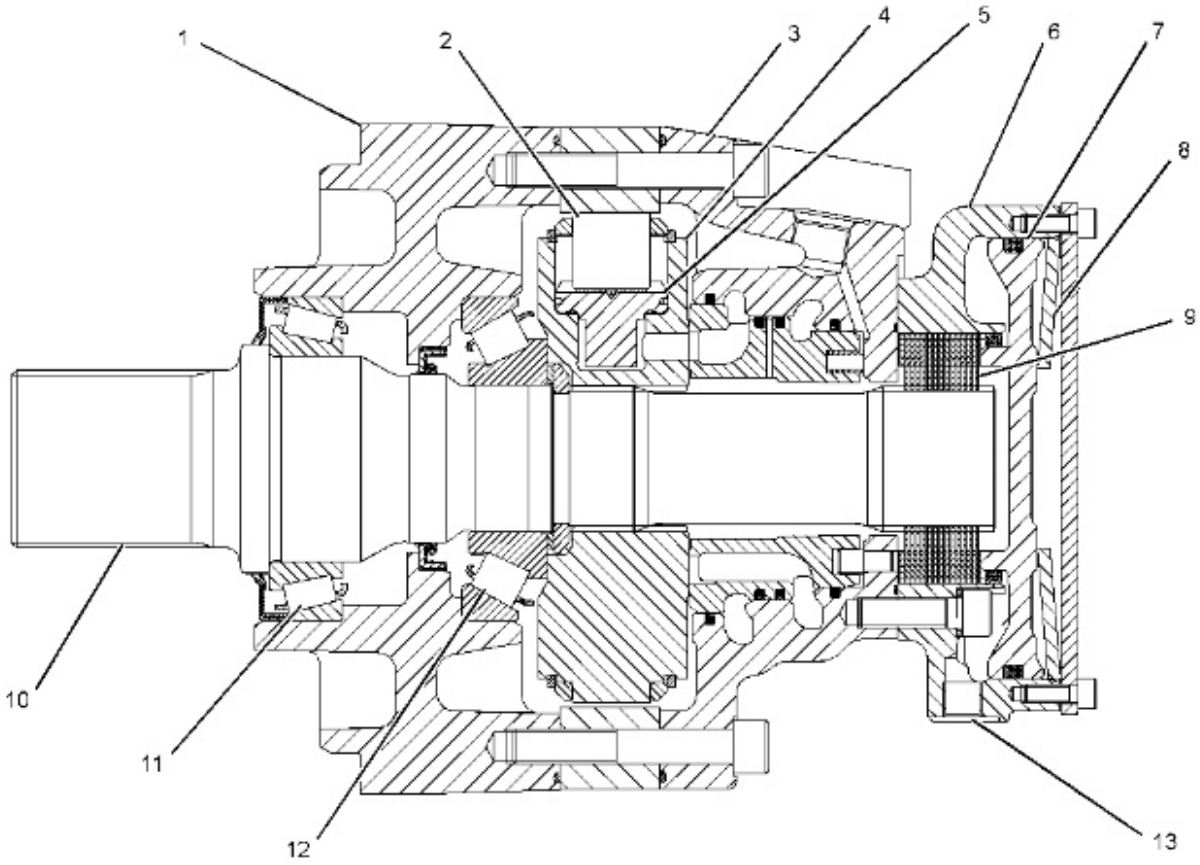


Illustration 1 g01455785

Piston Motor Group (hydrostatic system)

(1) Shaft housing

(2) Roller

(3) Rotor housing

(4) Rotor

(5) Piston assembly

(6) Brake housing

(7) Brake piston

(8) Belleville washer

(9) Brake disc pack

(10) Shaft

(11) Roller bearing

(12) Roller bearing

(13) Port for the brake release

The Piston Motor Group (hydrostatic system) is of a radial piston type. The Piston Motor Group (hydrostatic system) that is standard equipment for the machine is a motor that is single speed. The Piston Motor Group (hydrostatic system) consists of three sections. These sections are the shaft housing (1), the rotor housing (3) and the brake housing (6). Rotor (4) is connected to shaft (10) by splines. Brake disc pack (9) is engaged by brake piston (7) and belleville washer (8) when there is no hydraulic oil pressure. When there is hydraulic oil pressure, the oil pressure forces brake piston (7) against belleville washer (8). This allows brake disc pack (9) to disengage.

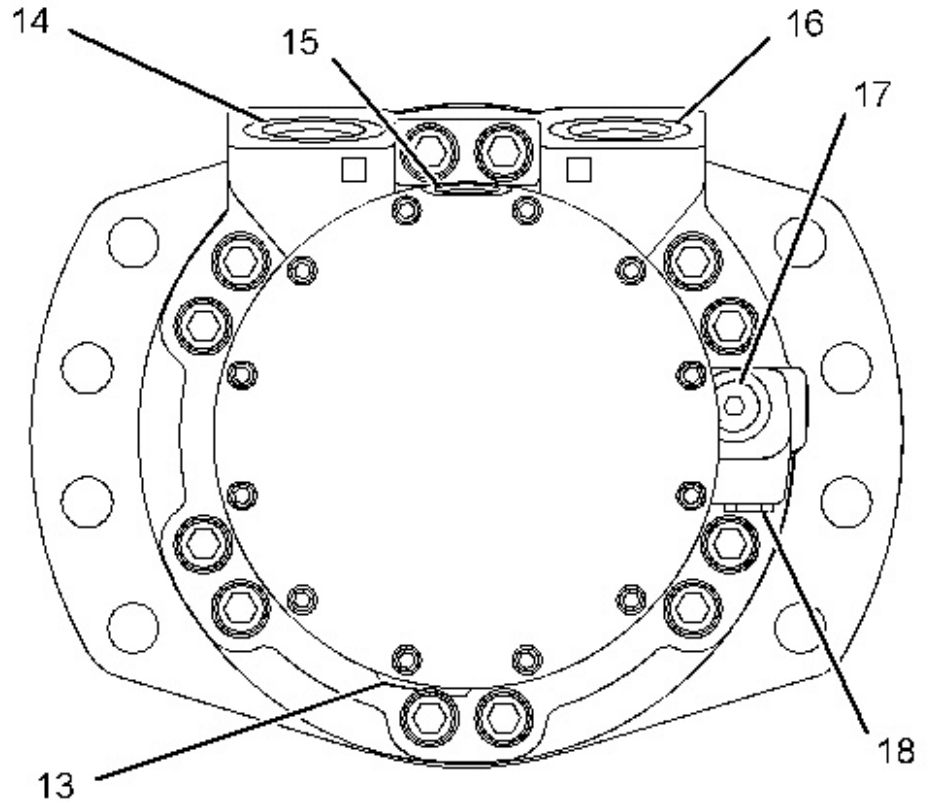


Illustration 2 g01455789

(13) Port for the brake release

(14) Port for the "A" or "B" high pressure loop

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(17) Flushing valve

(18) Regulator valve

The hydraulic oil that flows from the Piston Pump (hydrostatic system) flows into ports (14) and (16). One port will receive the high pressure oil and the other port will be the low pressure oil that is in the return loop. The port that receives the high pressure oil is determined by the desired direction of travel of the machine and the rotation of the motor. The direction of rotation is different for each motor. The motor that is on the right side of the machine will rotate in the opposite direction as the motor that is on the left side. For the following example of the operation of the motor, port (16) is considered to be the high pressure port.

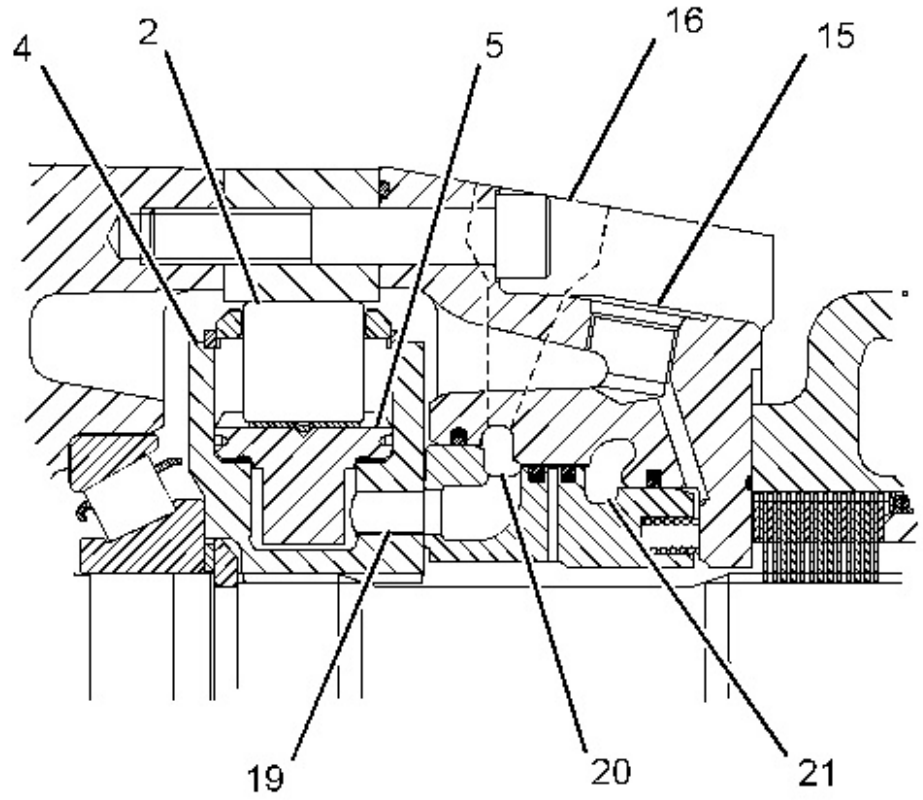


Illustration 3 g01455793

(2) Roller

(4) Rotor

(5) Piston assembly

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(19) Exposed port

(20) Annular passages for port (16)

(21) Annular passages for port (14)

The high pressure hydraulic oil flows through the port (16) and into the annular passage (20). The hydraulic oil then flows through the exposed ports (19). The exposed ports are part of the rotor (4). The hydraulic oil flows through the exposed ports into the cavity that is below the piston assemblies (5).

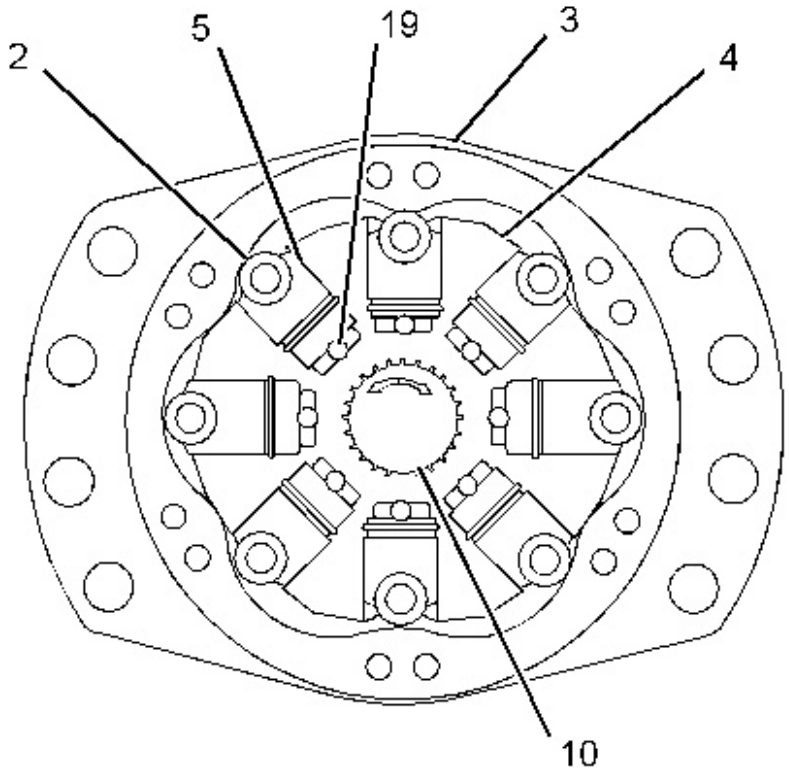


Illustration 4 g01455796

(2) Roller

(3) Rotor housing

(4) Rotor

(5) Piston assembly

(10) Shaft

(19) Exposed port

As the oil pressure in the cavity increases, the piston assembly (5) is forced outward. As the piston assembly is forced outward, the piston rollers (2) roll on the inner diameter of the rotor housing (3). The inner diameter of the rotor housing (3) has a wavy shape. As the piston rollers move along the inner diameter of the rotor housing, the piston rollers follow the wavy inner diameter which causes the rotor to turn.

Because the rotor is connected to the shaft (10) by splines, the rotor turns the shaft. As the rotor turns, the previously exposed ports (19) are covered and the previously covered ports are exposed. The fully extended piston assembly next passes over an exposed port.

As the piston rollers follow the inner diameter of the rotor housing, the rollers force the piston assembly toward the shaft (10). The hydraulic oil that is in the cavity is forced through the exposed port by the inward motion of the piston assembly. The hydraulic oil then returns to an annular passage (21). The oil then flows out of the port (14). This oil is the low pressure loop.

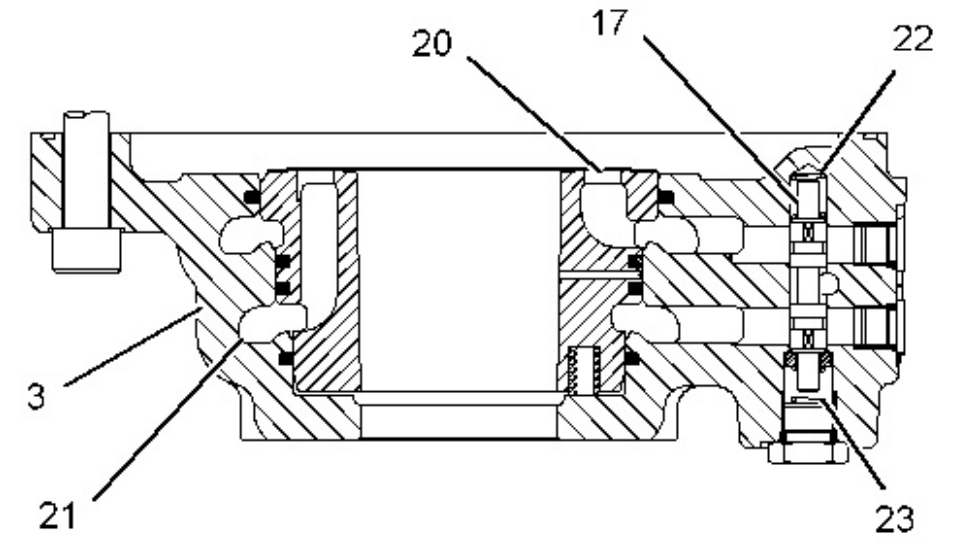


Illustration 5 g01455799

(3) Rotor housing

(17) Flushing valve

(20) Annular passages for port (13)

(21) Annular passages for port (15)

(22) Spring

(23) Spring

The port (15) provides a case drain for the oil that leaks past the piston assemblies and from the flushing valve (17). The flushing valve is a shuttle valve that provides a means for the oil for the hydrostatic loop to flow to the hydraulic oil cooler in order to cool the motor. The flushing valve also provides a means to flush harmful particles from the motor.

The oil that flows through the flushing valve flows from the low pressure side of the drive loop. When the oil pressure in the annular passage (20) increases, the oil pressure acts against the spool for flushing valve (17). The oil pressure overcomes the force of the spring (23). The oil pressure forces the spool to shift downward. When the spool shifts downward the spool opens a path to the Return Manifold Group for the oil that is in annular passage (21).

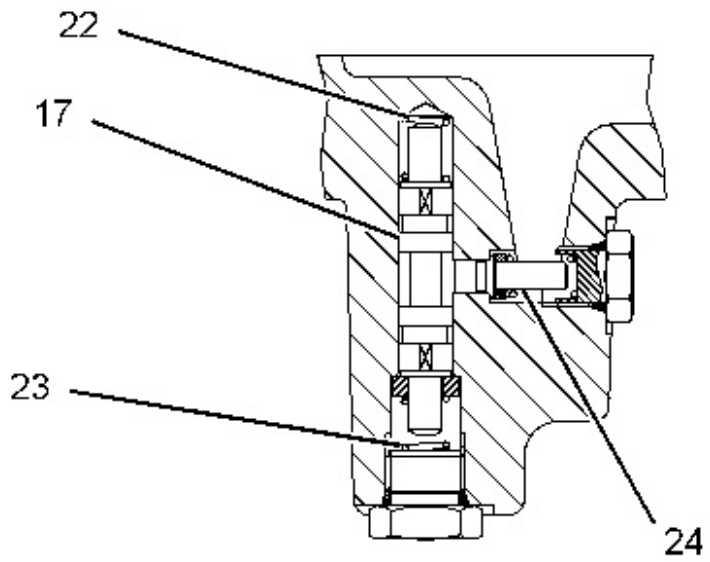


Illustration 6 g01455810

(17) Flushing valve

(22) Spring

(23) Spring

(24) Regulator valve

The oil from the annular passage (21) flows past the spool (17) to the regulator valve (24). The pressure of the oil from the annular passage (21) forces the regulator valve (24) to open.

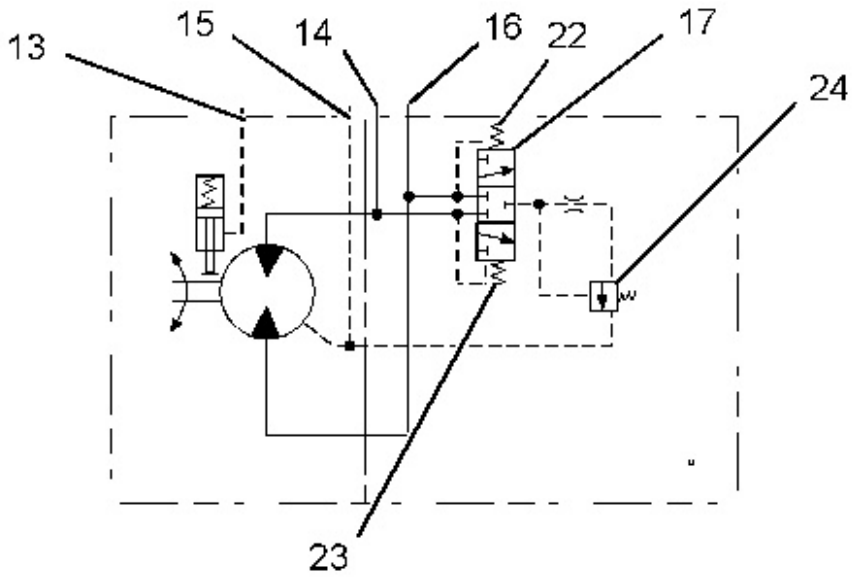


Illustration 7 g01455816

(13) Port for the brake release

(14) Port for the "A" or "B" high pressure loop

(15) Port for the motor case drain

(16) Port for the "A" or "B" high pressure loop

(17) Flushing valve

(22) Spring

(23) Spring

(24) Regulator valve

The oil flows past the regulator valve (24) and out of port (14). The oil then flows to the Return Manifold Group. The oil then flows through the oil cooler. Then, the oil returns to the hydraulic oil tank.

If the oil pressure in the annular passage (14) increases, the oil pressure acts against the spool for flushing valve (17). The oil pressure overcomes the force of the spring (22). The oil pressure forces the spool (17) to shift upward. When the spool shifts upward, the spool opens a path to the Return Manifold Group for the oil that is in annular passage (20) .

The oil from the annular passage (20) flows past the spool (17) to the regulator valve (24). The pressure of the oil from the annular passage (20) forces the regulator valve (24) to open.

The oil flows past the regulator valve (24) and out of the port (16). The oil then flows to the Return Manifold Group. The oil then flows through the oil cooler. Then, the oil returns to the hydraulic oil tank.

Piston Motor Group (Two Speed)

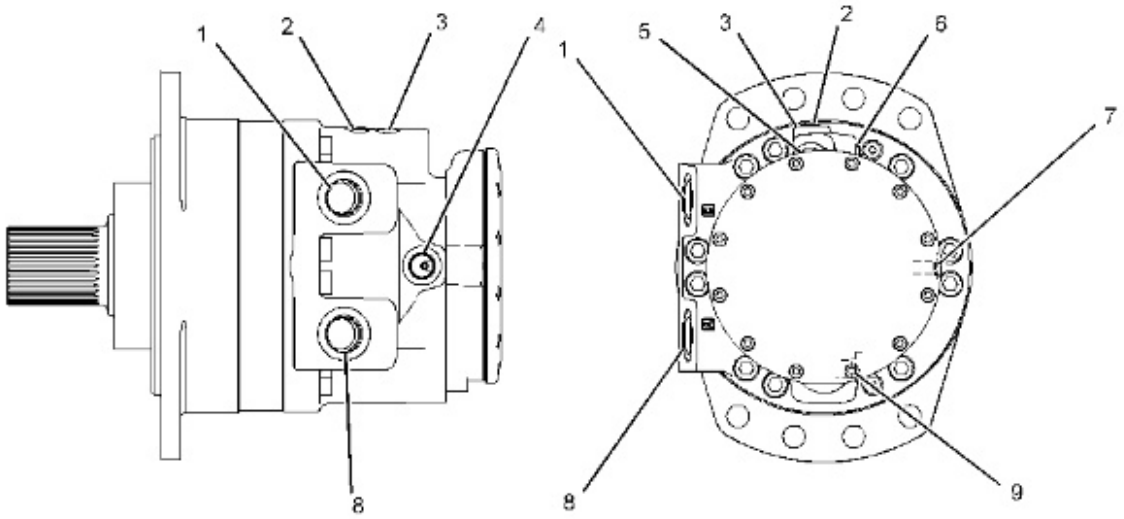


Illustration 8 g01455828

(1) Port for the "A" or "B" high pressure loop

(2) Control valve (charge oil)

(3) Speed selector valve

(4) Port for the motor case drain

(5) Flushing valve

(6) Regulator valve

(7) Port for the brake release

(8) Port for the "A" or "B" high pressure loop

(9) Port for the two speed control

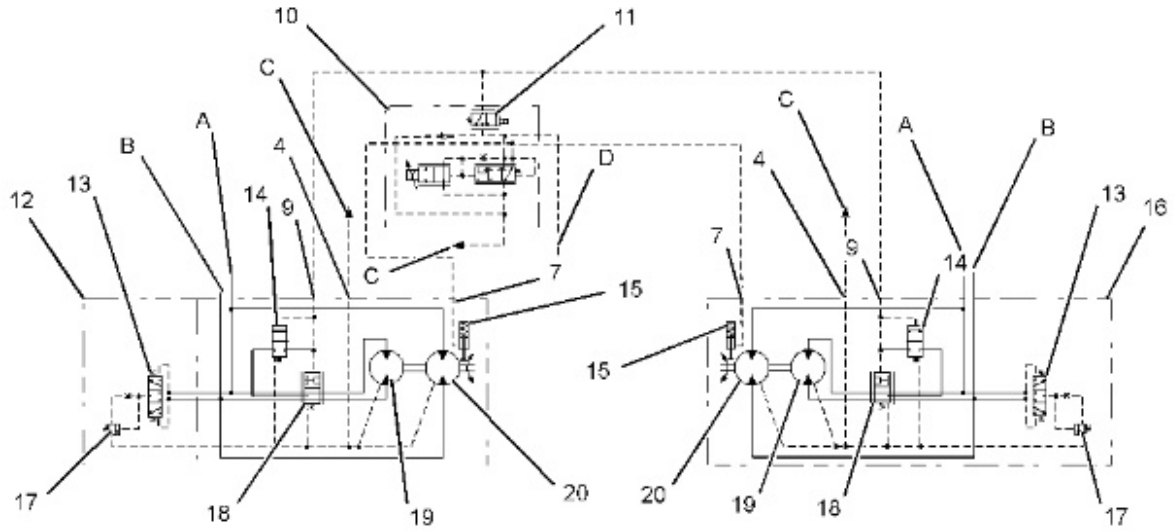


Illustration 9 g01455838

Hydraulic Schematic for the Two Speed

(4) Port for the motor case drain

(7) Port for the brake release

(9) Port for the two speed control

(10) Solenoid Valve and Mounting Group (parking brake)

(11) Solenoid Valve Group (two speed control)

(12) Piston Motor Group (hydrostatic left side)

(13) Flushing valve

(14) Control valve (charge oil)

(15) Parking brake

(16) Piston Motor Group (hydrostatic right side)

(17) Regulator valve

(18) Speed selector valve

(19) Cylinders in the motor that do not receive oil

(20) Cylinders in the motor that receive oil

(A) High pressure line for the "A" loop

(B) High pressure line for the "B" loop

(C) Line to the Return Manifold Group

(D) Oil line from the Gear Pump (charge oil, implement, air conditioner and fan drive)

If the Piston Motor Group (two speed) is not in the rabbit mode, the motor operates in the same manner as the standard piston motor. Refer to " Piston Motor Group (Hydrostatic System)" for additional information.

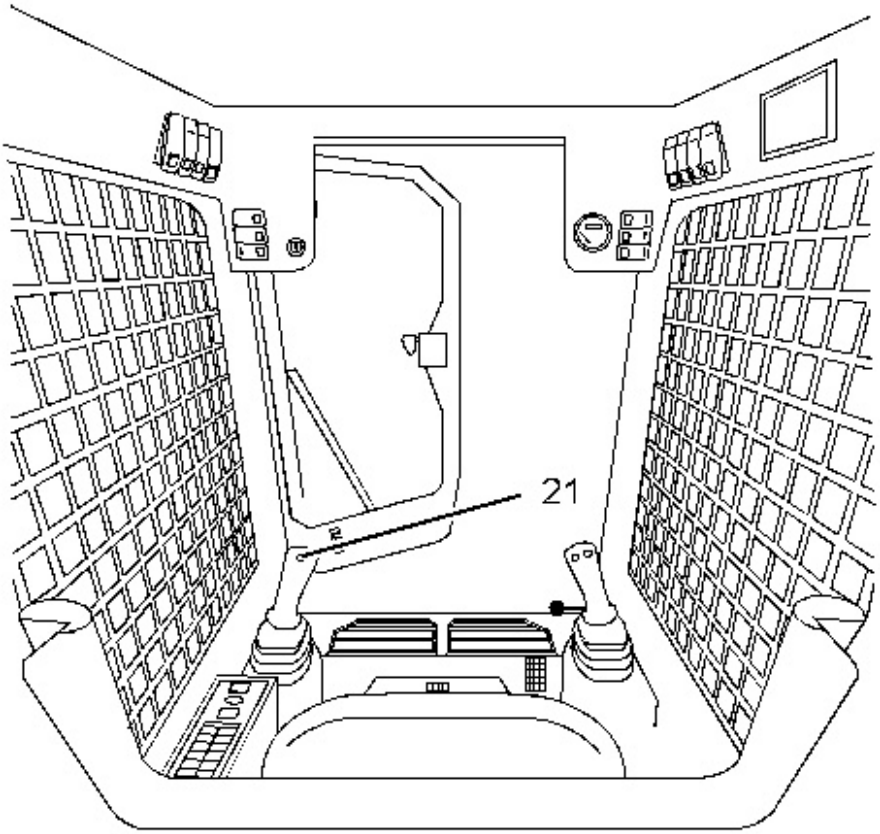


Illustration 10 g01455922

Travel control lever

(21) Travel control lever

When the machine is equipped with two speed capability, the machine can be switched to rabbit mode. A control switch is mounted on the travel control lever (21) which activates the two speed function.

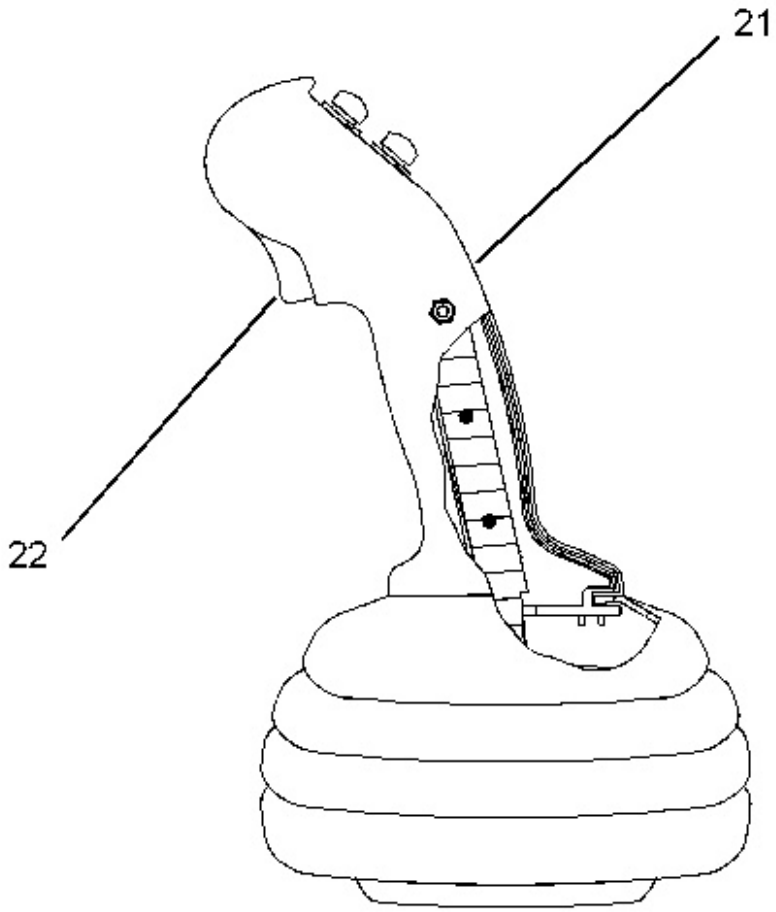


Illustration 11 g01455935

Two speed control switch

(21) Travel control lever

(22) Two speed control switch

The two speed control switch (22) is a toggle switch. Press the button once in order to activate the rabbit mode. Press the switch again in order to deactivate the rabbit mode and return to the normal mode. When the machine is in the normal mode, the hydrostatic system functions in the same manner as the machines that are equipped with the standard piston motors. Refer to the Operation and Maintenance Manual, "Operator Controls (Joystick Controls)" for additional information.

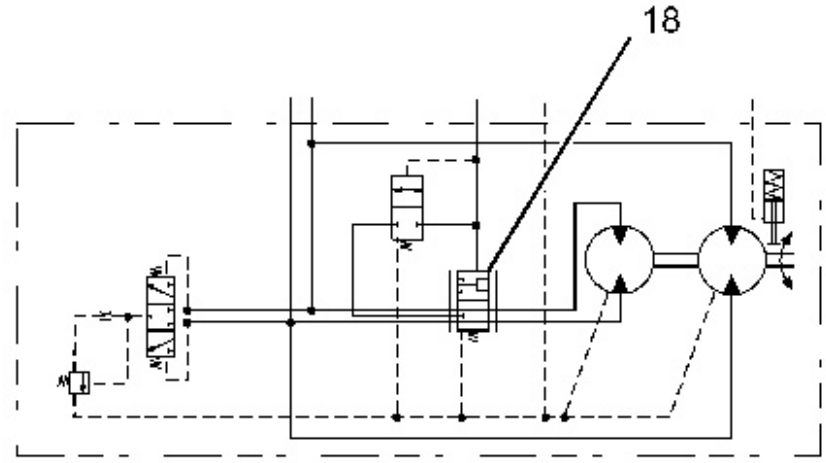


Illustration 12 g01455947

(18) Speed selector valve

When the operator presses the two speed control switch (22) in order to activate the rabbit mode, the switch sends an electrical signal to the Solenoid Valve Group (two speed control) (11). Since the solenoid in the Solenoid Valve Group (two speed control) is now energized the spool that is part of the Solenoid Valve Group (two speed control) shifts to the left. When the spool is shifted to the left the spool will allow charge oil to flow to the port that is for the two speed control (9). The oil then flows to the speed selector valve (18) that is a part of the Piston Motor Group (hydrostatic left side) (12) and the speed selector valve (18) that is a part of the Piston Motor Group (hydrostatic right side) (16) .

When the charge oil pressure is greater than the force of the spring that is positioning the speed selector valves, the charge oil pressure forces the selector valves to shift downward. When the speed selector valves are shifted downward, the speed selector valves will block the flow of high pressure oil from port (A) or (B) to half of the pistons in the motors. The cylinders that do not receive oil (19) will then freewheel as the motor shaft spins. Because only half of the pistons receive oil flow, the oil can fill the cylinders faster. This causes the motor shaft to rotate faster. The output torque of the motor will decrease with the increase in speed.

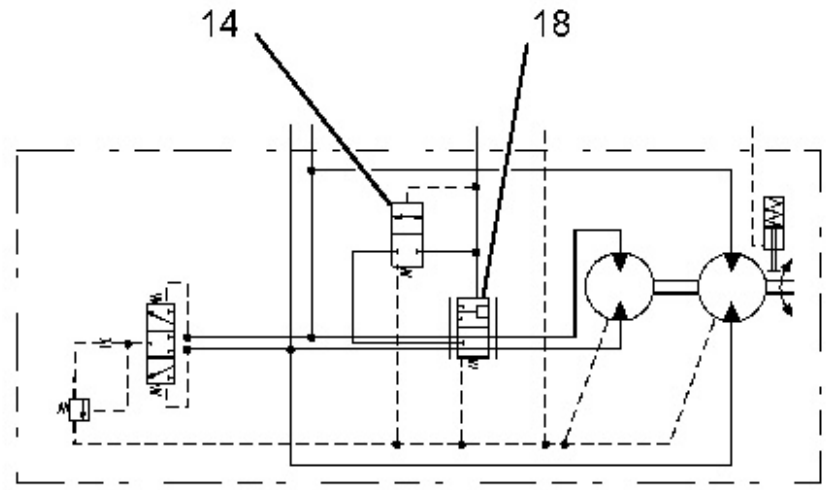


Illustration 13 g01455950

(14) Control valve (charge oil)

(18) Speed selector valve

When the charge oil pressure becomes large, the charge oil pressure also overcomes the force of the spring that is a part of each of the control valves (charge oil) (14). The charge oil pressure causes each of the control valves (charge oil) that are a part of each piston motor to shift downward. When the control valve (charge oil) shifts downward, the control valve allows a constant flow of charge oil to the motor which will keep the pistons in the motor that are freewheeling seated against the cam ring. This keeps the pistons from sliding while the motor is operating at a higher speed.

When the machine is first started, the machine is automatically reset to the normal mode.

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Systems Operation
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8822-00 **Publication Date -01/02/2008** **Date Updated -25/02/2008**

i03980174

Tandem Drive and Axle

SMCS - 3007

Tandem Drive

The tandem drive consists of the following major components:

- Drive chains
- Drive sprockets
- Axles
- Mounting hardware

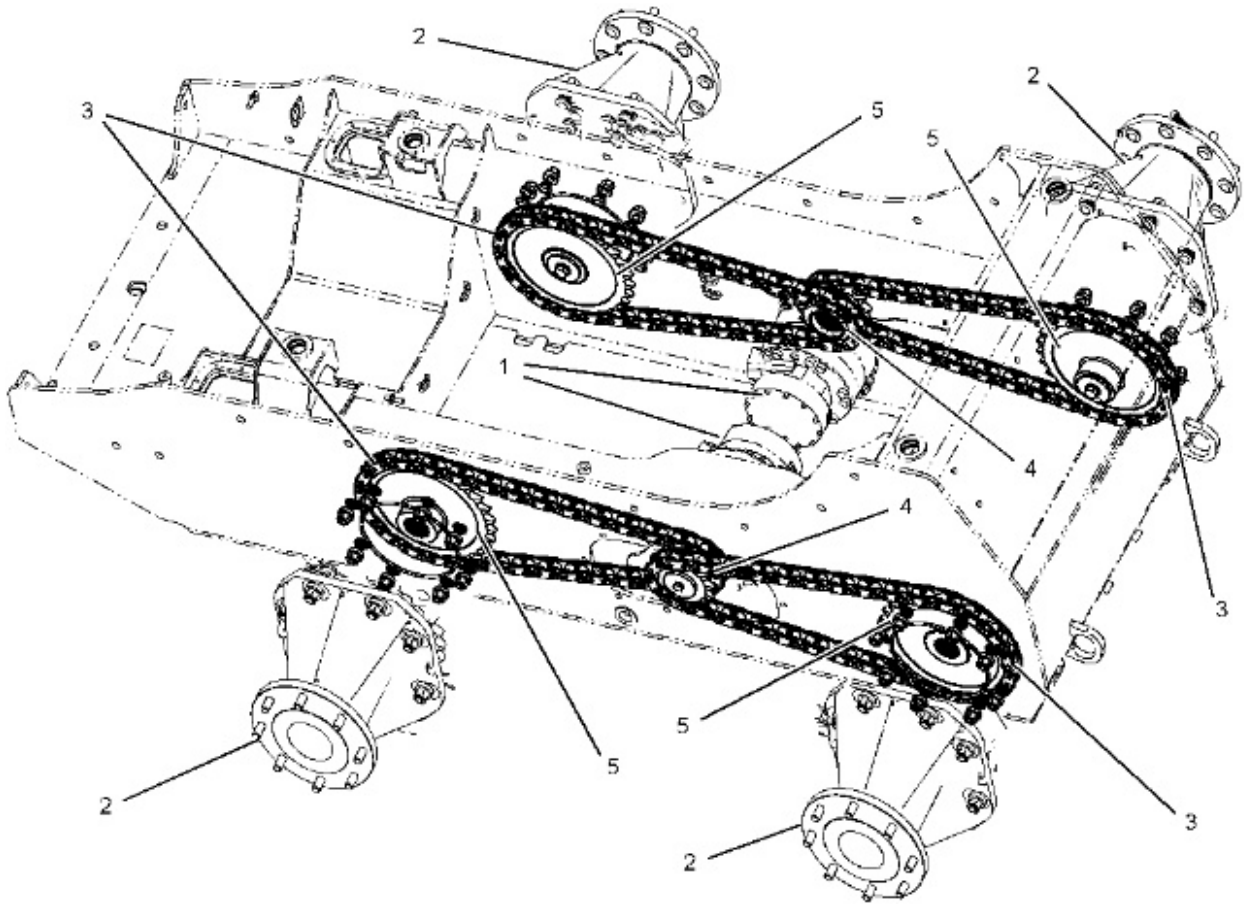


Illustration 1 g01470393

(1) Piston motors (hydrostatic)

(2) Axles

(3) Drive chains

(4) Drive sprockets

(5) Axle sprockets

The tandem drive transfers mechanical power from the piston motors (hydrostatic) (1) to the axles (2) through the chains (3). Torque and speed from each motor is transferred to the chains by double drive sprockets (4). Drive sprockets (4) are not as large as axle sprockets (5). Torque multiplication is created in the tandem drive system because a small gear drives a larger gear.

The inboard chains drive a single sprocket at the rear axles. The outboard chains drive a single sprocket (5) at the front axles.

The chains (3) are high strength drive chains. Lubrication is supplied by an oil bath of "10W30" oil in each drive chain box. The chains are dipped at the bottom of the axle sprockets as the chains rotate.

As running time is accumulated on the drive train, the chains will elongate due to wear in the chain links. Adjustment slots are provided in the axle. Refer to Operation and Maintenance Manual, "Drive Chain Tension - Check/Adjust" for the proper adjustment procedure for the chains.

The teeth on the sprockets are heat treated in order to provide resistance to surface wear. The axle sprockets (5) are attached to the spindles by internal splines, a hardened washer, and a bolt. The

double drive sprockets (4) are attached to the hydraulic motors by internal splines, a retainer, and a bolt.

Axle

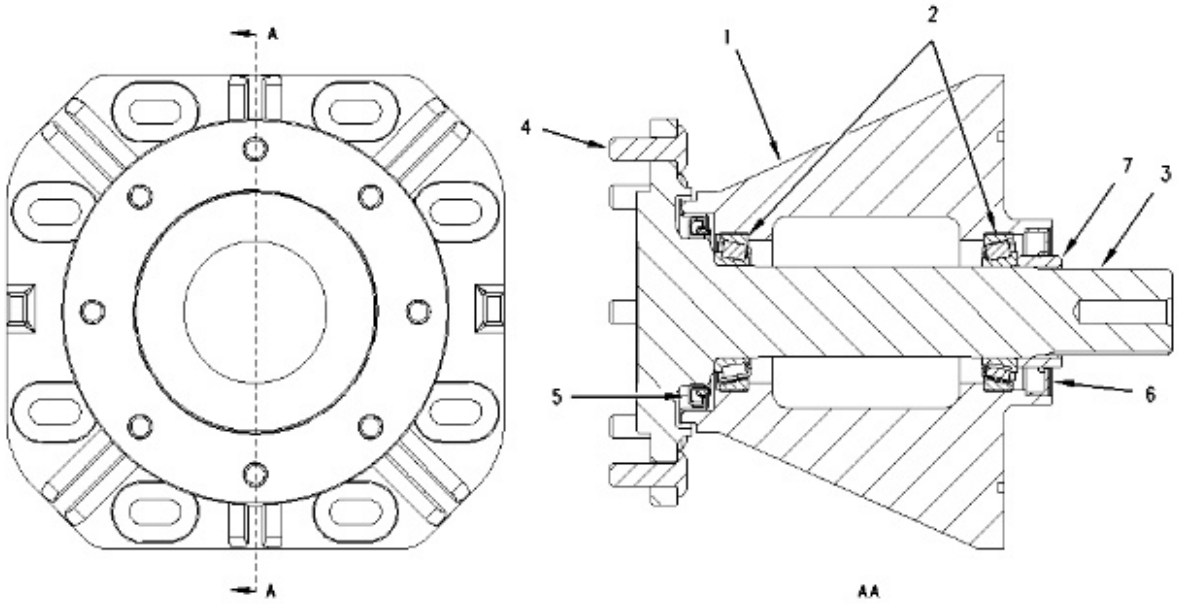


Illustration 2 g00598054

(1) Housing

(2) Roller bearing cup and cone

(3) Spindle

(4) Stud

(5) Seal

(6) Seal

(7) Spacer

The axle consists of the following components:

- housing
- spindle
- two grease seals
- bearing spacer
- two tapered roller bearings

The spindle flange provides a protective lip for hard objects and the flange provides a mounting for the wheel rims.

Bearing grease is retained by the two grease seals (5) and (6) and the bearing spacer (7). The inside lip seal (6) sits on the bearing spacer. The inside lip seal separates the grease for the axle bearing and the oil that is in the drive chain box. The outer seal (5) features sealing elements that are resistant to contamination in addition to an internal grease seal.

Two identical tapered roller bearings support the spindle at each end of the axle housing.

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i02699417

Machine Preparation

SMCS - 4350-035; 5050-035

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic system.

1. Move the machine to a smooth horizontal location. Move the machine away from other machines and personnel. Lower the bucket to the ground. Stop the engine.
2. Permit only one operator on the machine.
3. Block the front tires and the rear tires of the machine.
4. Place a barrier around the machine in order to keep personnel away from rotating machinery.
5. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Visual checks and measurements are the first steps during troubleshooting. Refer to Testing and Adjusting, "Visual Inspection". Next, perform the operational checks. Refer to Testing and Adjusting, "Operational Checks". Finally, perform the required tests and adjustments on the machine.

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Testing and Adjusting
236B, 246B, 252B and 262B Skid Steer Loaders Hydraulic System
Media Number -RENR4867-03 **Publication Date -01/11/2009** **Date Updated -24/11/2009**

i02045270

Visual Inspection

SMCS - 4350-035; 5050-040

Before you perform this procedure, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the system is the first step when you troubleshoot a problem.



Illustration 1 g00696549

1. Check the hydraulic oil level in the sight glass for the hydraulic tank.
2. Look for air bubbles in the oil. Look for water in the oil.

   Note: Air bubbles may be caused by a fitting that is loose or damaged. A loose fitting or a damaged fitting allows air to enter the suction side of the system. This causes the oil to leak.
3. Add oil to the hydraulic system, if necessary. Refer to the Operation and Maintenance Manual for the recommended oil and for the correct procedure.
4. Check all lines, all hoses, and all connections for damage and for leaks. Look for fluid on the ground under the machine.

   Note: If fluid can leak out of a fitting or out of a connection, air can leak into the system.



Illustration 2 g01050319

5. Remove the hydraulic oil filter and inspect the filter for foreign material. A magnet will separate ferrous particles from nonferrous particles.

Next, perform the operational checks and last perform the instrument tests.

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i02721470

Operational Checks

SMCS - 4350-535; 5050-535

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

The following operational checks can be used for the following items:

- find leakage in the system.
- determine whether the pilot operated hydraulic controls are functioning correctly.
- determine whether the pumps and motors are functioning correctly.
- determine whether the whole work tool system is functioning correctly.

In order for the hydraulic system to function properly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set properly will have an impact on other components in the system.

Note: When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Lift Cylinder Speed Test

Note: Perform the lift cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. If the automatic leveling switch is in the ON position, then turn the automatic leveling switch to the OFF position.
5. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
6. Operate the lift cylinder through at least five lift cycles. This will ensure that there is warm oil in the lift cylinders.
7. Tilt the bucket to the full TILT BACK position. Lower the bucket to the full LOWER position.
8. Raise the bucket from the full LOWER position. Record the time from the full LOWER position to the full RAISE position.
9. Lower the bucket from the full RAISE position. Record the time from the full RAISE position to the full LOWER position.
10. Raise the bucket to the full RAISE position. Move the hydraulic control to the FLOAT position. Record the time from the full RAISE position to the full LOWER position.

Table 1

TRAVEL TIME (SPEED) FOR THE LIFT CYLINDERS		
Position of the Hydraulic Control	**236B/ 246B**	**252B/ 262B**
RAISE	2.7 ± 0.5 seconds	4.8 ± 0.5 seconds
LOWER	2.7 ± 0.5 seconds	3.4 ± 0.5 seconds
FLOAT	2.8 ± 0.5 seconds	3.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Tilt Cylinder Speed Test

Note: Perform the tilt cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.

2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinders.
6. Tilt the bucket to the full TILT BACK position. Raise the bucket to the full RAISE position.
7. Tilt the bucket from the full TILT BACK position to the full DUMP position. Record the time from the full TILT BACK position to the full DUMP position.
8. Tilt the bucket from the full DUMP position to the full TILT BACK position. Record the time from the full DUMP position to the full TILT BACK position.
9. Lower the bucket to the ground.

Table 2

TRAVEL TIME (SPEED) FOR THE TILT CYLINDERS	
Position of the Hydraulic Control	**236B/ 246B/ 252B/ 262B**
DUMP	2.1 ± 0.5 seconds
TILT BACK	1.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Hydraulic Quick Coupler (if equipped)

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Press the switch in order to engage the quick coupler. Record the time that is needed to engage the quick coupler. Press the switch in order to disengage the quick coupler. Record the time that is needed to disengage the quick coupler.

Table 3

TRAVEL TIME (SPEED) FOR THE COUPLER CYLINDERS	
Engaging the quick coupler	3.0 seconds maximum
Disengaging the quick coupler	3.0 seconds maximum

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Drift Check (Lift and Tilt Cylinder)

Use this procedure to determine the amount of wear that occurs in the lift cylinders and the tilt cylinders.

Note: Perform the following tests with a general purpose bucket on the machine. If a general purpose bucket is not available, use a load weight of 200 kg (441 lb).

1. Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.
2. Run the engine at HIGH IDLE.
3. Operate the lift cylinders through at least five cycles. This will ensure that there is warm oil in the lift cylinder.
4. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinder.
5. Raise the bucket to the full RAISE position.
6. Tilt the bucket forward until the bucket is parallel with the ground.
7. Reduce the engine speed to LOW IDLE. Stop the engine.
8. Mark the cylinders.
9. Use a stopwatch to count for one minute. Measure the drift of the cylinders.

   Table 4

CYLINDER DRIFT		
Cylinders	**Time**	**Cylinder Drift**
Tilt Cylinders	1 minute	3 mm (0.118 inch)
Lift Cylinders	1 minute	3 mm (0.118 inch)

   Note: If the lift cylinder drift and/or the tilt cylinder drift exceeds the maximum, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

10. Start the engine and lower the bucket to the ground.

Test for Tracking of the Machine (Drift)

This test will determine if each displacement stop is adjusted correctly in each group of rotation. The two displacement stops adjust the maximum stroke of the swashplate in each of the groups of rotation in the forward direction.

Note: If the machine drifts to the same side in both forward and reverse, check the chain tension on both sides of the machine before you proceed with the test.

1. Move the machine to a testing location that is flat, level and 30.5 m (100 ft) long. Allow enough space on each side of the centerline for any machine drift that could exceed 3 m (10 ft).

   .

2. Inflate all four tires to the same air pressure.

3. Start the test outside the test area. The machine must enter the testing location in straight line travel and the machine must be traveling at full speed. The engine must be set to HIGH IDLE and the speed and direction control must be positioned fully forward.

4. Measure the amount of drift and record the direction of the drift.

Table 5

Test for Displacement Stop	
Test	**Specification**
Engine Speed	2860 ± 50 RPM
Drift	3 m (10 ft)

5. If the machine does not pass this test, refer to the Testing and Adjusting, "Maximum Runout Test".

Test for the Operation of the Two Speed Function (if equipped)

Use the following check in order to determine if the two speed function is operating correctly.

1. Fasten the seat belt and lower the armrest.

2. Start the engine. Run the engine at HIGH IDLE.

3. Disengage the parking brake.

4. Move the pilot operated hydraulic control all the way forward.

5. While you keep the machine at full speed, press the switch in order to activate the FAST mode. There should be a noticeable increase in the speed of the machine and the indicator for two speed should light. If there is not a noticeable increase in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

6. While the machine is still traveling, press the switch in order to deactivate the FAST mode. There should be a noticeable decrease in the speed of the machine and the indicator for two speed should shut off. If there is not a noticeable decrease in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

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Hydrostatic System Troubleshooting

SMCS - 4350-035

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Operate the machine in each direction. Note the noises that are not normal and find the sources of the noises.

Troubleshooting Problem List and Probable Causes

Problem 1

The piston pump makes noise.

Probable Cause

1. The hydraulic oil level is low.
2. The hydraulic oil is aerated.
3. The viscosity of the hydraulic oil is incorrect.
4. The charge pressure is too low.
5. The parking brake is not fully disengaging.
6. The hydraulic inlet strainer may be clogged.
7. The gear pump or the piston pump are worn.
8. The hydraulic oil filter may be clogged.

Problem 2

The drive torque is not at specifications.

Probable Cause

1. The relief valve (crossover) may be improperly set. Replace the relief valve.
2. The relief valve (crossover) is stuck in the OPEN position. Replace the relief valve.
3. The brakes are not fully disengaging.
4. The pilot pressure is too low.
5. The piston pump may not be functioning correctly.
6. The piston motor may not be functioning correctly.
7. The chain drives may be misadjusted.
8. The pilot operated hydraulic controls may not be functioning properly.
9. The axle bearings may be damaged.

Problem 3

The output of the piston pump is low.

Probable Cause

1. The hydraulic oil level is low.

2. The gear pump has excessive wear.
3. The pilot pressure is low.
4. The viscosity of the hydraulic oil is incorrect.
5. The speed sensing valve is out of adjustment.
6. The piston pump has too much wear.
7. The relief valves (crossover) are not set to the correct specifications.
8. The pump may have an internal leak.
9. Both of the motors may have an internal leak.
10. The relief valve (charge) is out of adjustment.

Problem 4

There is no pressure from the piston pump.

Probable Cause

1. The hydraulic oil level in the hydraulic tank is low.
2. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
3. The relief valve (charge) is damaged.
4. The gear pump has failed.
5. The speed sensing valve may have failed.
6. The mechanical linkage between the piston pump and the engine has broken.
7. The piston pump has a severe internal leak.

Problem 5

The machine moves when the pilot operated hydraulic control (hydrostatic) is in the NEUTRAL position.

Probable Cause

1. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
2. The neutral position for the piston pump is not set correctly.
3. The piston pump may be worn or damaged.
4. The neutral null setting on the piston pump is incorrect.

Problem 6

The machine will not start to move until the engine speed is very high.

Probable Cause

1. The speed sensing valve is not properly adjusted.
2. There may be a problem with the pilot operated hydraulic control (hydrostatic).
3. The pilot pressure is too low.
4. The brakes may be engaged.
5. The charge pressure may be low.

Problem 7

The machine has low performance. The machine has weak force.

Probable Cause

1. High idle is not set to the correct specifications.
2. Engine power is low.
3. The speed sensing valve is not properly adjusted.
4. A pilot operated hydraulic control is not functioning correctly.
5. The viscosity of the hydraulic oil is incorrect.
6. The parking brake is not fully disengaged.
7. The relief valves (crossover) are not set to the correct specifications.
8. The pilot pressure may be too low.
9. The orifices at the hydraulic control may be plugged.
10. The motors may be worn or the pumps may be worn.
11. The charge pressure is low.

Problem 8

The machine does not move correctly when the pilot operated hydraulic control (hydrostatic) is actuated.

Probable Cause

1. The speed sensing valve may not be set correctly.
2. The charge pressure is too low.
3. The pilot operated hydraulic control (hydrostatic) may not be functioning correctly.
4. The orifices at the hydraulic control may be plugged.
5. The motors may be worn or the pumps may be worn.

Problem 9

The charge pressure is low at LOW IDLE and HIGH IDLE.

Probable Cause

1. There is a leak in the system.
2. The relief valve (charge) is out of adjustment.
3. The gear pump is worn.
4. There is a restriction between the piston pump and the charge pump.

Problem 10

The brakes on the machine are dragging.

Probable Cause

1. The solenoid valve (parking brake) is sticking.
2. The solenoid valve (parking brake) is receiving poor voltage.
3. There is a bad internal seal on the piston motor.
4. The charge pressure is low.
5. The gear pump is worn.
6. There is a restriction between the charge pump and the piston pump.

Problem 11

The machine is not modulating correctly.

Probable Cause

1. The oil temperature is too low.
2. There is a restriction in one of the pilot lines.
3. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
4. The piston pump is worn or damaged.
5. The piston motor is worn or damaged.

Problem 12

The wheel speed is low on both sides of the machine.

Probable Cause

1. The engine may have low power.

2. The machine may not have warmed up sufficiently.
3. The chain drives may be out of adjustment.
4. The axles may be misaligned.
5. The parking brake may be partially engaged.
6. The speed sensing valve may be out of adjustment.
7. The pilot pressure may be incorrect.
8. The charge pressure may be low.
9. High idle is not set to the correct specification.
10. The piston pump is worn or the piston motors are worn.

Problem 13

The machine does not track straight.

Probable Cause

1. The neutral null setting is incorrect.
2. The pilot operated hydraulic control (hydrostatic) is not functioning correctly.
3. One section of the piston pump could be malfunctioning.
4. A piston motor may be malfunctioning.
5. The displacement stops on the piston pumps may need adjustment.
6. The chains may be out of adjustment.
7. The axles may be misaligned.
8. The tires may be mismatched.
9. The tire pressure may be incorrect.
10. The orifices on the hydraulic control may be plugged.

Problem 14

The hydrostatic system is noisy.

Probable Cause

1. The flushing valve in the piston motor is malfunctioning.
2. The piston pump is worn.
3. The charge pressure is low.

4. There is air in the hydraulic oil.
5. The chains are rubbing on the bottom of the chain case.

Problem 15

The two speed function will not operate.

Probable Cause

1. The parking brake is engaged.
2. The solenoid valve (two speed) is sticking.
3. The charge pressure may be low.
4. The solenoid valve (two speed) is not receiving enough voltage.
5. The piston motors are damaged.
6. There is a leak in the system.

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System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Use the following procedure to release the pressure in the hydraulic system. Perform this procedure before any work is done to the hydraulic system.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the pilot accumulator.
2. Stop the engine. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Move the pilot operated hydraulic controls through all of the positions.
4. Turn the engine start switch to the OFF position.
5. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.

The pressure in the hydraulic system has now been released.

Note: Some pilot lines on the downstream side of the accumulator may still contain pressurized oil. Use caution when you disconnect these pilot lines.

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Hydrostatic System - Flush and Fill

SMCS - 4350-046; 4350-544

WARNING

Personal injury or death can result from improperly checking for a leak.

Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.

If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Clean all lines and all components with **4C-6796** Mineral Spirits , and install new filters. After the system has been flushed, dispose of the fluid according to local regulations.

Note: During the filling and the flushing procedure, the hydrostatic system must be at maximum output. The hydrostatic system is normally neutralized when the parking brake is applied. Disengage the parking brake for the following procedure.

Filling the Hydrostatic System

There are two procedures for filling the hydrostatic system on the machine. The recommended procedure should be used when all of the tools are available. The second procedure is the alternative procedure. The second procedure should be used if a **4C-9710** Hand Pump is not available.

Table 1

REQUIRED TOOLS			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-0855	Gauge 0 to 4000 kPa (580 psi)	1
	177-7861	Hose	1
	6V-4143	Coupler Assemblies	2
	6V-3989	Unvalved Nipple	1
B	4C-9710	Hand Pump	1

Recommended Procedure

1. Release the hydraulic system pressure. Refer to Testing and Adjusting for your machine.
2. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.



Illustration 1 g01966595

3. Install tooling (B) to the charge pressure tap (1) .

4. Attach a coupler assembly on the hose from the **4C-9710** Hand Pump onto the fitting for the charge pressure (1) on the hydrostatic pump. Pump hydraulic oil into the fitting for the charge pressure (1) until one of the following events occurs.
    - three minutes elapse.
    - the hydraulic oil level is at the middle of the sight gauge.

    This will pump hydraulic oil into the piston pump.
5. Add hydraulic oil to the hydraulic oil tank if the oil level has not reached the middle of the sight gauge.

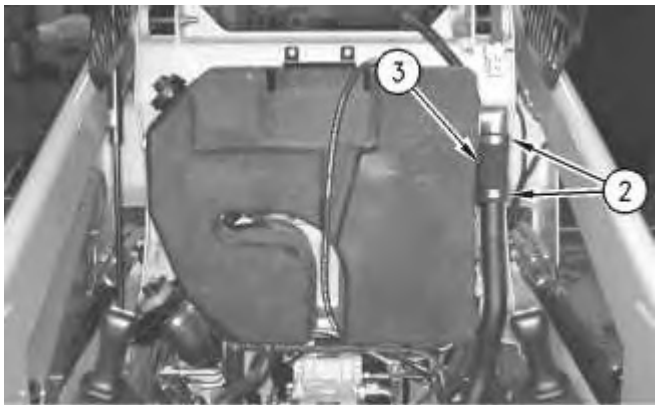


Illustration 2 g00786943

6. Disconnect Tooling (B) from the charge pressure tap.



Illustration 3 g01051682

(4) Charge pressure tap

7. Install tooling (A) to the charge pressure tap. Route the hose so that the hose will not be damaged from lowering the cab.

8. Lower the cab. Refer to the Operation and Maintenance Manual for your machine.

9. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.

10. Start the engine and run the engine at LOW IDLE.

11. Look at the pressure gauge. The pressure should be 3100 ± 200 kPa (450 ± 29 psi) within 15 seconds after start-up. If the pressure is low, stop the engine immediately. Check the hydraulic oil level in the tank. Determine the cause for low charge oil pressure before restarting the engine.

    Note: If the charge pressure is not reached within 15 seconds, damage to the hydrostatic system will occur. Do not allow the hydrostatic system to operate with incorrect charge system pressures.

12. If the charge pressure is reached, stop the engine. Check the hydraulic oil level in the tank. Add hydraulic oil to the hydraulic tank if the oil level is low. Refer to the Operation and Maintenance Manual for your machine.

Alternate Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Follow this procedure if a **4C-9710** Hand Pump is not available.

1. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.

2. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.



Illustration 4 g01366434

3. Disconnect the hydraulic hose (1) .
4. Add hydraulic oil to the piston pump until the port is full.
5. Connect the hydraulic hose (1) .
6. Add hydraulic oil to the hydraulic oil tank until oil reaches the middle of the sight gauge.

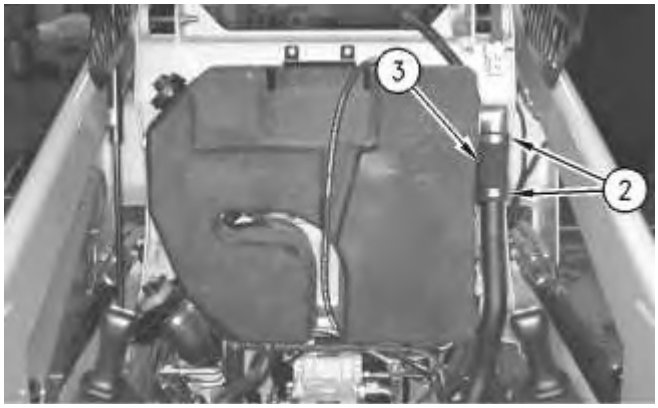


Illustration 5 g00786943

7. Loosen two hose clamps (2) and disconnect hose (3) . Fill the hose with hydraulic fluid and reconnect the hose. Tighten the two hose clamps.



Illustration 6 g01051682

8. Install the **8T-0855** Pressure Gauge to the charge pressure tap (4) with a **177-7861** Hose .
9. Lower the cab.
10. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.
11. Start the engine and run the engine at LOW IDLE.
12. Look at the pressure gauge. The pressure should be 3100 ± 200 kPa (450 ± 29 psi) within 15 seconds after start-up. If the pressure is low, stop the engine immediately. Check the hydraulic oil level in the tank. Determine the cause for low charge oil pressure before you restart the engine.

    Note: If charge pressure is not reached within 15 seconds, damage to the hydrostatic system will occur. Do not allow the hydrostatic system to operate with incorrect charge system pressures.

Flushing The Hydrostatic System

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Flushing of the entire hydrostatic system should be performed after a failure of a component or the replacement of a component.

Note: If the oil becomes contaminated, premature component failure could result. Contaminated oil can also contribute to overheating.

Use the following procedure to flush the oil in the system.

Flush the Drive Lines

1. Block the machine. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.

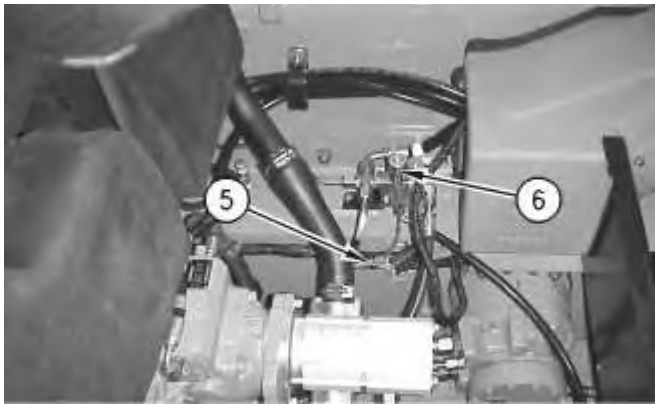


Illustration 7 g00788064

2. Disconnect electrical connection (5) for brake solenoid (6) .
3. Lower the cab.
4. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.
5. Start the engine and allow the engine to run for five minutes before you begin the flushing procedure.
6. Run the engine speed at LOW IDLE.
7. Depress the parking brake switch in order to activate the hydrostatic system and the hydraulic system.

8. Move the pilot operated hydraulic control (hydrostatic) to the FORWARD position. Hold the hydraulic control in the FORWARD position for five seconds after you hear the engine lug slightly.

9. Move the hydraulic control to the NEUTRAL position for five seconds.

10. Move the hydraulic control to the REVERSE position. Hold the hydraulic control in the REVERSE position for five seconds. Release the control to the NEUTRAL position.

11. Adjust the engine speed to HIGH IDLE. Run the machine at HIGH IDLE for one minute.

12. Repeat Steps 8 through 10.

13. Check the hydraulic oil contamination level. Refer to Testing and Adjusting, "Hydraulic Oil Contamination - Test" for the proper procedure.

14. If the levels are not low enough, a **102-2828** Oil Filter (Cleanup) can be installed in order to reduce the levels of contamination. Flush the system up to four times. If the levels are not low enough after the fourth time, drain the hydraulic oil and change the hydraulic oil filter. Refer to the Operation and Maintenance Manual for your machine.

15. When the hydrostatic system is within standards, reconnect the electrical connection (5) for the brake solenoid (6) .

16. Lower the cab and bolt down the cab. Refer to the Operation and Maintenance Manual for your machine.

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Hydrostatic System - Test and Adjust

SMCS - 4350-025; 4350-081

Table 1

Required Tools		
Part number	**Description**	**Quantity**
6V-4143	Quick Connect Coupler	10
177-7861	Hose As	5
6V-3989	Fitting As	6
6V-3966	Fitting As	2
8T-0855	Pressure Gauge 0 to 4000 kPa (580 psi)	3
8T-0854	Pressure Gauge 0 to 1000 kPa (145 psi)	1
8T-0860	Pressure Gauge 0 to 40000 kPa (5802 psi)	1
186-2613	Pressure Gauge 0 to 70000 kPa (10153 psi)	2
1U-5796	Pressure Differential Tool Gp	1
164-3310	Infrared Thermometer	1
9U-7400	Multitach Tool Gp	1
1U-6605	Reflective Tape	1
7X-2444	Swivel Tee	1
4J-5477	O-Ring Seal	1
5P-2937	O-Ring Adapter	1
3J-7354	O-Ring Seal	1

Install a **6V-4143** Quick Connect Coupler to each end of the **177-7861** Hose As . Install a **6V-3989** Fitting to the **8T-0855** . Install a **6V-3989** Fitting to the **8T-0854** Pressure Gauge . You will also need to install a **6V-3989** Fitting to the **186-2613** Pressure Gauge .

Install a **6V-3966** Fitting As into both of the **7X-2444** Swivel Tee and the **5P-2937** O-Ring Adapter .

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".

The tests for the hydraulic system should be done in the following order. In order for the hydrostatic system to function correctly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set correctly will have an impact on other components in the system.

It is not advisable to bypass preceding tests. Do not perform a test before the tests that precede that test have been done. Table 1 lists the equipment that is needed to perform testing on the hydrostatic system. Equivalent tooling may be substituted.

Clearly mark all of the hoses and the corresponding pressure gauges, when the hoses are installed. The hoses and the pressure gauges will be used multiple times in the testing and adjusting procedures.

Throughout the entire testing procedure, MB pressure refers to the hydraulic oil pressure in the forward hydrostatic loop. MA pressure refers to the hydraulic oil pressure in the reverse hydrostatic loop.

Note: The oil in the hydraulic system must be at an operating temperature of 45° ± 5°C (113° ± 9° F). This temperature range is specified for only the standard oil from the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the hydraulic filter. In order to increase the hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the machine in the forward and reverse directions. Move the work tool through the full range of motion.

Baseline for the Hydrostatic System

1. Use cribbing to elevate the machine. The wheels must not touch the ground.

2. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.

3. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the correct procedure.

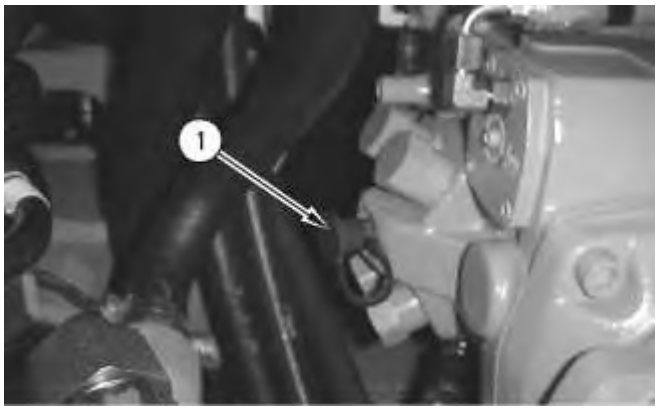


Illustration 1 g00788958

(1) Charge pressure tap

4. Install the **177-7861** Hose to the charge pressure tap (1) on the right side of the hydrostatic piston pump. Connect the **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 2 g00788976

(2) Speed sensing pressure tap

5. Install the **177-7861** Hose to the speed sensing pressure tap (2) . The speed sensing pressure tap is located on the top of the hydrostatic piston pump. Connect the **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 3 g00592868

6. Install the **9U-7400** Multitach Tool Gp on the rear frame and position the sensor in order to pick up the reflective tape on the crankshaft pulley.



Illustration 4 g00592874

7. Install the **9U-7400** Multitach Tool Group in the engine compartment and position the sensor in order to pick up the reflective tape on the fan blade.

8. Route the test hoses so that the cab does not rest on the hoses. Lower the cab. Ensure that the test hoses and cables do not contact the tires. Securely bolt the cab to the frame.

9. Start the engine and operate each work tool function. Operate the hydrostatic drive forward and operate the hydrostatic drive rearward until the hydraulic system reaches an operating temperature of 45° ± 5°C (113° ± 9° F).

10. Set the engine to LOW IDLE and verify the engine RPM. Determine if the engine RPM is within the proper specification. If the engine RPM for LOW IDLE is incorrect, perform the following adjustments to the cable assembly of the governor control:

    - Set the throttle to the HIGH IDLE position.
    - Install the cable assembly to the engine so the cable nuts can be positioned and tightened in order to set the throttle's bracket. The bracket must make contact with the HIGH IDLE stop.
    - Move the throttle to the LOW IDLE position.
    - Adjust the **6V-7357** Bolt until the low idle stop remains in slight contact with the bracket.
    - Tighten the **5C-2890** Nut in order to lock the bolt in place.

    Note: LOW IDLE and HIGH IDLE have been preset at the factory. The setting of the LOW IDLE and the HIGH IDLE on these engines should not be adjusted. Adjusting the setting can void the warranties on the fuel injection pump and the engine. Adjusting the setting can invalidate the standards for emissions. Adjustment of the LOW IDLE and the HIGH IDLE should be made only by trained personnel. The LOW IDLE and HIGH IDLE for most engine applications is given in the Systems Operation, "Engine Design". Some engine applications may have a different LOW IDLE and HIGH IDLE.

    Note: Verify the engine rpm for the LOW IDLE and the HIGH IDLE by referring to the Technical Marketing Information (TMI) or to the Fuel Setting and Related Information Fiche.

Table 2

Model	Low Idle Engine RPM
236B/ 246B/ 252B/ 262B	1000 ± 50 RPM

11. Record the following items at LOW IDLE: engine RPM, charge pressure and speed sensing pressure.

Table 3

Model	Charge Pressure	Pressure for Speed Sensing
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**		
236B/ 246B/ 252B/ 262B	3100 ± 200 kPa (450 ± 29 psi)	950 ± 200 kPa (138 ± 29 psi)

12. Increase the engine speed to HIGH IDLE.

    If the engine speed for HIGH IDLE is incorrect, perform the following checks:

    - Set the throttle to the HIGH IDLE position.
    - Install the cable assembly to the engine so the cable nuts can be positioned and tightened in order to set the throttle's bracket. The bracket must make contact with the high idle stop.
    - Move the throttle to the LOW IDLE position.
    - Adjust the **6V-7357** Bolt until the LOW IDLE stop remains in slight contact with the bracket.
    - Tighten the **5C-2890** Nut in order to lock the bolt in place.

    Note: Low idle and high idle have been preset at the factory. The setting of the LOW IDLE and the HIGH IDLE on these engines should not be adjusted. Adjusting the setting can void the warranties on the fuel injection pump and the engine. Adjusting the setting can invalidate the standards for emissions. Adjustment of the LOW IDLE and the HIGH IDLE should be made only by trained personnel. LOW IDLE and HIGH IDLE for most engine applications is given in the Systems Operation, "Engine Design". Some engine applications may have a different LOW IDLE and HIGH IDLE.

Table 4

Model	High Idle Engine RPM
236B/ 246B/ 252B/ 262B	2860 ± 50 RPM

13. For machines with a standard fan, record the fan RPM at HIGH IDLE engine RPM.

Table 5

Model	Maximum Fan RPM
236B/ 252B	2000 ± 50 RPM
246B/ 262B	2450 ± 50 RPM

14. For machines with a demand fan, perform the following:

    a. Set the engine RPM to HIGH IDLE and install a jumper connector into the plug of the control module for the demand fan. Allow the completion of the calibration of the fan. The fan will stabilize. Record the calibrated fan RPM.

Table 6

Model	Calibrated Fan RPM
246B/ 262B	1764 ± 50 RPM

    b. Remove the jumper connector from the plug of the control module for the fan.

    c. Disconnect the hydraulic oil temperature sensor at the fan motor. Record the maximum fan RPM.

Table 7

Model	Maximum Fan RPM
246B/ 262B	2400 ± 50 RPM

15. Set the engine RPM on all machines. Refer to the table below. Record the speed sensing pressure and the charge pressure.

Table 8

Model	Engine RPM	Speed Sensing Pressure	Charge Pressure
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**			
236B/ 246B/ 252B/ 262B	2300 ± 25 RPM	2000 ± 150 kPa (290 ± 22 psi)	3225 ± 200 kPa (468 ± 29 psi)

Speed Sensing Valve Adjustment

If the speed sensing pressure is low at low idle, perform the following adjustment.

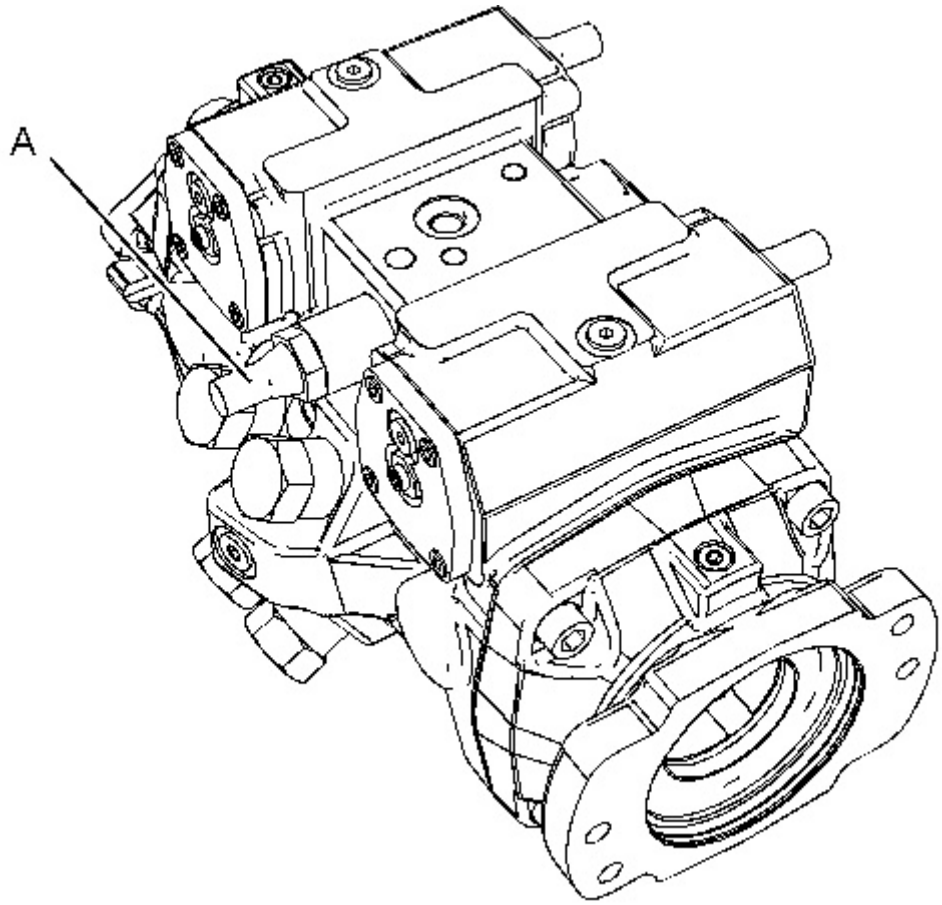


Illustration 5 g01422109

Remove cap (A) from the speed sensing valve.

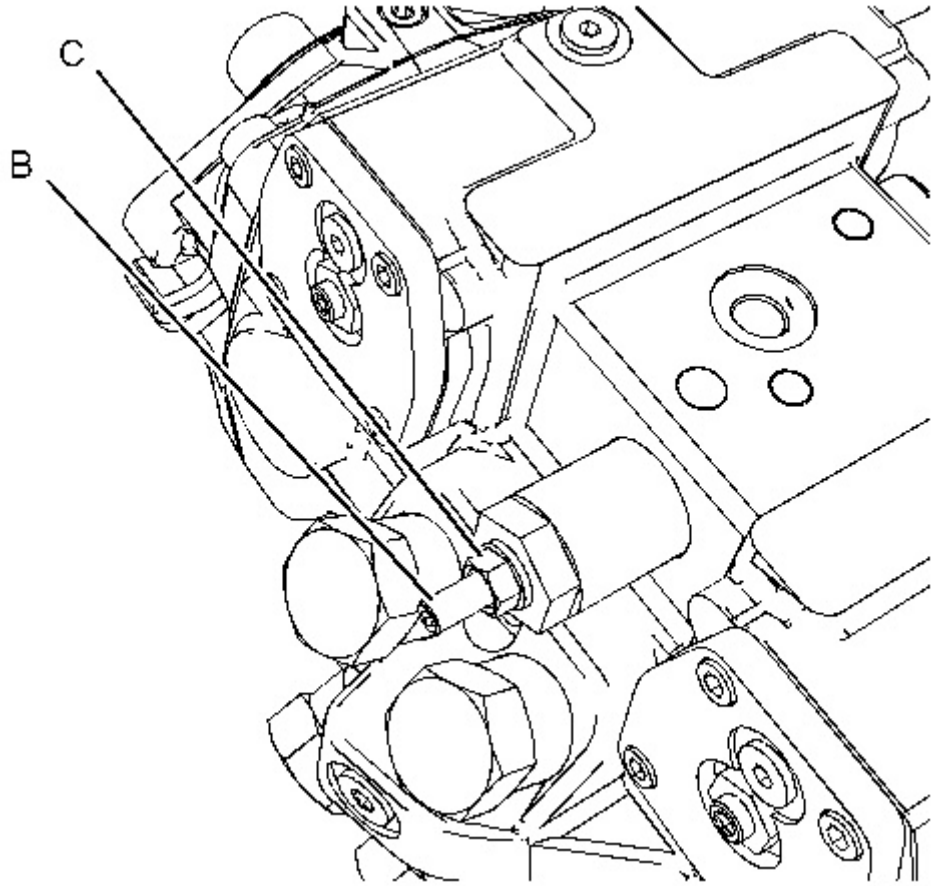


Illustration 6 g01422113

Adjustment to the speed sensing valve

Loosen locknut (C) on the speed sensing valve.

- Turn the adjustment screw (B) on the speed sensing valve counterclockwise.

If the speed sensing pressure is high at low idle, perform the following adjustment.

- Turn the adjustment screw (B) on the speed sensing valve clockwise.

If the speed sensing pressure is low at high idle, perform the following adjustments.

- Turn the adjustment screw (B) on the speed sensing valve counterclockwise.

Note: If any adjustments have been made to the speed sensing valve, then repeat the test until the values are within specifications.

Tighten locknut (C) on the speed sensing valve.

Start To Move Test

Perform the start to move test in order to verify that forward and reverse machine movement begins within specified time after the operator initiates a command.

1. Perform the Hydrostatic System Baseline Test before testing for start to move.

2. Start the engine and operate each work tool function. Operate the hydrostatic drive forward and operate the hydrostatic drive rearward. Operate until the hydraulic system reaches an operating temperature of 45° ± 5°C (113° ± 9° F).

3. Set the engine speed to LOW IDLE.

4. Quickly move the joystick control for drive into forward to the 12 o'clock position. Capture the time until the machine moves. Use a stopwatch to measure the specifications. Immediately return the joystick to the neutral position.

5. Repeat four times. Calculate the average in order to determine the Forward Start to Move time.

6. Quickly move the joystick control for drive into rearward to the 6 o'clock position. Capture the time until the machine moves. Use a stopwatch to measure the specifications. Immediately return the joystick to the neutral position.

7. Repeat four times. Calculate the average in order to determine the Forward Start to Move time.

Table 9

Model	Start to Move Forward.	Start to Move Reverse.
236B/ 246B/ 252B/ 262B	1 second max	1.5 seconds max

Pump Neutral Position Test

Perform the test for the neutral position of the pump in order to make sure that the piston pump is synchronized. If the pump is not synchronized, the machine could drift or the machine could move with the pilot operated hydraulic control (hydrostatic) in the NEUTRAL position. If the pump is not synchronized, the wheel on one side of the machine could start to move before the wheel on the other side of the machine starts to move.

Note: If the left wheel and the right wheel start to move at the same time, this test is not required.

1. Use cribbing to elevate the machine. The wheels must not touch the ground. Make sure that all hoses are out of the way of the rotating wheels.

2. Sit in the operator's seat. Fasten the seat belt and lower the armrest.

3. Start the engine and run the engine at LOW idle.

4. Move the pilot operated hydraulic control (hydrostatic) slowly forward. Check that the left wheel and the right wheel start to move at the same time. If the left wheel and the right wheel start to move at the same time, proceed to the "Maximum Runout"test. If the left wheel and the right wheel do not start to move at the same time, proceed to step 5.

5. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.

Note: Perform the test on rotating group 2 of the piston pump first. Rotating group 2 powers the piston motor which is on the right side of the machine. Rotating group 2 is farthest from the engine.

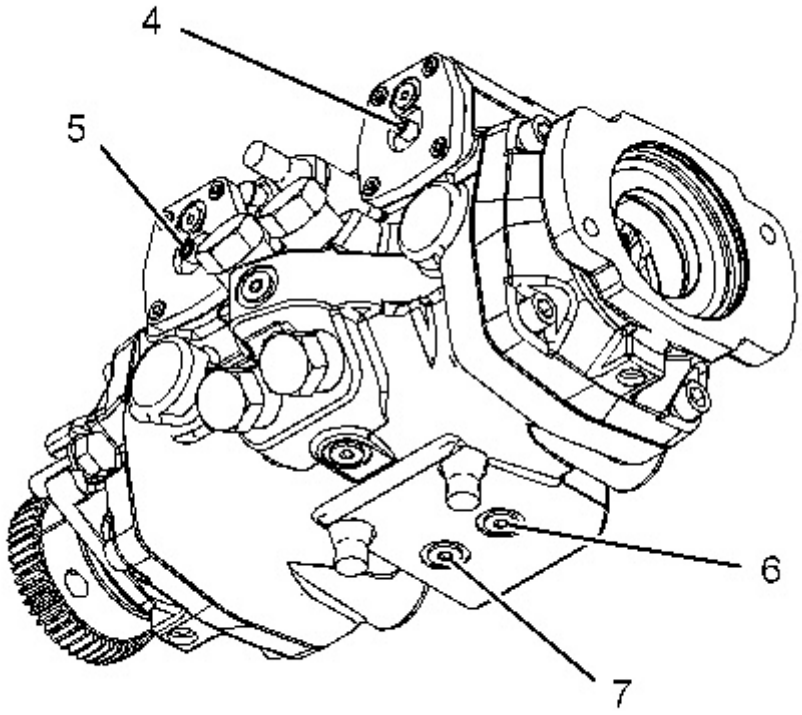


Illustration 7 g01116389

(4) Neutral adjusting bolt for rotating group 2

(5) Neutral adjusting bolt for rotating group 1

(6) MA Port for rotating group 2

(7) MA Port for rotating group 1

6. Remove the plug from the MA port for rotating group 2 (6) . Install **6V-3965** Fitting with **3J -1907** O-Ring Seal into the MA port for rotating group 2 (6) . Install **8T-0860** Pressure Gauge (0 to 40000 kPa) to the MA port for rotating group 2 (6) with the following items: **6V-3989** Fitting , two **6V-4143** Quick Connect Couplers and **177-7860** Hose .

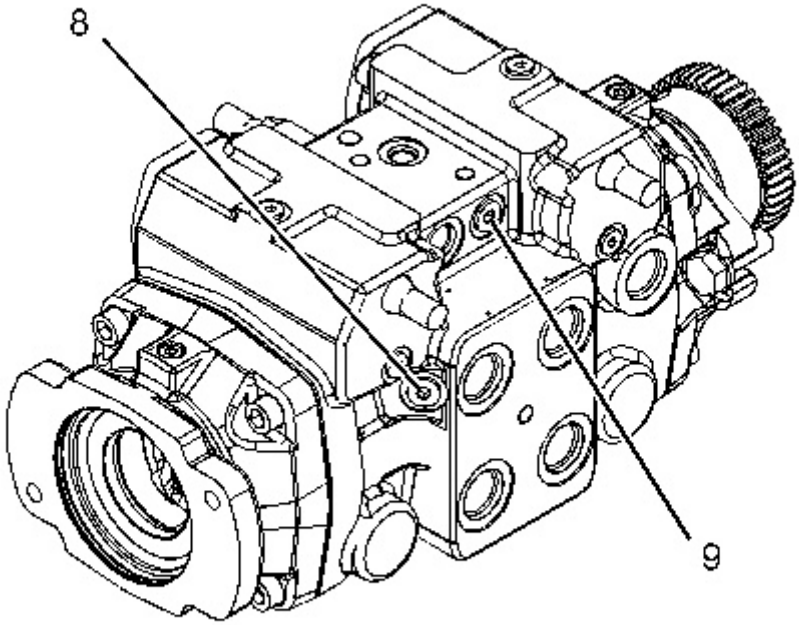


Illustration 8 g01116394

(8) MB Port for rotating group 2

(9) MB Port for rotating group 1

7. Install **8T-0860** Pressure Gauge (0 to 40000 kPa) to the MB port for rotating group 2 (8) with the following items: **6V-3989** Fitting , two **6V-4143** Quick Connect Couplers and **177-7860** Hose .
8. Place the two gauges in an easily visible position.
9. Lower the cab. Route the test hoses so that the cab does not rest on any of the hoses.
10. Fasten the seat belt and lower the armrest.
11. Start the engine and run the engine at LOW idle.
12. Raise the cab.
13. Loosen the locknut for the neutral adjusting bolt. Do not use an impact socket.
14. Turn neutral adjustment screw for rotating group 2 (4) clockwise. Mark the location of the neutral adjusting bolt when the MB pressure begins to increase.
15. Turn neutral adjustment screw (4) counterclockwise. Mark the location of the neutral adjusting bolt when the MA pressure begins to increase.

16. Turn the neutral adjustment screw (4) midway between the two marks.

17. Hold the neutral adjustment screw (4) in position as you tighten the locknut to a torque of 30.0 ± 1.5 N·m (22.1 ± 1.1 lb ft).

18. Lower the cab.

    Note: In the next step, the wheels will rotate. Make sure that all hoses are out of the way of the rotating wheels.

19. Move the pilot operated hydraulic control (hydrostatic) slowly forward. Check that the left wheel and the right wheel start to move at the same time.

20. If the wheels do not start to move at the same time, then repeat this adjustment procedure for rotating group 1.

Maximum Runout

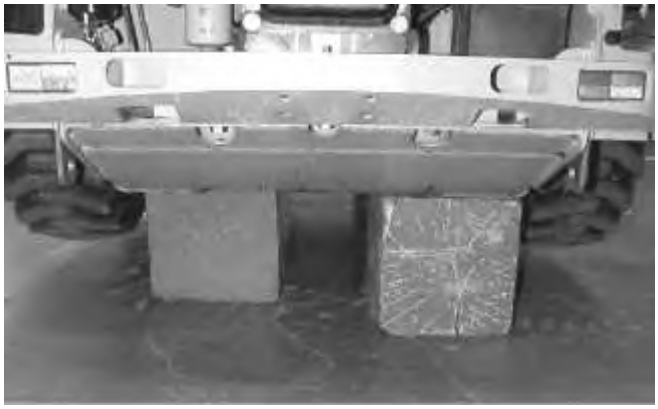


Illustration 9 g00560554

Use cribbing to elevate the machine.

1. Use cribbing to elevate the machine. The wheels must not touch the ground.

2. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.

3. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the correct procedure.



Illustration 10 g00788958

(1) Charge pressure tap

4. Install the **177-7861** Hose to the charge pressure tap (1) on the right side of the hydrostatic piston pump. Connect an **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 11 g00788976

(2) Speed sensing pressure tap

5. Install the **177-7861** Hose to the speed sensing pressure tap (2) on the top of the hydrostatic piston pump and connect an **8T-0855** Pressure Gauge to the other end of this hose.

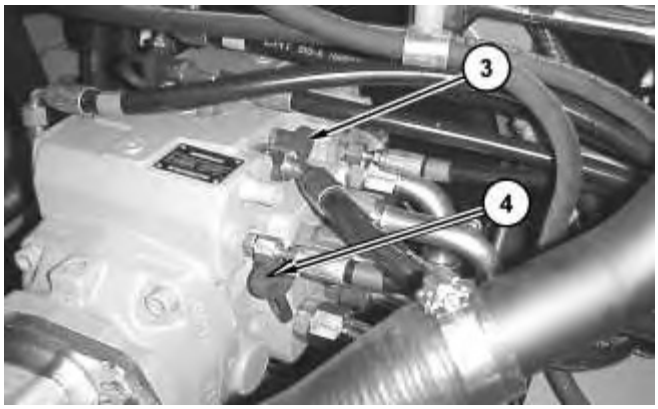


Illustration 12 g01364143

6. Install the **177-7861** Hose to the MB1 (3) and the MB2 (4) onto the pressure ports on the right side of the hydrostatic piston pump. Connect **186-2613** Pressure Gauge to the other end of these hoses and place the hoses in a visible position.



Illustration 13 g00592868

7. Install the **9U-7400** Multitach Tool Gp on the rear frame. Position the sensor in order to read the reflective tape on the crankshaft pulley.

8. Route the test hoses so that the cab does not rest on the hoses. Lower the cab. Ensure that the test hoses and cables do not contact the tires. Securely bolt the cab to the frame.

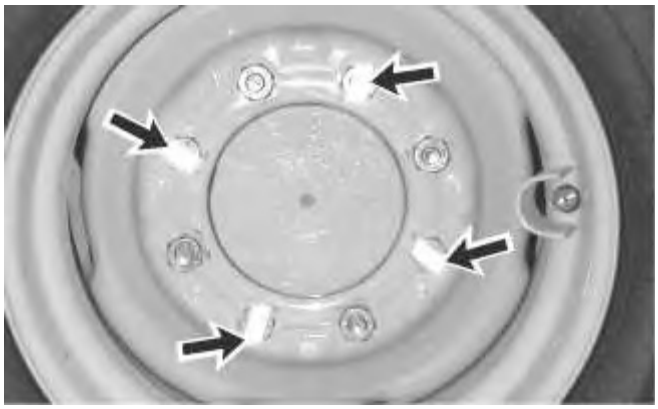


Illustration 14 g00726910

The illustration shows the correct placement of the reflective tape.

9. One wheel on each side of the machine will be checked for correct maximum runout. Apply **1U-6605** Reflective Tape to the wheel studs of each wheel at 90° intervals. Set the sensor to read the tape strips.

10. Start the machine and set the engine to HIGH IDLE. Verify that the hydraulic oil temperature is within the specification of 45° ± 5°C (113° ± 9° F).

11. Operate the left hydraulic pilot control valve in the forward direction. Hold the hydraulic pilot control valve in this position.

12. Use the **9U-7401** Multitach Tool Gp to record the wheel speed. Record the wheel speeds for both sides of the machine. Divide the indicated wheel speed by four in order to calculate the actual wheel speed.

Table 10

Model	Wheel Speed
236B/ 246B	79 ± 6 RPM
236B and 246B (slow speed)	66 ± 6 RPM
252B/ 262B	74 ± 5 RPM
252B and 262B (slow speed)	61 ± 5 RPM

Note: If the wheels are not within 1 RPM of each other, perform the maximum displacement stop adjustment procedure. The hystat displacement stops control of the maximum stroke of the swashplate in each rotating group in the forward direction.

Maximum Displacement Stop Adjustment Procedure

1. To reduce the right wheel speed runout, turn the maximum displacement adjustment screw clockwise. To increase the right side wheel speed runout, turn the maximum displacement adjustment screw counterclockwise. The right side maximum displacement adjustment screw is located on the right side of the hydrostatic pump farthest from the engine. Make

adjustments by turning the screw in increments of 1/8 of a turn and recheck using the maximum runout test.

2. To reduce the left side wheel speed runout, turn the maximum displacement adjustment screw clockwise. To increase the left side wheel speed runout, turn the maximum displacement adjustment screw counterclockwise. The left side maximum displacement adjustment screw is located on the right side of the hydrostatic pump. Make adjustments by turning the screw in increments of 1/8 of a turn and recheck using the maximum runout test.

3. Once the right and left wheel speeds are within the specification, tighten the adjustment screw and the adjustment screw locknut to 22 ± 1 N·m (16.2 ± 0.7 lb ft) and install a **6E-5060** Cap As .

Stall Test

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

The test can be used in order to identify low power problems with the engine. The test is also used to identify the crossover relief valves that may be malfunctioning.

1. Raise the cab. Refer to Operations and Maintenance Manual, "Cab Support Operation" for the correct procedure.

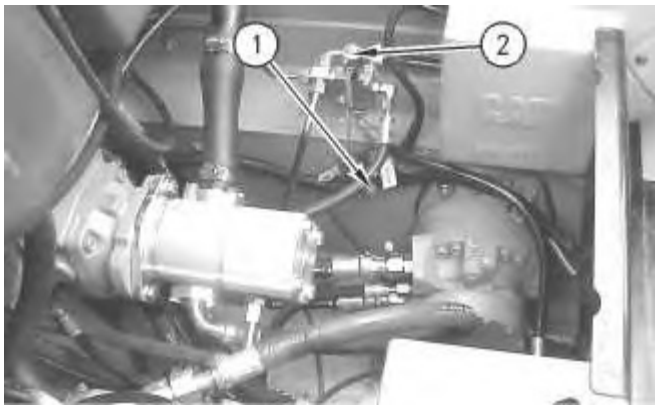


Illustration 15 g00790186

(1) Electrical connection

(2) Brake solenoid

2. Position the machine against an object that will prevent the machine from moving. It is possible to drive through the brakes. Disconnect the electrical connection (1) for the brake solenoid (2) .

3. The **6V-3121** Multitach or the **9U-7400** Multitach Tool Group should still be installed on the machine. If a unit is not installed on the machine, reinstall a multitach.

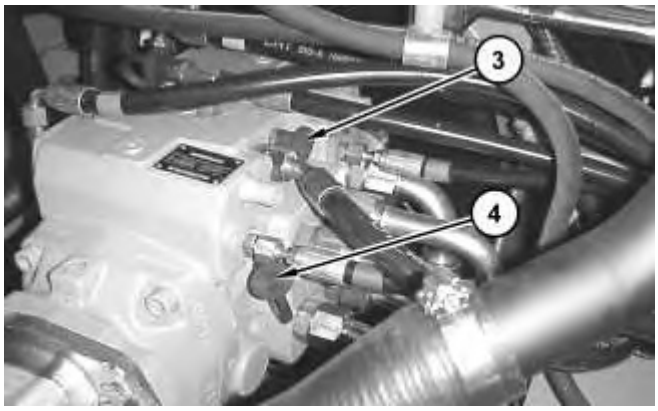


Illustration 16 g01365563

(3) Pressure tap MB for rotating group 1

(4) Pressure tap MB for rotating group 2

4. The two **177-7861** Hose Assemblies should still be attached to the MB pressure ports (3) and (4) . If the hose assemblies are not installed on the machine, reinstall the hose assemblies.

5. Route the test hoses and cables so that the cab will not rest on the hoses and cables. Properly secure the cab.

6. Sit in the operator's seat and fasten the seat belt. Lower the armrest.
7. Start the engine and run the engine at LOW IDLE.
8. Slowly increase the engine speed to HIGH IDLE.
9. Push the pilot operated hydraulic control to the FORWARD position until the engine RPM stabilizes.

   Note: Do not continue to stall the hydrostatic system for more than 15 seconds. Damage to the machine may result.

   Note: The wheels should not spin. If the wheels spin, refer to the Testing and Adjusting, "Brake Test".
10. Record the engine stall speed. Record the MB1 and MB2 pressure values.

Table 11

Model	**Engine Stall**	**MB1 Pressure**	**MB2 Pressure**
236B/ 246B/ 252B/ 262B	2700 ± 200 RPM	38300 ± 2000 kPa (5555 ± 290 psi)	38300 ± 2000 kPa (5555 ± 290 psi)

If the engine stall RPM is not correct, refer to the troubleshooting section.

If the MB pressures are not within the specification, the crossover relief valves may need to be adjusted. Refer to the procedure below.

1. Remove the cap of the crossover relief valve that is not within the specification. Remove the spring and the crossover relief valve.

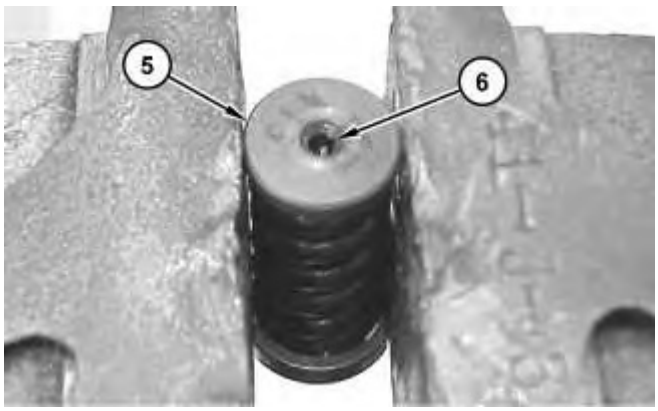


Illustration 17 g01365567

2. Place crossover relief valve (5) into a vise.
3. Turn the set screw (6) counterclockwise in order to loosen the setscrew.

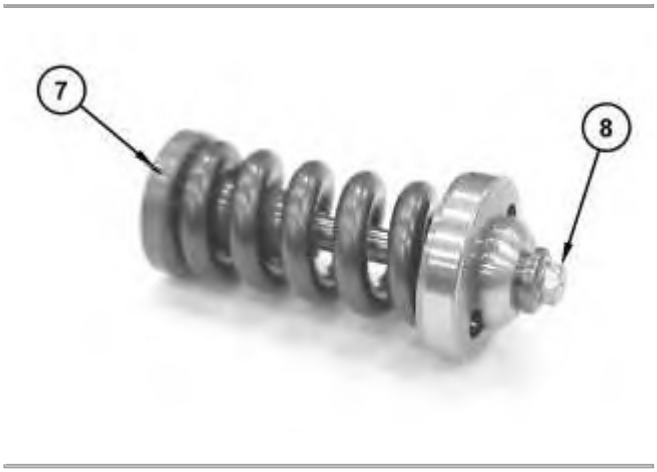


Illustration 18 g01365572

4. Place retainer (7) of the crossover relief valve in a vise. Turn adjustment screw (8) in order to adjust the relief pressure. Turn the adjustment screw clockwise in order to increase the pressure or turn the adjustment screw counterclockwise in order to decrease the pressure. One full turn of the adjustment screw is approximately 6400 kPa (928 psi).

   Note: When you adjust the crossover relief valve to decrease the pressure, turn the adjustment screw for an additional 1/4 turn past the estimated adjustment setting. Then, turn the adjustment screw clockwise for 1/4 turn.

5. Tighten setscrew (6) to a torque of 6.5 N·m (58 lb in).

6. Install crossover relief valve (5) , the spring, and the cap. Tighten the cap to a torque of 160 ± 10 N·m (118 ± 7 lb ft).

Double Stall Test

The test will determine if engine performance is low.

Note: The **6V-3121** Multitach or the **9U-7400** Multitach Tool Group should still be installed on the machine. If the unit is not installed, reinstall the unit.

1. Position the machine against an object that will prevent the machine from moving. It is possible to drive through the brakes.

2. Raise the cab. Refer to the Operations and Maintenance Manual, "Cab Support Operation" for the correct procedure.

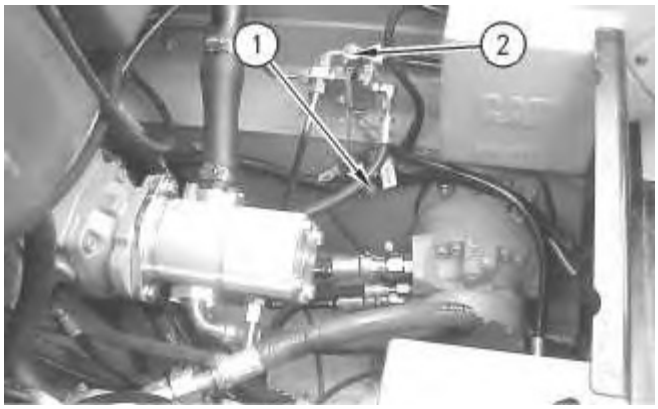


Illustration 19 g01356435

(1) Electrical connection

(2) Brake solenoid

3. Disconnect the electrical connection (1) for the brake solenoid (2) .
4. Sit in the operator's seat and fasten the seat belt. Lower the armrest.
5. Start the engine. Run the engine at LOW IDLE and verify that the oil temperature is within the specification of 45° ± 5°C (113° ± 9°F).
6. Slowly increase the engine speed to HIGH IDLE.

   Note: Do not stall the machine for more than 15 seconds. Damage to the machine could result.
7. Push the pilot operated hydraulic control in the FORWARD direction.
8. At the same time, push the pilot operated hydraulic control (work tool) to the TILT BACK position.
9. Record the engine rpm.

Table 12

Model	Double Stall Engine
236B/ 246B/ 252B/ 262B	2300 ± 400 rpm

If the engine stall RPM is not correct, refer to the troubleshooting section.

Test and Adjust - Work Tool System

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is

injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system. Refer to the Testing and Adjusting, "Visual Inspection".

Note: The hydraulic oil temperature during all system tests must be at an operating temperature of 45° ± 5°C (113° ± 9° F). Use the **164-3310** Infrared Thermometer or a equivalent to measure this temperature at the hydraulic filter. In order to increase the hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the machine in the forward and reverse directions for several minutes.

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Worksheets - Troubleshoot

SMCS - 4350-035; 5050-035

The following tables are provided in order to record information as you perform the tests on the machine. Make copies of these tables so that the tables may be reused for other machines.

The worksheets are designed to be used for the following pressure tests:

- Engine idle
- Cycle times
- Drift checks
- Pump Flow
- Baseline for the hydrostatic system
- Hydrostatic system
- Pilot system
- Main relief valves
- Line relief valves

Troubleshooting Worksheets

The following tables are provided in order to record information as you perform the tests on the machine.

Table 1

MACHINE MODEL		**DATE**	
SERIAL NUMBER		**SERVICE METER HOURS**	
ENGINE SERIAL NUMBER		**ARRANGEMENT NUMBER**	

Table 2

LIFT CYLINDER SPEED TEST			
LIFT'S DIRECTION	**TIME (sec) (236B and 246B)**	**TIME (sec) (252B and 262B)**	**ACTUAL**
Raise	2.7 ± 0.5	4.8 ± 0.5	
Lower	2.7 ± 0.5	3.4 ± 0.5	
Float	2.8 ± 0.5	3.6 ± 0.5	

Table 3

TILT CYLINDER SPEED TEST		
TILT'S DIRECTION	**TIME (sec)**	**ACTUAL**
Tilt Forward	2.1 ± 0.5	
Tilt Back	1.6 ± 0.5	

Table 4

SPEED TEST FOR THE COUPLER CYLINDERS		
CYLINDER POSITION	**MAXIMUM TIME (sec)**	**ACTUAL**
Engaging the quick coupler	3	
Disengaging the quick coupler	3	

Table 5

LIFT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 6

TILT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 7

ENGINE IDLE		
TEST	**SPECIFICATION**	**ACTUAL**

High Idle	2860 ± 50 RPM	
Low Idle	1000 ± 50 RPM	

Table 8

BASELINE FOR THE HYDROSTATIC SYSTEM				
Oil Temperature Range 45° ± 5°C (113° ± 9°F)				
TEST	LOW IDLE		2300 ± 25 RPM	
	SPECIFICATION	ACTUAL	SPECIFICATION	ACTUAL
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Speed Sensing Pressure	950 ± 200 kPa (138 ± 29 psi)		2000 ± 150 kPa (290 ± 22 psi)	

Table 9

TEST	HIGH IDLE SPECIFICATION	ACTUAL
Fan Speed	2000 ± 50 RPM (236B and 252B) 2450 ± 50 RPM (246B and 262B)	
Demand Fan (if equipped)	1764 ± 50 RPM (246B and 262B)	

Table 10

HYDROSTATIC SYSTEM TESTS		
MAXIMUM RUNOUT HIGH IDLE		
Oil Temperature Range 45° ± 5°C (113° ± 9°F)		
TEST	SPECIFICATION	ACTUAL
RPM for left wheel for standard equipped machines	79 ± 6 (236B and 246B) (1) 74 ± 5 (252B and 262B) (1)	
RPM for right wheel for standard equipped machines	79 ± 6 (236B and 246B) (1) 74 ± 5 (252B and 262B) (1)	

RPM for the left wheel on machines that are equipped with two-speed capability in normal mode	66 ± 6 (236B and 246B) [1] 61 ± 5 (252B and 262B) [1]	
RPM for the right wheel on machines that are equipped with two-speed capability in normal mode	66 ± 6 (236B and 246B) [1] 61 ± 5 (252B and 262B) [1]	
Difference in RPM between wheels	1 RPM maximum	
MAXIMUM DISPLACEMENT STOP TEST		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Drift	3 m (10 ft)	
SINGLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2700 ± 200 RPM	
MB Pressure Pump 1	38300 ± 2000 kPa (5555 ± 290 psi)	
MB Pressure Pump 2	38300 ± 2000 kPa (5555 ± 290 psi)	
DOUBLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2300 ± 400 RPM	

[1] The wheel speeds must be within 1 RPM of each other.

Table 11

MAIN RELIEF VALVE PRESSURE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	
Main Relief	23000 ± 700 kPa (3336 ± 102 psi)	

Table 12

LINE RELIEF VALVE PRESSURE (MACHINE TEST)		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**

Lift Cylinder Head RAISE Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Head TILT FORWARD Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Rod TILT BACK Position	23000 ± 700 kPa (3336 ± 102 psi)	
Auxiliary Head	23000 ± 700 kPa (3336 ± 102 psi)	

Table 13

LINE RELIEF VALVE PRESSURE (BENCH TEST)		
HIGH IDLE		
TEST	**PRESSURE**	**ACTUAL**
Lift Cylinder RAISE	27600 ± 700 kPa (4003 ± 102 psi)	
Tilt Cylinder FORWARD	24500 ± 700 kPa (3554 ± 102 psi)	
Tilt Cylinder RACK BACK	27600 ± 700 kPa (4003 ± 102 psi)	
Auxiliary	24500 ± 700 kPa (3554 ± 102 psi)	

Table 14

PILOT SYSTEM PRESSURE TEST				
TEST	**LOW IDLE**		**2300 ± 25 RPM**	
	SPECIFICATION	**ACTUAL**	**SPECIFICATION**	**ACTUAL**
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Pilot Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	

Table 15

BRAKE TEST

LOW IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
Brake Line Pressure	3100 ± 200 kPa (450 ± 29 psi)	

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Machine Preparation

SMCS - 4350-035; 5050-035

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic system.

1. Move the machine to a smooth horizontal location. Move the machine away from other machines and personnel. Lower the bucket to the ground. Stop the engine.
2. Permit only one operator on the machine.
3. Block the front tires and the rear tires of the machine.
4. Place a barrier around the machine in order to keep personnel away from rotating machinery.
5. Release the system pressure before attempting any adjustment. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the proper procedure.

When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Visual checks and measurements are the first steps during troubleshooting. Refer to Testing and Adjusting, "Visual Inspection". Next, perform the operational checks. Refer to Testing and Adjusting, "Operational Checks". Finally, perform the required tests and adjustments on the machine.

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Visual Inspection

SMCS - 4350-035; 5050-040

Before you perform this procedure, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

A visual inspection of the system is the first step when you troubleshoot a problem.



Illustration 1 g00696549

1. Check the hydraulic oil level in the sight glass for the hydraulic tank.
2. Look for air bubbles in the oil. Look for water in the oil.

   Note: Air bubbles may be caused by a fitting that is loose or damaged. A loose fitting or a damaged fitting allows air to enter the suction side of the system. This causes the oil to leak.
3. Add oil to the hydraulic system, if necessary. Refer to the Operation and Maintenance Manual for the recommended oil and for the correct procedure.
4. Check all lines, all hoses, and all connections for damage and for leaks. Look for fluid on the ground under the machine.

   Note: If fluid can leak out of a fitting or out of a connection, air can leak into the system.



Illustration 2 g01050319

5. Remove the hydraulic oil filter and inspect the filter for foreign material. A magnet will separate ferrous particles from nonferrous particles.

Next, perform the operational checks and last perform the instrument tests.

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Operational Checks

SMCS - 4350-535; 5050-535

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.

The following operational checks can be used for the following items:

- find leakage in the system.
- determine whether the pilot operated hydraulic controls are functioning correctly.
- determine whether the pumps and motors are functioning correctly.
- determine whether the whole work tool system is functioning correctly.

In order for the hydraulic system to function properly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set properly will have an impact on other components in the system.

Note: When any test is performed on the hydraulic system, the hydraulic oil must be at an operating temperature of 45° ± 5°C (113° ± 9°F). This temperature range is specified for the standard filled oil at the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the canister for the hydraulic filter. To increase hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the work tool through the full range of motion.

Lift Cylinder Speed Test

Note: Perform the lift cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. If the automatic leveling switch is in the ON position, then turn the automatic leveling switch to the OFF position.
5. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
6. Operate the lift cylinder through at least five lift cycles. This will ensure that there is warm oil in the lift cylinders.
7. Tilt the bucket to the full TILT BACK position. Lower the bucket to the full LOWER position.
8. Raise the bucket from the full LOWER position. Record the time from the full LOWER position to the full RAISE position.
9. Lower the bucket from the full RAISE position. Record the time from the full RAISE position to the full LOWER position.
10. Raise the bucket to the full RAISE position. Move the hydraulic control to the FLOAT position. Record the time from the full RAISE position to the full LOWER position.

Table 1

TRAVEL TIME (SPEED) FOR THE LIFT CYLINDERS		
Position of the Hydraulic Control	**236B2**	**252B2**
RAISE	2.7 ± 0.5 seconds	4.8 ± 0.5 seconds
LOWER	2.7 ± 0.5 seconds	3.4 ± 0.5 seconds
FLOAT	2.8 ± 0.5 seconds	3.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Tilt Cylinder Speed Test

Note: Perform the tilt cylinder speed test with an empty general purpose bucket. If a general purpose bucket is not available, then use a load weight of 200 kg (441 lb).

1. Fasten the seat belt and lower the armrest.

2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinders.
6. Tilt the bucket to the full TILT BACK position. Raise the bucket to the full RAISE position.
7. Tilt the bucket from the full TILT BACK position to the full DUMP position. Record the time from the full TILT BACK position to the full DUMP position.
8. Tilt the bucket from the full DUMP position to the full TILT BACK position. Record the time from the full DUMP position to the full TILT BACK position.
9. Lower the bucket to the ground.

Table 2

TRAVEL TIME (SPEED) FOR THE TILT CYLINDERS	
Position of the Hydraulic Control	**236B2/ 252B2**
DUMP	2.1 ± 0.5 seconds
TILT BACK	1.6 ± 0.5 seconds

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Hydraulic Quick Coupler (if equipped)

1. Fasten the seat belt and lower the armrest.
2. Start the engine.
3. Disengage the parking brake.
4. Run the engine at HIGH IDLE with the pilot operated hydraulic control (hydrostatic) in the HOLD position.
5. Press the switch in order to engage the quick coupler. Record the time that is needed to engage the quick coupler. Press the switch in order to disengage the quick coupler. Record the time that is needed to disengage the quick coupler.

Table 3

TRAVEL TIME (SPEED) FOR THE COUPLER CYLINDERS	
Engaging the quick coupler	3.0 seconds maximum
Disengaging the quick coupler	3.0 seconds maximum

If the speeds are not correct, refer to the Testing and Adjusting, "Hydraulic System Troubleshooting".

Drift Check (Lift and Tilt Cylinder)

Use this procedure to determine the amount of wear that occurs in the lift cylinders and the tilt cylinders.

Note: Perform the following tests with a general purpose bucket on the machine. If a general purpose bucket is not available, use a load weight of 200 kg (441 lb).

1. Before you perform these procedures, refer to Testing and Adjusting, "Machine Preparation" for the correct procedure for machine preparation.
2. Run the engine at HIGH IDLE.
3. Operate the lift cylinders through at least five cycles. This will ensure that there is warm oil in the lift cylinder.
4. Operate the tilt cylinders through at least five cycles. This will ensure that there is warm oil in the tilt cylinder.
5. Raise the bucket to the full RAISE position.
6. Tilt the bucket forward until the bucket is parallel with the ground.
7. Reduce the engine speed to LOW IDLE. Stop the engine.
8. Mark the cylinders.
9. Use a stopwatch to count for one minute. Measure the drift of the cylinders.

   Table 4

CYLINDER DRIFT		
Cylinders	**Time**	**Cylinder Drift**
Tilt Cylinders	1 minute	3 mm (0.118 inch)
Lift Cylinders	1 minute	3 mm (0.118 inch)

   Note: If the lift cylinder drift and/or the tilt cylinder drift exceeds the maximum, refer to Testing and Adjusting, "Hydraulic System Troubleshooting" for probable causes.

10. Start the engine and lower the bucket to the ground.

Test for Tracking of the Machine (Drift)

This test will determine if each displacement stop is adjusted correctly in each group of rotation. The two displacement stops adjust the maximum stroke of the swashplate in each of the groups of rotation in the forward direction.

Note: If the machine drifts to the same side in both forward and reverse, check the chain tension on both sides of the machine before you proceed with the test.

1. Move the machine to a testing location that is flat, level and 30.5 m (100 ft) long. Allow enough space on each side of the centerline for any machine drift that could exceed 3 m (10 ft).

   .

2. Inflate all four tires to the same air pressure.

3. Start the test outside the test area. The machine must enter the testing location in straight line travel and the machine must be traveling at full speed. The engine must be set to HIGH IDLE and the speed and direction control must be positioned fully forward.

4. Measure the amount of drift and record the direction of the drift.

Table 5

Test for Displacement Stop	
Test	**Specification**
Engine Speed	2860 ± 50 RPM
Drift	3 m (10 ft)

5. If the machine does not pass this test, refer to the Testing and Adjusting, "Maximum Runout Test".

Test for the Operation of the Two Speed Function (if equipped)

Use the following check in order to determine if the two speed function is operating correctly.

1. Fasten the seat belt and lower the armrest.

2. Start the engine. Run the engine at HIGH IDLE.

3. Disengage the parking brake.

4. Move the pilot operated hydraulic control all the way forward.

5. While you keep the machine at full speed, press the switch in order to activate the FAST mode. There should be a noticeable increase in the speed of the machine and the indicator for two speed should light. If there is not a noticeable increase in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

6. While the machine is still traveling, press the switch in order to deactivate the FAST mode. There should be a noticeable decrease in the speed of the machine and the indicator for two speed should shut off. If there is not a noticeable decrease in the speed of the machine, refer to the Testing and Adjusting, "Hydrostatic System Troubleshooting".

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Hydrostatic System Troubleshooting

SMCS - 4350-035

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

To prevent injury or death, make sure that the area around the machine is clear of personnel and obstructions before operating the machine.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Operate the machine in each direction. Note the noises that are not normal and find the sources of the noises.

Troubleshooting Problem List and Probable Causes

Problem 1

The piston pump makes noise.

Probable Cause

1. The hydraulic oil level is low.
2. The hydraulic oil is aerated.
3. The viscosity of the hydraulic oil is incorrect.
4. The charge pressure is too low.
5. The parking brake is not fully disengaging.
6. The hydraulic inlet strainer may be clogged.
7. The gear pump or the piston pump are worn.
8. The hydraulic oil filter may be clogged.

Problem 2

The drive torque is not at specifications.

Probable Cause

1. The relief valve (crossover) may be improperly set. Replace the relief valve.
2. The relief valve (crossover) is stuck in the OPEN position. Replace the relief valve.
3. The brakes are not fully disengaging.
4. The pilot pressure is too low.
5. The piston pump may not be functioning correctly.
6. The piston motor may not be functioning correctly.
7. The chain drives may be misadjusted.
8. The pilot operated hydraulic controls may not be functioning properly.
9. The axle bearings may be damaged.

Problem 3

The output of the piston pump is low.

Probable Cause

1. The hydraulic oil level is low.

2. The gear pump has excessive wear.
3. The pilot pressure is low.
4. The viscosity of the hydraulic oil is incorrect.
5. The speed sensing valve is out of adjustment.
6. The piston pump has too much wear.
7. The relief valves (crossover) are not set to the correct specifications.
8. The pump may have an internal leak.
9. Both of the motors may have an internal leak.
10. The relief valve (charge) is out of adjustment.

Problem 4

There is no pressure from the piston pump.

Probable Cause

1. The hydraulic oil level in the hydraulic tank is low.
2. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
3. The relief valve (charge) is damaged.
4. The gear pump has failed.
5. The speed sensing valve may have failed.
6. The mechanical linkage between the piston pump and the engine has broken.
7. The piston pump has a severe internal leak.

Problem 5

The machine moves when the pilot operated hydraulic control (hydrostatic) is in the NEUTRAL position.

Probable Cause

1. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
2. The neutral position for the piston pump is not set correctly.
3. The piston pump may be worn or damaged.
4. The neutral null setting on the piston pump is incorrect.

Problem 6

The machine will not start to move until the engine speed is very high.

Probable Cause

1. The speed sensing valve is not properly adjusted.
2. There may be a problem with the pilot operated hydraulic control (hydrostatic).
3. The pilot pressure is too low.
4. The brakes may be engaged.
5. The charge pressure may be low.

Problem 7

The machine has low performance. The machine has weak force.

Probable Cause

1. High idle is not set to the correct specifications.
2. Engine power is low.
3. The speed sensing valve is not properly adjusted.
4. A pilot operated hydraulic control is not functioning correctly.
5. The viscosity of the hydraulic oil is incorrect.
6. The parking brake is not fully disengaged.
7. The relief valves (crossover) are not set to the correct specifications.
8. The pilot pressure may be too low.
9. The orifices at the hydraulic control may be plugged.
10. The motors may be worn or the pumps may be worn.
11. The charge pressure is low.

Problem 8

The machine does not move correctly when the pilot operated hydraulic control (hydrostatic) is actuated.

Probable Cause

1. The speed sensing valve may not be set correctly.
2. The charge pressure is too low.
3. The pilot operated hydraulic control (hydrostatic) may not be functioning correctly.
4. The orifices at the hydraulic control may be plugged.
5. The motors may be worn or the pumps may be worn.

Problem 9

The charge pressure is low at LOW IDLE and HIGH IDLE.

Probable Cause

1. There is a leak in the system.
2. The relief valve (charge) is out of adjustment.
3. The gear pump is worn.
4. There is a restriction between the piston pump and the charge pump.

Problem 10

The brakes on the machine are dragging.

Probable Cause

1. The solenoid valve (parking brake) is sticking.
2. The solenoid valve (parking brake) is receiving poor voltage.
3. There is a bad internal seal on the piston motor.
4. The charge pressure is low.
5. The gear pump is worn.
6. There is a restriction between the charge pump and the piston pump.

Problem 11

The machine is not modulating correctly.

Probable Cause

1. The oil temperature is too low.
2. There is a restriction in one of the pilot lines.
3. The pilot operated hydraulic control (hydrostatic) is not functioning properly.
4. The piston pump is worn or damaged.
5. The piston motor is worn or damaged.

Problem 12

The wheel speed is low on both sides of the machine.

Probable Cause

1. The engine may have low power.

2. The machine may not have warmed up sufficiently.
3. The chain drives may be out of adjustment.
4. The axles may be misaligned.
5. The parking brake may be partially engaged.
6. The speed sensing valve may be out of adjustment.
7. The pilot pressure may be incorrect.
8. The charge pressure may be low.
9. High idle is not set to the correct specification.
10. The piston pump is worn or the piston motors are worn.

Problem 13

The machine does not track straight.

Probable Cause

1. The neutral null setting is incorrect.
2. The pilot operated hydraulic control (hydrostatic) is not functioning correctly.
3. One section of the piston pump could be malfunctioning.
4. A piston motor may be malfunctioning.
5. The displacement stops on the piston pumps may need adjustment.
6. The chains may be out of adjustment.
7. The axles may be misaligned.
8. The tires may be mismatched.
9. The tire pressure may be incorrect.
10. The orifices on the hydraulic control may be plugged.

Problem 14

The hydrostatic system is noisy.

Probable Cause

1. The flushing valve in the piston motor is malfunctioning.
2. The piston pump is worn.
3. The charge pressure is low.

4. There is air in the hydraulic oil.
5. The chains are rubbing on the bottom of the chain case.

Problem 15

The two speed function will not operate.

Probable Cause

1. The parking brake is engaged.
2. The solenoid valve (two speed) is sticking.
3. The charge pressure may be low.
4. The solenoid valve (two speed) is not receiving enough voltage.
5. The piston motors are damaged.
6. There is a leak in the system.

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System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Use the following procedure to release the pressure in the hydraulic system. Perform this procedure before any work is done to the hydraulic system.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the pilot accumulator.
2. Stop the engine. Turn the engine start switch to the ON position. Disengage the parking brake.
3. Move the pilot operated hydraulic controls through all of the positions.
4. Turn the engine start switch to the OFF position.
5. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.

The pressure in the hydraulic system has now been released.

Note: Some pilot lines on the downstream side of the accumulator may still contain pressurized oil. Use caution when you disconnect these pilot lines.

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Hydrostatic System - Flush and Fill

SMCS - 4350-544; 4350-046

WARNING

Personal injury or death can result from improperly checking for a leak.

Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.

If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Clean all lines and all components with **4C-6796** Mineral Spirits , and install new filters. After the system has been flushed, dispose of the fluid according to local regulations.

Note: During the filling and the flushing procedure, the hydrostatic system must be at maximum output. The hydrostatic system is normally neutralized when the parking brake is applied. Disengage the parking brake for the following procedure.

Filling the Hydrostatic System

There are two procedures for filling the hydrostatic system on the machine. The recommended procedure should be used when all of the tools are available. The second procedure is the alternative procedure. The second procedure should be used if a **4C-9710** Hand Pump is not available.

Table 1

REQUIRED TOOLS			
Tool	**Part Number**	**Part Description**	**Qty**
A	8T-0855	Gauge 0 to 4000 kPa (580 psi)	1
	177-7861	Hose	1
	6V-4143	Coupler Assemblies	2
	6V-3989	Unvalved Nipple	1
B	4C-9710	Hand Pump	1

Recommended Procedure

1. Release the hydraulic system pressure. Refer to Testing and Adjusting for your machine.
2. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.



Illustration 1 g01966595

3. Install tooling (B) to the charge pressure tap (1) .

4. Attach a coupler assembly on the hose from the **4C-9710** Hand Pump onto the fitting for the charge pressure (1) on the hydrostatic pump. Pump hydraulic oil into the fitting for the charge pressure (1) until one of the following events occurs.
    - three minutes elapse.
    - the hydraulic oil level is at the middle of the sight gauge.

    This will pump hydraulic oil into the piston pump.
5. Add hydraulic oil to the hydraulic oil tank if the oil level has not reached the middle of the sight gauge.

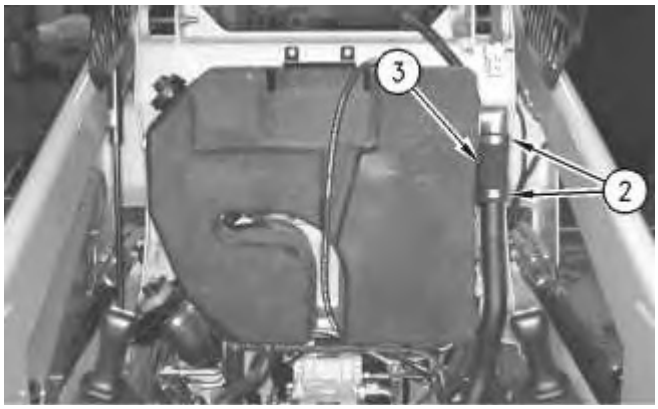


Illustration 2 g00786943

6. Disconnect Tooling (B) from the charge pressure tap.



Illustration 3 g01051682

(4) Charge pressure tap

7. Install tooling (A) to the charge pressure tap. Route the hose so that the hose will not be damaged from lowering the cab.

8. Lower the cab. Refer to the Operation and Maintenance Manual for your machine.

9. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.

10. Start the engine and run the engine at LOW IDLE.

11. Look at the pressure gauge. The pressure should be 3100 ± 200 kPa (450 ± 29 psi) within 15 seconds after start-up. If the pressure is low, stop the engine immediately. Check the hydraulic oil level in the tank. Determine the cause for low charge oil pressure before restarting the engine.

    Note: If the charge pressure is not reached within 15 seconds, damage to the hydrostatic system will occur. Do not allow the hydrostatic system to operate with incorrect charge system pressures.

12. If the charge pressure is reached, stop the engine. Check the hydraulic oil level in the tank. Add hydraulic oil to the hydraulic tank if the oil level is low. Refer to the Operation and Maintenance Manual for your machine.

Alternate Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

Follow this procedure if a **4C-9710** Hand Pump is not available.

1. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.

2. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.



Illustration 4 g01366434

3. Disconnect the hydraulic hose (1) .
4. Add hydraulic oil to the piston pump until the port is full.
5. Connect the hydraulic hose (1) .
6. Add hydraulic oil to the hydraulic oil tank until oil reaches the middle of the sight gauge.

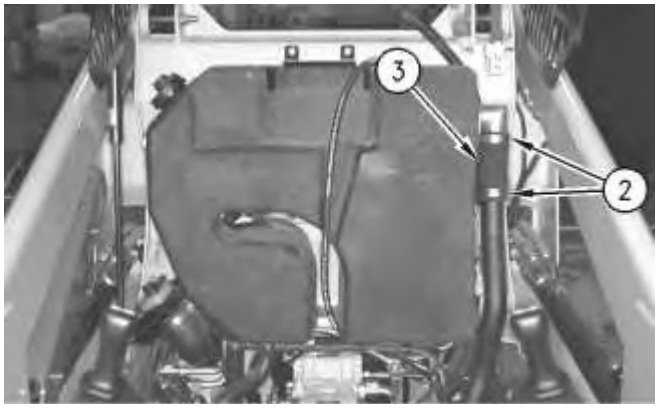


Illustration 5 g00786943

7. Loosen two hose clamps (2) and disconnect hose (3) . Fill the hose with hydraulic fluid and reconnect the hose. Tighten the two hose clamps.



Illustration 6 g01051682

8. Install the **8T-0855** Pressure Gauge to the charge pressure tap (4) with a **177-7861** Hose .
9. Lower the cab.
10. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.
11. Start the engine and run the engine at LOW IDLE.
12. Look at the pressure gauge. The pressure should be 3100 ± 200 kPa (450 ± 29 psi) within 15 seconds after start-up. If the pressure is low, stop the engine immediately. Check the hydraulic oil level in the tank. Determine the cause for low charge oil pressure before you restart the engine.

    Note: If charge pressure is not reached within 15 seconds, damage to the hydrostatic system will occur. Do not allow the hydrostatic system to operate with incorrect charge system pressures.

Flushing The Hydrostatic System

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Flushing of the entire hydrostatic system should be performed after a failure of a component or the replacement of a component.

Note: If the oil becomes contaminated, premature component failure could result. Contaminated oil can also contribute to overheating.

Use the following procedure to flush the oil in the system.

Flush the Drive Lines

1. Block the machine. Raise the cab. Refer to the Operation and Maintenance Manual for your machine.

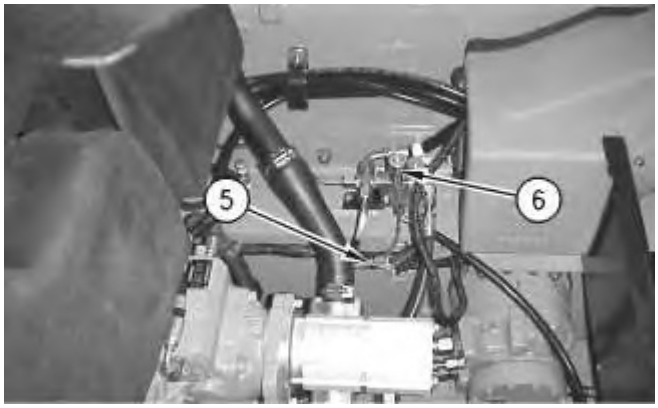


Illustration 7 g00788064

2. Disconnect electrical connection (5) for brake solenoid (6) .
3. Lower the cab.
4. Sit in the operator's seat. Fasten the seat belt. Lower the armrest.
5. Start the engine and allow the engine to run for five minutes before you begin the flushing procedure.
6. Run the engine speed at LOW IDLE.
7. Depress the parking brake switch in order to activate the hydrostatic system and the hydraulic system.

8. Move the pilot operated hydraulic control (hydrostatic) to the FORWARD position. Hold the hydraulic control in the FORWARD position for five seconds after you hear the engine lug slightly.

9. Move the hydraulic control to the NEUTRAL position for five seconds.

10. Move the hydraulic control to the REVERSE position. Hold the hydraulic control in the REVERSE position for five seconds. Release the control to the NEUTRAL position.

11. Adjust the engine speed to HIGH IDLE. Run the machine at HIGH IDLE for one minute.

12. Repeat Steps 8 through 10.

13. Check the hydraulic oil contamination level. Refer to Testing and Adjusting, "Hydraulic Oil Contamination - Test" for the proper procedure.

14. If the levels are not low enough, a **102-2828** Oil Filter (Cleanup) can be installed in order to reduce the levels of contamination. Flush the system up to four times. If the levels are not low enough after the fourth time, drain the hydraulic oil and change the hydraulic oil filter. Refer to the Operation and Maintenance Manual for your machine.

15. When the hydrostatic system is within standards, reconnect the electrical connection (5) for the brake solenoid (6) .

16. Lower the cab and bolt down the cab. Refer to the Operation and Maintenance Manual for your machine.

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Hydrostatic System - Test and Adjust

SMCS - 4350-081; 4350-025

Table 1

Required Tools		
Part number	**Description**	**Quantity**
6V-4143	Quick Connect Coupler	10
177-7861	Hose As	5
6V-3989	Fitting As	6
6V-3966	Fitting As	2
8T-0855	Pressure Gauge 0 to 4000 kPa (580 psi)	3
8T-0854	Pressure Gauge 0 to 1000 kPa (145 psi)	1
8T-0860	Pressure Gauge 0 to 40000 kPa (5802 psi)	1
186-2613	Pressure Gauge 0 to 70000 kPa (10153 psi)	2
1U-5796	Pressure Differential Tool Gp	1
164-3310	Infrared Thermometer	1
9U-7400	Multitach Tool Gp	1
1U-6605	Reflective Tape	1
7X-2444	Swivel Tee	1
4J-5477	O-Ring Seal	1
5P-2937	O-Ring Adapter	1

3J-7354	O-Ring Seal	1

Install a **6V-4143** Quick Connect Coupler to each end of the **177-7861** Hose As. Install a **6V-3989** Fitting to the **8T-0855** . Install a **6V-3989** Fitting to the **8T-0854** Pressure Gauge. You will also need to install a **6V-3989** Fitting to the **186-2613** Pressure Gauge .

Install a **6V-3966** Fitting As into both of the **7X-2444** Swivel Tee and the **5P-2937** O-Ring Adapter.

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Before any tests are performed, prepare the machine. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system for oil leaks and damaged parts. Refer to Testing and Adjusting, "Visual Inspection".

The tests for the hydraulic system should be done in the following order. In order for the hydrostatic system to function correctly, each component in the system must be set to the correct specifications. Some components must be set prior to the testing of other components. A component that is not set correctly will have an impact on other components in the system.

It is not advisable to bypass preceding tests. Do not perform a test before the tests that precede that test have been done. Table 1 lists the equipment that is needed to perform testing on the hydrostatic system. Equivalent tooling may be substituted.

Clearly mark all of the hoses and the corresponding pressure gauges, when the hoses are installed. The hoses and the pressure gauges will be used multiple times in the testing and adjusting procedures.

Throughout the entire testing procedure, MB pressure refers to the hydraulic oil pressure in the forward hydrostatic loop. MA pressure refers to the hydraulic oil pressure in the reverse hydrostatic loop.

Note: The oil in the hydraulic system must be at an operating temperature of 45° ± 5°C (113° ± 9° F). This temperature range is specified for only the standard oil from the factory. Use the **164-3310** Infrared Thermometer or the equivalent to measure this temperature at the hydraulic filter. In order to increase the hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the machine in the forward and reverse directions. Move the work tool through the full range of motion.

Baseline for the Hydrostatic System

1. Use cribbing to elevate the machine. The wheels must not touch the ground.
2. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.
3. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the correct procedure.

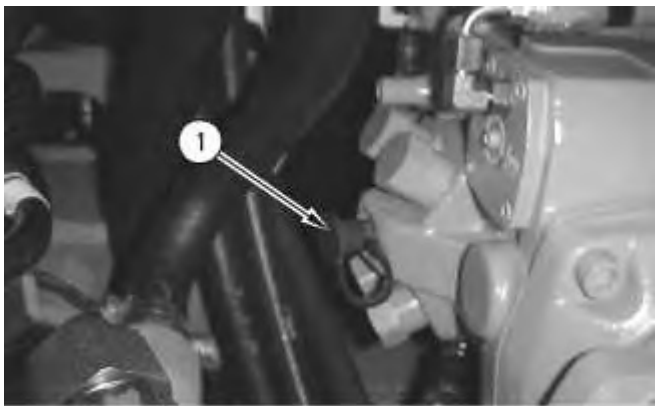


Illustration 1 g00788958

(1) Charge pressure tap

4. Install the **177-7861** Hose to the charge pressure tap (1) on the right side of the hydrostatic piston pump. Connect the **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 2 g00788976

(2) Speed sensing pressure tap

5. Install the **177-7861** Hose to the speed sensing pressure tap (2). The speed sensing pressure tap is located on the top of the hydrostatic piston pump. Connect the **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 3 g00592868

6. Install the **9U-7400** Multitach Tool Gp on the rear frame and position the sensor in order to pick up the reflective tape on the crankshaft pulley.



Illustration 4 g00592874

7. Install the **9U-7400** Multitach Tool Group in the engine compartment and position the sensor in order to pick up the reflective tape on the fan blade.

8. Route the test hoses so that the cab does not rest on the hoses. Lower the cab. Ensure that the test hoses and cables do not contact the tires. Securely bolt the cab to the frame.

9. Start the engine and operate each work tool function. Operate the hydrostatic drive forward and operate the hydrostatic drive rearward until the hydraulic system reaches an operating temperature of 45° ± 5°C (113° ± 9° F).

10. Set the engine to LOW IDLE and verify the engine RPM. Determine if the engine RPM is within the proper specification. If the engine RPM for LOW IDLE is incorrect, perform the following adjustments to the cable assembly of the governor control:

    - Set the throttle to the HIGH IDLE position.
    - Install the cable assembly to the engine so the cable nuts can be positioned and tightened in order to set the throttle's bracket. The bracket must make contact with the HIGH IDLE stop.
    - Move the throttle to the LOW IDLE position.
    - Adjust the **6V-7357** Bolt until the low idle stop remains in slight contact with the bracket.
    - Tighten the **5C-2890** Nut in order to lock the bolt in place.

    Note: LOW IDLE and HIGH IDLE have been preset at the factory. The setting of the LOW IDLE and the HIGH IDLE on these engines should not be adjusted. Adjusting the setting can void the warranties on the fuel injection pump and the engine. Adjusting the setting can invalidate the standards for emissions. Adjustment of the LOW IDLE and the HIGH IDLE should be made only by trained personnel. The LOW IDLE and HIGH IDLE for most engine applications is given in the Systems Operation, "Engine Design". Some engine applications may have a different LOW IDLE and HIGH IDLE.

    Note: Verify the engine rpm for the LOW IDLE and the HIGH IDLE by referring to the Technical Marketing Information (TMI) or to the Fuel Setting and Related Information Fiche.

Table 2

Model	Low Idle Engine RPM
236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	1000 ± 50 RPM
236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	1100 ± 50 RPM

11. Record the following items at LOW IDLE: engine RPM, charge pressure and speed sensing pressure.

Table 3

Model	Charge Pressure	Pressure for Speed Sensing
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**		
236B2/ 252B2	3100 ± 200 kPa (450 ± 29 psi)	950 ± 200 kPa (138 ± 29 psi)

12. Increase the engine speed to HIGH IDLE.

    If the engine speed for HIGH IDLE is incorrect, perform the following checks:

    - Set the throttle to the HIGH IDLE position.
    - Install the cable assembly to the engine so the cable nuts can be positioned and tightened in order to set the throttle's bracket. The bracket must make contact with the high idle stop.
    - Move the throttle to the LOW IDLE position.
    - Adjust the **6V-7357** Bolt until the LOW IDLE stop remains in slight contact with the bracket.
    - Tighten the **5C-2890** Nut in order to lock the bolt in place.

    Note: Low idle and high idle have been preset at the factory. The setting of the LOW IDLE and the HIGH IDLE on these engines should not be adjusted. Adjusting the setting can void the warranties on the fuel injection pump and the engine. Adjusting the setting can invalidate the standards for emissions. Adjustment of the LOW IDLE and the HIGH IDLE should be made only by trained personnel. LOW IDLE and HIGH IDLE for most engine applications is given in the Systems Operation, "Engine Design". Some engine applications may have a different LOW IDLE and HIGH IDLE.

Table 4

Model	High Idle Engine RPM
236B2/ 252B2	2860 ± 50 RPM

13. For machines with a standard fan, record the fan RPM at HIGH IDLE engine RPM.

Table 5

Model	Maximum Fan RPM
236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	2000 ± 50 RPM
236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	2100 ± 50 RPM

14. Set the engine RPM on all machines. Refer to the table below. Record the speed sensing pressure and the charge pressure.

Table 6

Model	Engine RPM	Speed Sensing Pressure	Charge Pressure
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**			
236B2/ 252B2	2300 ± 25 RPM	2000 ± 150 kPa (290 ± 22 psi)	3225 ± 200 kPa (468 ± 29 psi)

Speed Sensing Valve Adjustment

If the speed sensing pressure is low at low idle, perform the following adjustment.

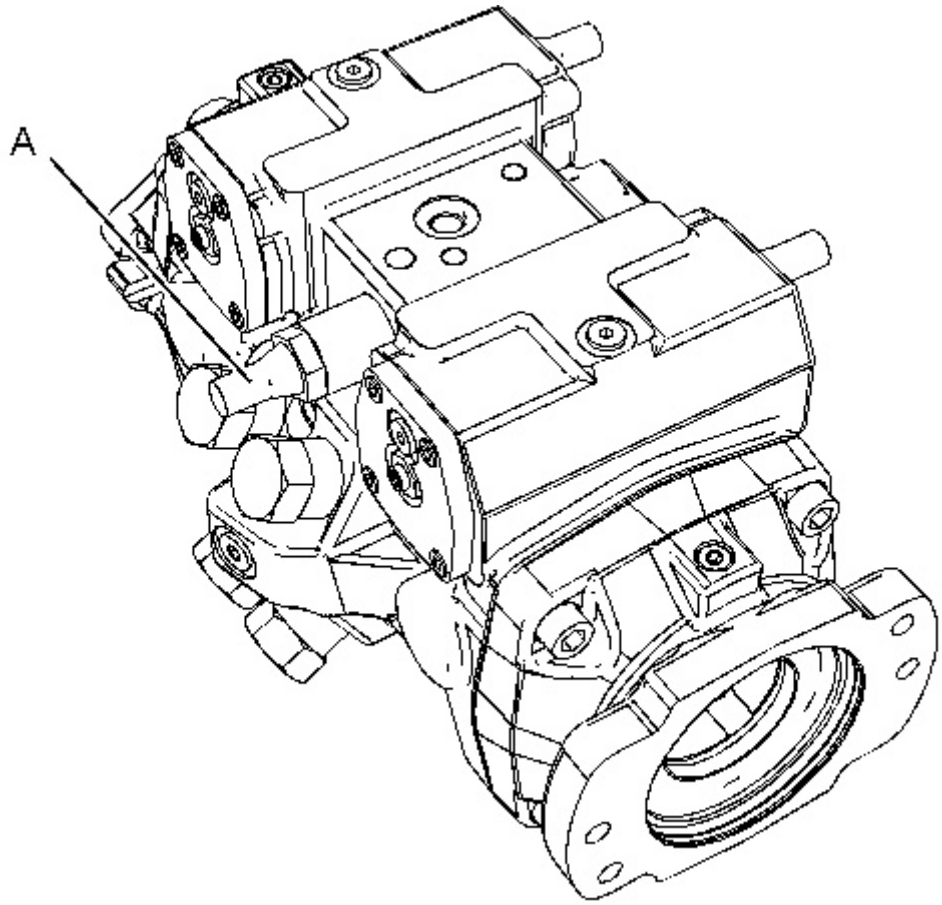


Illustration 5 g01422109

Remove cap (A) from the speed sensing valve.

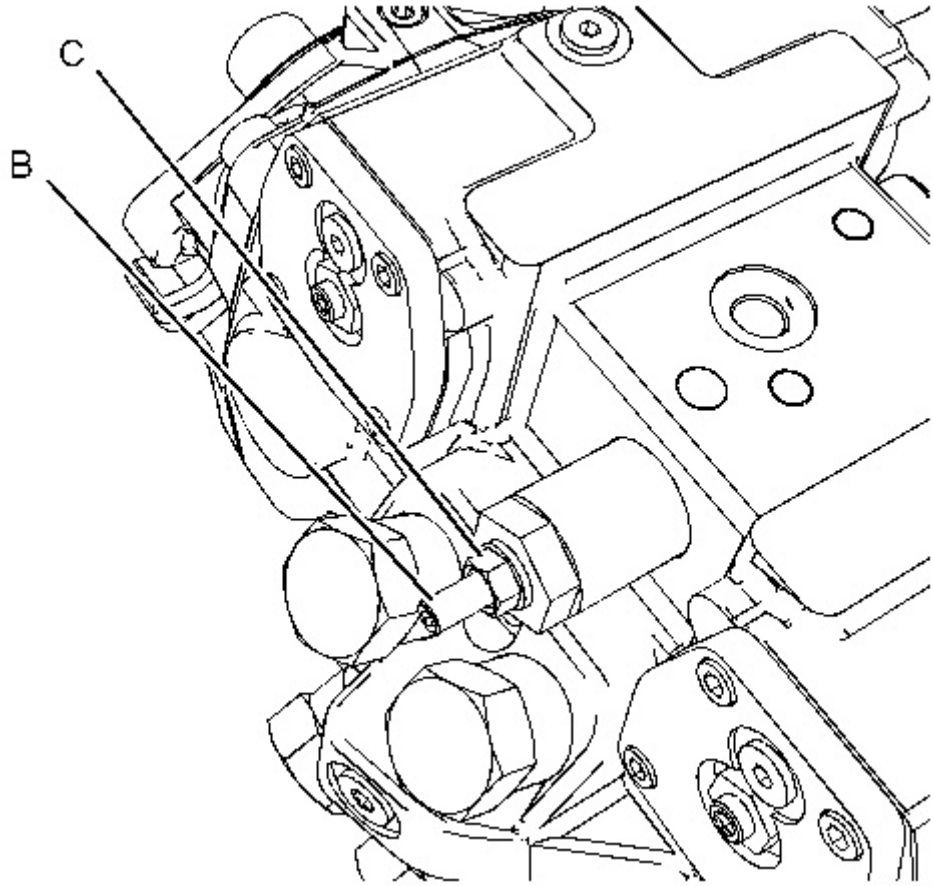


Illustration 6 g01422113

Adjustment to the speed sensing valve

Loosen locknut (C) on the speed sensing valve.

- Turn the adjustment screw (B) on the speed sensing valve counterclockwise.

If the speed sensing pressure is high at low idle, perform the following adjustment.

- Turn the adjustment screw (B) on the speed sensing valve clockwise.

If the speed sensing pressure is low at high idle, perform the following adjustments.

- Turn the adjustment screw (B) on the speed sensing valve counterclockwise.

Note: If any adjustments have been made to the speed sensing valve, then repeat the test until the values are within specifications.

Tighten locknut (C) on the speed sensing valve.

Start To Move Test

Perform the start to move test in order to verify that forward and reverse machine movement begins within specified time after the operator initiates a command.

1. Perform the Hydrostatic System Baseline Test before testing for start to move.

2. Start the engine and operate each work tool function. Operate the hydrostatic drive forward and operate the hydrostatic drive rearward. Operate until the hydraulic system reaches an operating temperature of 45° ± 5°C (113° ± 9° F).

3. Set the engine speed to LOW IDLE.

4. Quickly move the joystick control for drive into forward to the 12 o'clock position. Capture the time until the machine moves. Use a stopwatch to measure the specifications. Immediately return the joystick to the neutral position.

5. Repeat four times. Calculate the average in order to determine the Forward Start to Move time.

6. Quickly move the joystick control for drive into rearward to the 6 o'clock position. Capture the time until the machine moves. Use a stopwatch to measure the specifications. Immediately return the joystick to the neutral position.

7. Repeat four times. Calculate the average in order to determine the Forward Start to Move time.

Table 7

Model	Start to Move Forward.	Start to Move Reverse.
236B2/ 252B2	1 second max	1.5 seconds max

Pump Neutral Position Test

Perform the test for the neutral position of the pump in order to make sure that the piston pump is synchronized. If the pump is not synchronized, the machine could drift or the machine could move with the pilot operated hydraulic control (hydrostatic) in the NEUTRAL position. If the pump is not synchronized, the wheel on one side of the machine could start to move before the wheel on the other side of the machine starts to move.

Note: If the left wheel and the right wheel start to move at the same time, this test is not required.

1. Use cribbing to elevate the machine. The wheels must not touch the ground. Make sure that all hoses are out of the way of the rotating wheels.

2. Sit in the operator's seat. Fasten the seat belt and lower the armrest.

3. Start the engine and run the engine at LOW idle.

4. Move the pilot operated hydraulic control (hydrostatic) slowly forward. Check that the left wheel and the right wheel start to move at the same time. If the left wheel and the right wheel start to move at the same time, proceed to the "Maximum Runout"test. If the left wheel and the right wheel do not start to move at the same time, proceed to step 5.

5. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the proper procedure.

Note: Perform the test on rotating group 2 of the piston pump first. Rotating group 2 powers the piston motor which is on the right side of the machine. Rotating group 2 is farthest from the engine.

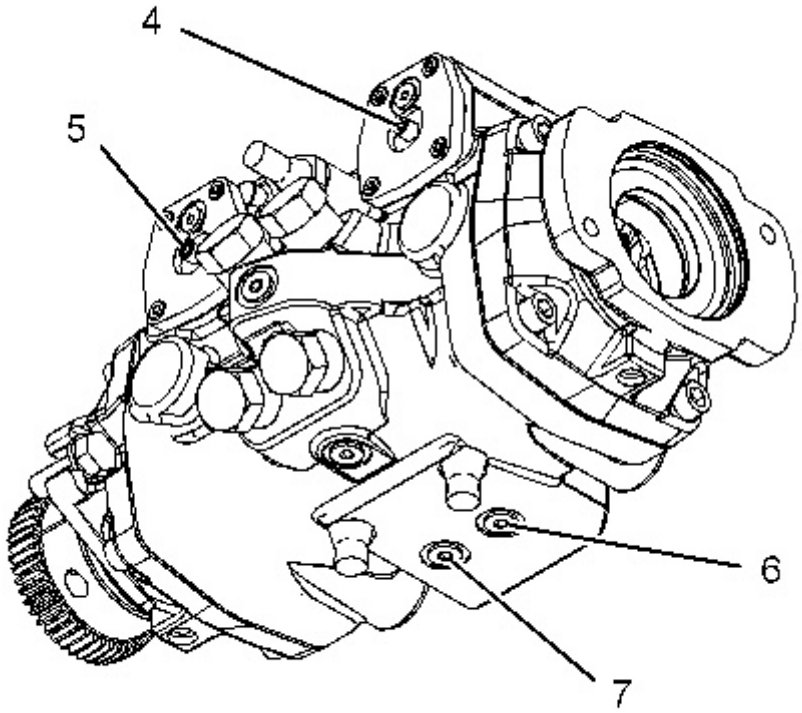


Illustration 7 g01116389

(4) Neutral adjusting bolt for rotating group 2

(5) Neutral adjusting bolt for rotating group 1

(6) MA Port for rotating group 2

(7) MA Port for rotating group 1

6. Remove the plug from the MA port for rotating group 2 (6). Install **6V-3965** Fitting with **3J-1907** O-Ring Seal into the MA port for rotating group 2 (6). Install **8T-0860** Pressure Gauge (0 to 40000 kPa) to the MA port for rotating group 2 (6) with the following items: **6V-3989** Fitting, two **6V-4143** Quick Connect Couplers and **177-7860** Hose .

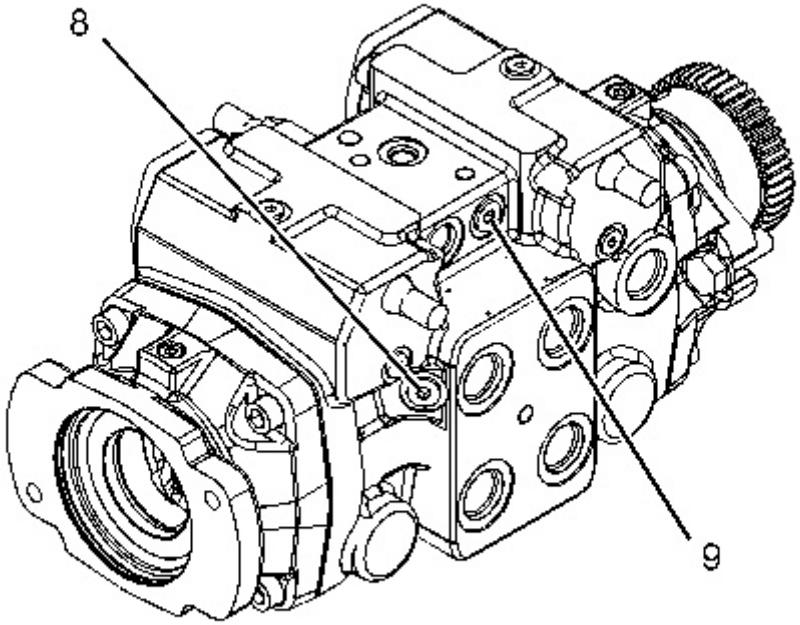


Illustration 8 g01116394

(8) MB Port for rotating group 2

(9) MB Port for rotating group 1

7. Install **8T-0860** Pressure Gauge (0 to 40000 kPa) to the MB port for rotating group 2 (8) with the following items: **6V-3989** Fitting, two **6V-4143** Quick Connect Couplers and **177-7860** Hose .
8. Place the two gauges in an easily visible position.
9. Lower the cab. Route the test hoses so that the cab does not rest on any of the hoses.
10. Fasten the seat belt and lower the armrest.
11. Start the engine and run the engine at LOW idle.
12. Raise the cab.
13. Loosen the locknut for the neutral adjusting bolt. Do not use an impact socket.
14. Turn neutral adjustment screw for rotating group 2 (4) clockwise. Mark the location of the neutral adjusting bolt when the MB pressure begins to increase.
15. Turn neutral adjustment screw (4) counterclockwise. Mark the location of the neutral adjusting bolt when the MA pressure begins to increase.

16. Turn the neutral adjustment screw (4) midway between the two marks.

17. Hold the neutral adjustment screw (4) in position as you tighten the locknut to a torque of 30.0 ± 1.5 N·m (22.1 ± 1.1 lb ft).

18. Lower the cab.

    Note: In the next step, the wheels will rotate. Make sure that all hoses are out of the way of the rotating wheels.

19. Move the pilot operated hydraulic control (hydrostatic) slowly forward. Check that the left wheel and the right wheel start to move at the same time.

20. If the wheels do not start to move at the same time, then repeat this adjustment procedure for rotating group 1.

Maximum Runout

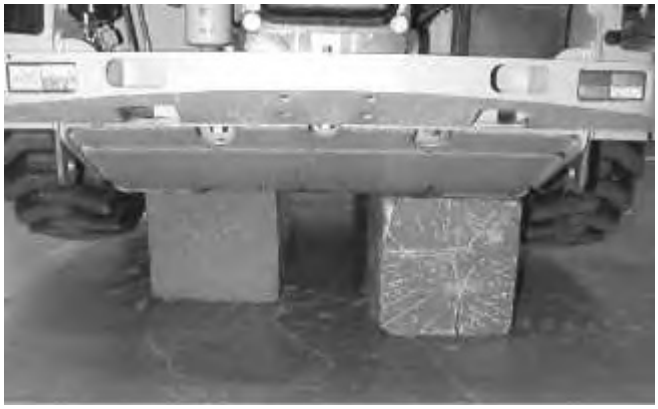


Illustration 9 g00560554

Use cribbing to elevate the machine.

1. Use cribbing to elevate the machine. The wheels must not touch the ground.

2. Release the hydraulic system pressure. Refer to Testing and Adjusting, "Hydraulic System Pressure - Release" for the correct procedure.

3. Raise the cab. Refer to Operation and Maintenance Manual, "Cab Support Operation" for the correct procedure.



Illustration 10 g00788958

(1) Charge pressure tap

4. Install the **177-7861** Hose to the charge pressure tap (1) on the right side of the hydrostatic piston pump. Connect an **8T-0855** Pressure Gauge to the other end of this hose. Place the hose in a visible position.



Illustration 11 g00788976

(2) Speed sensing pressure tap

5. Install the **177-7861** Hose to the speed sensing pressure tap (2) on the top of the hydrostatic piston pump and connect an **8T-0855** Pressure Gauge to the other end of this hose.

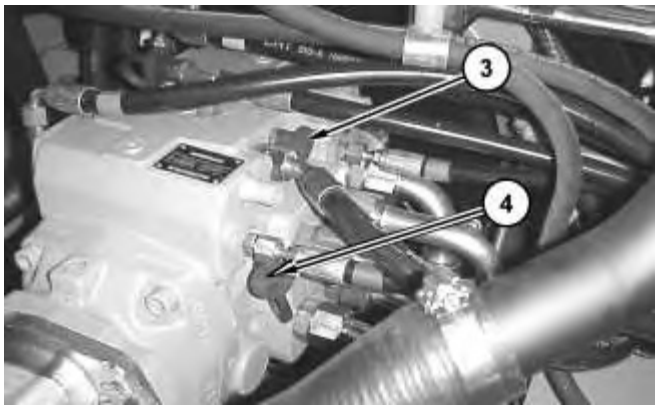


Illustration 12 g01364143

6. Install the **177-7861** Hose to the MB1 (3) and the MB2 (4) onto the pressure ports on the right side of the hydrostatic piston pump. Connect **186-2613** Pressure Gauge to the other end of these hoses and place the hoses in a visible position.



Illustration 13 g00592868

7. Install the **9U-7400** Multitach Tool Gp on the rear frame. Position the sensor in order to read the reflective tape on the crankshaft pulley.

8. Route the test hoses so that the cab does not rest on the hoses. Lower the cab. Ensure that the test hoses and cables do not contact the tires. Securely bolt the cab to the frame.

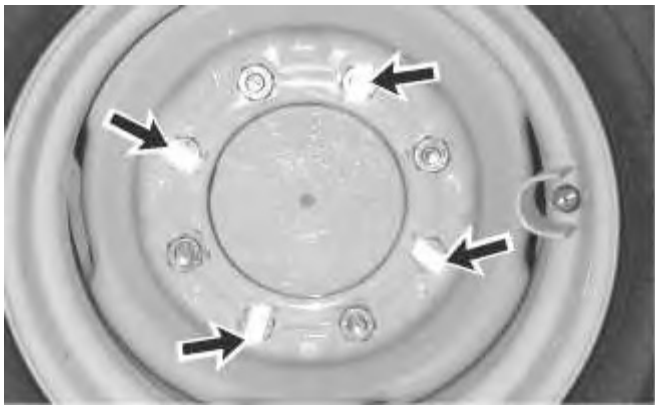


Illustration 14 g00726910

The illustration shows the correct placement of the reflective tape.

9. One wheel on each side of the machine will be checked for correct maximum runout. Apply **1U-6605** Reflective Tape to the wheel studs of each wheel at 90° intervals. Set the sensor to read the tape strips.

10. Start the machine and set the engine to HIGH IDLE. Verify that the hydraulic oil temperature is within the specification of 45° ± 5°C (113° ± 9° F).

11. Operate the left hydraulic pilot control valve in the forward direction. Hold the hydraulic pilot control valve in this position.

12. Use the **9U-7401** Multitach Tool Gp to record the wheel speed. Record the wheel speeds for both sides of the machine. Divide the indicated wheel speed by four in order to calculate the actual wheel speed.

    Note: All machines should be tested in the slow speed mode..

Table 8

Model	Wheel Speed
236B2	79 ± 6 RPM
236B2 (2 speed)	66 ± 6 RPM
252B2	74 ± 5 RPM
252B2 (2 speed)	61 ± 5 RPM

Note: If the wheels are not within 1 RPM of each other, perform the maximum displacement stop adjustment procedure. The hystat displacement stops control of the maximum stroke of the swashplate in each rotating group in the forward direction.

Maximum Displacement Stop Adjustment Procedure

1. To reduce the right wheel speed runout, turn the maximum displacement adjustment screw clockwise. To increase the right side wheel speed runout, turn the maximum displacement adjustment screw counterclockwise. The right side maximum displacement adjustment

screw is located on the right side of the hydrostatic pump farthest from the engine. Make adjustments by turning the screw in increments of 1/8 of a turn and recheck using the maximum runout test.

2. To reduce the left side wheel speed runout, turn the maximum displacement adjustment screw clockwise. To increase the left side wheel speed runout, turn the maximum displacement adjustment screw counterclockwise. The left side maximum displacement adjustment screw is located on the right side of the hydrostatic pump. Make adjustments by turning the screw in increments of 1/8 of a turn and recheck using the maximum runout test.

3. Once the right and left wheel speeds are within the specification, tighten the adjustment screw and the adjustment screw locknut to 22 ± 1 N·m (16.2 ± 0.7 lb ft) and install a **6E-5060** Cap As .

Stall Test

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

The test can be used in order to identify low power problems with the engine. The test is also used to identify the crossover relief valves that may be malfunctioning.

1. Raise the cab. Refer to Operations and Maintenance Manual, "Cab Support Operation" for the correct procedure.

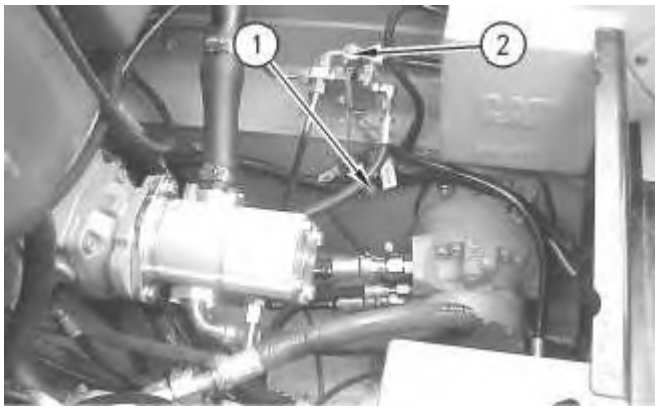


Illustration 15 g00790186

(1) Electrical connection

(2) Brake solenoid

2. Position the machine against an object that will prevent the machine from moving. It is possible to drive through the brakes. Disconnect the electrical connection (1) for the brake solenoid (2) .

3. The **6V-3121** Multitach or the **9U-7400** Multitach Tool Group should still be installed on the machine. If a unit is not installed on the machine, reinstall a multitach.

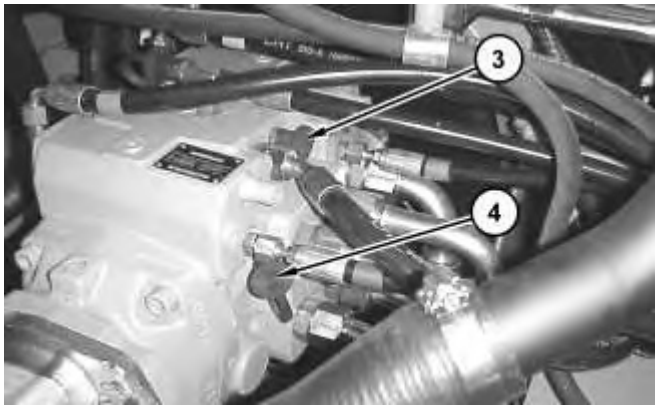


Illustration 16 g01365563

(3) Pressure tap MB for rotating group 1

(4) Pressure tap MB for rotating group 2

4. The two **177-7861** Hose Assemblies should still be attached to the MB pressure ports (3) and (4). If the hose assemblies are not installed on the machine, reinstall the hose assemblies.

5. Route the test hoses and cables so that the cab will not rest on the hoses and cables. Properly secure the cab.

6. Sit in the operator's seat and fasten the seat belt. Lower the armrest.
7. Start the engine and run the engine at LOW IDLE.
8. Slowly increase the engine speed to HIGH IDLE.
9. Push the pilot operated hydraulic control to the FORWARD position until the engine RPM stabilizes.

   Note: Do not continue to stall the hydrostatic system for more than 15 seconds. Damage to the machine may result.

   Note: The wheels should not spin. If the wheels spin, refer to the Testing and Adjusting, "Brake Test".
10. Record the engine stall speed. Record the MB1 and MB2 pressure values.

Table 9

Model	**Engine Stall**	**MB1 Pressure**	**MB2 Pressure**
236B2/ 252B2	2700 ± 200 RPM	38300 ± 2000 kPa (5555 ± 290 psi)	38300 ± 2000 kPa (5555 ± 290 psi)

If the engine stall RPM is not correct, refer to the troubleshooting section.

If the MB pressures are not within the specification, the crossover relief valves may need to be adjusted. Refer to the procedure below.

1. Remove the cap of the crossover relief valve that is not within the specification. Remove the spring and the crossover relief valve.

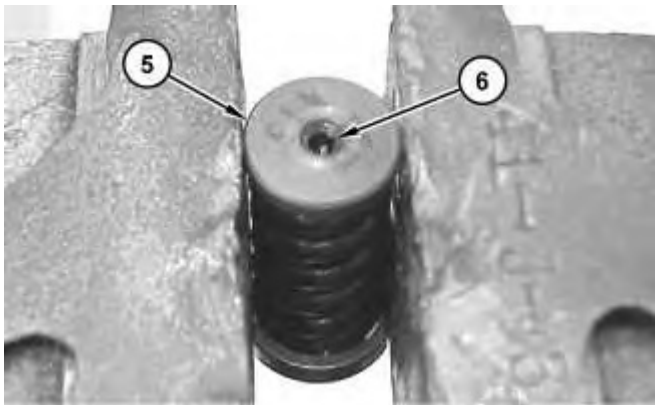


Illustration 17 g01365567

2. Place crossover relief valve (5) into a vise.
3. Turn the set screw (6) counterclockwise in order to loosen the setscrew.



Illustration 18 g01365572

4. Place retainer (7) of the crossover relief valve in a vise. Turn adjustment screw (8) in order to adjust the relief pressure. Turn the adjustment screw clockwise in order to increase the pressure or turn the adjustment screw counterclockwise in order to decrease the pressure. One full turn of the adjustment screw is approximately 6400 kPa (928 psi).

   Note: When you adjust the crossover relief valve to decrease the pressure, turn the adjustment screw for an additional 1/4 turn past the estimated adjustment setting. Then, turn the adjustment screw clockwise for 1/4 turn.

5. Tighten setscrew (6) to a torque of 6.5 N·m (58 lb in).

6. Install crossover relief valve (5), the spring, and the cap. Tighten the cap to a torque of 160 ± 10 N·m (118 ± 7 lb ft).

Double Stall Test

The test will determine if engine performance is low.

Note: The **6V-3121** Multitach or the **9U-7400** Multitach Tool Group should still be installed on the machine. If the unit is not installed, reinstall the unit.

1. Position the machine against an object that will prevent the machine from moving. It is possible to drive through the brakes.

2. Raise the cab. Refer to the Operations and Maintenance Manual, "Cab Support Operation" for the correct procedure.

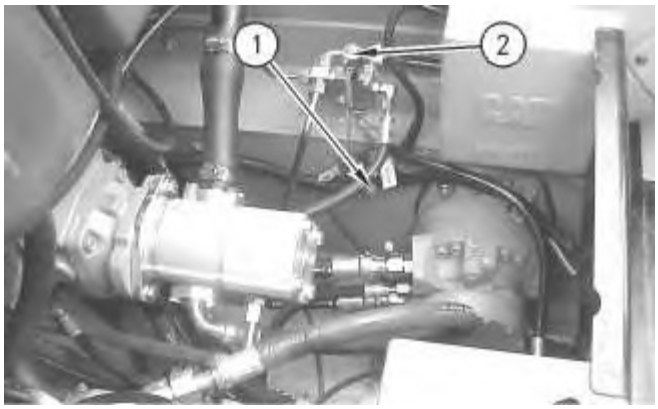


Illustration 19 g01356435

(1) Electrical connection

(2) Brake solenoid

3. Disconnect the electrical connection (1) for the brake solenoid (2) .
4. Sit in the operator's seat and fasten the seat belt. Lower the armrest.
5. Start the engine. Run the engine at LOW IDLE and verify that the oil temperature is within the specification of 45° ± 5°C (113° ± 9°F).
6. Slowly increase the engine speed to HIGH IDLE.

   Note: Do not stall the machine for more than 15 seconds. Damage to the machine could result.
7. Push the pilot operated hydraulic control in the FORWARD direction.
8. At the same time, push the pilot operated hydraulic control (work tool) to the TILT BACK position.
9. Record the engine rpm.

Table 10

Model	Double Stall Engine
236B2/ 252B2	2300 ± 400 rpm

If the engine stall RPM is not correct, refer to the troubleshooting section.

Test and Adjust − Work Tool System

WARNING

Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is

injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Do not adjust the main relief valve above the specified pressure. Adjustment of the main relief valve above the specified pressure may cause damage to the gear pump.

Before any tests are performed, prepare the machine for troubleshooting. Refer to Testing and Adjusting, "Machine Preparation". Before any tests are performed, visually inspect the complete hydraulic system. Refer to the Testing and Adjusting, "Visual Inspection".

Note: The hydraulic oil temperature during all system tests must be at an operating temperature of 45° ± 5°C (113° ± 9° F). Use the **164-3310** Infrared Thermometer or a equivalent to measure this temperature at the hydraulic filter. In order to increase the hydraulic system temperature, start the engine and operate all hydraulic cylinders for at least five cycles. Move the machine in the forward and reverse directions for several minutes.

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Worksheets - Troubleshoot

SMCS - 4350-035; 5050-035

The following tables are provided in order to record information as you perform the tests on the machine. Make copies of these tables so that the tables may be reused for other machines.

The worksheets are designed to be used for the following pressure tests:

- Engine idle
- Cycle times
- Drift checks
- Pump Flow
- Baseline for the hydrostatic system
- Hydrostatic system
- Pilot system
- Main relief valves
- Line relief valves

Troubleshooting Worksheets

The following tables are provided in order to record information as you perform the tests on the machine.

Table 1

MACHINE MODEL		**DATE**	
SERIAL NUMBER		**SERVICE METER HOURS**	
ENGINE SERIAL NUMBER		**ARRANGEMENT NUMBER**	

Table 2

LIFT CYLINDER SPEED TEST			
LIFT'S DIRECTION	**TIME (sec) (236B2)**	**TIME (sec) (252B2)**	**ACTUAL**
Raise	2.7 ± 0.5	4.8 ± 0.5	
Lower	2.7 ± 0.5	3.4 ± 0.5	
Float	2.8 ± 0.5	3.6 ± 0.5	

Table 3

TILT CYLINDER SPEED TEST		
TILT'S DIRECTION	**TIME (sec)**	**ACTUAL**
Tilt Forward	2.1 ± 0.5	
Tilt Back	1.6 ± 0.5	

Table 4

SPEED TEST FOR THE COUPLER CYLINDERS		
CYLINDER POSITION	**MAXIMUM TIME (sec)**	**ACTUAL**
Engaging the quick coupler	3	
Disengaging the quick coupler	3	

Table 5

LIFT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 6

TILT CYLINDER DRIFT			
LOAD	**TIME**	**MAXIMUM**	**ACTUAL**
200 kg (441)	1 min	3 mm (0.118 inch)	

Table 7

ENGINE IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	

Low Idle 236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	1000 ± 50 RPM	
Low Idle 236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	1100 ± 50 RPM	

Table 8

BASELINE FOR THE HYDROSTATIC SYSTEM				
Oil Temperature Range **45° ± 5°C (113° ± 9°F)**				
TEST	**LOW IDLE**		**2300 ± 25 RPM**	
	SPECIFICATION	**ACTUAL**	**SPECIFICATION**	**ACTUAL**
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Speed Sensing Pressure	950 ± 200 kPa (138 ± 29 psi)		2000 ± 150 kPa (290 ± 22 psi)	

Table 9

TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Fan Speed	2000 ± 50 RPM 236B2 (HEN6750-8969) 252B2 (SCP4600-5409)	
	2100 ± 50 RPM 236B2 (HEN8070-Up) 252B2 (SCP5410-Up)	

Table 10

HYDROSTATIC SYSTEM TESTS		
MAXIMUM RUNOUT HIGH IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
RPM for left wheel for standard equipped machines	79 ± 6 (236B2) [(1)] 74 ± 5 (252B2) [(1)]	

RPM for right wheel for standard equipped machines	79 ± 6 (236B2) [1] 74 ± 5 (252B2) [1]	
RPM for the left wheel on machines that are equipped with two-speed capability in slow speed mode (speed 1)	66 ± 6 (236B2) [1] 61 ± 5 (252B2) [1]	
RPM for the right wheel on machines that are equipped with two-speed capability in slow speed mode (speed 1)	66 ± 6 (236B2) [1] 61 ± 5 (252B2) [1]	
Difference in RPM between wheels	1 RPM maximum	
MAXIMUM DISPLACEMENT STOP TEST		
TEST	**HIGH IDLE SPECIFICATION**	**ACTUAL**
Drift	3 m (10 ft)	
SINGLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2700 ± 200 RPM	
MB Pressure Pump 1	38300 ± 2000 kPa (5555 ± 290 psi)	
MB Pressure Pump 2	38300 ± 2000 kPa (5555 ± 290 psi)	
DOUBLE STALL TEST		
TEST	**SPECIFICATION**	**ACTUAL**
Engine Stall Speed	2300 ± 400 RPM	

[1] The wheel speeds must be within 1 RPM of each other.

Table 11

MAIN RELIEF VALVE PRESSURE		
TEST	**SPECIFICATION**	**ACTUAL**
High Idle	2860 ± 50 RPM	
Main Relief	23000 ± 700 kPa (3336 ± 102 psi)	

Table 12

LINE RELIEF VALVE PRESSURE (MACHINE TEST)

TEST	HIGH IDLE SPECIFICATION	ACTUAL
Lift Cylinder Head RAISE Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Head TILT FORWARD Position	23000 ± 700 kPa (3336 ± 102 psi)	
Tilt Cylinder Rod TILT BACK Position	23000 ± 700 kPa (3336 ± 102 psi)	
Auxiliary Head	23000 ± 700 kPa (3336 ± 102 psi)	

Table 13

LINE RELIEF VALVE PRESSURE (BENCH TEST)		
HIGH IDLE		
TEST	PRESSURE	ACTUAL
Lift Cylinder RAISE	27600 ± 700 kPa (4003 ± 102 psi)	
Tilt Cylinder FORWARD	24500 ± 700 kPa (3554 ± 102 psi)	
Tilt Cylinder RACK BACK	27600 ± 700 kPa (4003 ± 102 psi)	
Auxiliary	24500 ± 700 kPa (3554 ± 102 psi)	

Table 14

PILOT SYSTEM PRESSURE TEST				
TEST	LOW IDLE		2300 ± 25 RPM	
	SPECIFICATION	ACTUAL	SPECIFICATION	ACTUAL
Charge Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	
Pilot Pressure	3100 ± 200 kPa (450 ± 29 psi)		3225 ± 200 kPa (468 ± 29 psi)	

Table 15

BRAKE TEST		
LOW IDLE		
TEST	**SPECIFICATION**	**ACTUAL**
Brake Line Pressure	3100 ± 200 kPa (450 ± 29 psi)	

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234229

MID 106 - CID 0598 - FMI 03

SMCS - 5479-038-V6

Conditions Which Generate This Code:

This diagnostic code is associated with the solenoid valve for the two speed. The FMI 03 means that the ECM determined that the voltage is above normal. A short to the + battery terminal will cause this code.

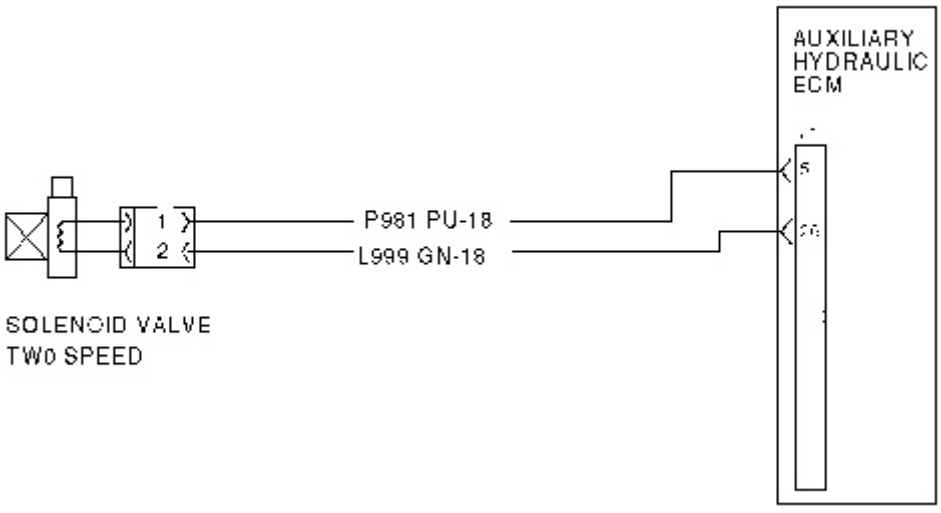


Illustration 1 g01037835

Schematic of the solenoid valve for the two speed

Test Step 1. CHECK FOR A SHORT TO + BATTERY IN THE WIRE HARNESS

A. Turn the key start switch to the OFF position.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 5 (wire P981-PU) to the following contacts of the wiring harness: contact 1, contact 24, contact 40, contact 42 and contact 58.

Expected Result:

The resistances should be greater than 5000 Ohms.

Results:

- **OK -** The resistances were greater than 5000 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was less than 5000 Ohms on one of the readings.

  Repair: There is a short in the wire harness. Locate the short. Repair the wire harness or replace the wire harness.

  Stop.

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Troubleshooting

247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Auxiliary Hydraulic Electronic Control System

Media Number -RENR6418-01 **Publication Date -01/12/2004** **Date Updated -14/12/2004**

i02234237

MID 106 - CID 0598 - FMI 05

SMCS - 5479-038-V6

Conditions Which Generate This Code:

This diagnostic code is associated with the solenoid valve for the two speed. The FMI 05 means that the ECM determined that the current is below normal. An open circuit will cause this code.

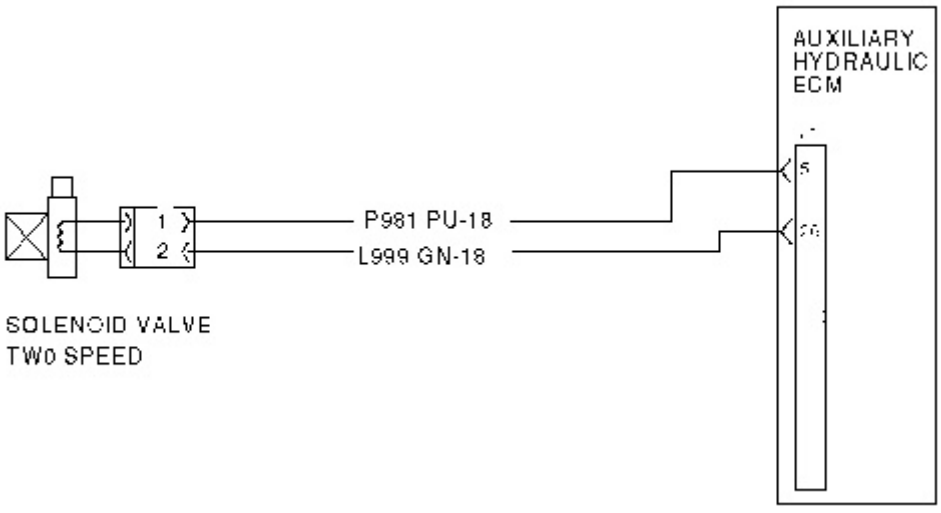


Illustration 1 g01037835

Schematic of the solenoid valve for the two speed

Test Step 1. CHECK FOR AN OPEN WINDING IN THE SOLENOID

A. Turn the key start switch to the OFF position.

B. Raise the cab. See Operation and Maintenance Manual, "Cab Tilting".

C. Disconnect the connector for the solenoid valve.

D. Measure the resistance of the coil.

Expected Result:

The resistance should be approximately 2.5 Ohms.

Results:

- **OK -** The resistance is approximately 2.5 Ohms. Proceed to Test Step 2.
- **NOT OK -** The resistance is considerably greater than 2.5 Ohms.

  Repair: The solenoid coil has failed. Replace the coil.

  Stop.

Test Step 2. CHECK FOR AN OPEN IN THE WIRE HARNESS

A. Reconnect the connector for the solenoid valve.

B. Remove the floorplate in order to get to the ECM.

C. Disconnect the wire harness from the ECM.

D. Measure the resistance from contact 5 (wire P981-PU) to contact 26 (wire L999-GN) of the wire harness connector.

Expected Result:

The resistance should be approximately 3 Ohms.

Results:

- **OK -** The resistance is approximately 3 Ohms.

  Repair: The ECM is very unlikely to have failed. Reconnect all connections and visually inspect the wire harness. Verify that the values that are present on the machine configuration screen match the machine's options. Verify that the values that are present on the machine configuration screen are installed correctly. Verify that the diagnostic code still exists. If the diagnostic code still exists perform the test steps again.Replace the ECM, if the cause of the diagnostic code was not found after the second attempt. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  Stop.

- **NOT OK -** The resistance was considerably greater than 3 Ohms.

  Repair: There is an open in the wire harness or a bad connection in a connector. Locate the open wire. Repair the wire harness and/or the connector or replace the wire harness and/or the connector.

Stop.

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Troubleshooting
247B, 257B, 267B, 277B and 287B Multi Terrain Loaders and 216B, 226B, 232B, 236B, 242B, 246B, 248B, 252B, 262B and 268B Skid Steer Loaders Interlock Electronic Control System
Media Number -RENR6417-01 **Publication Date -01/08/2005** **Date Updated -03/08/2005**

i02388145

Parking Brake Intermittent

SMCS - 4284-038

System Operation Description:

On some machines the parking brake will engage intermittently during normal operation. This can be caused by several components that are unrelated to each other. Components that can cause this problem are:

- Park brake switch
- Harnesses (cab panel, upper and lower platform)
- Seat / arm bar switch
- Main power relay
- Power and ground connections (including battery cables)
- Interlock ECM (unlikely)
- Aux Hydraulic ECM is not tied to the park brake solenoid therefore can not cause the park brake to be set

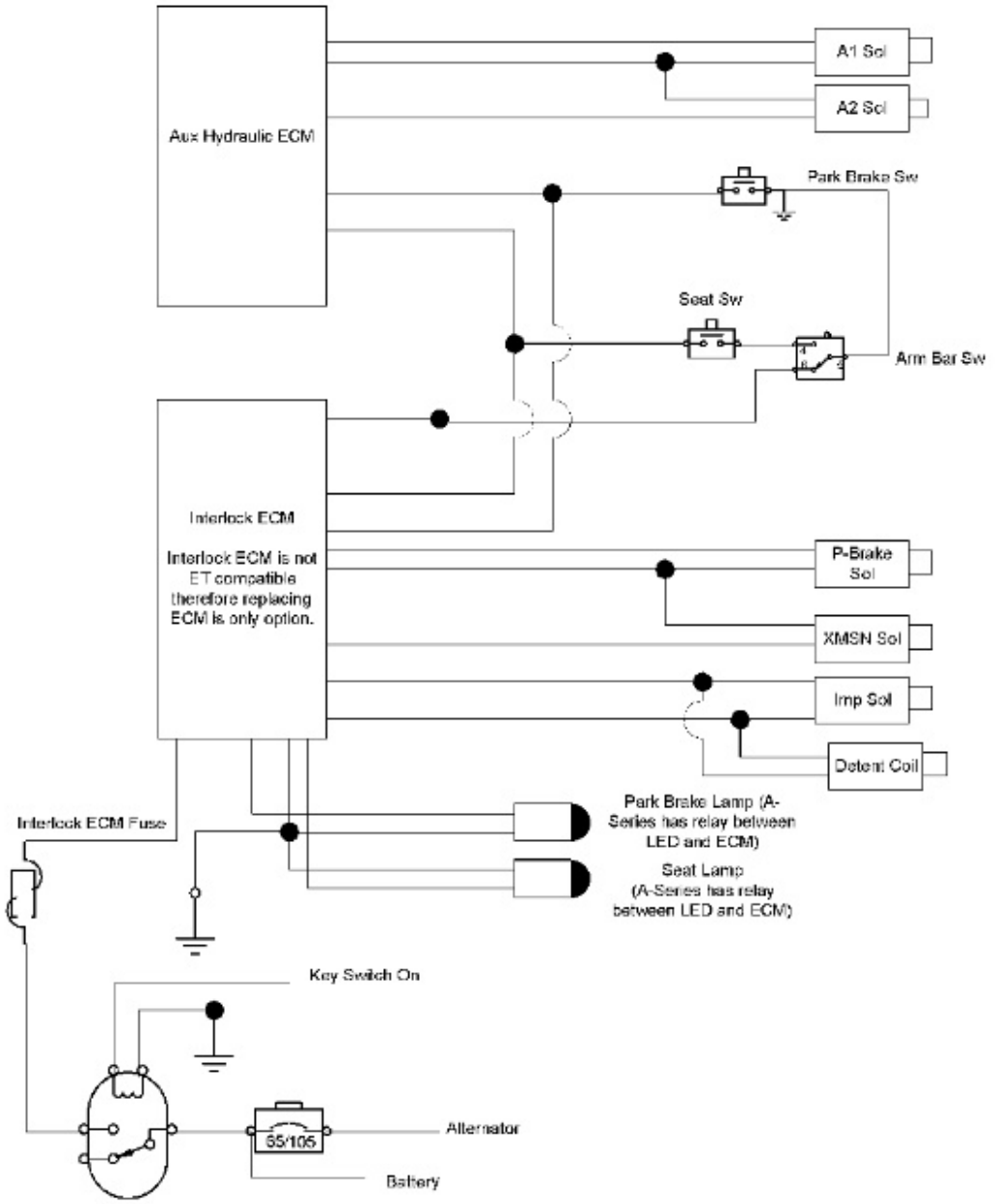


Illustration 1 g01192216

Parking brake circuit

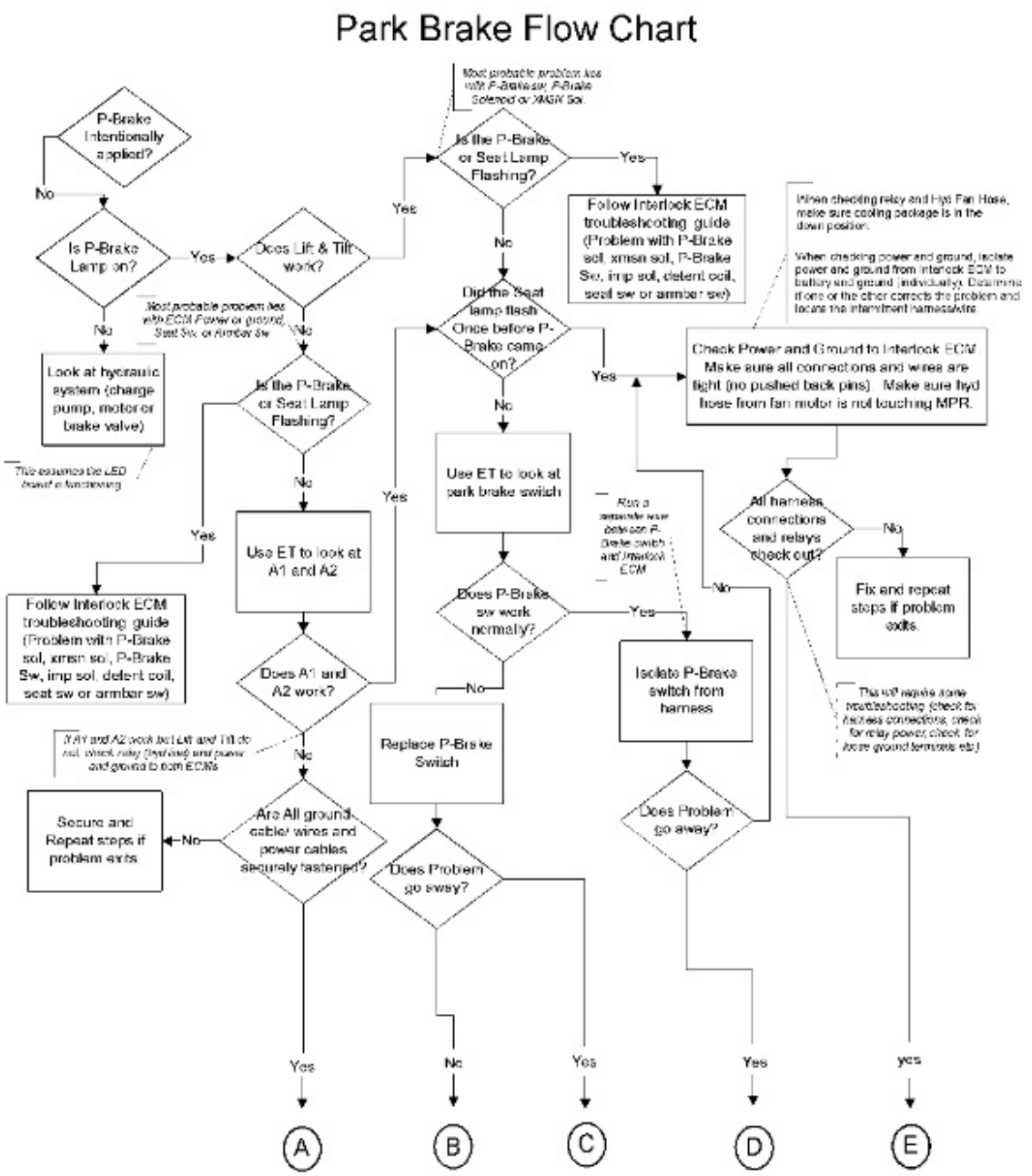


Illustration 2 g01192213

Parking brake troubleshooting flow chart

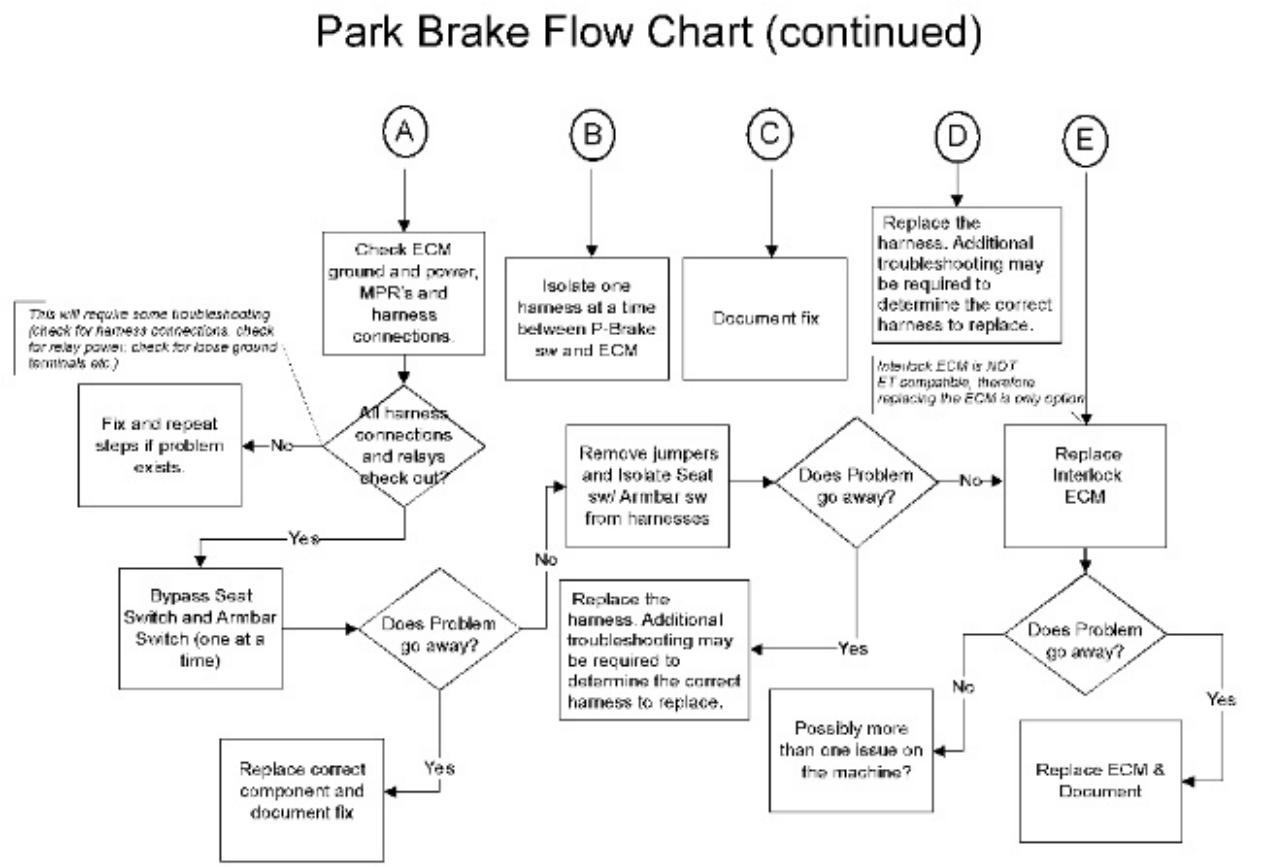


Illustration 3 g01192215

Parking brake troubleshooting flow chart (Continued)

Test Step 1. TROUBLESHOOT THE SYSTEM

A. Follow the flow chart in order to troubleshoot the parking brake system.

Expected Result:

The flow chart corrects the problem.

Results:

- **OK -** The parking brake is operating correctly. **Stop.**

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i02676118

System Pressure - Release

SMCS - 4350-553-PX; 5050-553-PX

Release Procedure

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

1. Start the engine and allow the engine to run for at least 15 seconds in order to recharge the accumulator.
2. Stop the engine. Keep the armrests in the LOWERED position. Turn the engine start switch to the ON position. Push the parking brake switch.
3. Move the hydraulic operated controls through all of the positions.
4. Push up on the locking tab for the auxiliary hydraulic pressure switch and press the bottom of the switch in order to release the hydraulic system pressure. Hold the switch for four seconds and release.
5. Turn the engine start switch to the OFF position.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856170

Axle

SMCS - 3278

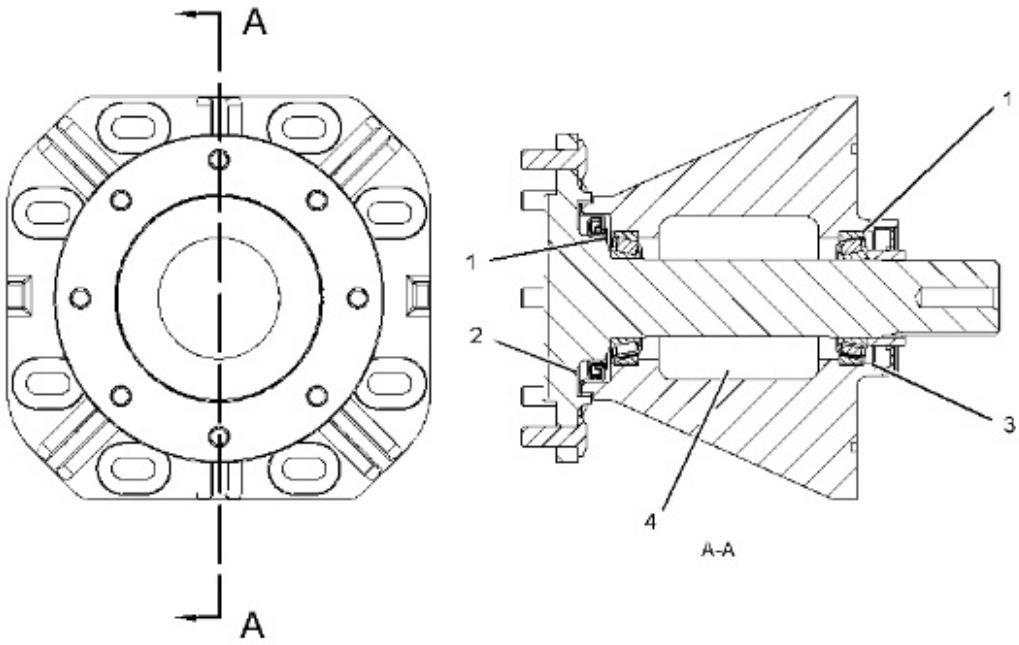


Illustration 1 g01422616

(1) Pack the bearing cones with **1P-0808** Multipurpose Grease prior to installation.

(2) After the installation of the bearings and before the installation of the seal, fill the cavities between the bearings and the seal with 15 g (0.5 oz) of **1P-0808** Multipurpose Grease.

(3) After the installation of the bearings and before the installation of the seal, fill the cavities between the bearings and the seal with 24 g (0.8 oz) of **1P-0808** Multipurpose Grease.

(4) Use a **5P-0960** Grease Cartridge to fill one-third of the cavity.

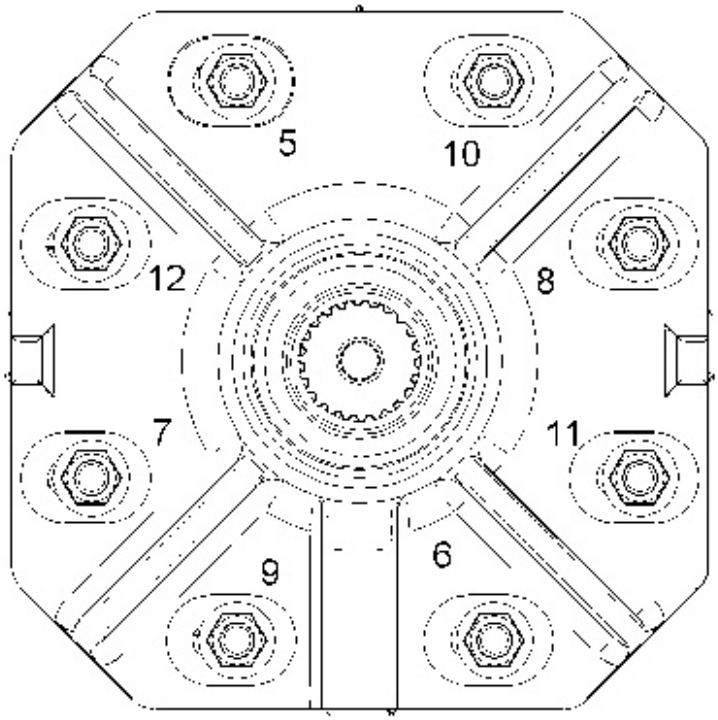


Illustration 2 g01422617

Use the following procedure to tighten the nuts:

1. Tighten nut (5) through nut (12) to a torque of 160 ± 15 N·m (120 ± 11 lb ft).
2. Again tighten nut (5) through nut (12) by an angle of 60 ± 5 degrees.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02856170

Axle

SMCS - 3278

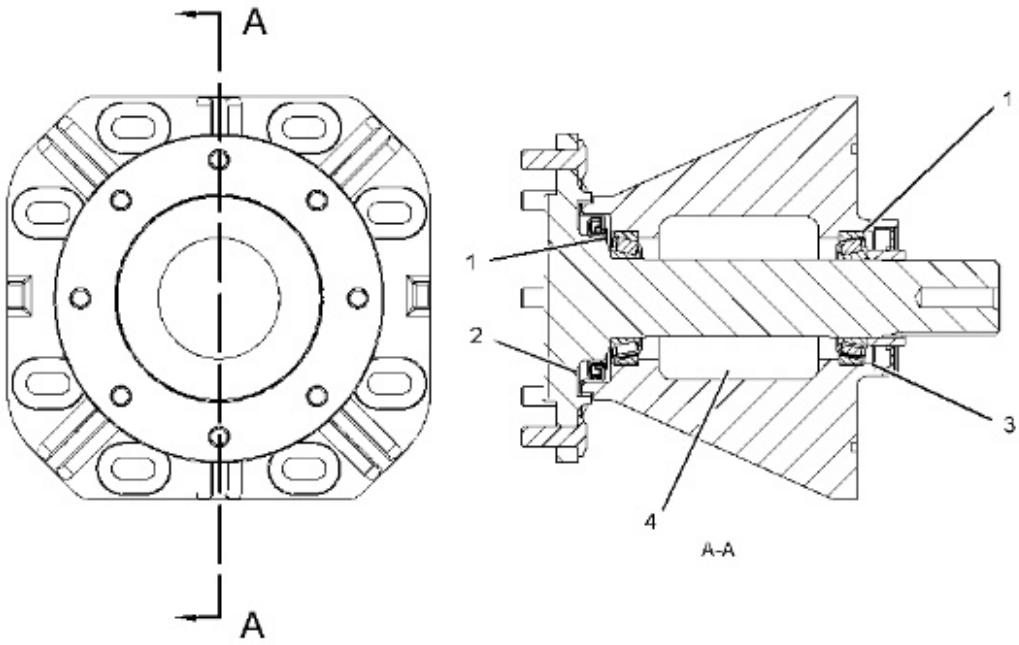


Illustration 1 g01422616

(1) Pack the bearing cones with **1P-0808** Multipurpose Grease prior to installation.

(2) After the installation of the bearings and before the installation of the seal, fill the cavities between the bearings and the seal with 15 g (0.5 oz) of **1P-0808** Multipurpose Grease.

(3) After the installation of the bearings and before the installation of the seal, fill the cavities between the bearings and the seal with 24 g (0.8 oz) of **1P-0808** Multipurpose Grease.

(4) Use a **5P-0960** Grease Cartridge to fill one-third of the cavity.

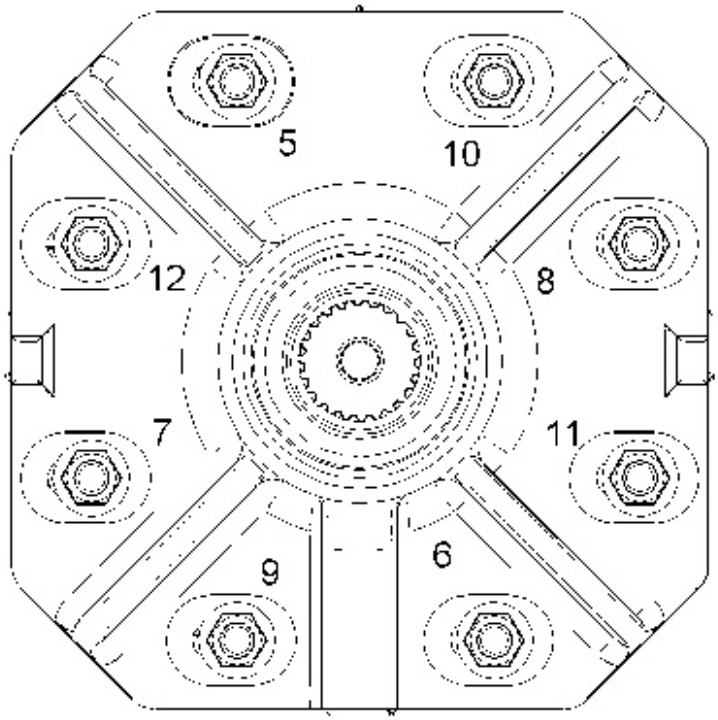


Illustration 2 g01422617

Use the following procedure to tighten the nuts:

1. Tighten nut (5) through nut (12) to a torque of 160 ± 15 N·m (120 ± 11 lb ft).
2. Again tighten nut (5) through nut (12) by an angle of 60 ± 5 degrees.

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i04638374

Axle - Remove

SMCS - 3278-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	169-5464	Quick Cure Primer	1
B	5P-3413	Pipe Sealant	1

Start By:

A. Remove the tire and rim. Refer to Disassembly and Assembly, "Tire and Rim - Remove and Install".
B. Tilt the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

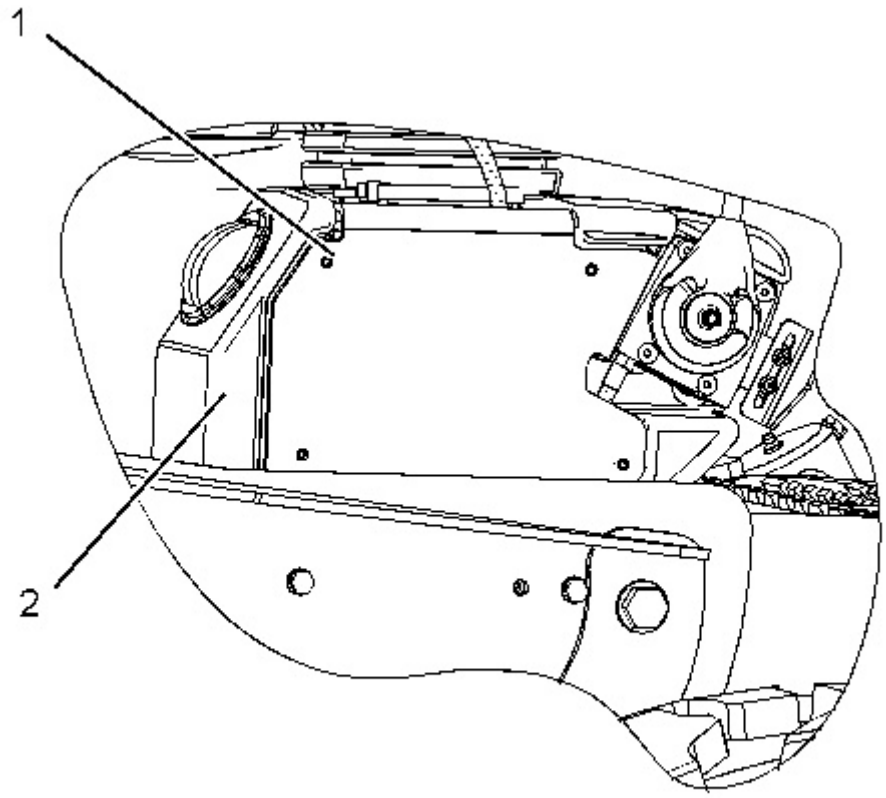


Illustration 1 g01051759

1. Remove bolts (1) .
2. Move console (2) aside.

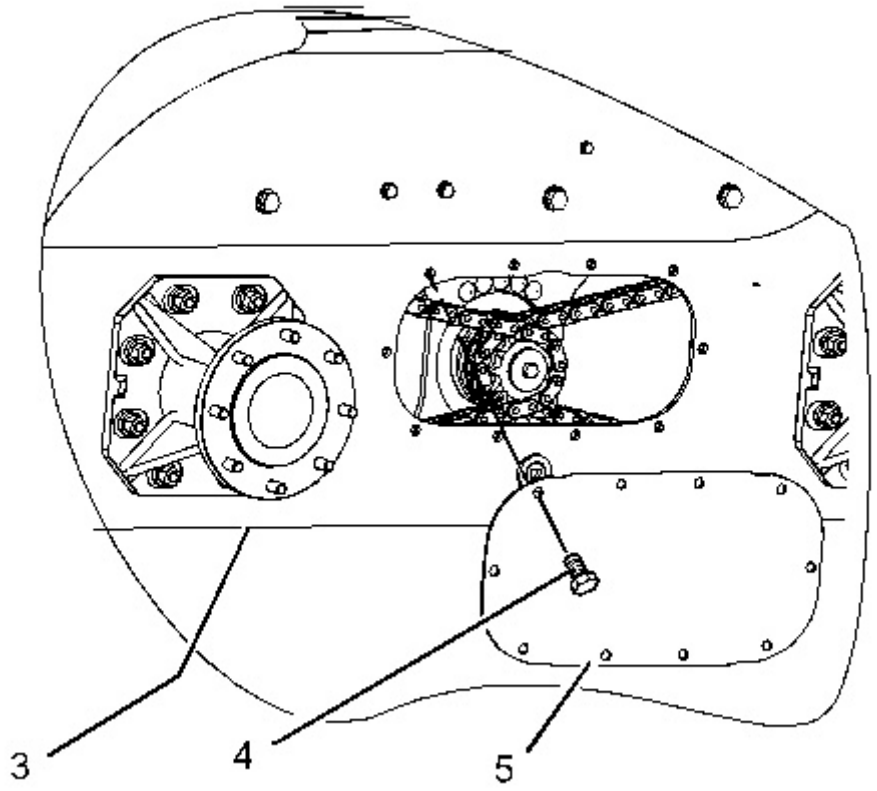


Illustration 2 g01053046

3. Remove plug (3) .
4. Drain the drive chain oil into a suitable container.
5. Apply Tooling (A) to plug (3) .
6. Apply Tooling (B) to plug (3) .
7. Install plug (3) .
8. Remove bolts (4) .
9. Remove cover (5) .

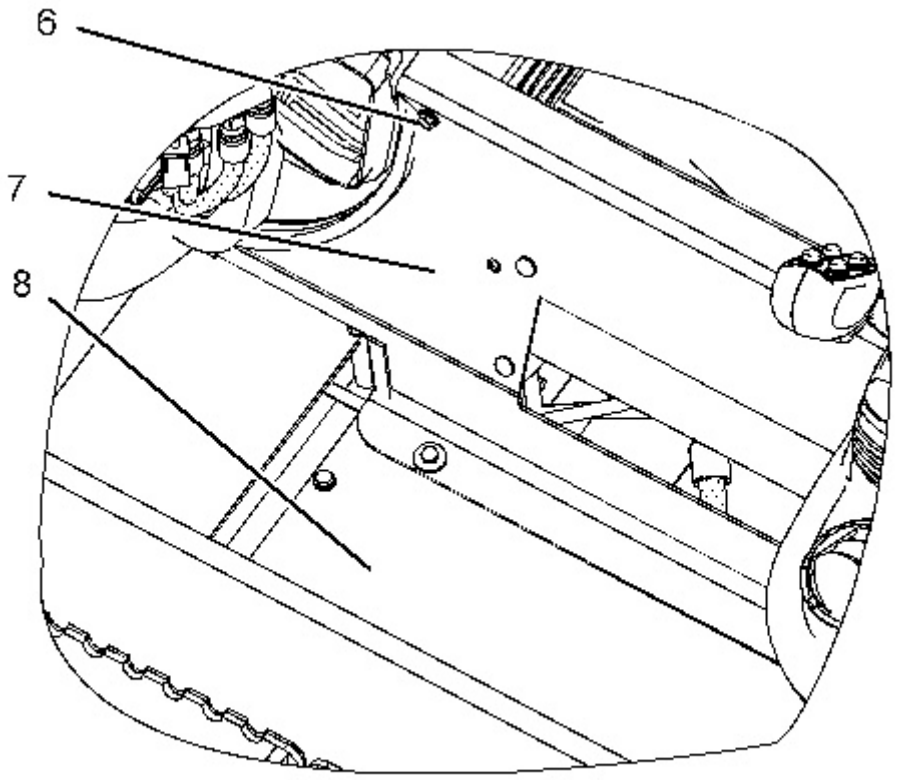


Illustration 3 g01051761

10. Remove bolts (6) .
11. Remove plate (7) .
12. Move plate (8) aside.

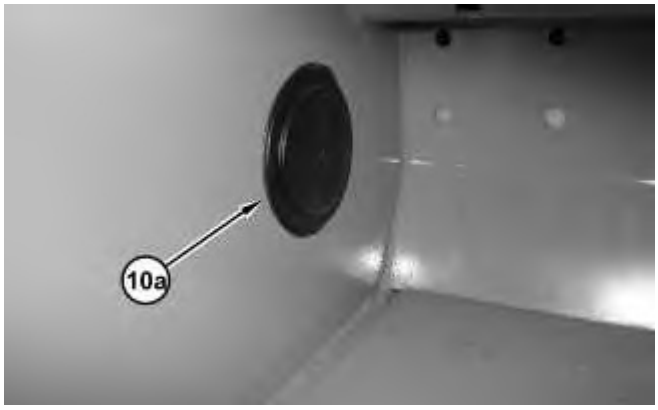


Illustration 4 g02781542

13. Remove cover (10a) .

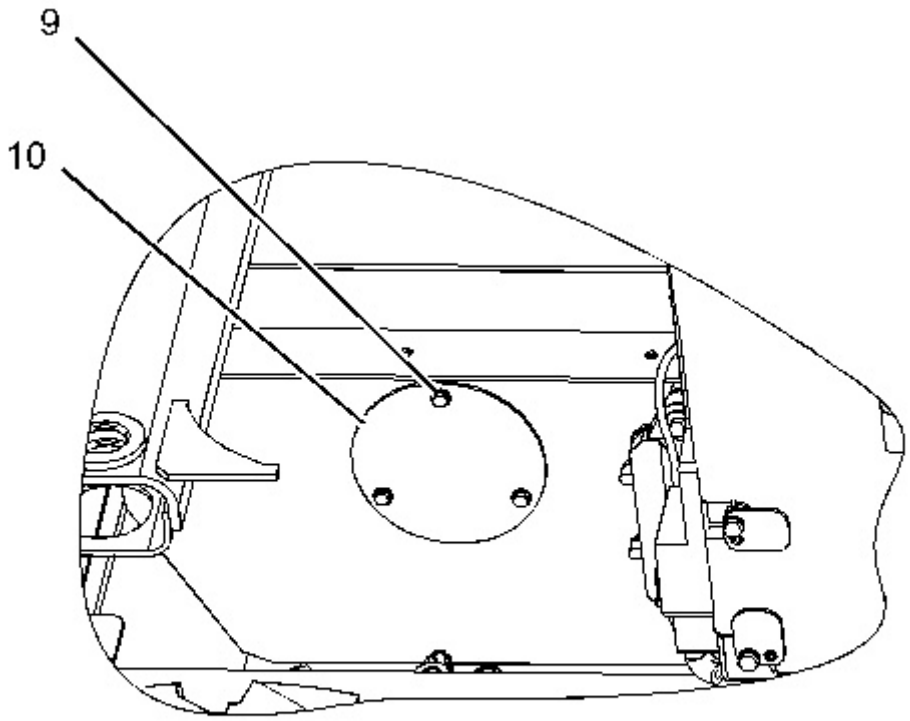


Illustration 5 g01051762

14. Remove bolts (9) .
15. Remove plate (10) .

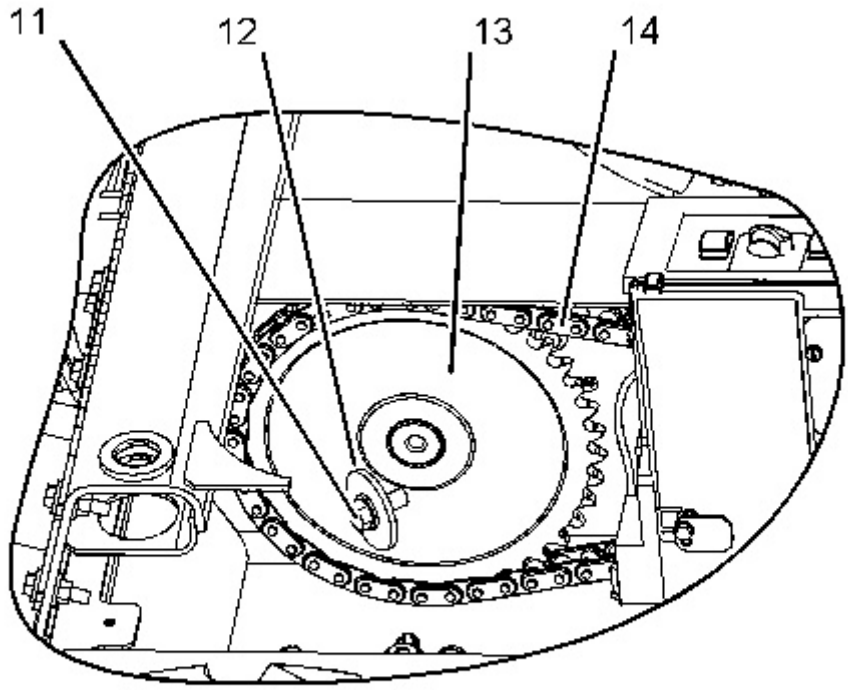


Illustration 6 g01051763

16. Remove bolt (11) .
17. Remove washer (12) .
18. Remove sprocket (13) .
19. Remove chain assembly (14) .

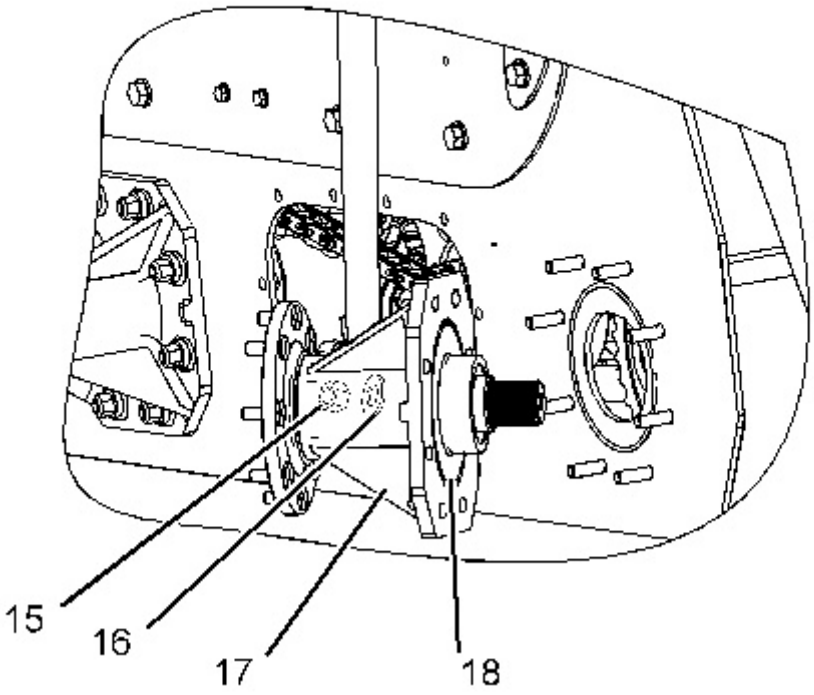


Illustration 7 g01051771

20. Use a suitable lifting device to support axle assembly (17) .
21. Remove nuts (15) .
22. Remove washers (16) .
23. Remove axle assembly (17) . The weight of the axle assembly is approximately 37 kg (82 lb).
24. Remove O-ring seal (18) .
25. Repeat Step 1 through Step 24 for the other axles.

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i02051363

Axle - Disassemble

SMCS - 3278-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	1P-5546	Crossblock	1
	8B-7550	Leg	2
	3H-0465	Puller Plate	4
	5F-7379	Forcing Bolt	1
	4C-5660	Adapter	2
	5B-0637	Nut	2
	8T-1757	Nut	2
	9X-8268	Washers	2
B	6V-3009	Crossblock	1
	126-7179	Leg	2
	126-7181	Puller Plate	4
	6V-4832	Screw	1
	8H-0663	Bearing Puller	1

Start By:

A. Remove the axle. Refer to Disassembly and Assembly, "Axle - Remove ".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Cleanliness is an important factor. Before you begin the disassembly procedure, the exterior of the components should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism. Precision components can be damaged by contaminants or by dirt. Perform disassembly procedures on a clean work surface. Keep components covered and protected at all times.

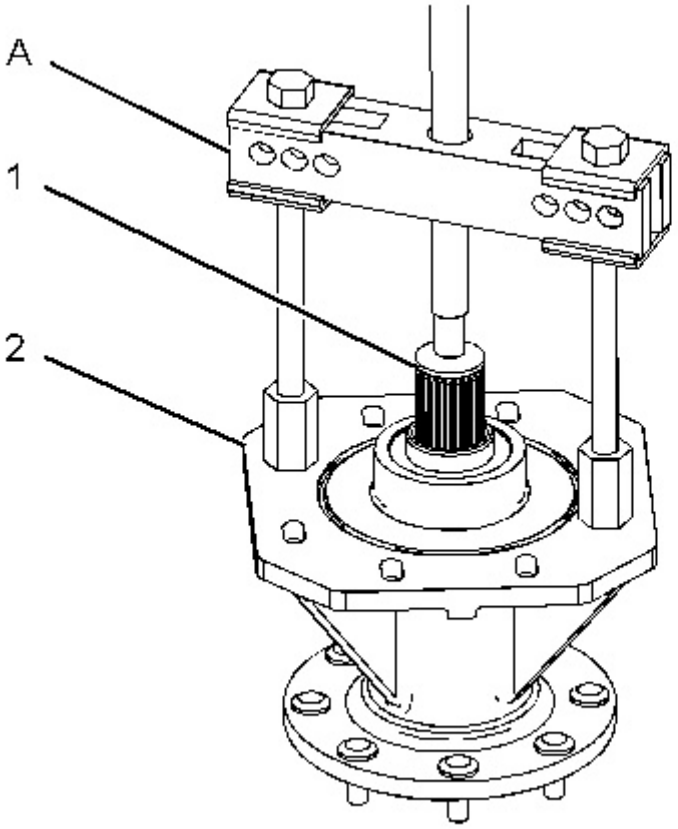


Illustration 1 g01053336

1. Use Tooling (A) to release spindle (1) from axle housing (2) .

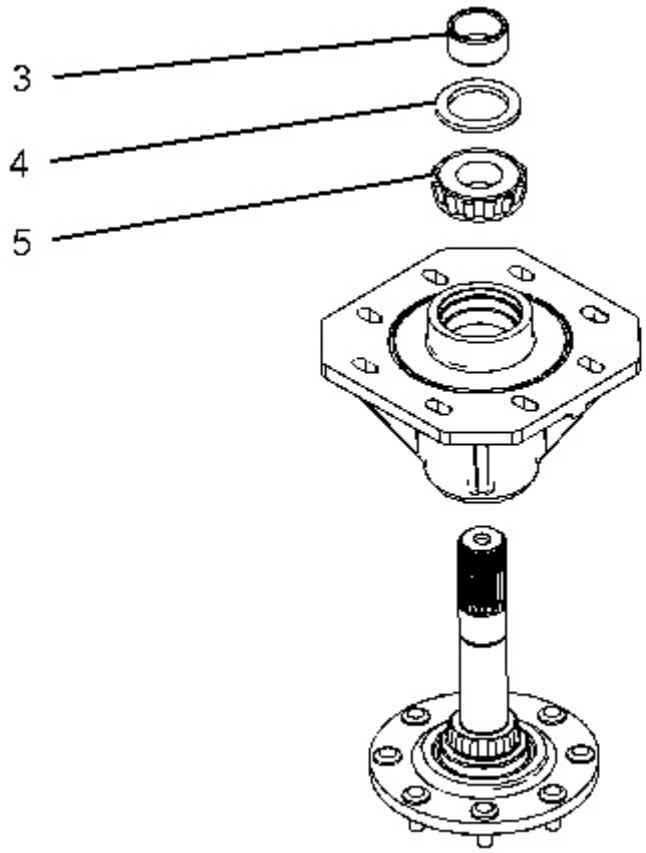


Illustration 2 g01053337

2. Remove spacer (3) .
3. Remove seal (4) .
4. Remove bearing cone (5) .

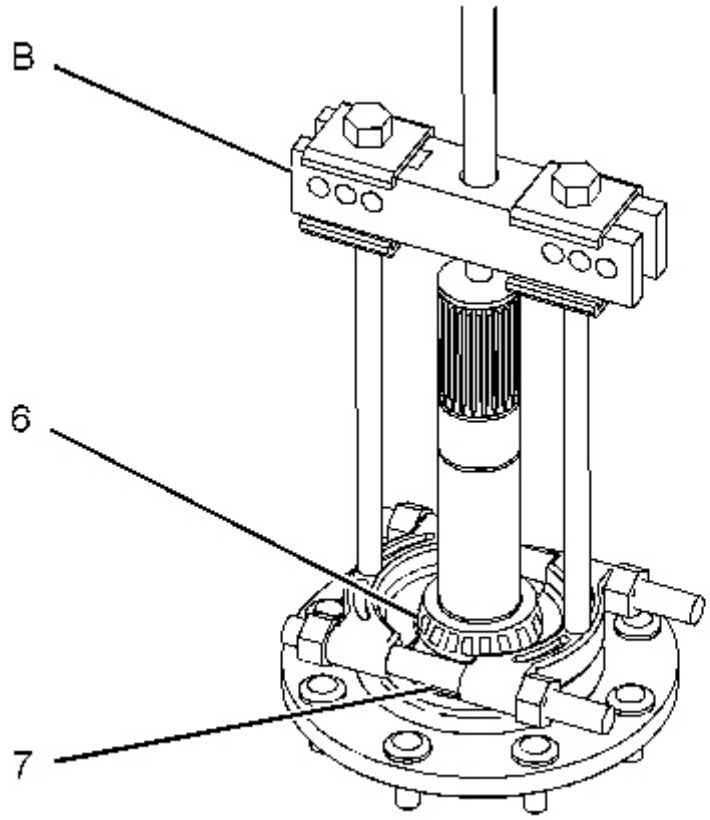


Illustration 3 g01053338

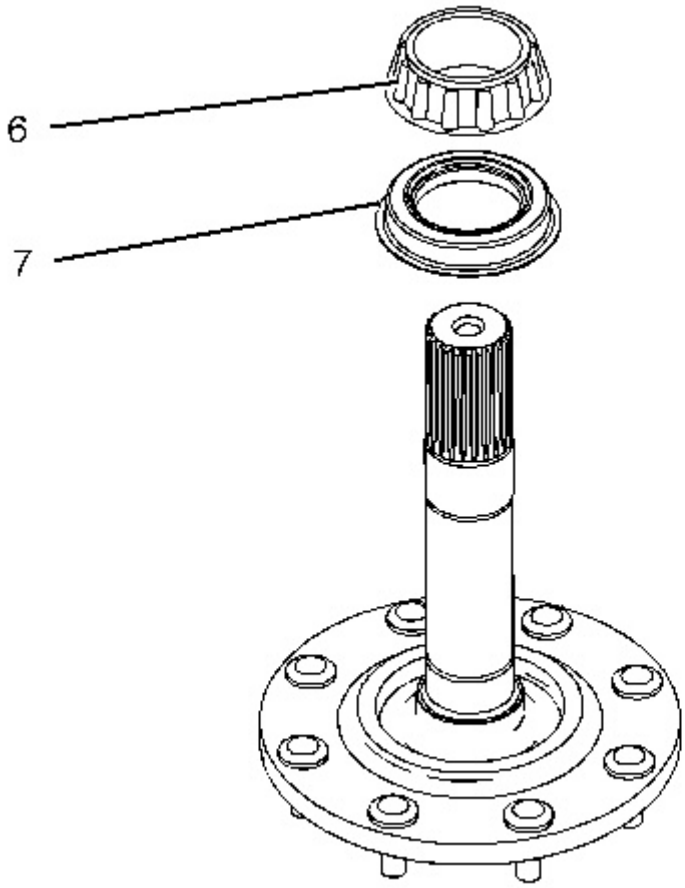


Illustration 4 g01053339

5. Use Tooling (B) to remove bearing cone (6) .
6. Remove seal (7) .

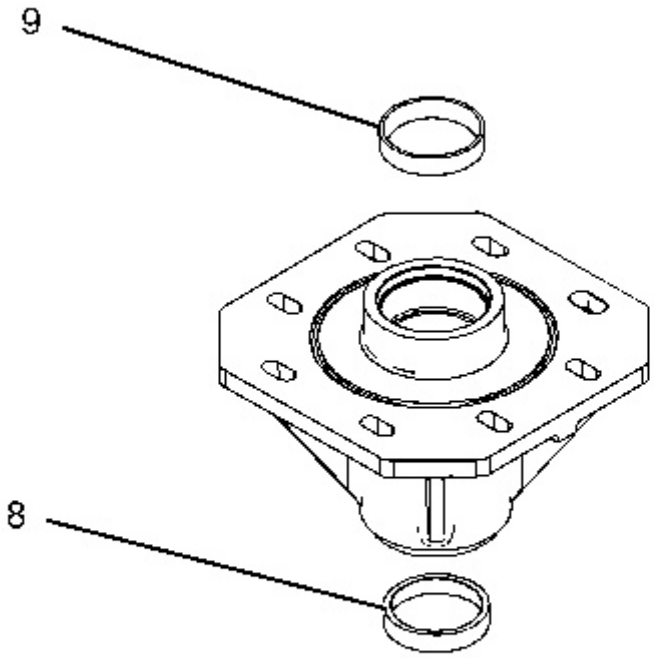


Illustration 5 g01053341

7. Remove bearing cup (8) .
8. Remove bearing cup (9) .

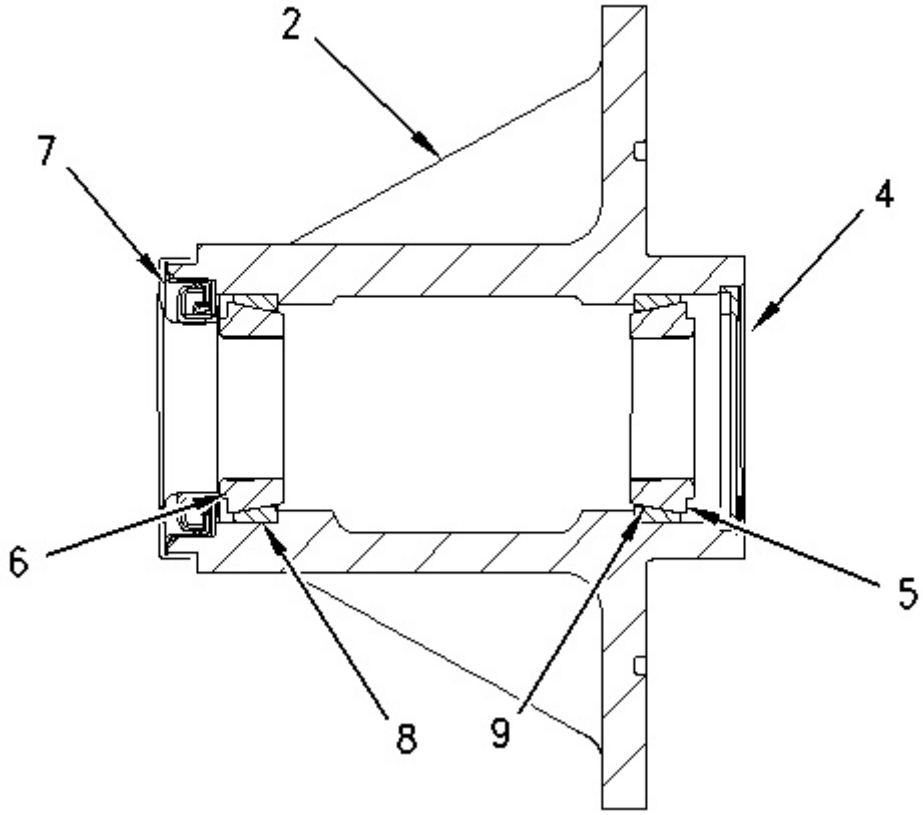


Illustration 6 g00682639

(2) Axle Housing

(4) Lip Type Seal

(5) Roller Bearing

(6) Roller Bearing

(7) Lip Type Seal

(8) Bearing Cup

(9) Bearing Cup

9. Illustration 6 shows the location of the components that are in the axle assembly.

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i02059199

Axle - Assemble

SMCS - 3278-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	1P-0520	Driver Gp	1
D	179-4353	Seal Driver	1
E	179-4350	Axle Bearing Driver	1
F	1P-0808	Multipurpose Grease	1

Note: Cleanliness is an important factor. Before assembly, thoroughly clean all parts in cleaning fluid. Allow the parts to air dry. Do not use wiping cloths or rags to dry parts. Lint may be deposited on the parts which may cause trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision component. Perform assembly procedures on a clean work surface. Keep components covered and protected at all times.

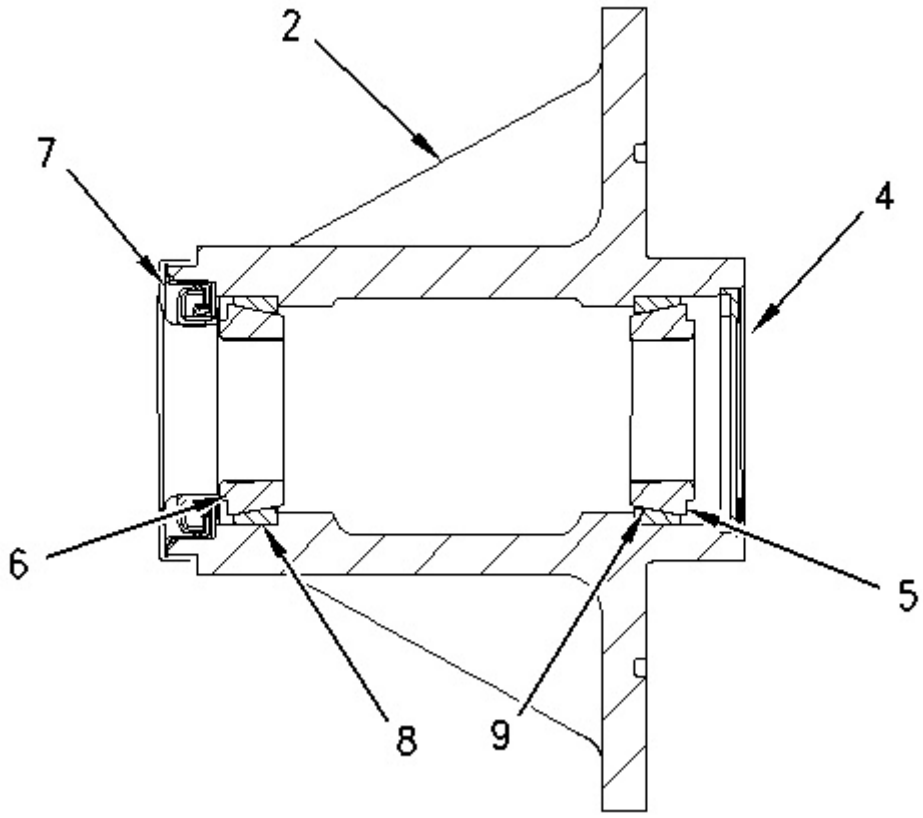


Illustration 1 g00682639

(2) Axle Housing

(4) Lip Type Seal

(5) Roller Bearing

(6) Roller Bearing

(7) Lip Type Seal

(8) Bearing Cup

(9) Bearing Cup

1. Illustration 1 shows the location of the components that are in the axle assembly.

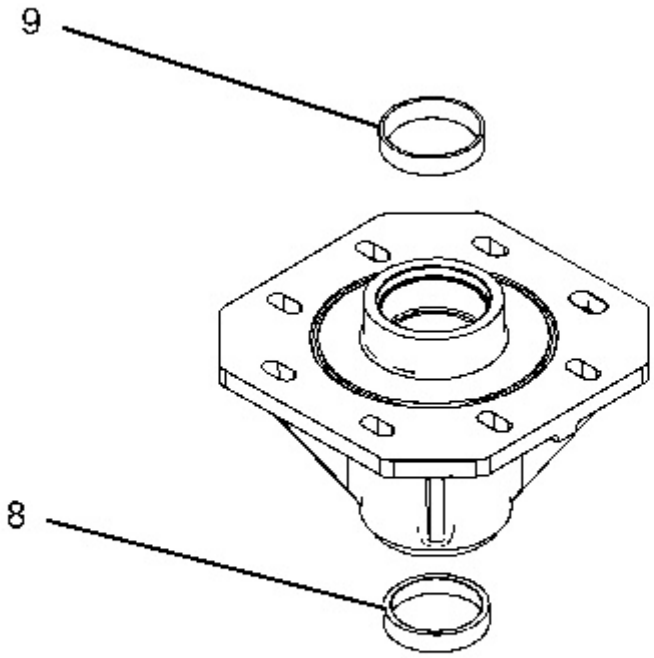


Illustration 2 g01053341

2. Use a suitable press and Tooling (C) to install bearing cup (9) .

   Note: Ensure that the bearing cup is seated.

3. Repeat Step 2 for bearing cup (8) on the other side.
4. Refill the cavity of the housing to one-third capacity with Tooling (F) .

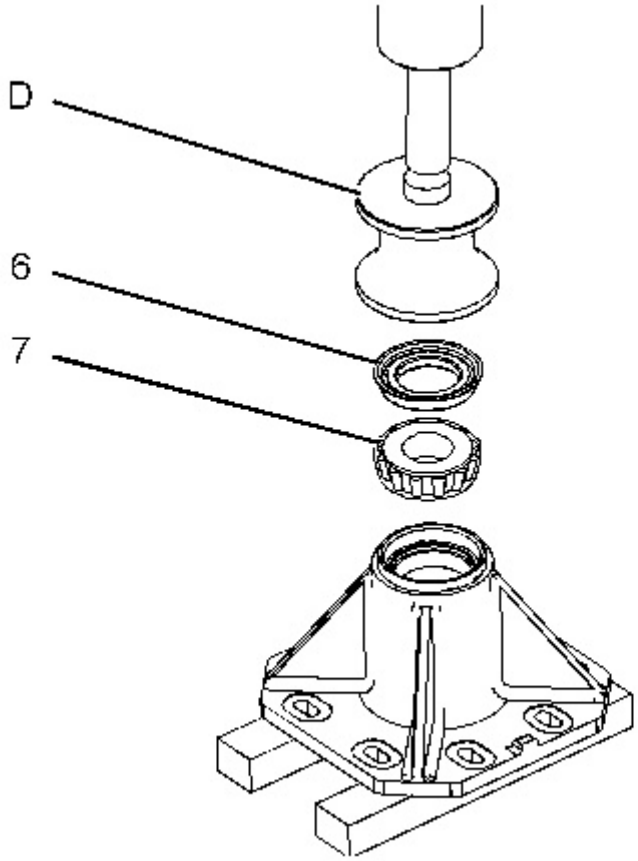


Illustration 3 g01053861

Note: Apply clean hydraulic oil on the sealing lip of a new lip type seal.

5. Pack bearing (7) with Tooling (F) .
6. Use a suitable press and Tooling (D) to install bearing cone (7) .
7. Use a suitable press and Tooling (D) to install seal (6).

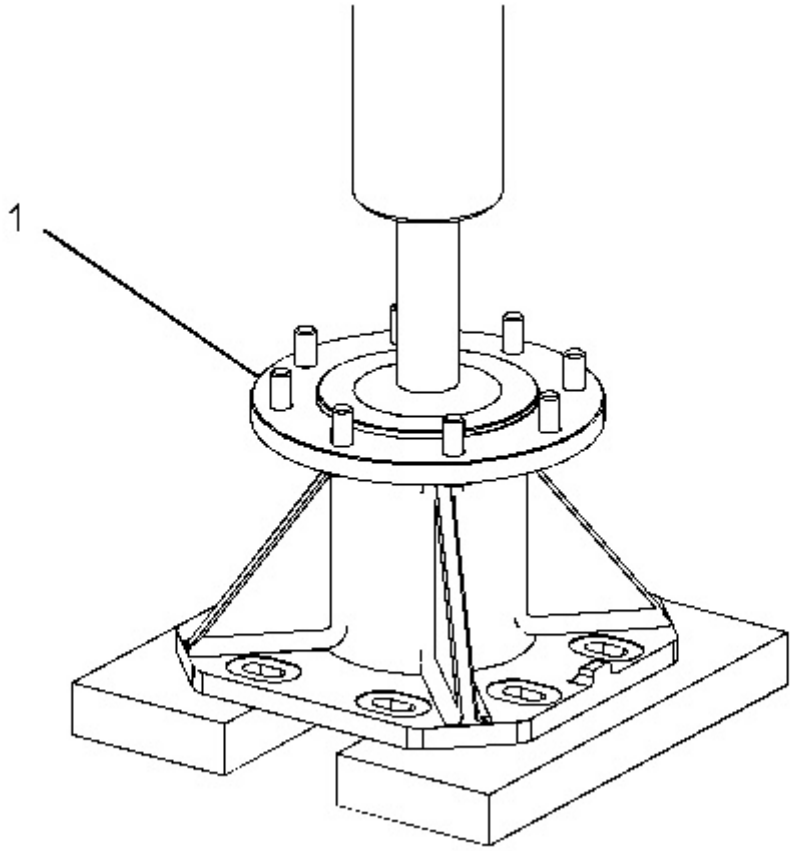


Illustration 4 g01053815

8. Use a suitable press to seat spindle (1) .

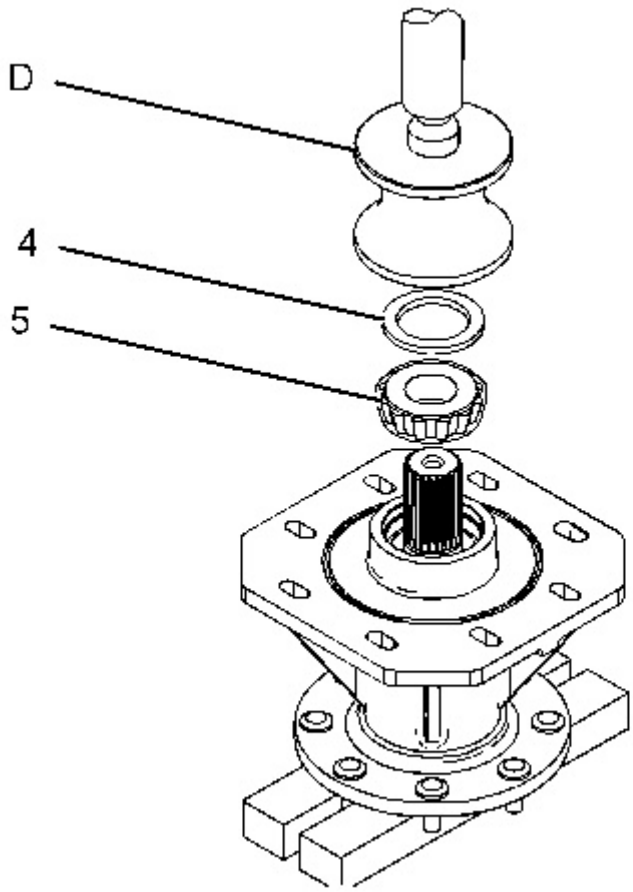


Illustration 5 g01053814

Note: Apply clean hydraulic oil on the sealing lip of a new lip type seal.

9. Use a suitable press and Tooling (D) to install seal (4) .
10. Pack bearing cone (5) with Tooling (F) .
11. Install bearing cone (5) .

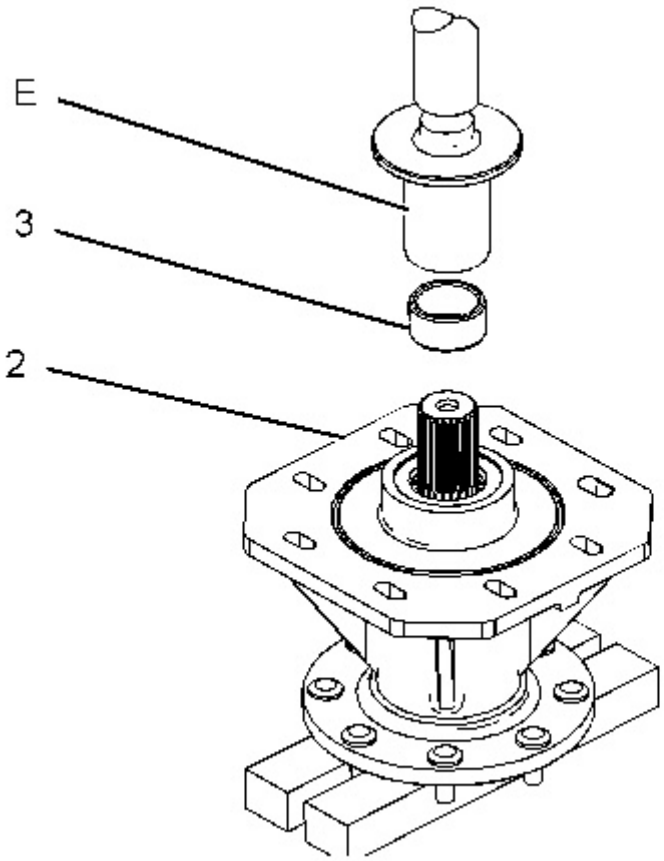


Illustration 6 g01053817

12. Use a suitable press and Tooling (E) to install spacer (3) in housing (2) .

End By: Install the axle. Refer to Disassembly and Assembly, "Axle - Install".

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i05025839

Axle - Install

SMCS - 3278-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-

Note: Cleanliness is an important factor. Before assembly, thoroughly clean all parts in cleaning fluid. Allow the parts to air dry. Do not use wiping cloths or rags to dry parts. Lint may be deposited on the parts which may cause trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision component. Perform assembly procedures on a clean work surface. Keep components covered and protected at all times.

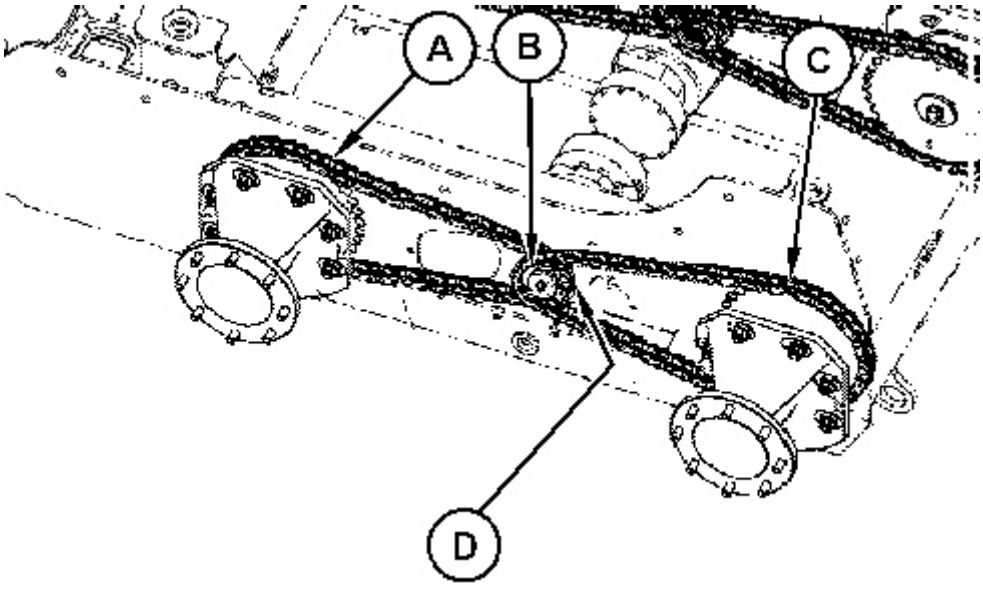


Illustration 1 g01609056

1. The front axle assemblies and the rear axle assemblies are driven by different drive chains. The drive chains are installed on Drive Sprocket (B) and Drive Sprocket (D). The drive sprockets are mounted on the drive shaft of the hydrostatic piston motor. The two drive sprockets are the same component. The drive sprocket on the hydrostatic piston motor has sprocket drives on different planes. The drive sprockets on the front and rear axles are the same component. The sprockets on the front and rear axles are mounted at 180 degrees of opposite direction. Note: Sprocket (A) is in line with Drive Sprocket (D) and that Sprocket (C) is in line with Drive Sprocket (B). The drive sprockets are installed in a manner that will allow the drive chains to turn in a straight line. If any of the sprockets are installed incorrectly the drive chains cannot be installed properly. Note the orientation of all of Drive Sprocket (B) and Drive Sprocket (D). Note the orientation of Sprocket (A) and Sprocket (C) on the axles. Mark all components prior to any removal for repair or replacement.

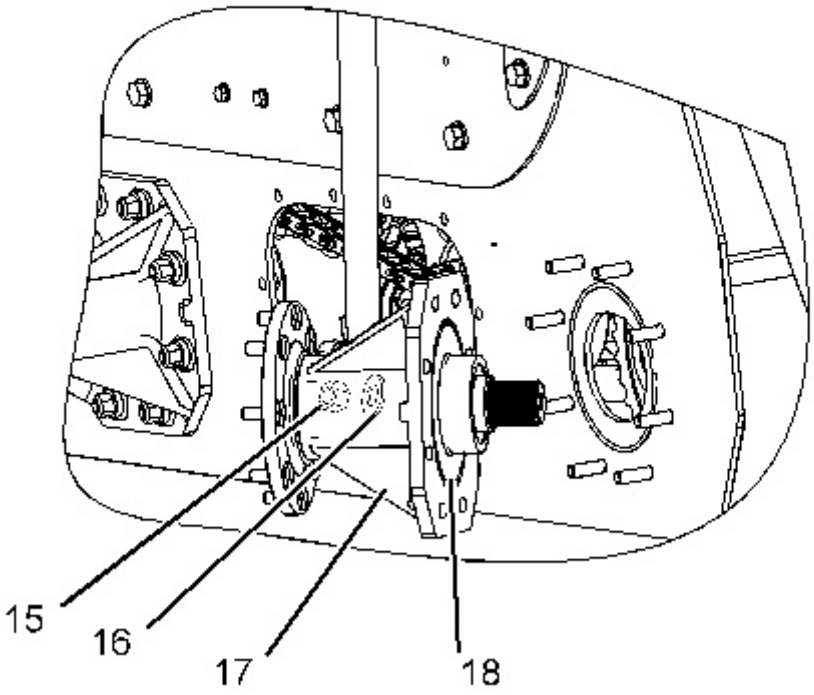


Illustration 2 g01051771

2. Install O-ring seal (18) .
3. Install axle assembly (17). The weight of axle assembly (17) is approximately 37 kg (82 lb).
4. Install washers (16) .
5. Install nuts (15) hand tight.

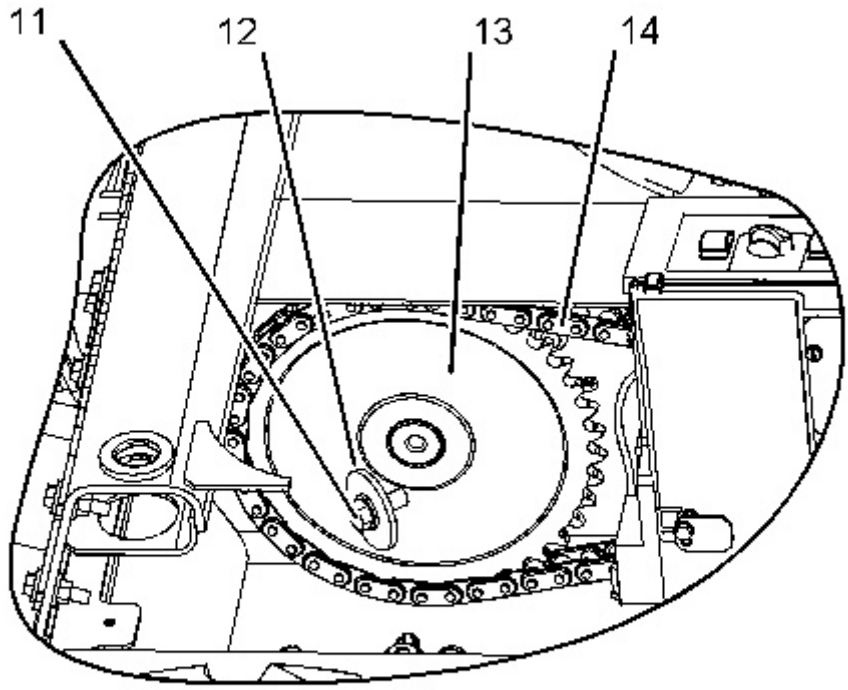


Illustration 3 g01051763

Note: Be sure that the drive sprockets are facing the proper direction in order for the drive chains to turn in a straight line.

6. Install chain assembly (14) .
7. Install sprocket (13) .
8. Install washer (12) .
9. Install bolt (11). Tighten bolt (11) to a torque of 240 ± 40 N·m (177 ± 30 lb ft).

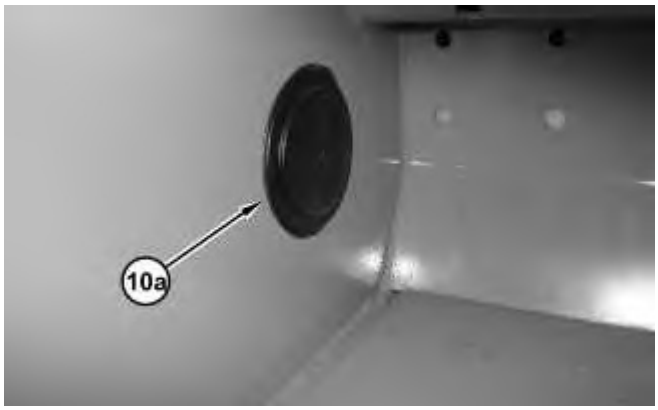


Illustration 4 g02781542

10. Use Tooling (A) to apply a continuous bead around access hole. Install cover (10a) .

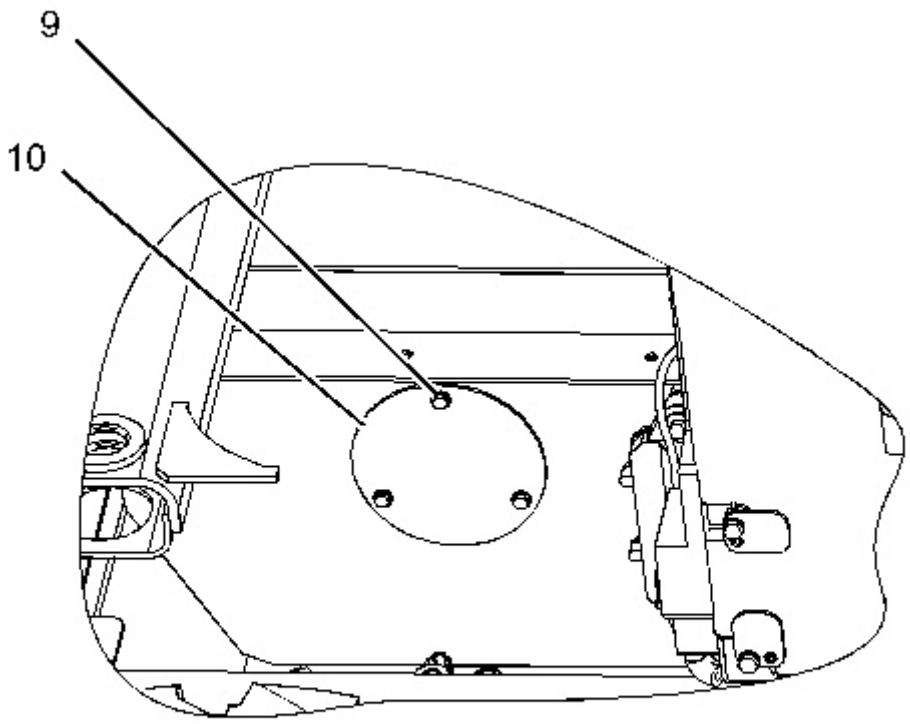


Illustration 5 g01051762

Note: Clean the plate and the mating surface before assembly.

11. Use Tooling (A) to apply a continuous bead around the access holes in the machine frame.
12. Install plate (10) .
13. Install bolts (9) .

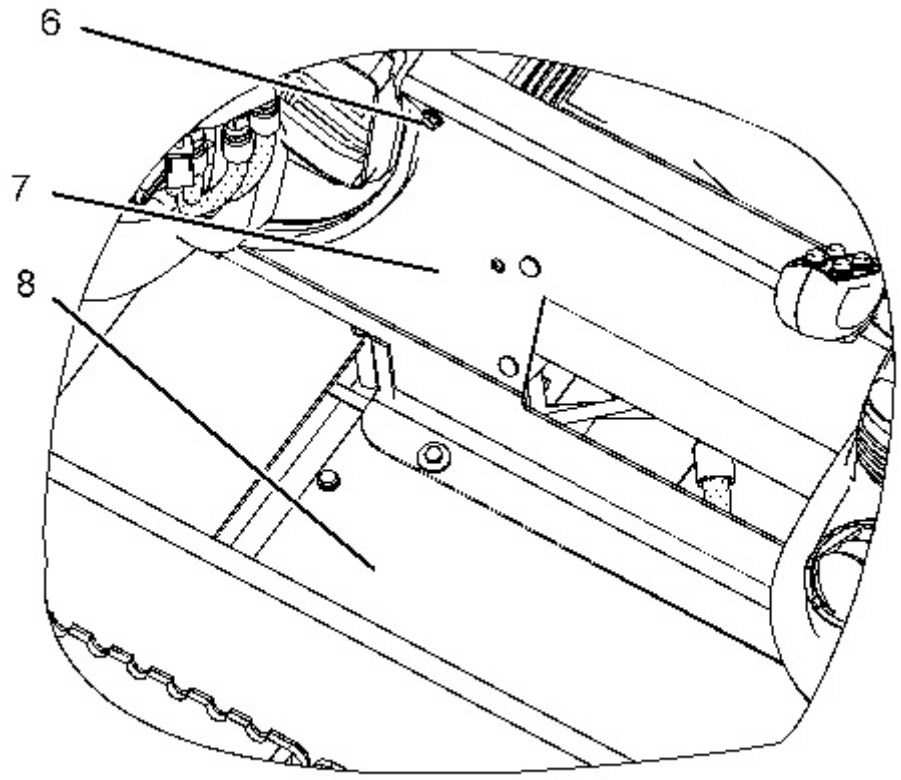


Illustration 6 g01051761

14. Position plate (8).
15. Install plate (7) .
16. Install bolts (6) .
17. Adjust the drive chain tension. Refer to Disassembly and Assembly, "Chain (Drive) - Adjust".
18. Refill the drive chain oil. Refer to Operation and Maintenance Manual, "Drive Chain Case Oil - Change".

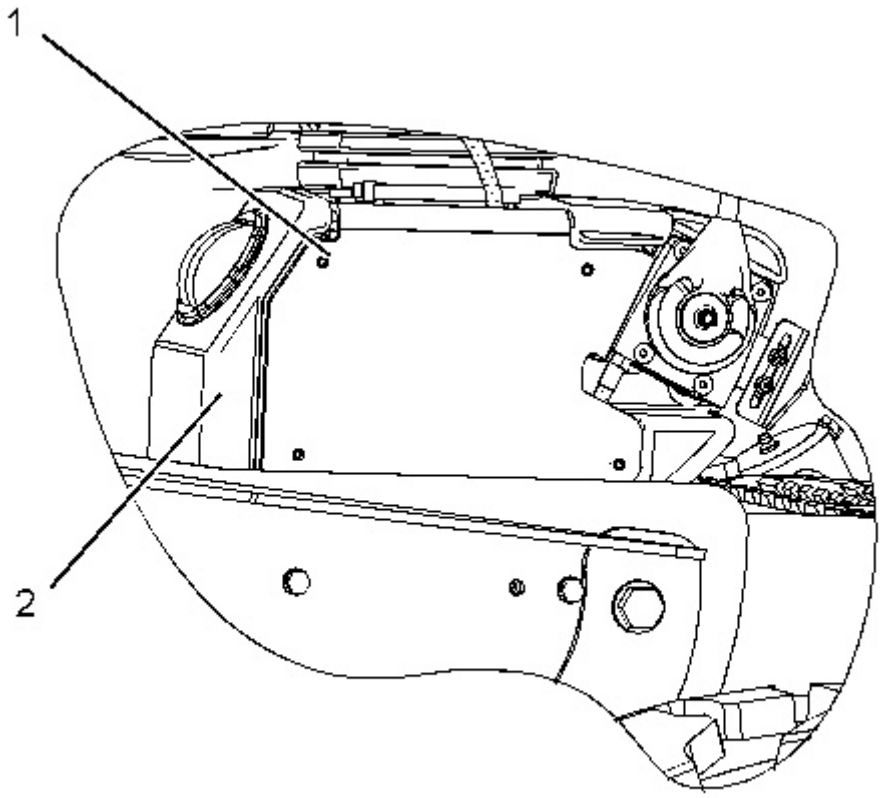


Illustration 7 g01051759

19. Position console (2) .
20. Install bolts (1) .
21. Repeat Step 2 through Step 20 for the other axles.

End By:

a. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".
b. Install the tire and rim. Refer to Disassembly and Assembly, "Tire and Rim - Remove and Install".

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i02369929

Pump Mounting - Remove and Install

SMCS - 3203-010-MT; 5062-010; 5070-010-MT

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

Start By:

A. Remove the engine. Refer to Disassembly and Assembly, "Engine - Remove".

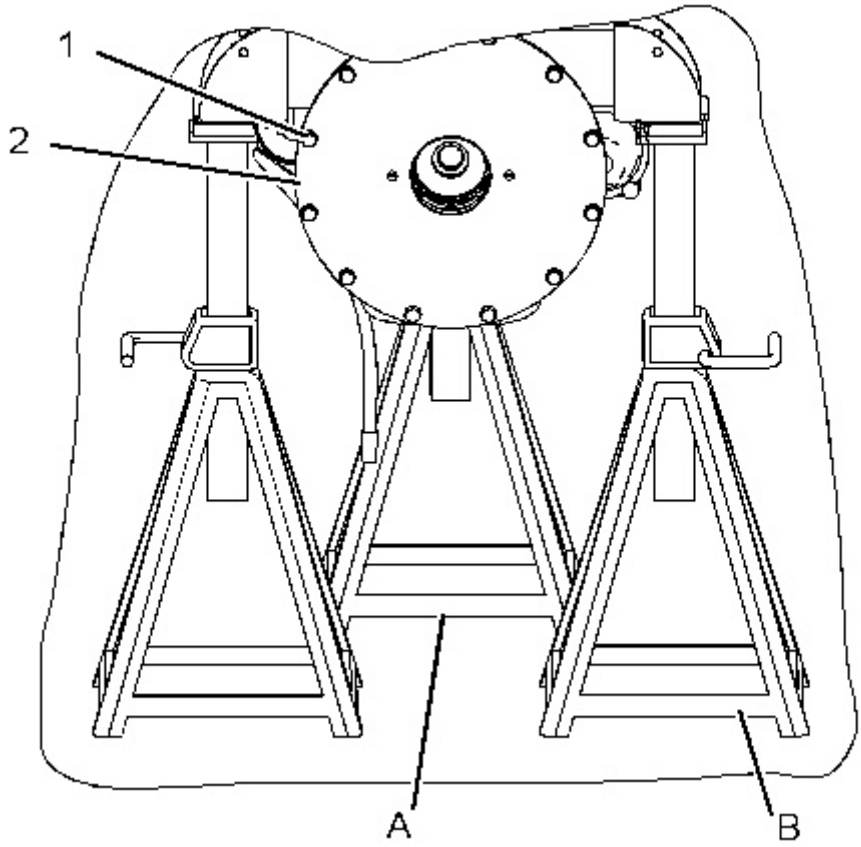


Illustration 1 g01091327

1. Use Tooling (A) and Tooling (B) to support the engine. Remove bolts (1) . Remove adapter plate (2) .

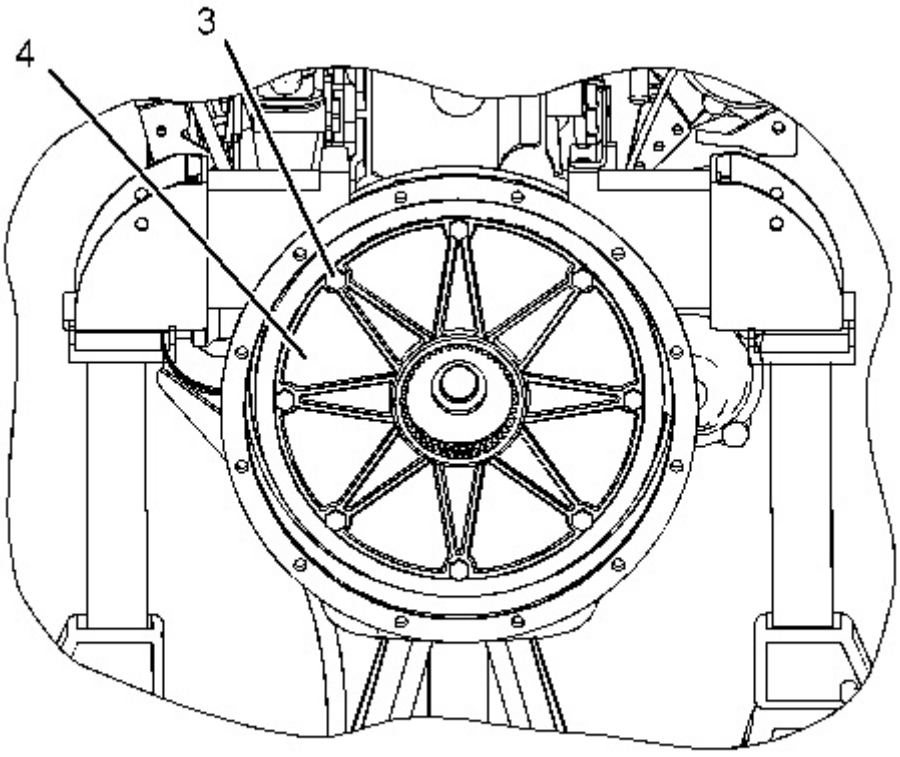


Illustration 2 g01091328

2. Remove bolts (3) . Remove nylon flange (4) .

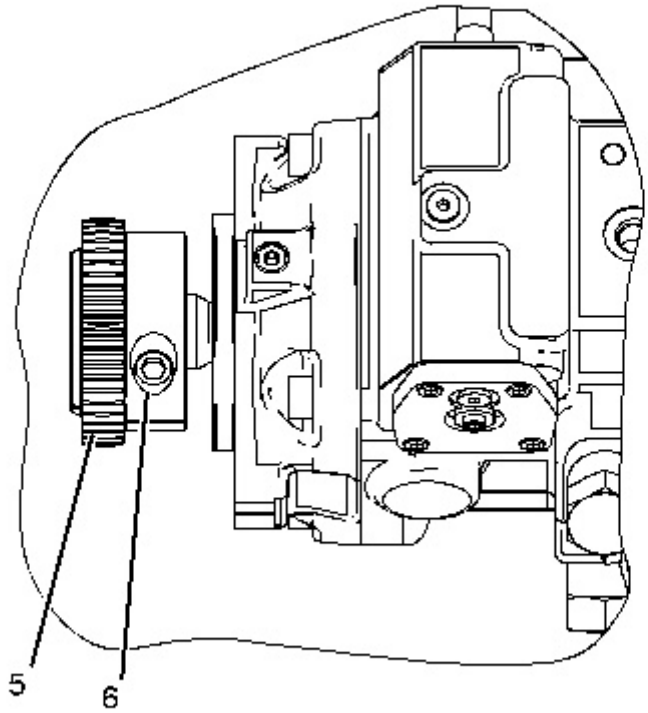


Illustration 3 g01093859

3. Remove bolt (6) . Discard bolt (6) . Remove hub (5) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

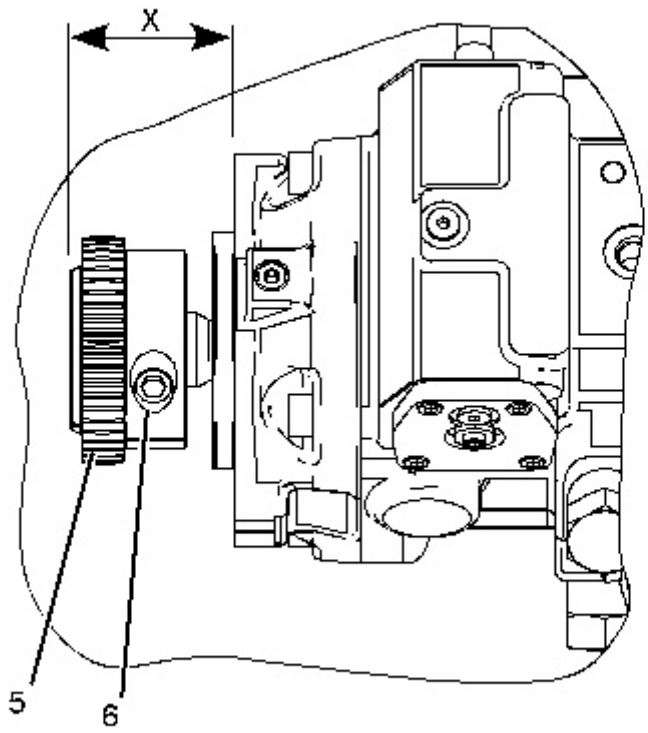


Illustration 4 g01041240

1. Install hub (5) . The face of hub (5) must be installed to a dimension of 70.9 ± 2 mm (2.80 ± .078 inch) from the face of the pump. This dimension is shown in the graphic above as Dimension (X) . Install new bolt (6) . Tighten the bolt to 102 ± 5 N·m (75 ± 4 lb ft).

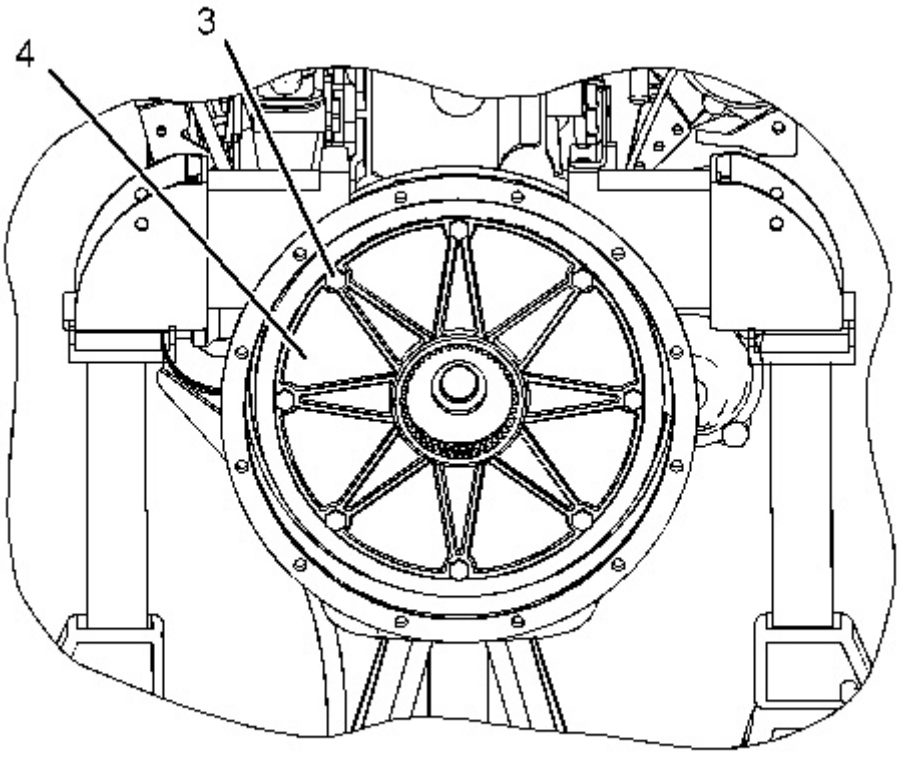


Illustration 5 g01091328

2. Install nylon flange (4) . Install bolts (3) .

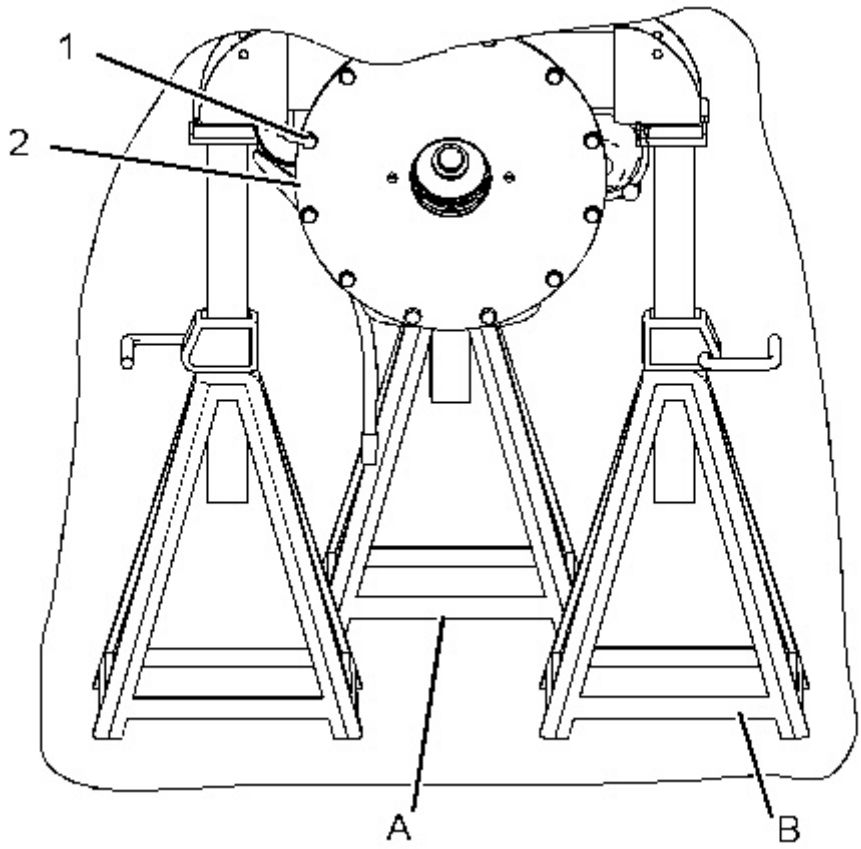


Illustration 6 g01091327

3. Install adapter plate (2) . Install bolts (1) .

End By: Install the engine. Refer to Disassembly and Assembly, "Engine - Install".

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i05293383

Chain (Drive) Tension - Adjust

SMCS - 3261-025

Adjustment Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Repair Stand Set	1
B	159-3337	Chain Tension Adjuster	1
C	-	Loctite 5900	-

1. Use a suitable lifting device and Tooling (A) to support the machine.

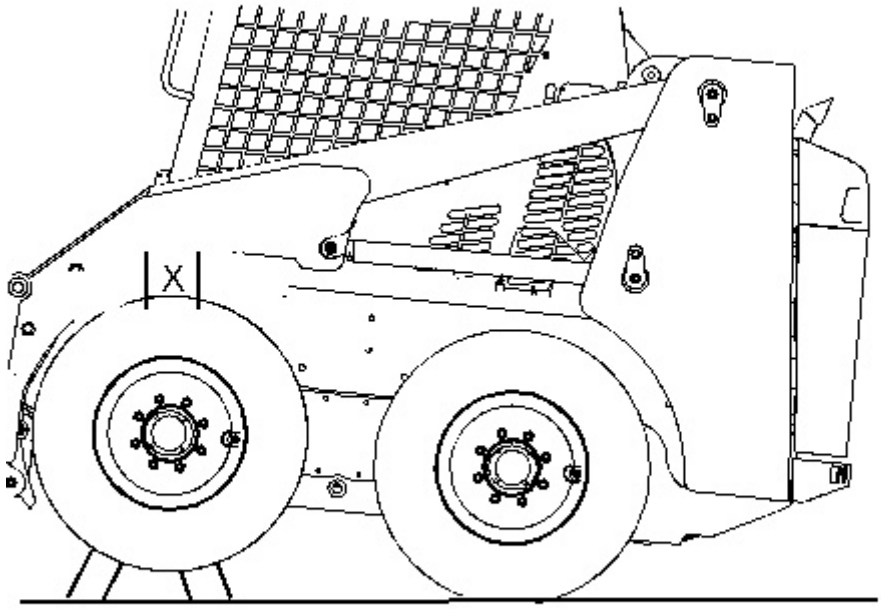


Illustration 1 g01052875

2. Rotate the wheel. Measure the Total Free Play (X) .

   Note: The Total Free Play of the arc along the circumference of the tire should be between 10.0 mm (0.39 inch) and 15.0 mm (0.6 inch). If the Total Free Play is between 10.0 mm (0.39 inch) and 15.0 mm (0.6 inch) the chain tension does not need further inspection. If the Total Free Play is not between 10.0 mm (0.39 inch) and 15.0 mm (0.6 inch), continue with the inspection.

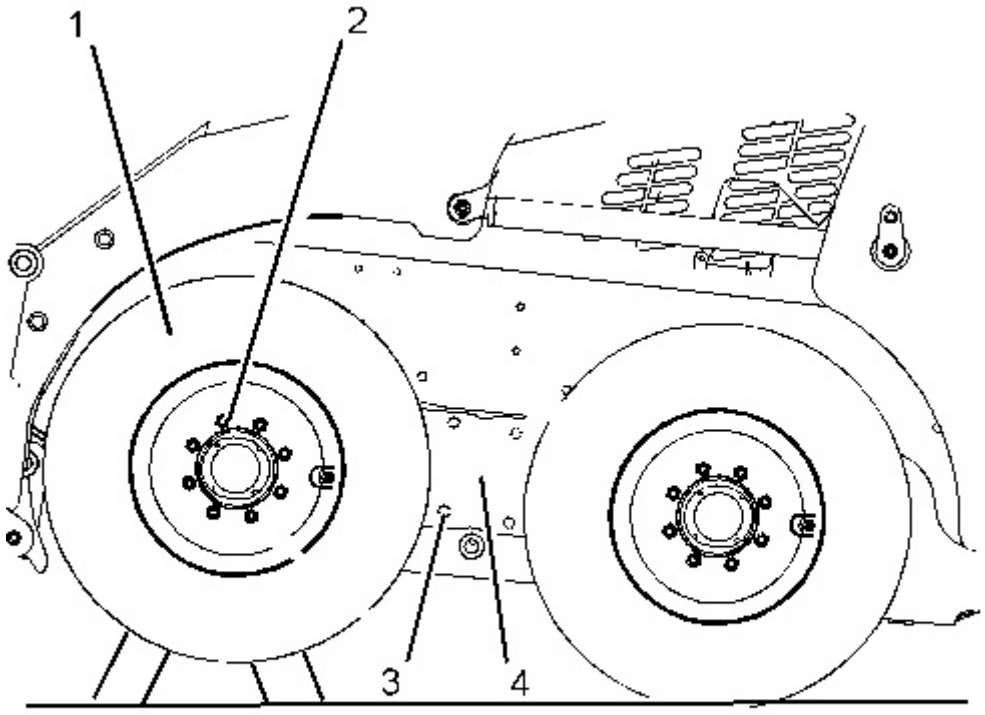


Illustration 2 g01052851

3. Use a suitable lifting device to support the tire. Remove lug nuts (2) . Remove tire (1) . The weight of tire (1) is approximately 51 kg (113 lb). Remove bolts (3) . Remove cover (4) .

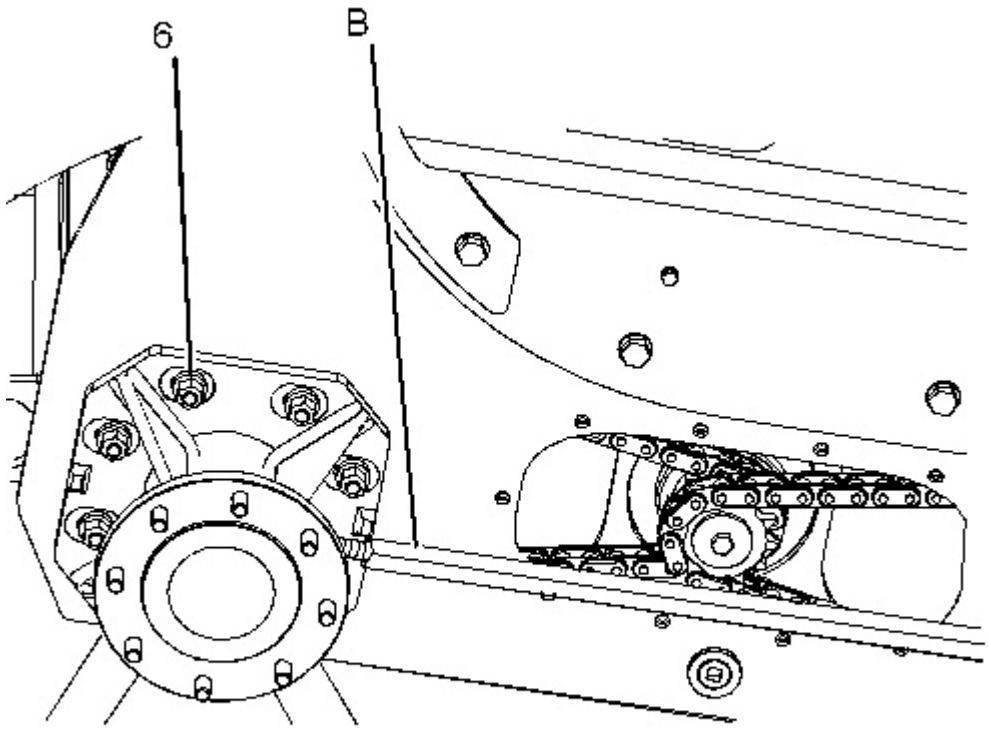


Illustration 3 g01092147

4. Loosen bolts (6) .
5. Position Tooling (B) .
6. Rotate Tooling (B) counterclockwise in order to tension the chain to the proper specification.

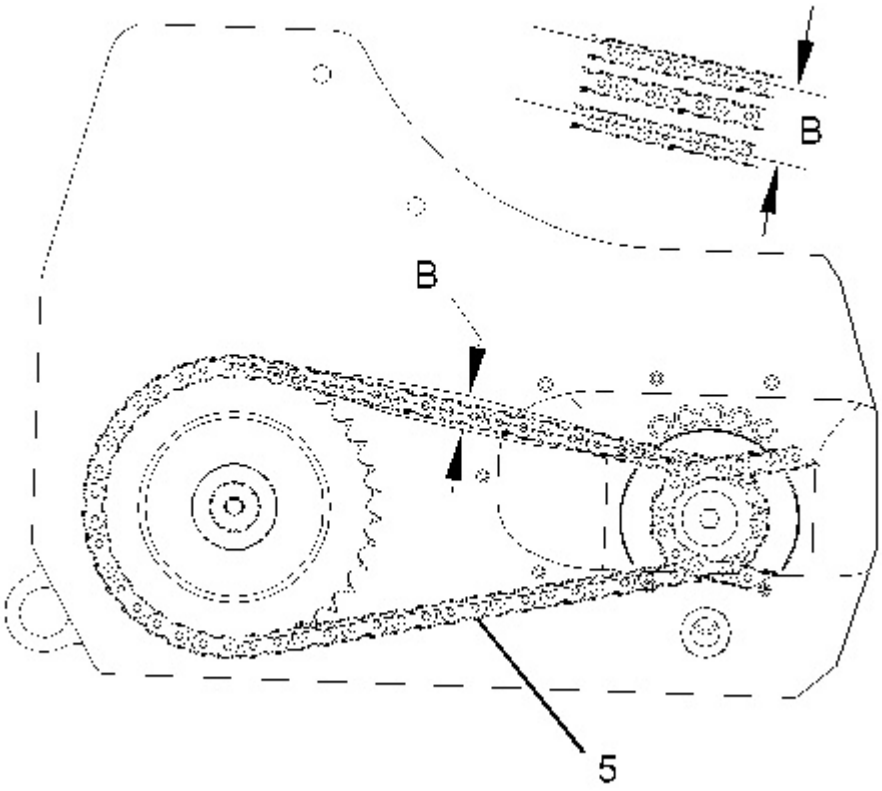


Illustration 4 g01095927

7. Ensure that chain (5) is taut below the sprockets when you are measuring the amount of movement in the chain.
8. The proper chain tension will be achieved when Dimension (B) is between 10.0 mm (0.39 inch) and 15.0 mm (0.6 inch). Dimension (B) is the total center movement of the chain.
9. If necessary, repeat the adjustment procedure for the drive chain on the other side of the machine.

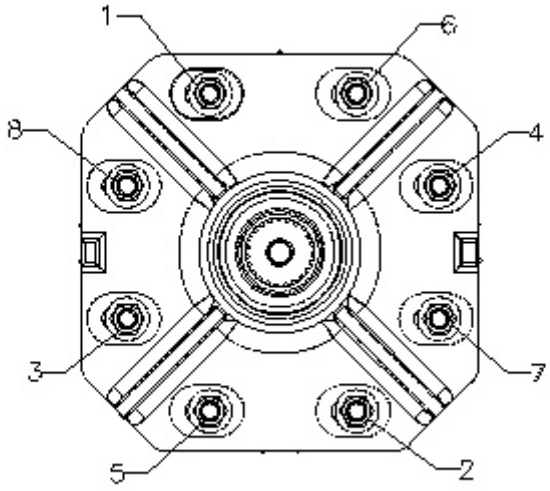


Illustration 5 g00554036

10. Tighten the bolts for the axle housing in the order that is shown above to 50 ± 15 N·m (37 ± 11 lb ft). Torque all nuts again to 50 ± 15 N·m (37 ± 11 lb ft) and turn an additional 90 ± 5 degrees in the same order.

11. Remove Tooling (B) .

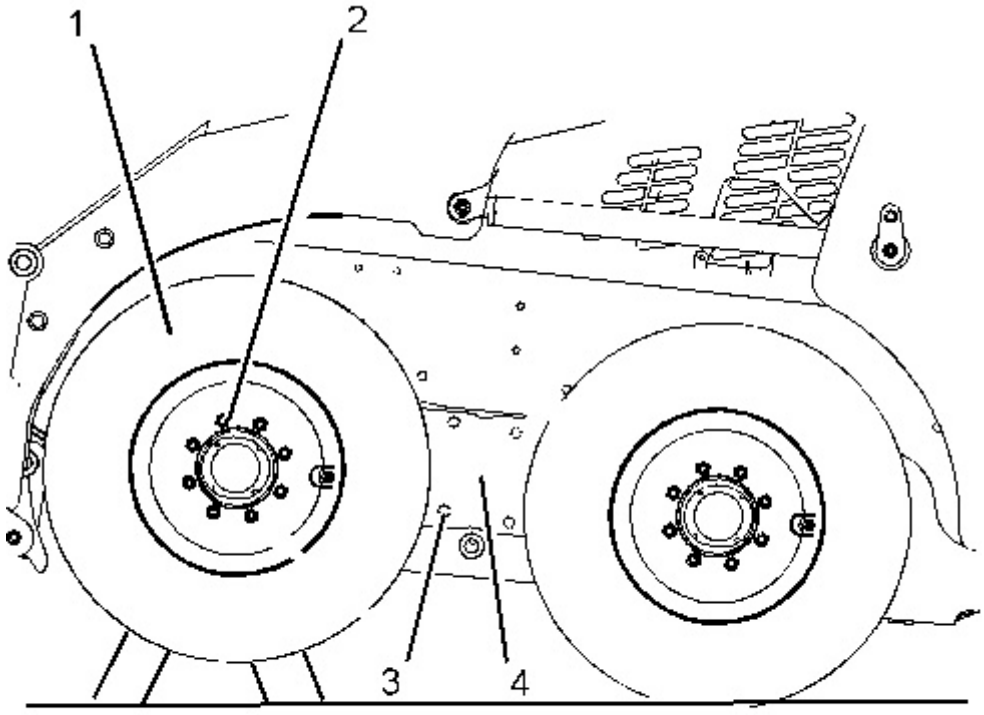


Illustration 6 g01052851

Note: Clean the cover and the mating surface before assembly.

12. Apply Tooling (C) in the bolt holes on the frame. Apply a 3.0 ± 1.0 mm (0.10 ± 0.04 inch) continuous bead of Tooling (C) to cover (4) .
13. Position cover (4) .
14. Install bolts (3) .
15. Use a suitable lifting device to install tire (1) . The weight of the tire (1) is approximately 51 kg (113 lb). Refer to Operation and Maintenance Manual, "Wheel Nuts - Tighten" for the procedure to tighten the lug nuts.
16. Use a suitable lifting device to support the machine and remove Tooling (A) .
17. If necessary, repeat the adjustment procedure for the rear of the machine.

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Pump Mounting (Hydrostatic)

SMCS - 3203-MT

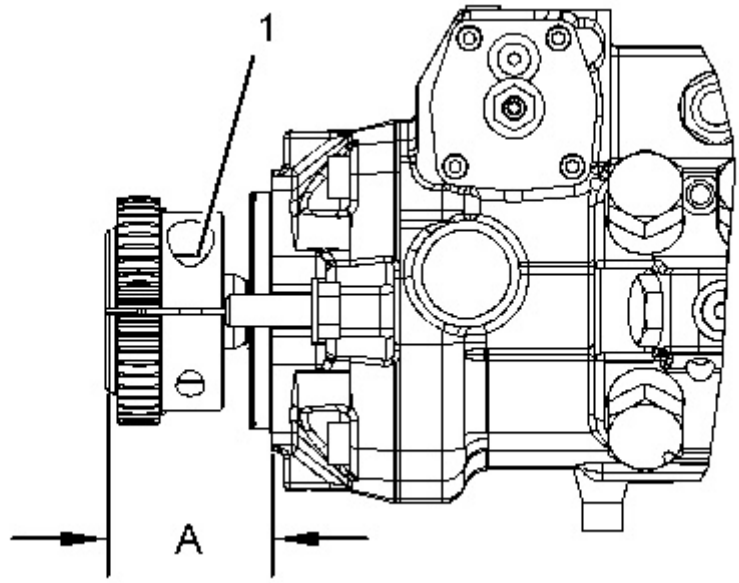


Illustration 1 g01421155

Hub assembly view

(A) The distance from the front face of the coupling hub assembly to the face of the piston pump group ... 70.9 mm (2.79 inch)

(1) Torque for the bolt ... 102 ± 5 N·m (75 ± 4 lb ft)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02943728

Tandem Drive

SMCS - 3007

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

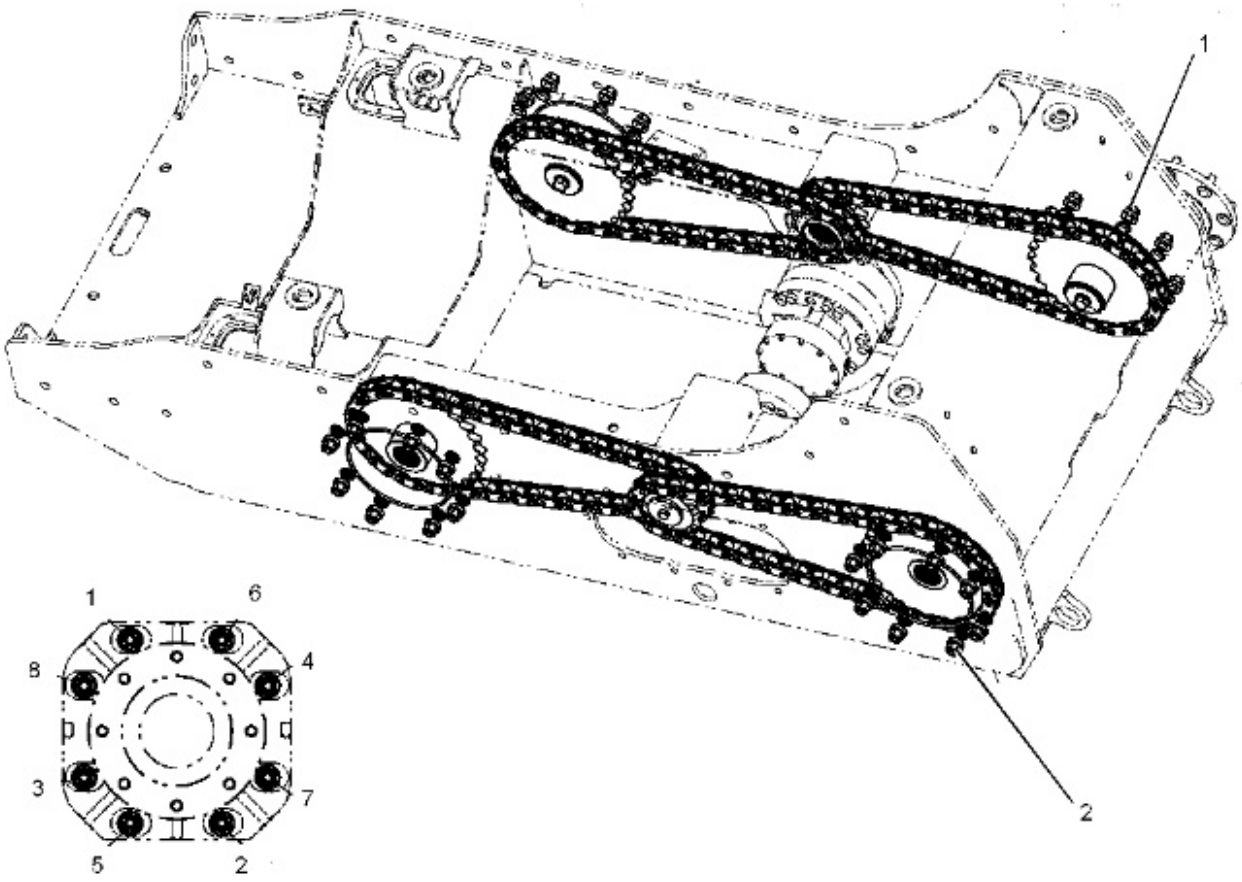


Illustration 1 g01458957

Right side view

Note: Install the studs (1) until the stud flange is firmly fixed against the chain box.

(2) Use the following procedure to tighten the nuts:

1. Tighten the nuts in the numerical sequence that is shown in Illustration 1 to 160 ± 15 N·m (120 ± 11 lb ft).
2. Again tighten the nuts in the numerical sequence by an additional angle of 60 ± 5 degrees.

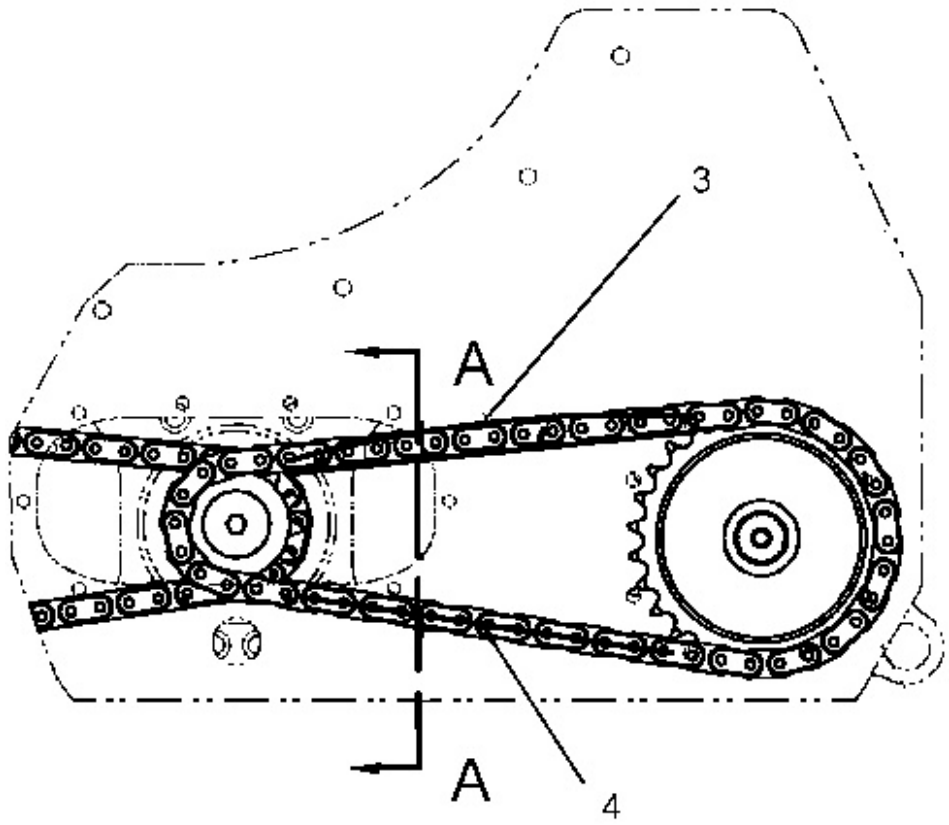


Illustration 2 g01458961

Right side view of the machine

(4) Taut side

Allowable free middle span movement on the slack side (3) of the tension chain assembly ... 10 to 15 mm (0.4 to 0.6 inch)

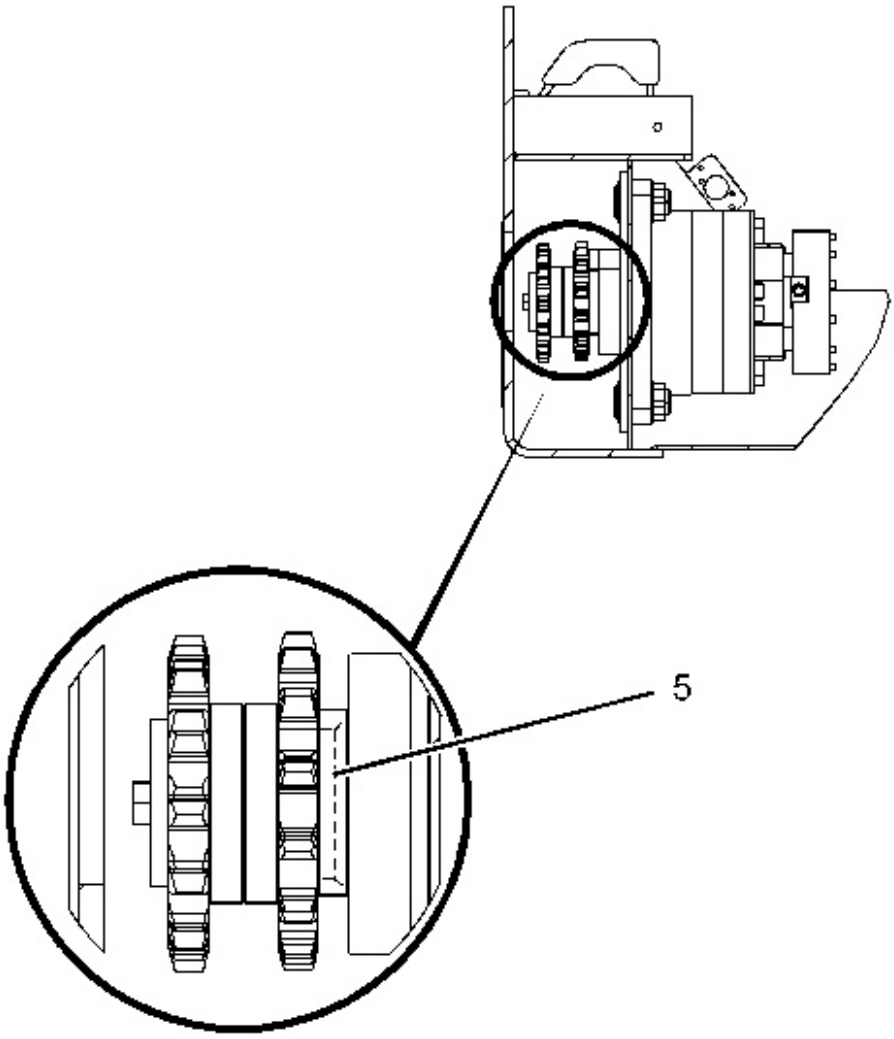


Illustration 3 g01423795

View A-A

(5) Orient the chamfer of the spacer toward the hydraulic motor.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02853442

Pump Mounting (Hydrostatic)

SMCS - 3203-MT

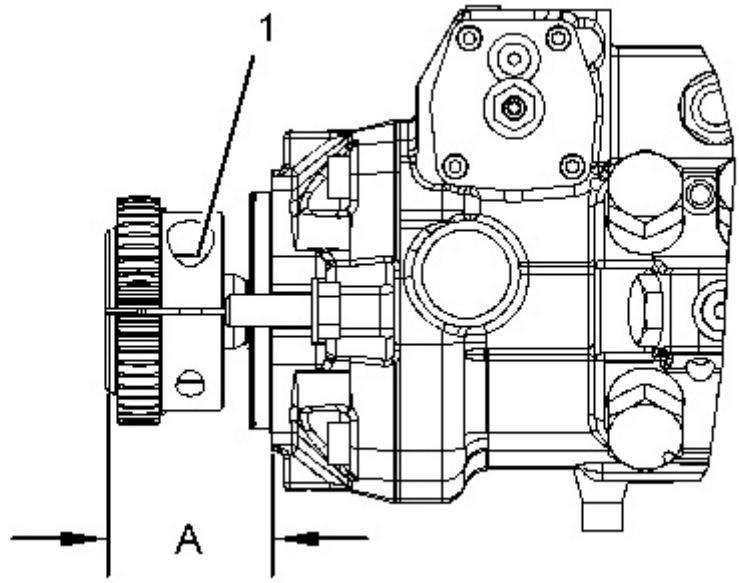


Illustration 1 g01421155

Hub assembly view

(A) The distance from the front face of the coupling hub assembly to the face of the piston pump group ... 70.9 mm (2.79 inch)

(1) Torque for the bolt ... 102 ± 5 N·m (75 ± 4 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02943728

Tandem Drive

SMCS - 3007

S/N - HEN6750-UP

S/N - SCP4600-UP

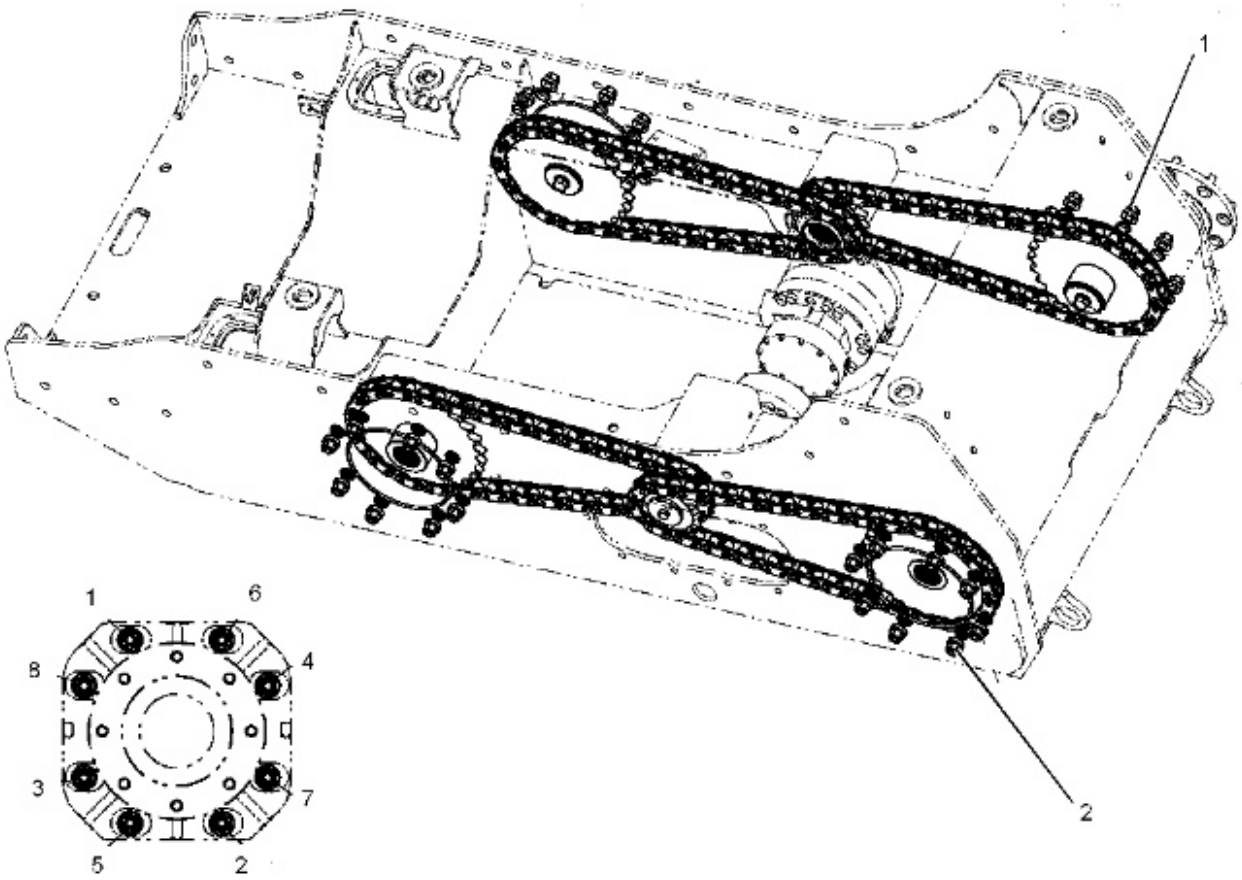


Illustration 1 g01458957

Right side view

Note: Install the studs (1) until the stud flange is firmly fixed against the chain box.

(2) Use the following procedure to tighten the nuts:

1. Tighten the nuts in the numerical sequence that is shown in Illustration 1 to 160 ± 15 N·m (120 ± 11 lb ft).
2. Again tighten the nuts in the numerical sequence by an additional angle of 60 ± 5 degrees.

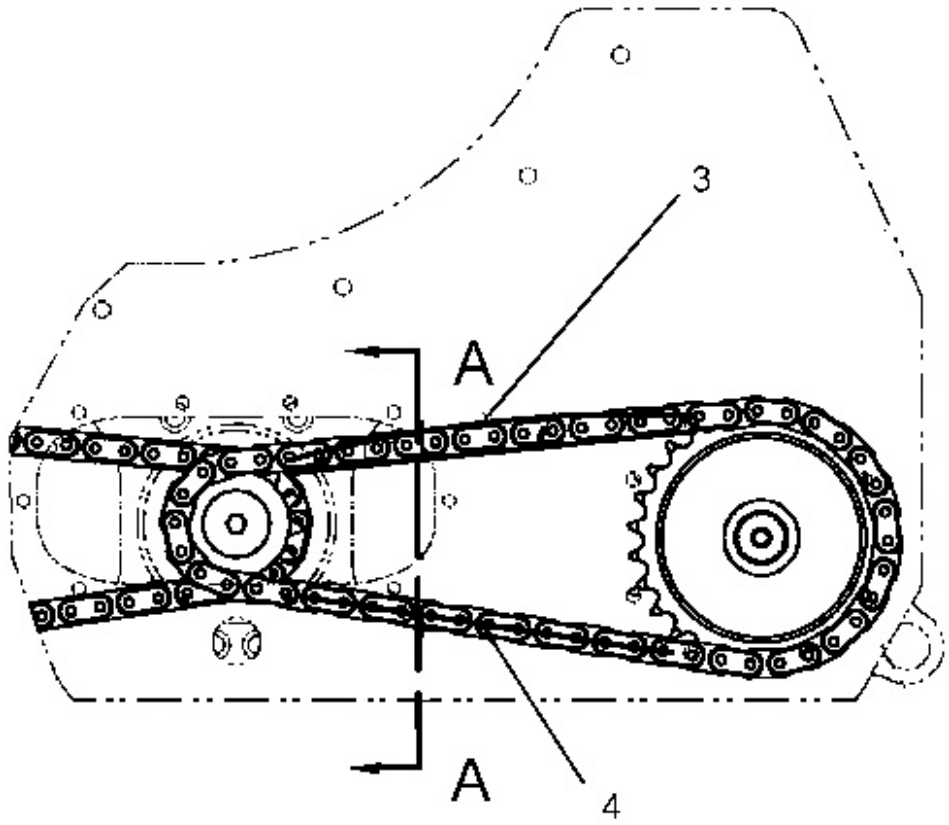


Illustration 2 g01458961

Right side view of the machine

(4) Taut side

Allowable free middle span movement on the slack side (3) of the tension chain assembly ... 10 to 15 mm (0.4 to 0.6 inch)

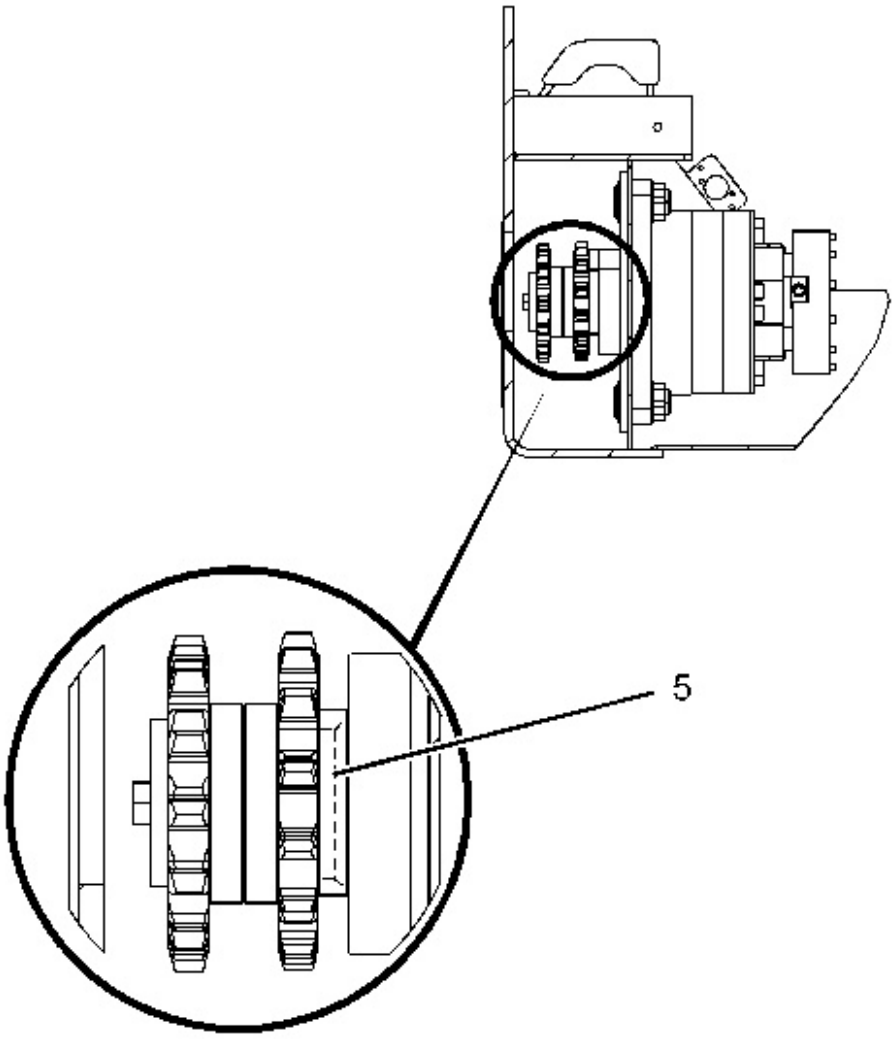


Illustration 3 g01423795

View A-A

(5) Orient the chamfer of the spacer toward the hydraulic motor.

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i02161306

Chain (Drive) - Remove

SMCS - 3261-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	169-5464	Quick Cure Primer	1
B	5P-3413	Pipe Sealant	1

Start By:

A. Remove the tire and rim. Refer to Disassembly and Assembly, "Tire and Rim - Remove and Install".
B. Tilt the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

Note: Cleanliness is an important factor. Before you begin the disassembly procedure, the exterior of the components should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism. Precision components can be damaged by contaminants or by dirt. Perform disassembly procedures on a clean work surface. Keep components covered and protected at all times.

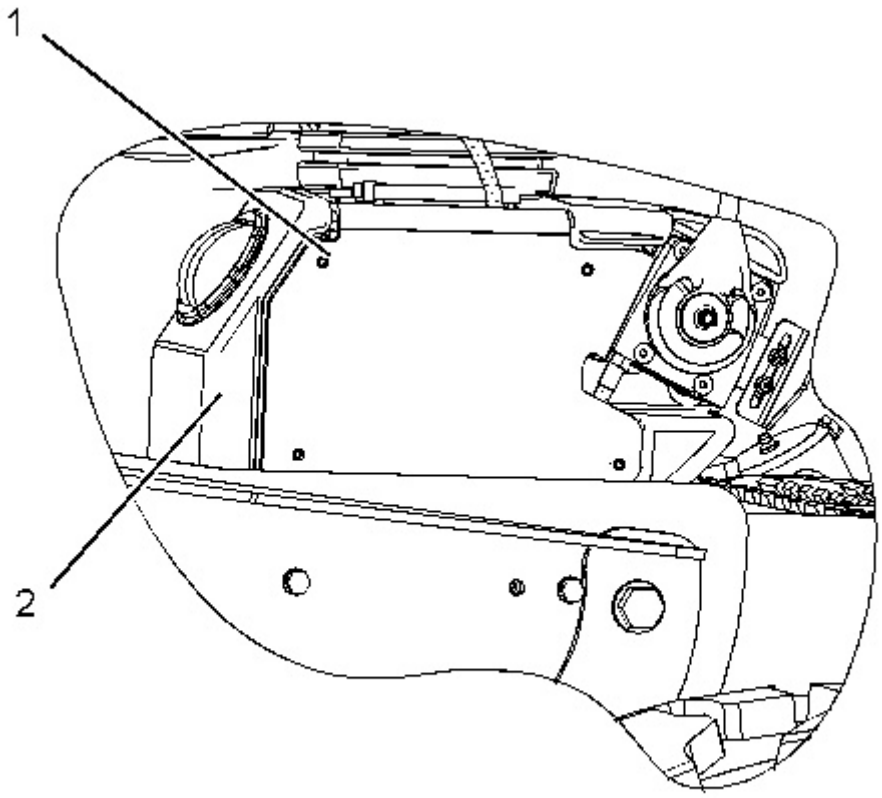


Illustration 1 g01051759

1. Remove bolts (1) .
2. Move console (2) aside.

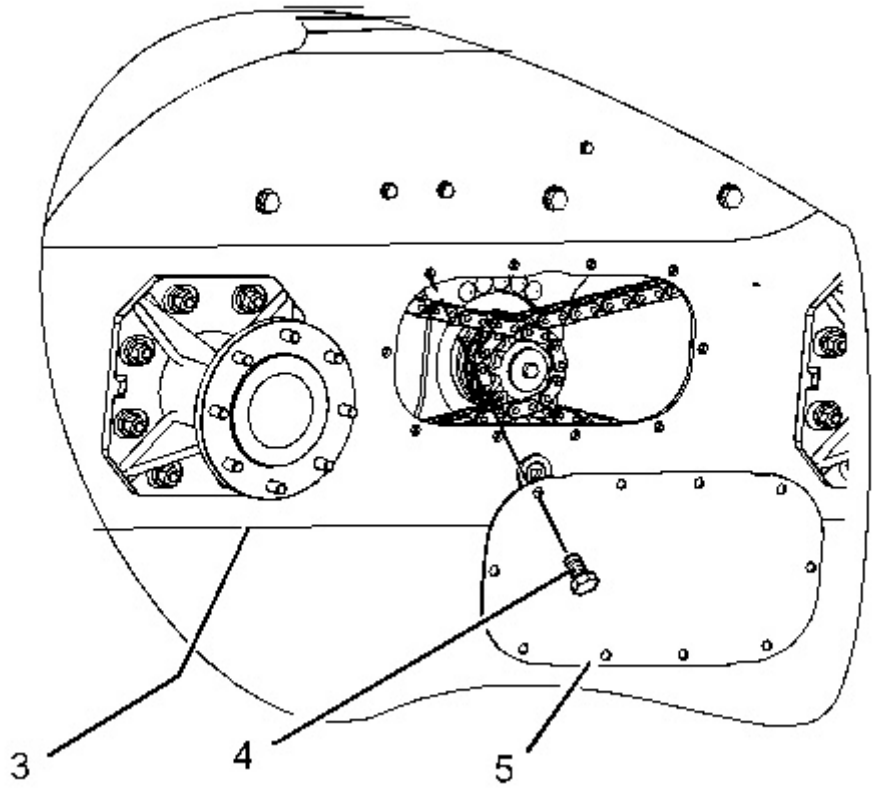


Illustration 2 g01053046

3. Remove plug (3) .
4. Drain the drive chain oil into a suitable container.
5. Apply Tooling (A) to plug (3).
6. Apply Tooling (B) to plug (3) .
7. Install plug (3) .
8. Remove bolts (4) .
9. Remove cover (5) .

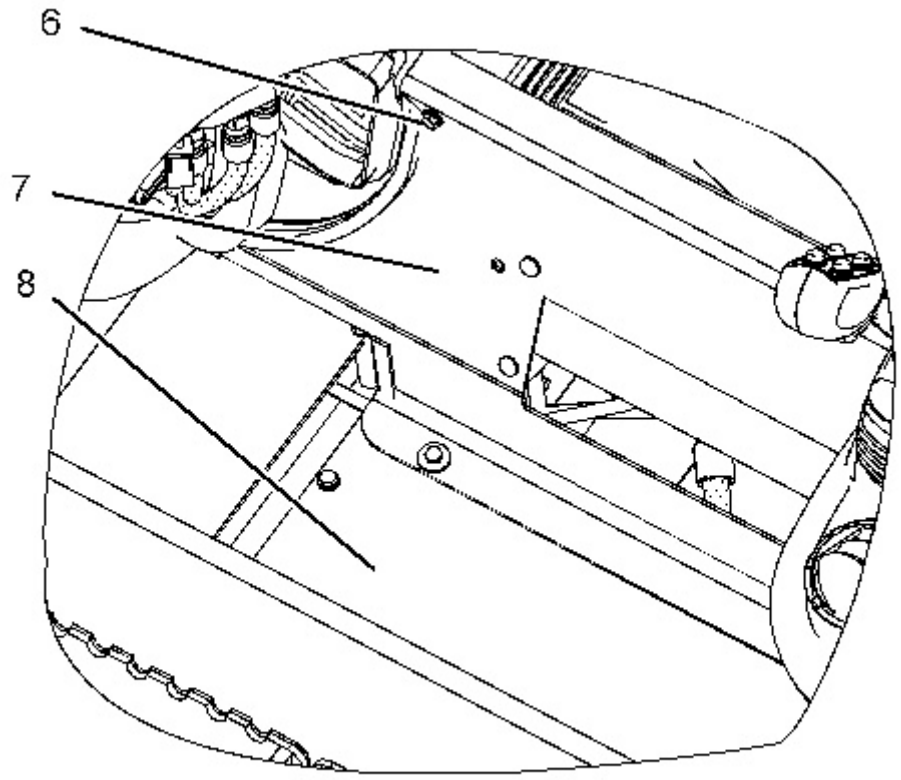


Illustration 3 g01051761

10. Remove bolts (6).
11. Remove plate (7).
12. Move plate (8) aside.

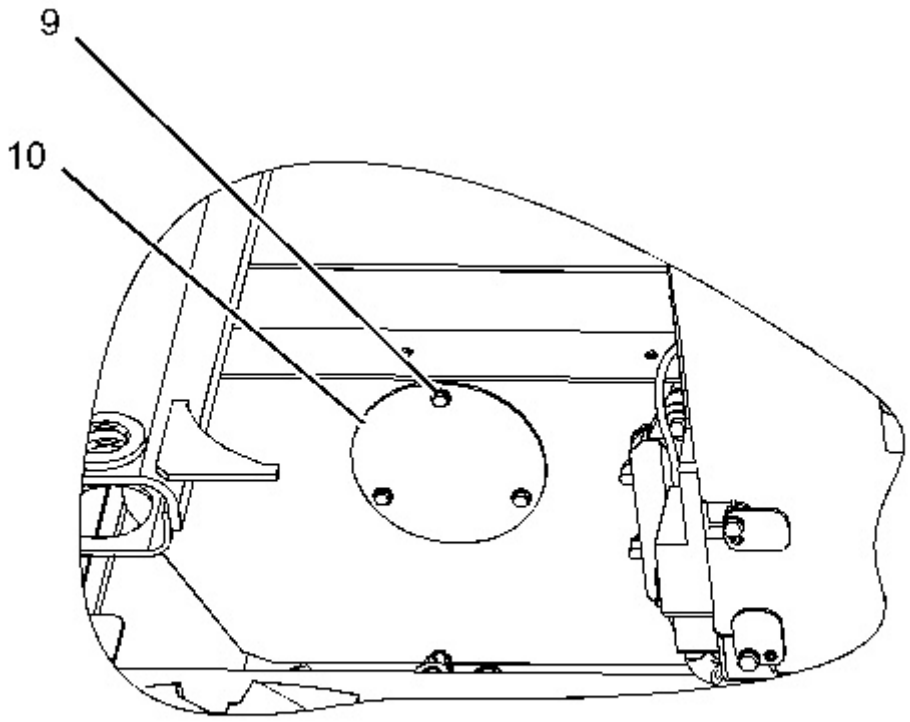


Illustration 4 g01051762

13. Remove bolts (9).
14. Remove plate (10) .

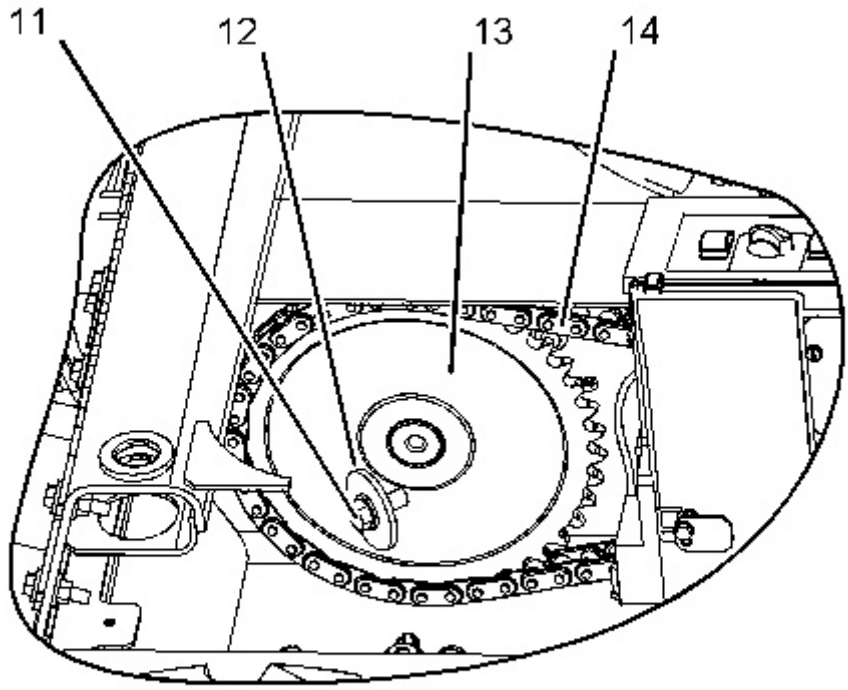


Illustration 5 g01051763

15. Remove bolt (11).
16. Remove washer (12) .
17. Remove sprocket (13).
18. Remove chain assembly (14) .

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i05025850

Chain (Drive) - Install

SMCS - 3261-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 5900	-

Note: Cleanliness is an important factor. Before assembly, thoroughly clean all parts in cleaning fluid. Allow the parts to air dry. Do not use wiping cloths or rags to dry parts. Lint may be deposited on the parts which may cause trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision component. Perform assembly procedures on a clean work surface. Keep components covered and protected at all times.

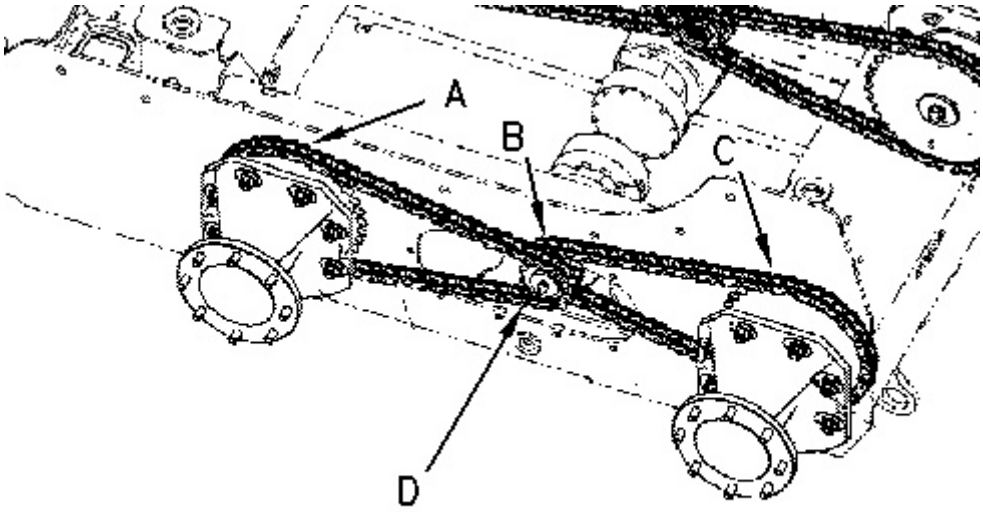


Illustration 1 g00577375

1. The front axle assemblies and the rear axle assemblies are driven by different drive chains. The drive chains are installed on Drive Sprocket (B) and Drive Sprocket (D). The drive sprockets are mounted on the drive shaft of the hydrostatic piston motor. The two drive sprockets are the same component. The drive sprocket on the hydrostatic piston motor has sprocket drives on different planes. The drive sprockets on the front and rear axles are the same component. The sprockets on the front and rear axles are mounted at 180 degrees of opposite direction. Note: Sprocket (A) is in line with Drive Sprocket (D) and that Sprocket (C) is in line with Drive Sprocket (B). The drive sprockets are installed in a manner that will allow the drive chains to turn in a straight line. If any of the sprockets are installed incorrectly the drive chains cannot be installed properly. Note the orientation of all of Drive Sprocket (B) and Drive Sprocket (D). Note the orientation of Sprocket (A) and Sprocket (C) on the axles. Mark all components prior to any removal for repair or replacement.

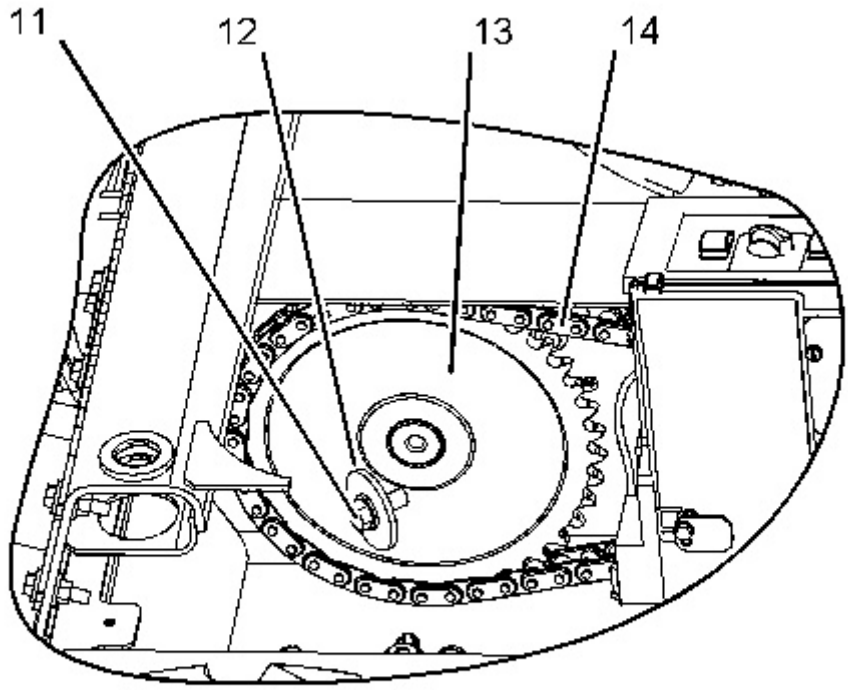


Illustration 2 g01051763

Note: Be sure that the drive sprockets are facing the proper direction in order for the drive chains to turn in a straight line.

2. Install chain assembly (14) .
3. Install sprocket (13) .
4. Install washer (12) .
5. Install bolt (11) .

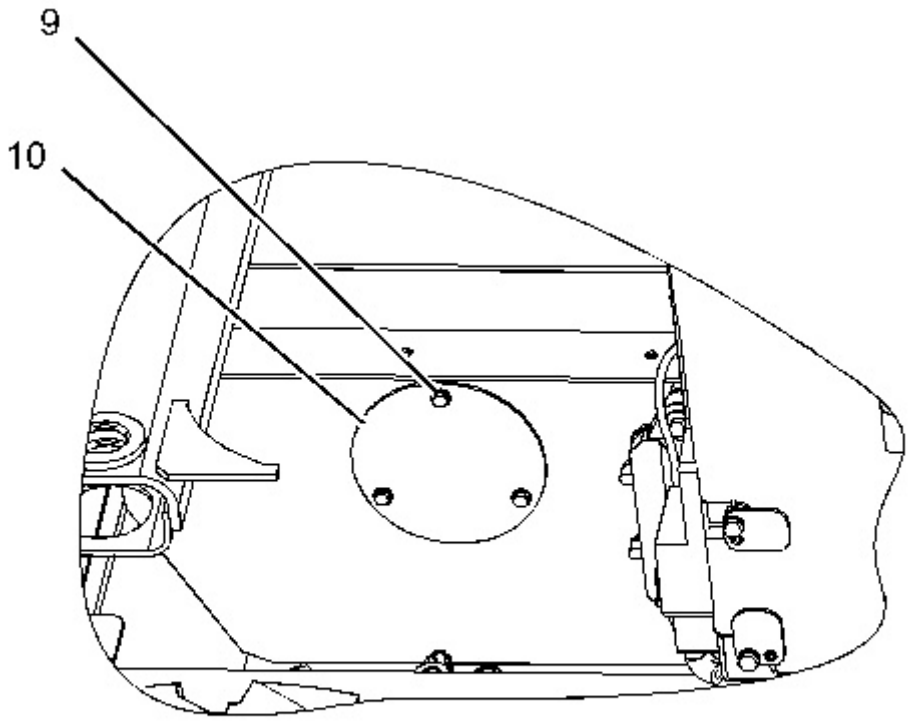


Illustration 3 g01051762

Note: Clean the plate and the mating surface before assembly.

6. Use Tooling (A) to apply a continuous bead around the access holes in the machine frame.
7. Install plate (10) .
8. Install bolts (9) .

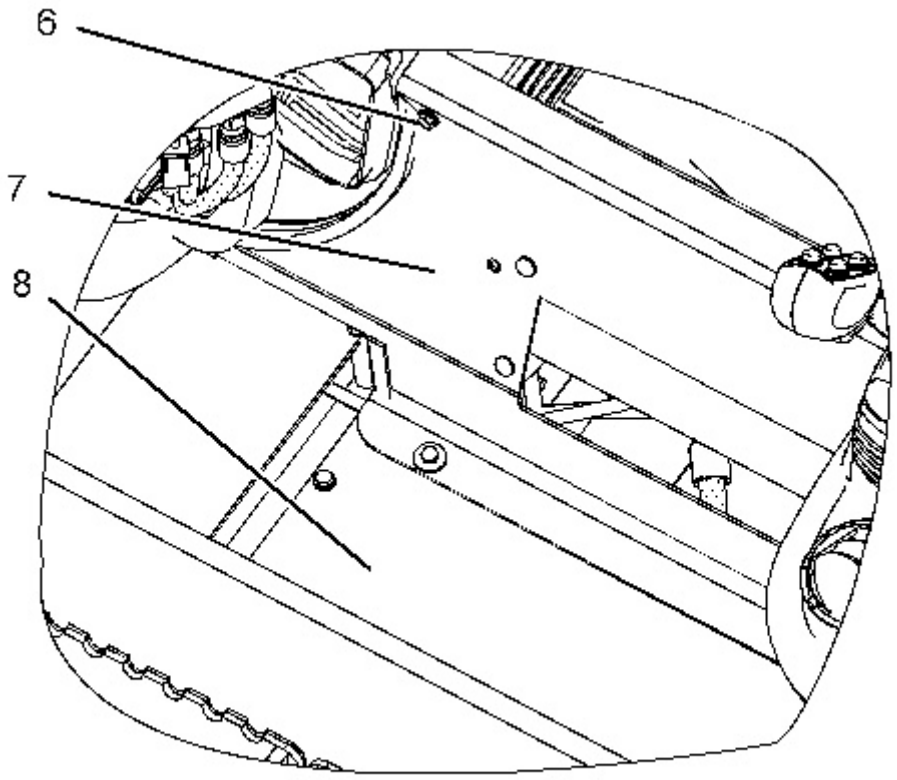


Illustration 4 g01051761

9. Position plate (8).
10. Install plate (7) .
11. Install bolts (6) .
12. Adjust the drive chain tension. Refer to Disassembly and Assembly, "Chain (Drive) - Adjust".
13. Refill the drive chain oil. Refer to Operation and Maintenance Manual, "Drive Chain Case Oil - Change".

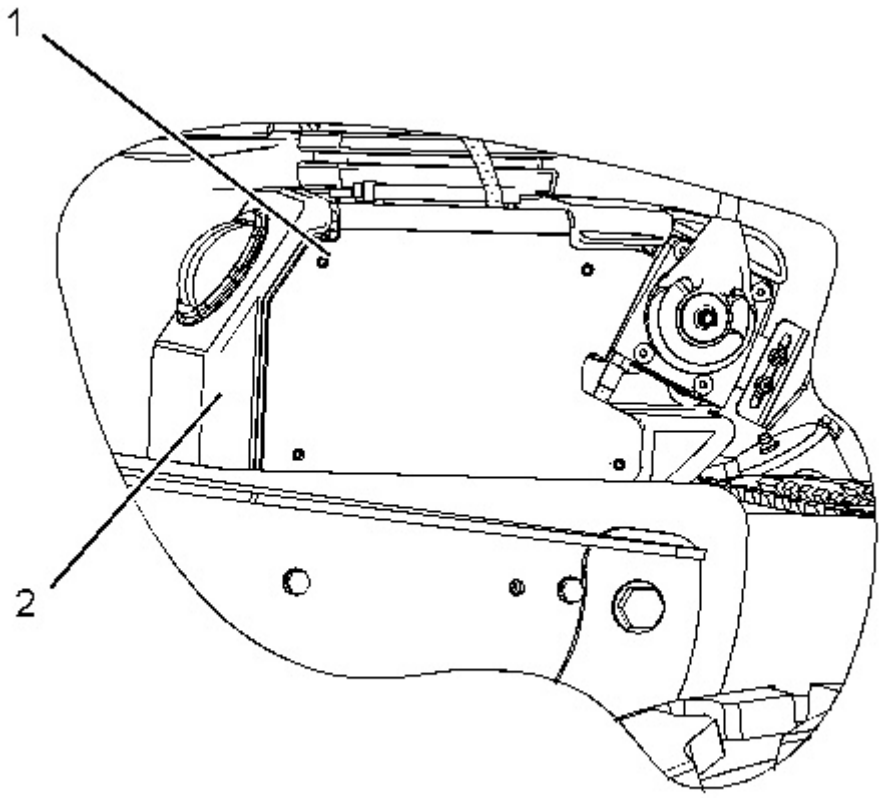


Illustration 5 g01051759

14. Position console (2) .
15. Install bolts (1) .

End By:

a. Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".
b. Install the tire and rim. Refer to Disassembly and Assembly, "Tire and Rim - Remove and Install".

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i02369929

Pump Mounting - Remove and Install

SMCS - 3203-010-MT; 5062-010; 5070-010-MT

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

Start By:

A. Remove the engine. Refer to Disassembly and Assembly, "Engine - Remove".

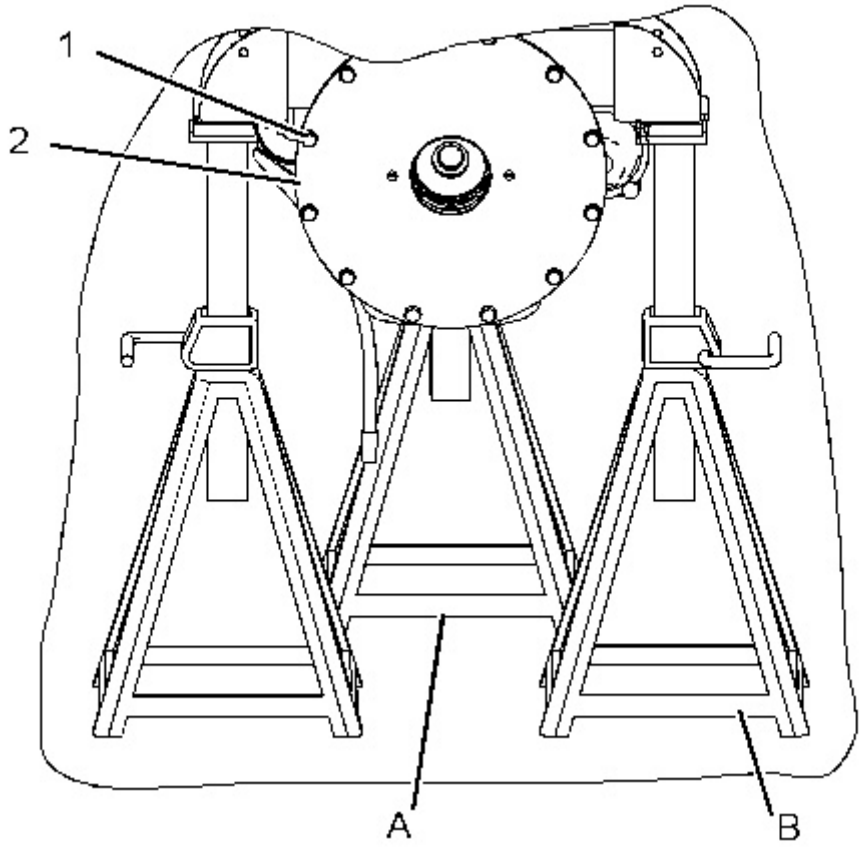


Illustration 1 g01091327

1. Use Tooling (A) and Tooling (B) to support the engine. Remove bolts (1) . Remove adapter plate (2) .

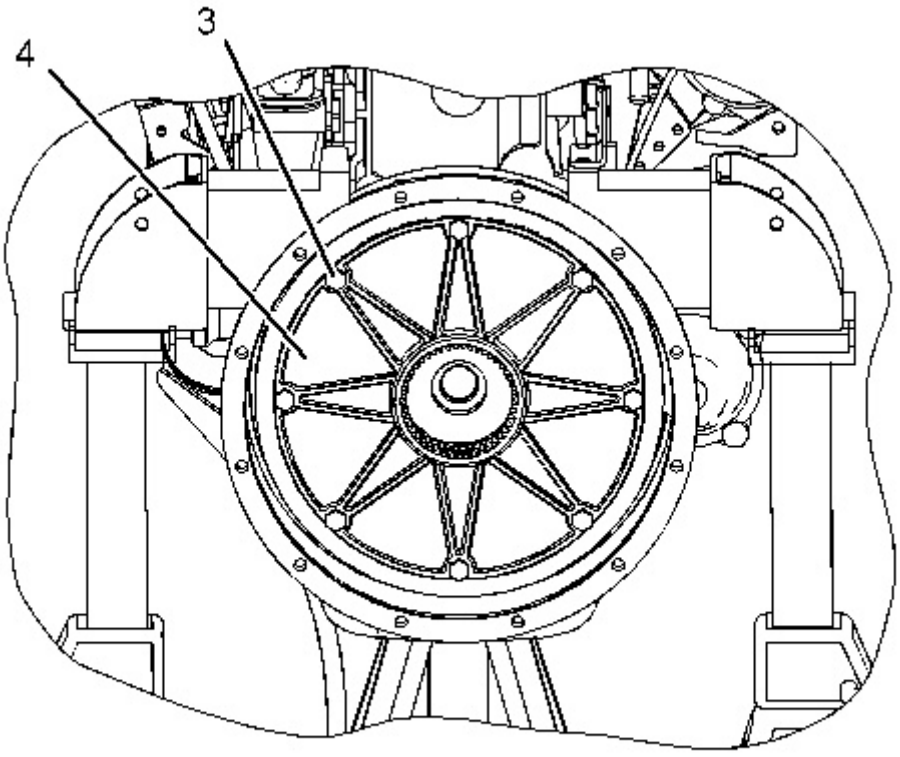


Illustration 2 g01091328

2. Remove bolts (3) . Remove nylon flange (4) .

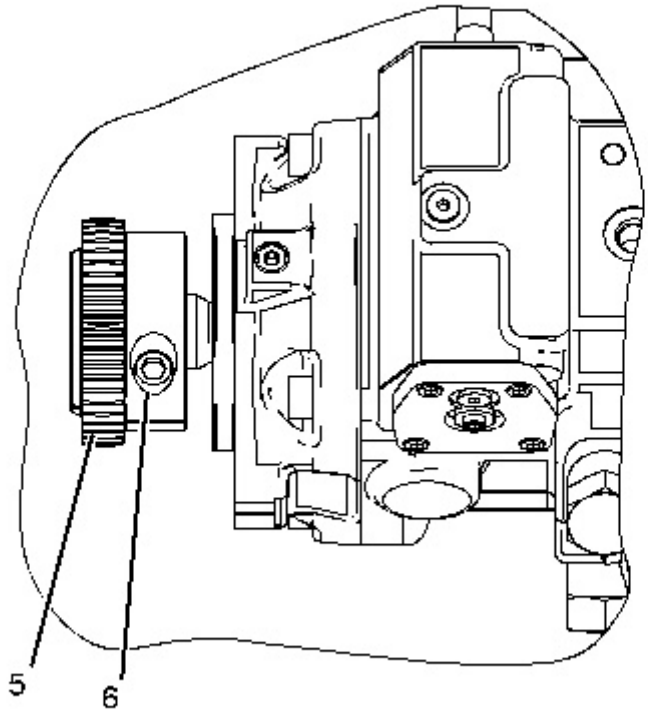


Illustration 3 g01093859

3. Remove bolt (6) . Discard bolt (6) . Remove hub (5) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

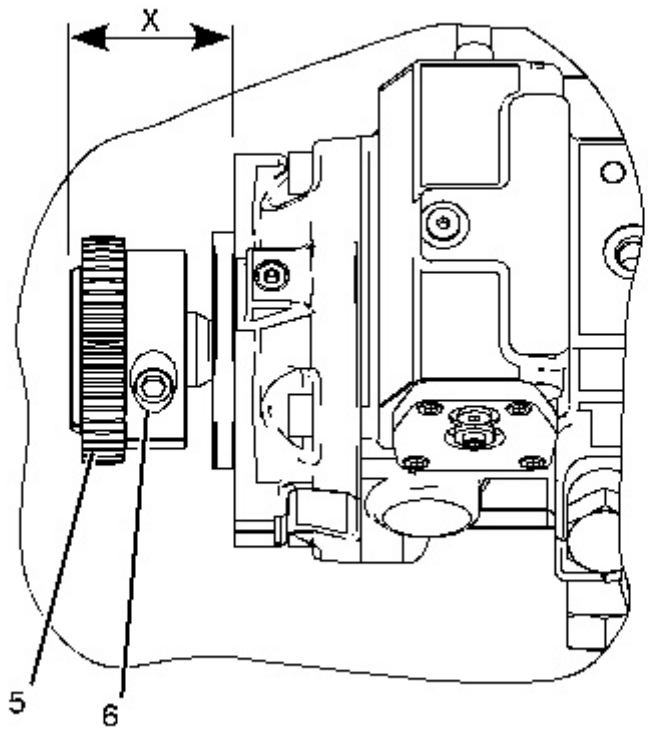


Illustration 4 g01041240

1. Install hub (5) . The face of hub (5) must be installed to a dimension of 70.9 ± 2 mm (2.80 ± .078 inch) from the face of the pump. This dimension is shown in the graphic above as Dimension (X) . Install new bolt (6) . Tighten the bolt to 102 ± 5 N·m (75 ± 4 lb ft).

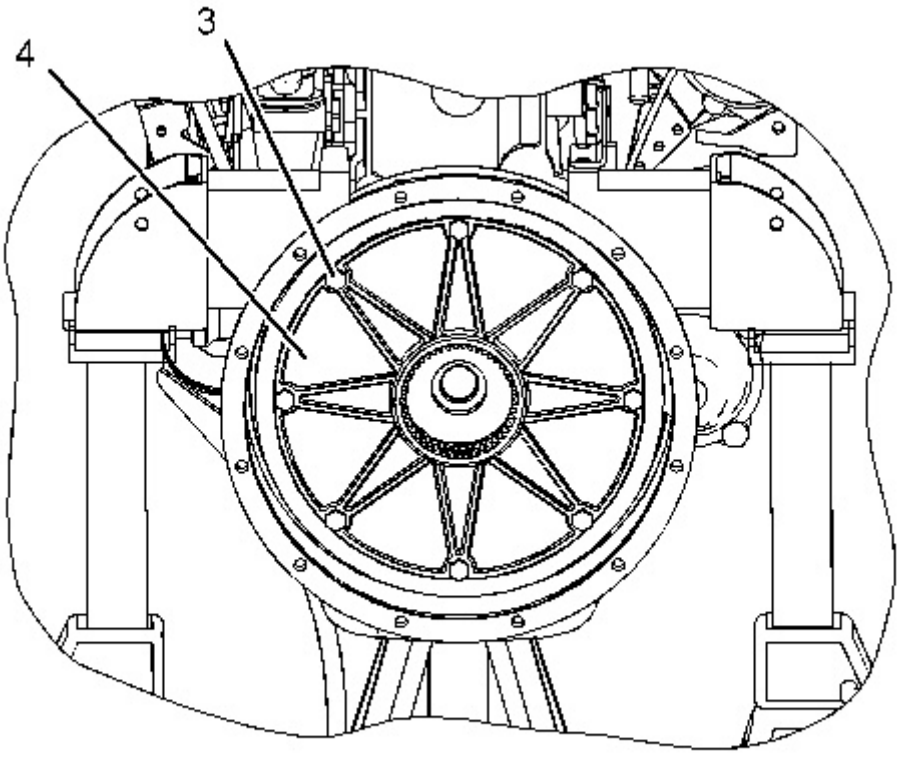


Illustration 5 g01091328

2. Install nylon flange (4) . Install bolts (3) .

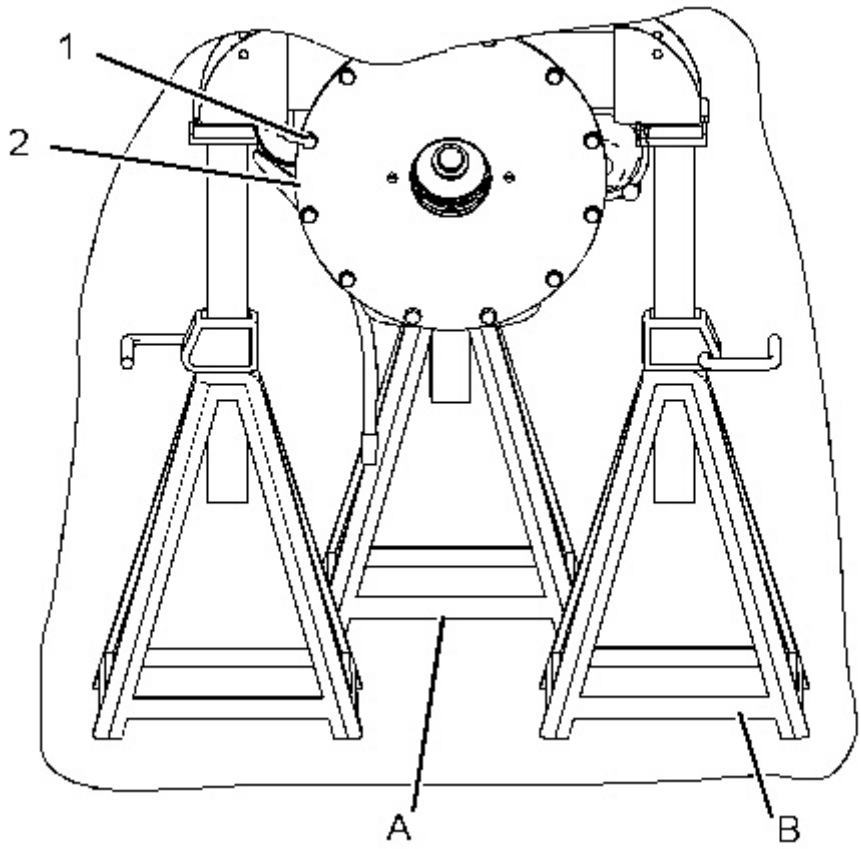


Illustration 6 g01091327

3. Install adapter plate (2) . Install bolts (1) .

End By: Install the engine. Refer to Disassembly and Assembly, "Engine - Install".

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i02369929

Pump Mounting - Remove and Install

SMCS - 3203-MT

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

Start By:

A. Remove the engine. Refer to Disassembly and Assembly, "Engine - Remove".

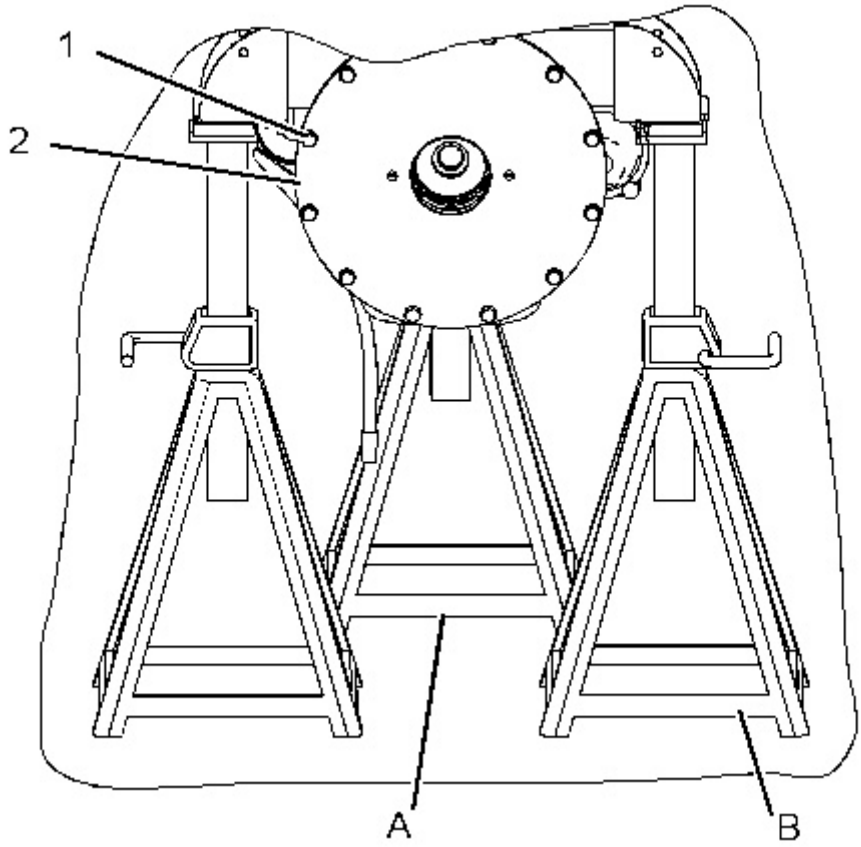


Illustration 1 g01091327

1. Use Tooling (A) and Tooling (B) to support the engine. Remove bolts (1) . Remove adapter plate (2) .

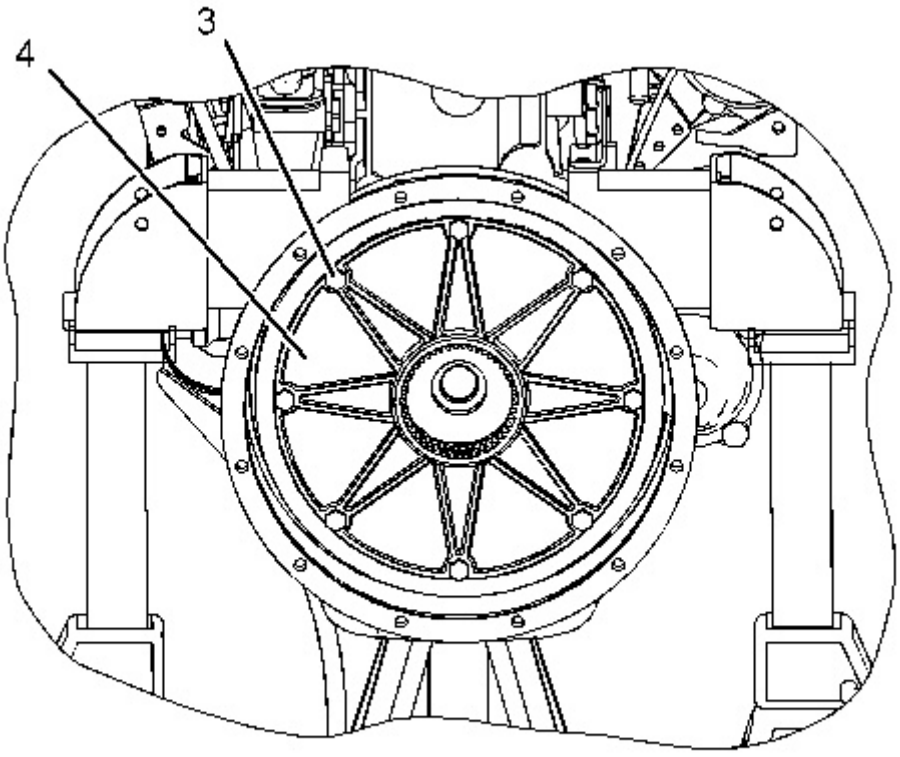


Illustration 2 g01091328

2. Remove bolts (3) . Remove nylon flange (4) .

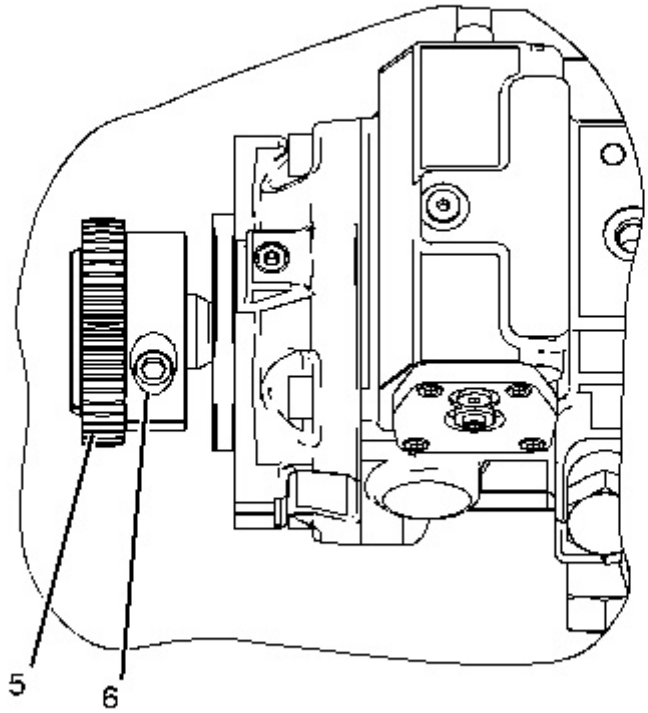


Illustration 3 g01093859

3. Remove bolt (6) . Discard bolt (6) . Remove hub (5) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

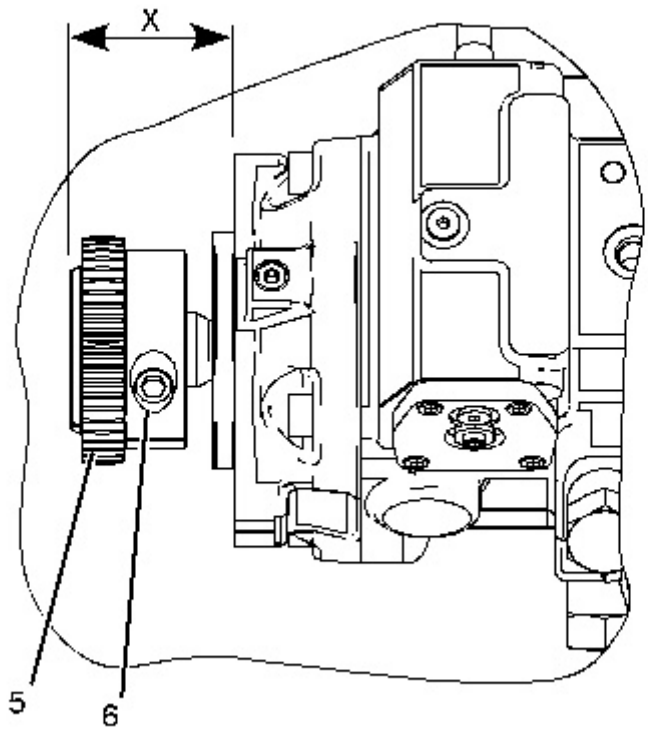


Illustration 4 g01041240

1. Install hub (5) . The face of hub (5) must be installed to a dimension of 70.9 ± 2 mm (2.80 ± .078 inch) from the face of the pump. This dimension is shown in the graphic above as Dimension (X) . Install new bolt (6) . Tighten the bolt to 102 ± 5 N·m (75 ± 4 lb ft).

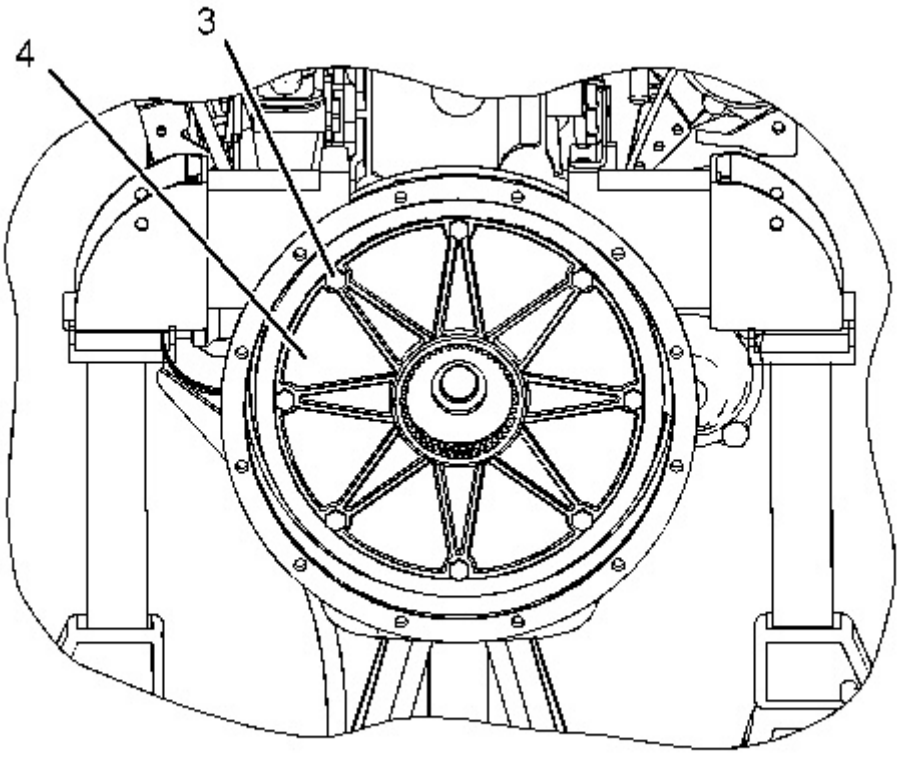


Illustration 5 g01091328

2. Install nylon flange (4) . Install bolts (3) .

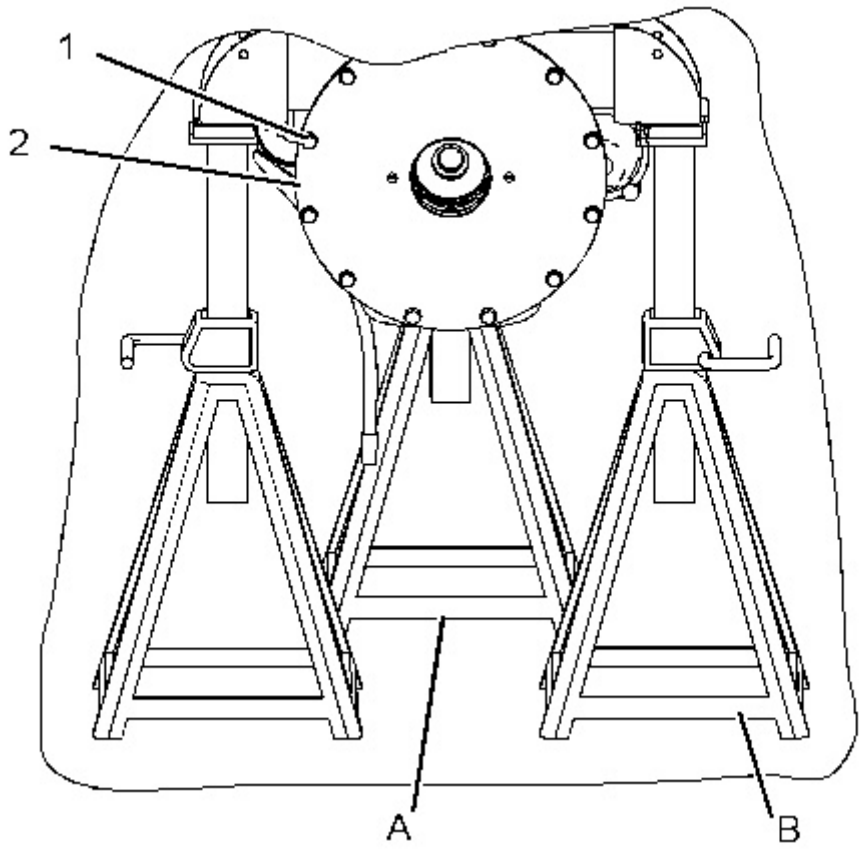


Illustration 6 g01091327

3. Install adapter plate (2) . Install bolts (1) .

End By: Install the engine. Refer to Disassembly and Assembly, "Engine - Install".

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i02851364

Hydraulic Oil Filter

SMCS - 5068

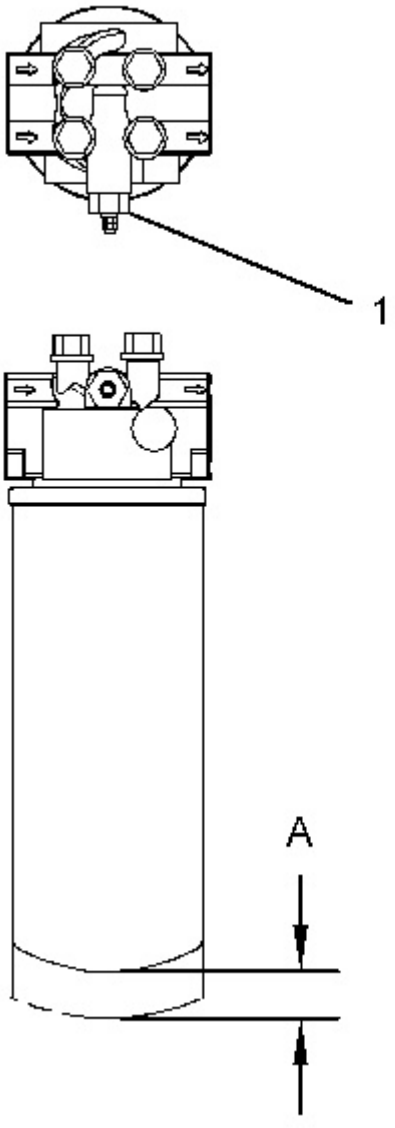


Illustration 1 g01420410

(1) **134-0404** Pressure Switch

Contact position ... Normally open
Operating voltage ... 6 to 30 VDC
Maximum current ... 200 mA
Pressure that is needed in order to close the circuit ... 275 ± 28 kPa (40 ± 4 psi)
Pressure that is needed in order to open the electrical circuit ... 205 kPa (30 psi)
Bypass pressure setting ... 345 kPa (50 psi)
Final installation torque ... 4.1 ± 2.7 N·m (35 ± 24 lb in)

(A) Minimum clearance that is needed in order to remove the oil filter assembly ... 23.1 mm (0.91 inch)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02851364

Hydraulic Oil Filter

SMCS - 5068

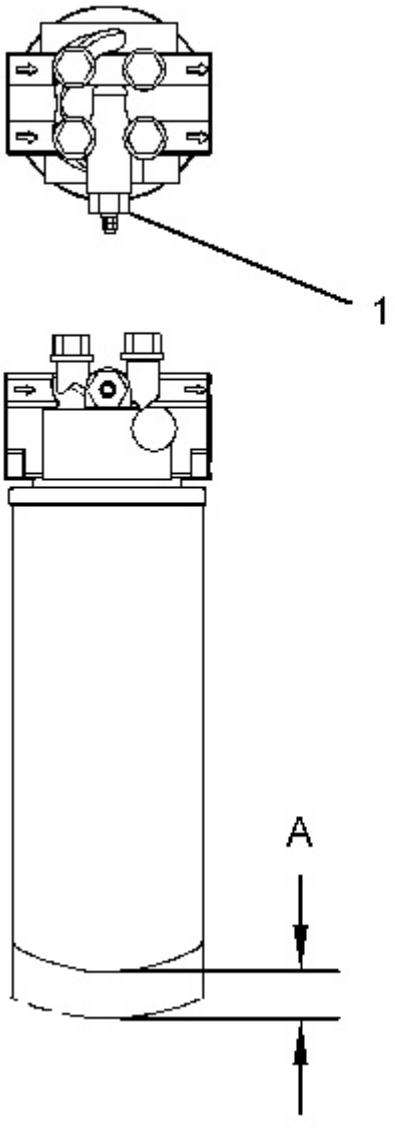


Illustration 1 g01420410

(1) **134-0404** Pressure Switch

Contact position ... Normally open
Operating voltage ... 6 to 30 VDC
Maximum current ... 200 mA
Pressure that is needed in order to close the circuit ... 275 ± 28 kPa (40 ± 4 psi)
Pressure that is needed in order to open the electrical circuit ... 205 kPa (30 psi)
Bypass pressure setting ... 345 kPa (50 psi)
Final installation torque ... 4.1 ± 2.7 N·m (35 ± 24 lb in)

(A) Minimum clearance that is needed in order to remove the oil filter assembly ... 23.1 mm (0.91 inch)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02853434

Return Manifold

SMCS - 3154-M9; 5264

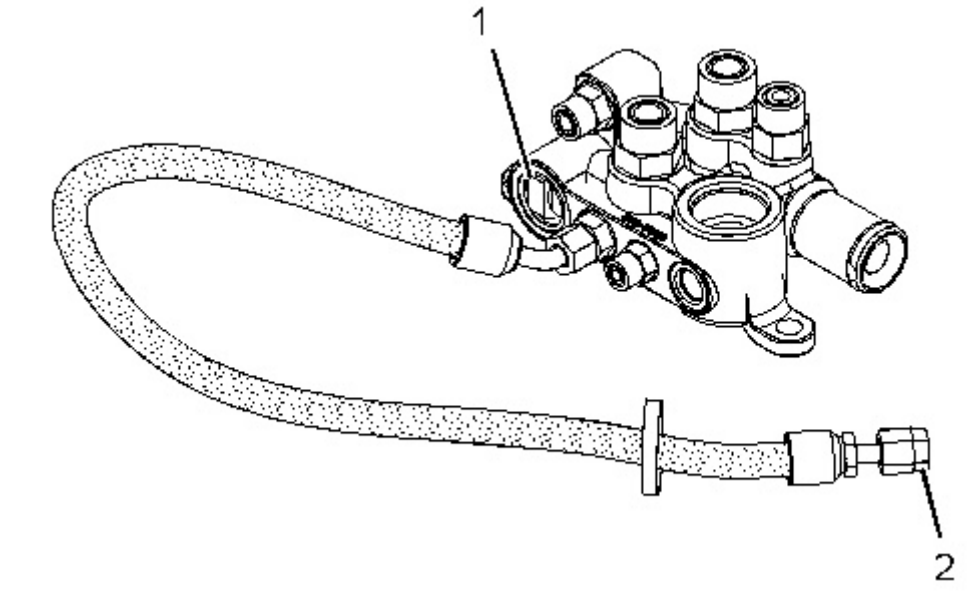


Illustration 1 g01421143

(1) **212-6604** Spring

Length under test force ... 17.85 mm (0.703 inch)
Test force ... 52 N (12 lb)
Free length after test ... 22.35 mm (0.880 inch)
Outside diameter ... 21.59 mm (0.850 inch)

(2) Torque for the plug assembly ... 22 ± 3 N·m (16 ± 2 lb ft)

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i02853434

Return Manifold

SMCS - 3154-M9; 5264

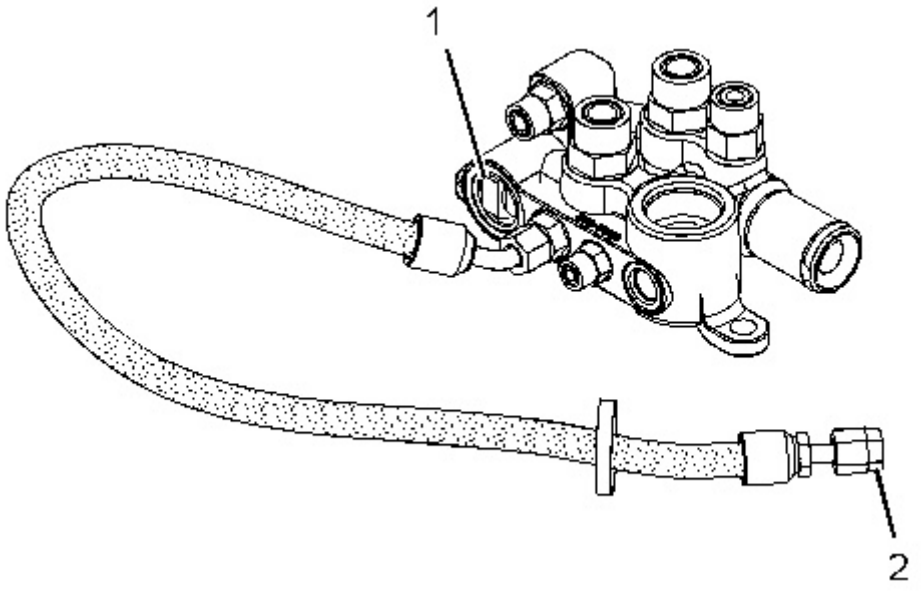


Illustration 1 g01421143

(1) **212-6604** Spring

Length under test force ... 17.85 mm (0.703 inch)
Test force ... 52 N (12 lb)
Free length after test ... 22.35 mm (0.880 inch)
Outside diameter ... 21.59 mm (0.850 inch)

(2) Torque for the plug assembly ... 22 ± 3 N·m (16 ± 2 lb ft)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02879873

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

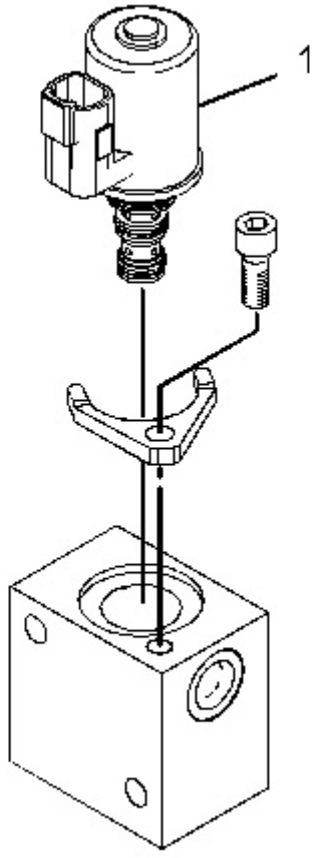


Illustration 1 g01433342

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of the coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02888178

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

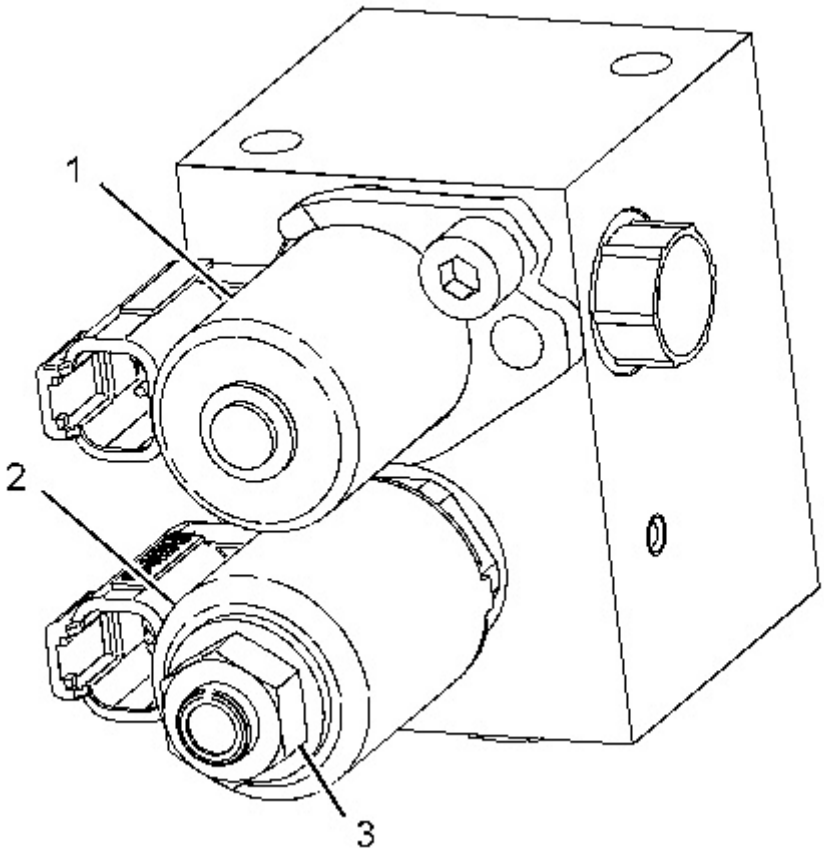


Illustration 1 g01437825

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

(2) **216-0610** Solenoid Valve Gp

Torque for installing the solenoid valve group ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the nut (3) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)
Operating voltage ... 12 VDC
Current at a maximum temperature of 121 °C (250 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02879873

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

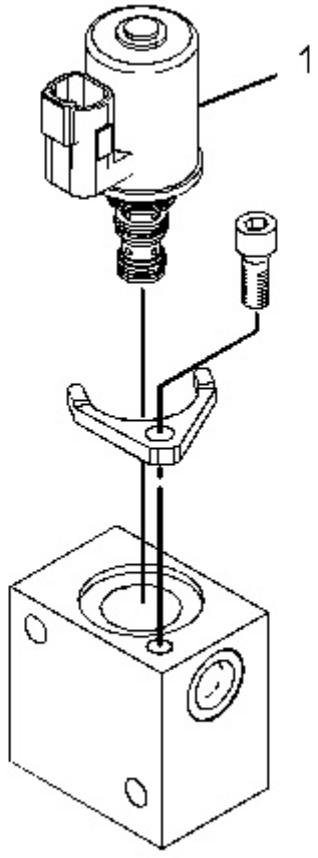


Illustration 1 g01433342

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of the coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02888178

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

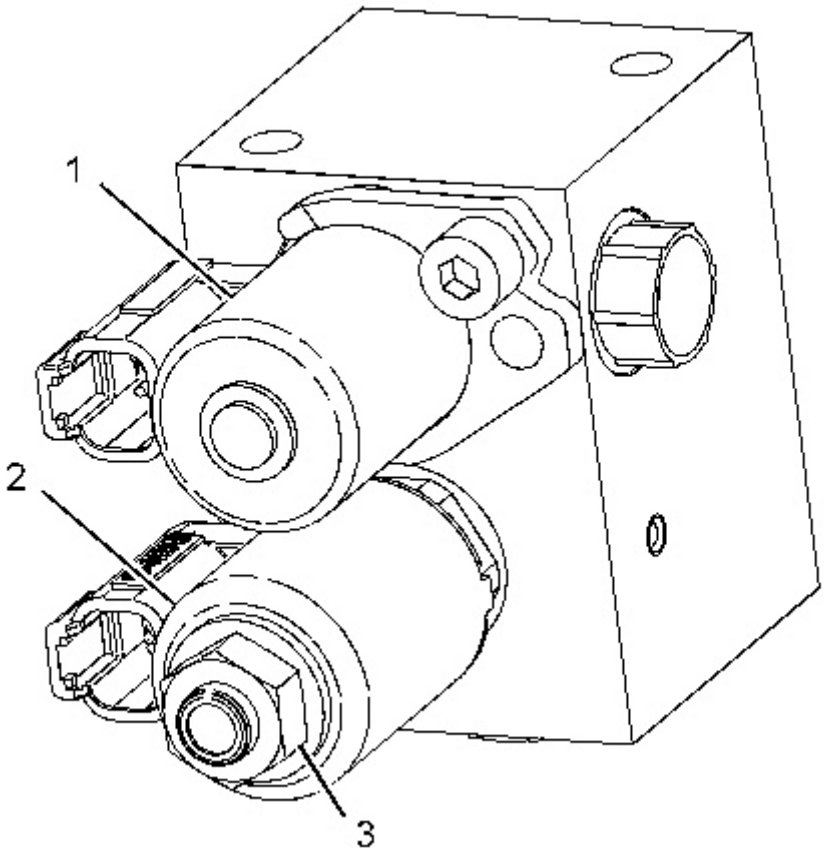


Illustration 1 g01437825

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

(2) **216-0610** Solenoid Valve Gp

Torque for installing the solenoid valve group ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the nut (3) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)
Operating voltage ... 12 VDC
Current at a maximum temperature of 121 °C (250 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms

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i02869984

Piston Motor

SMCS - 4351

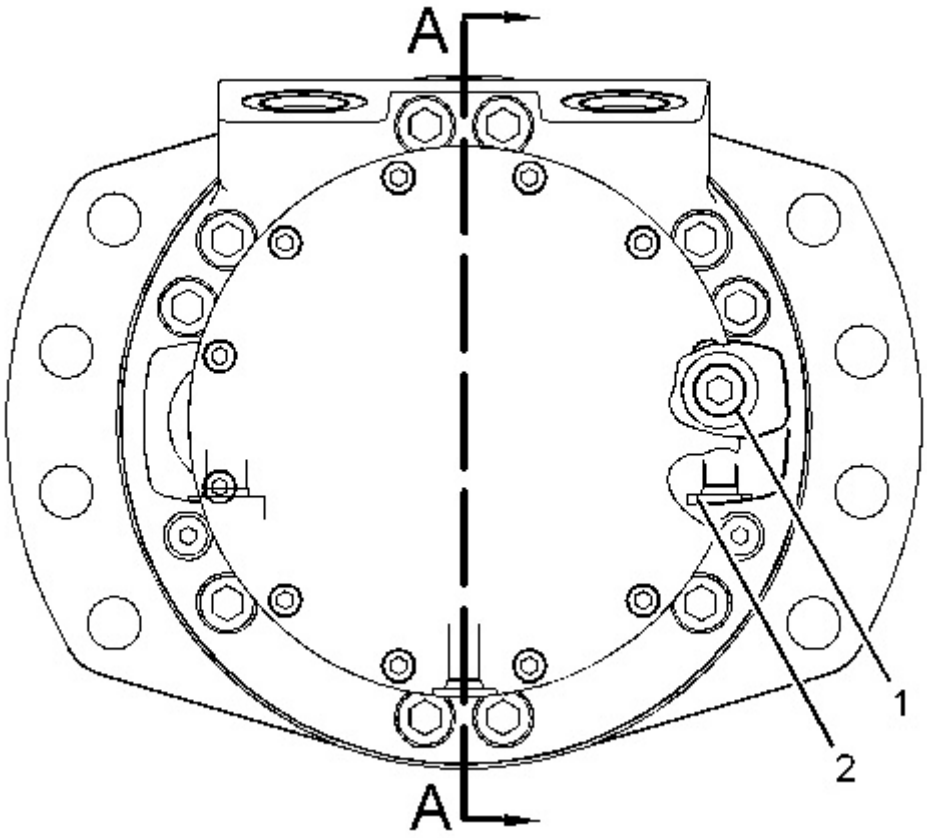


Illustration 1 g01429502

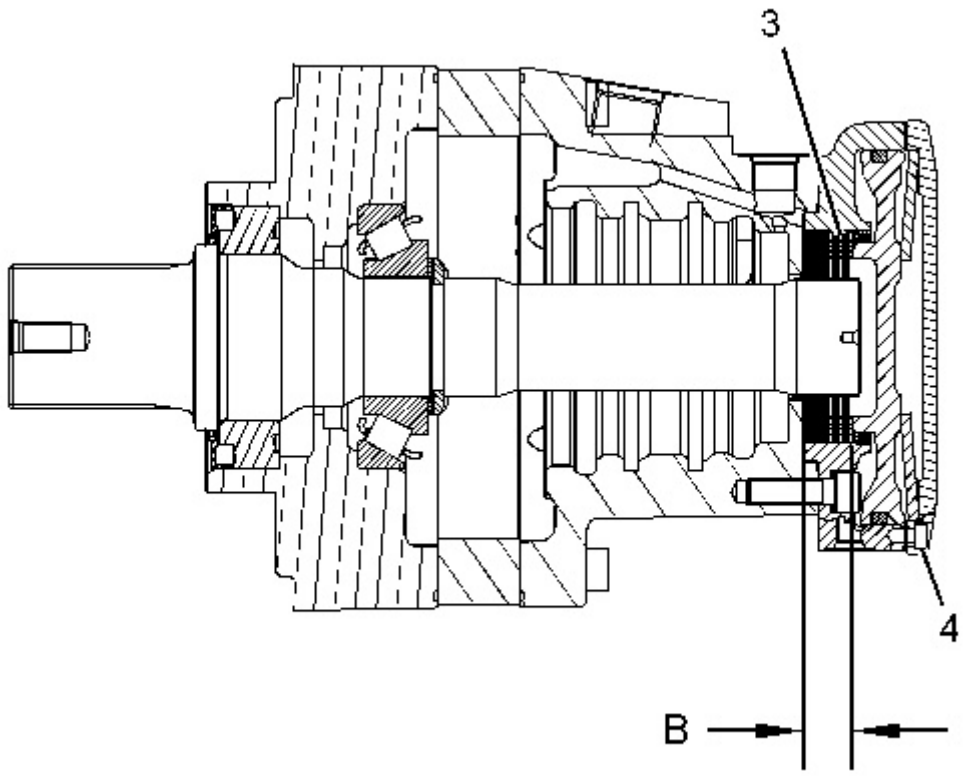


Illustration 2 g01429503

Section A-A

Displacement per revolution ... 410 cc (25.0 cu in)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 270 rpm

Full brake release pressure ... 2100 kPa (305 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

Spool actuation pressure for the two speed control valve ... 400 to 1900 kPa (58 to 275 psi)

(1) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (245 ± 22 lb in)

(2) Torque for the O-ring plug ... 13.5 ± 1.5 N·m (120 ± 13 lb in)

(3) As required, use the following shims in order to achieve the dimension (B) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 1
Thickness of shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(B) Thickness of the brake pack ... 20.20 ± 0.10 mm (0.795 ± 0.004 inch)

(4) Torque for the 12 bolts ... 15 ± 1 N·m (135 ± 9 lb in)

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i02875290

Piston Motor

SMCS - 4351

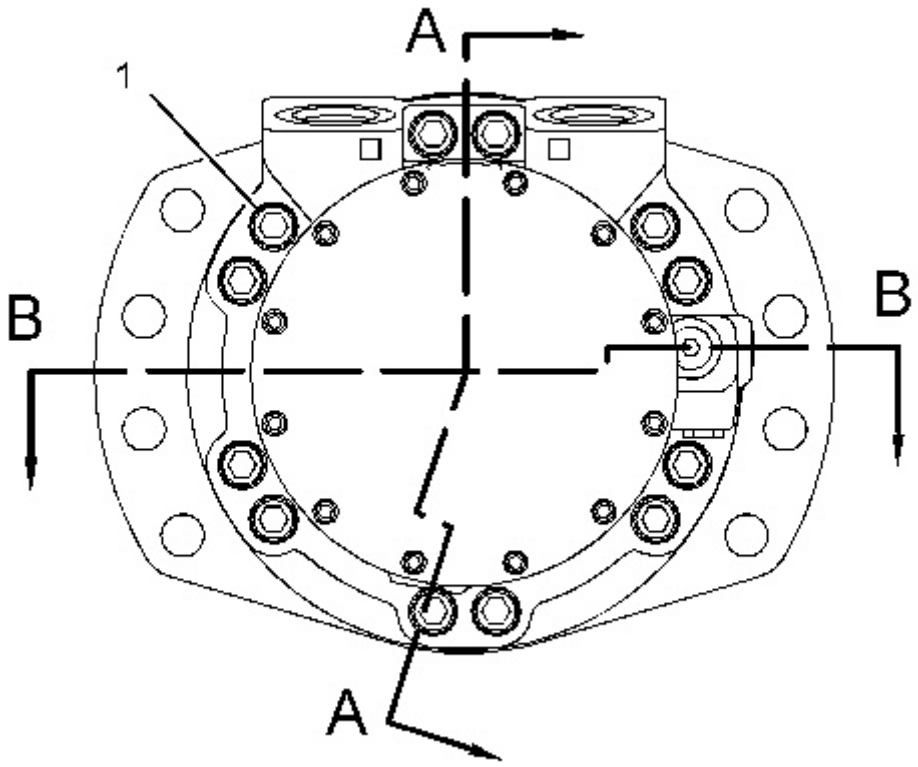


Illustration 1 g01431061

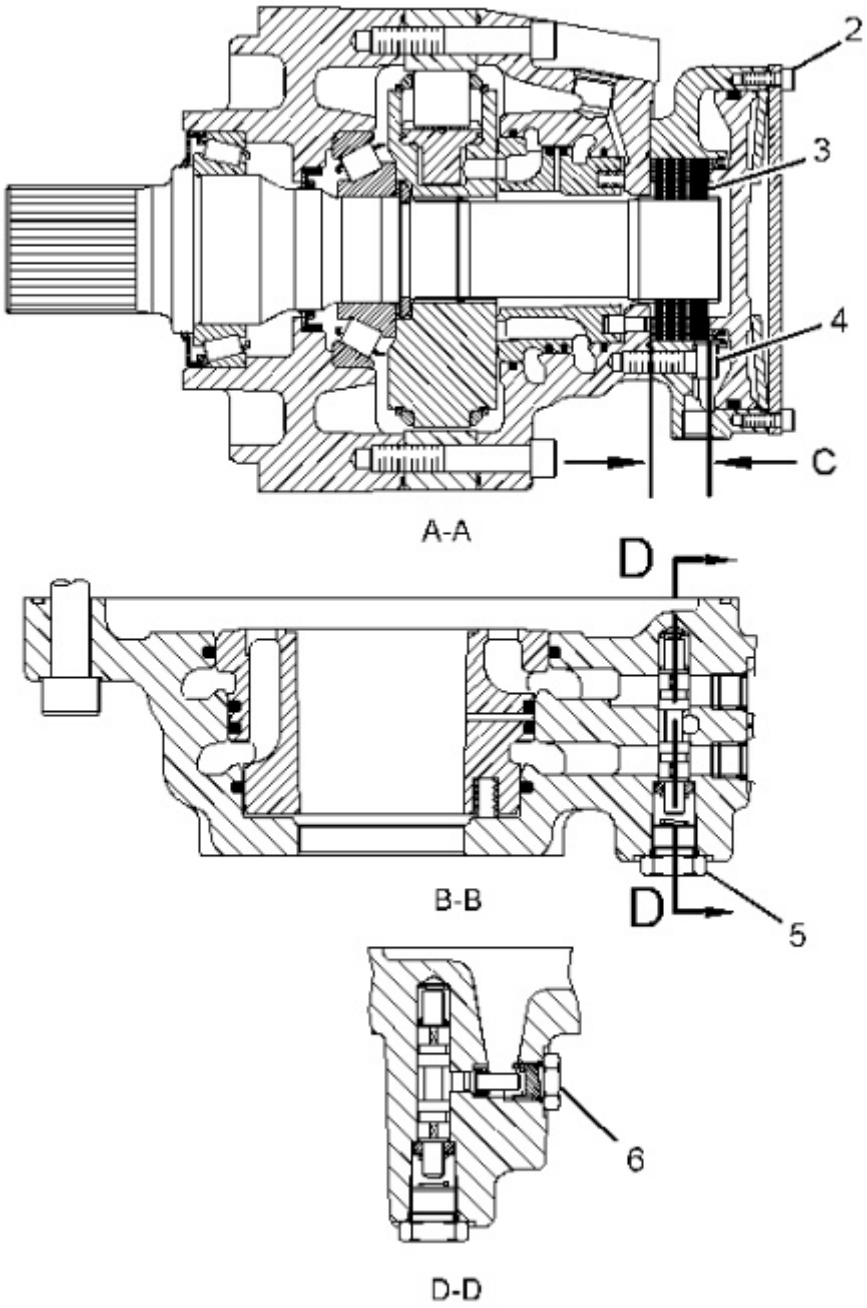


Illustration 2 g01431060

Displacement ... 750 cc (45.8 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(3) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 2
Thickness of one shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 1
Thickness of shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.40 ± 0.10 mm (1.118 ± 0.004 inch)

(4) Torque for the five bolts ... 73.5 ± 4.0 N·m (55 ± 3 lb ft)

(5) Torque for the O-ring plug ... 30.0 ± 1.5 N·m (22 ± 1 lb ft)

(6) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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i02872099

Piston Motor

SMCS - 4351

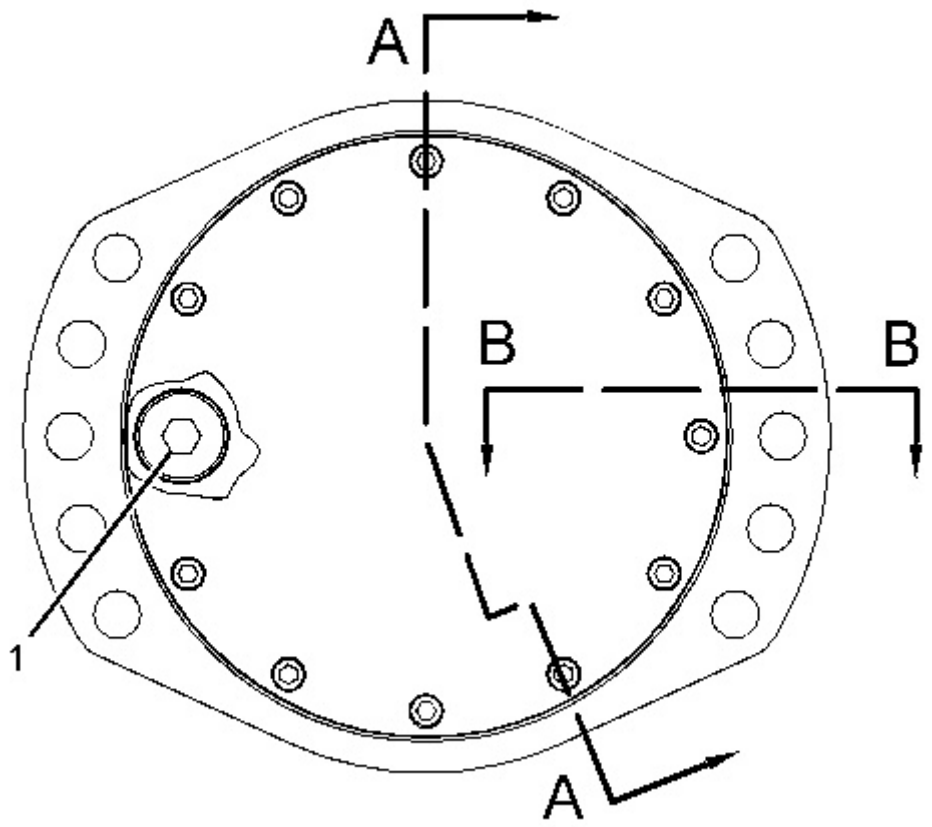


Illustration 1 g01430256

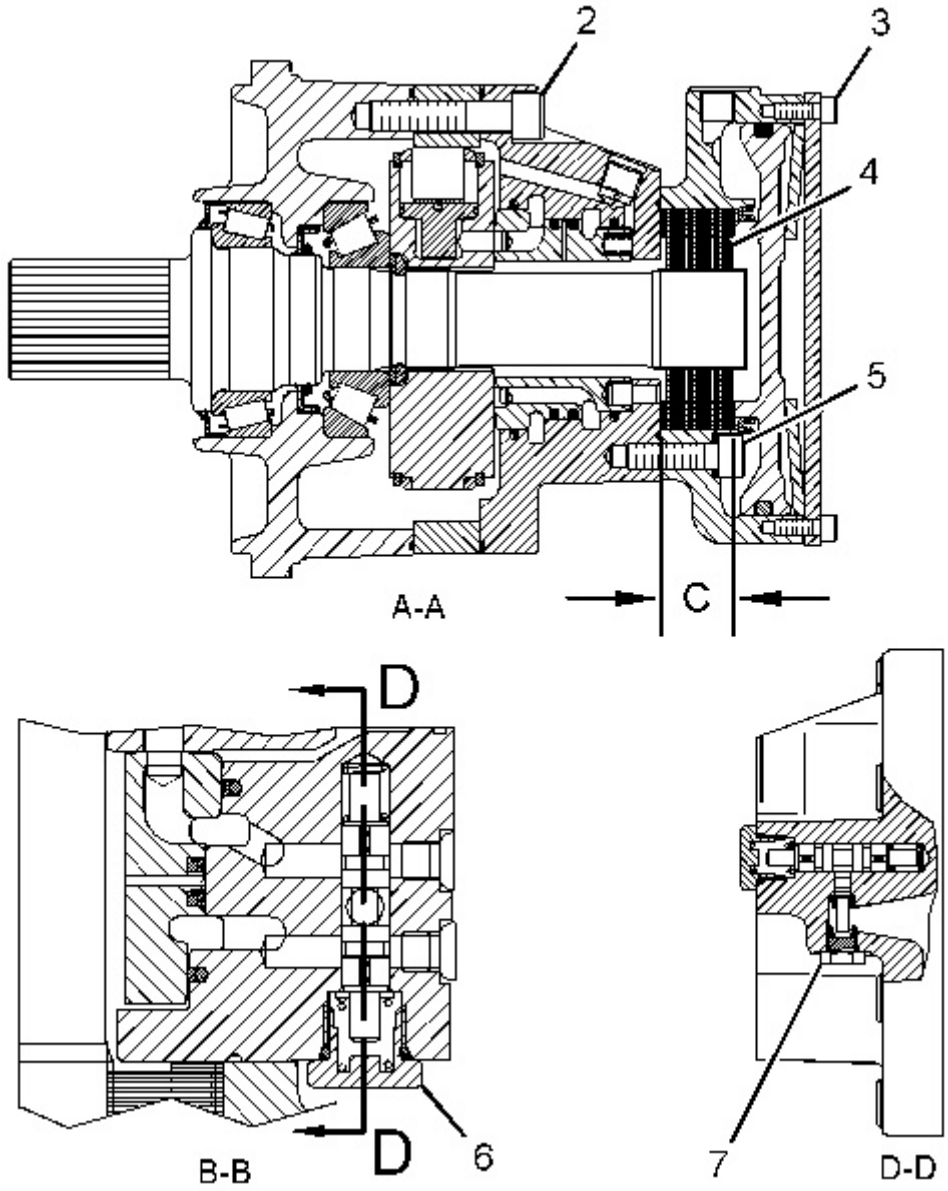


Illustration 2 g01430255

Displacement ... 400 cc (24.4 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the O-ring plug ... 70.0 ± 3.5 N·m (50 ± 3 lb ft)

(2) Torque for the six bolts ... 150 ± 5 N·m (110 ± 4 lb ft)

(3) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(4) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.20 ± 0.10 mm (1.110 ± 0.004 inch)

(5) Torque for the five bolts ... 73.5 ± 4.0 N·m (55 ± 3 lb ft)

(6) Torque for the O-ring plug ... 37.5 ± 2.5 N·m (28 ± 2 lb ft)

(7) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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i02871003

Piston Motor

SMCS - 4351

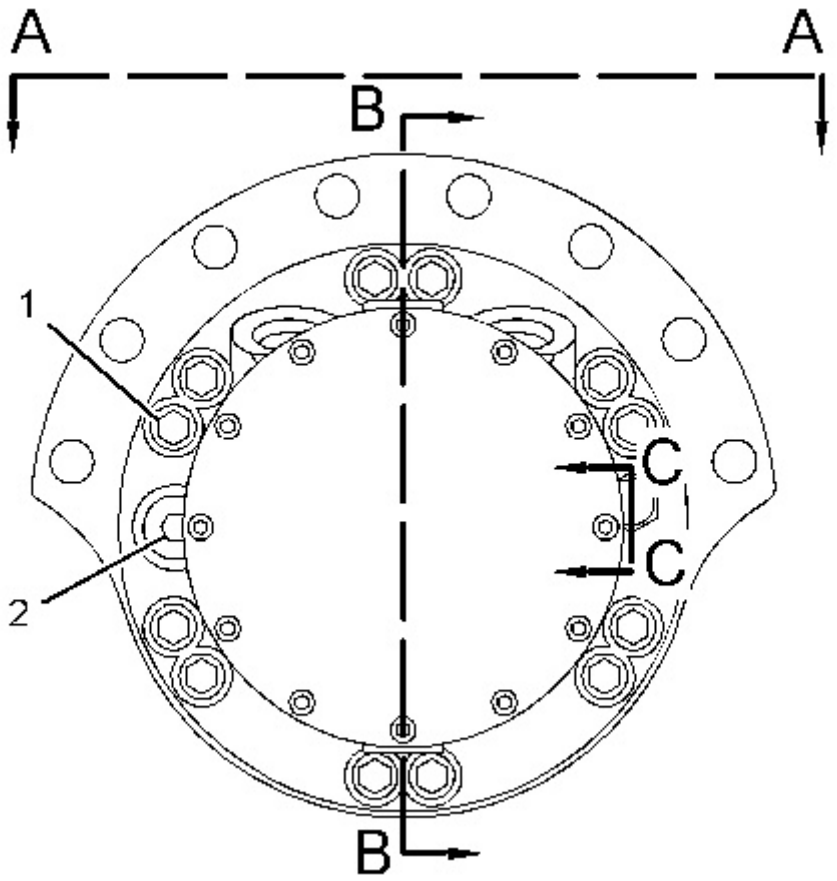


Illustration 1 g01429897

Rear view

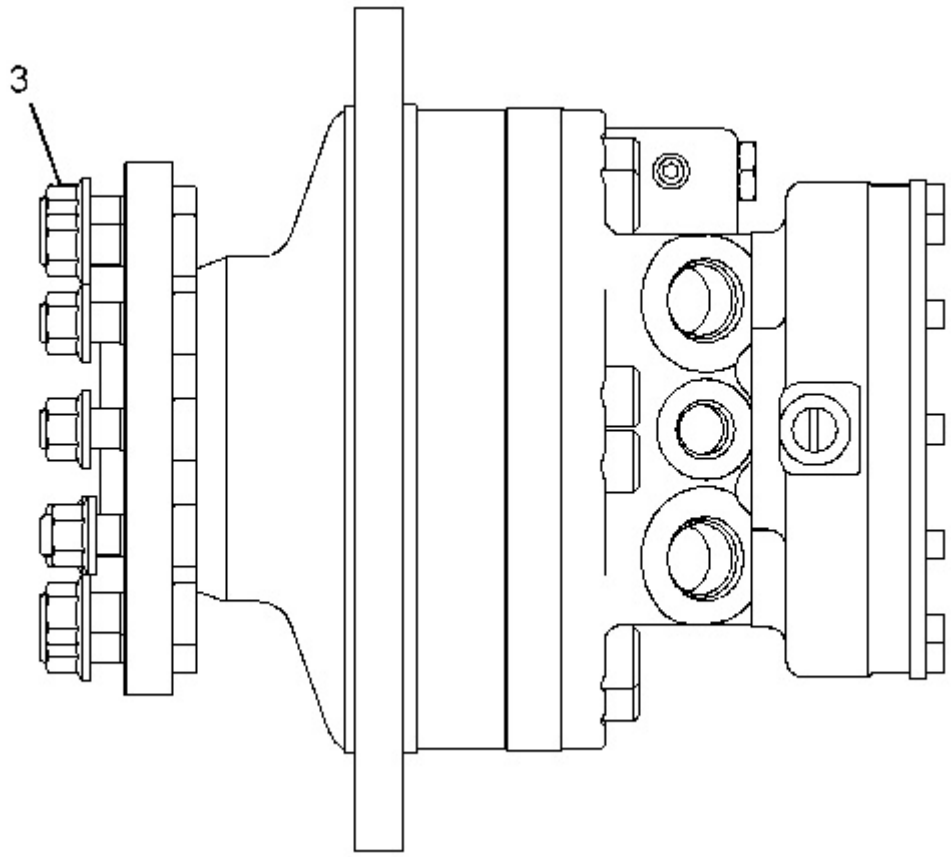


Illustration 2 g01429898

View A-A

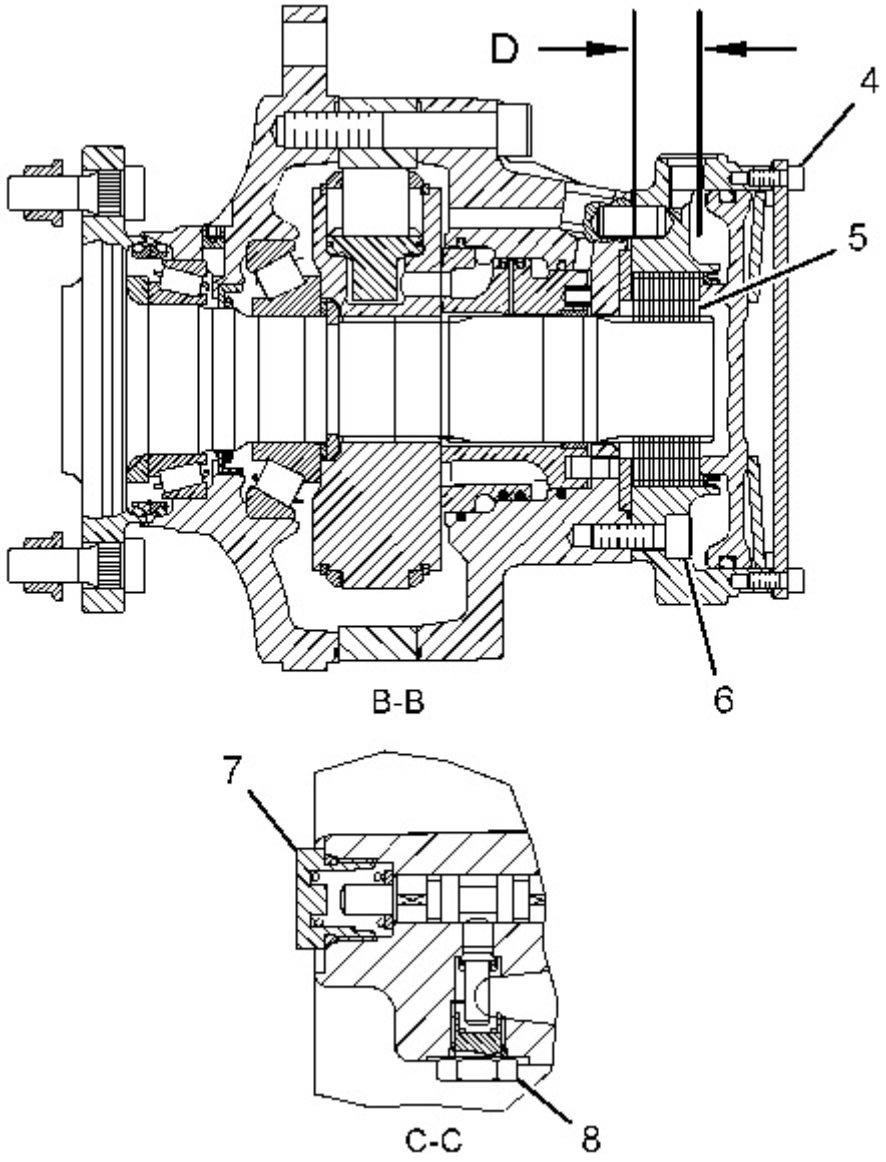


Illustration 3 g01429906

Displacement per revolution ... 620 cc (37.8 cu in)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 200 rpm

Full brake release pressure ... 1600 to 2000 kPa (230 to 290 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the O-ring plug ... 70 N·m (50 lb ft)

(3) Torque for the 12 nuts ... 175 N·m (130 lb ft)

(4) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(5) As required, use the following brake discs and inner plates in order to achieve the dimension (B) :

172-8173 Brake Disc
Quantity ... 14

268-1923 Inner Plate
Quantity ... 13
Thickness of one inner plate ... 1.00 ± 0.05 mm (0.039 ± 0.002 inch)

Note: Clamp the brake plates while you measure the brake pack.

(D) Maximum thickness of the brake pack ... 28.2 mm (1.11 inch)

(6) Torque for the five bolts ... 73.5 N·m (55 lb ft)

(7) Torque for the plug ... 37.0 ± 2.5 N·m (27 ± 2 lb ft)

(8) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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Piston Motor

SMCS - 4351

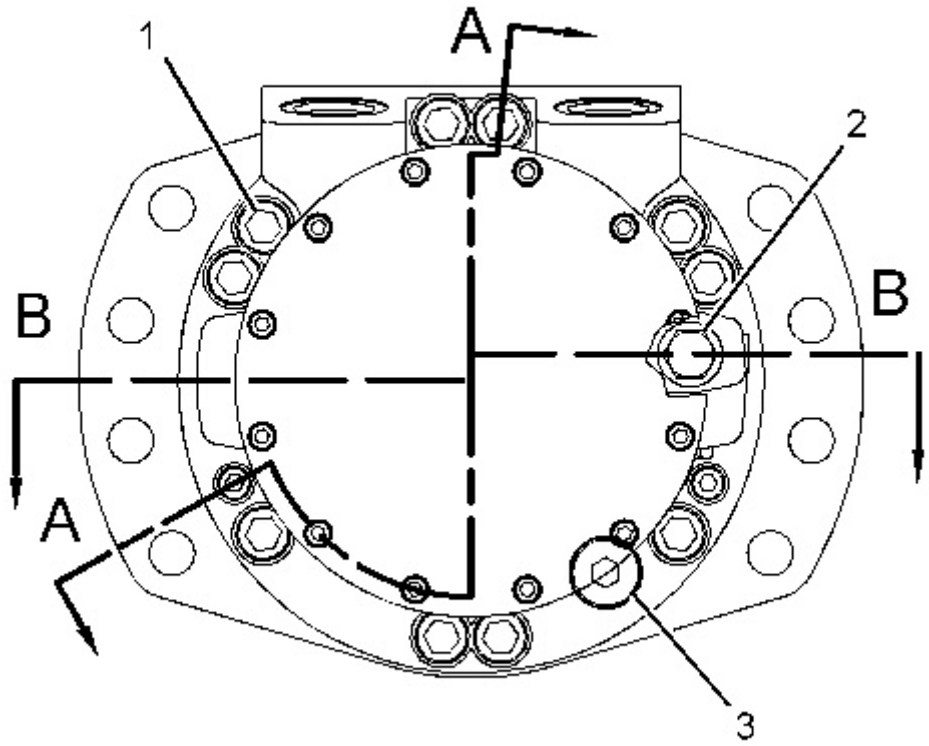


Illustration 1 g01431414

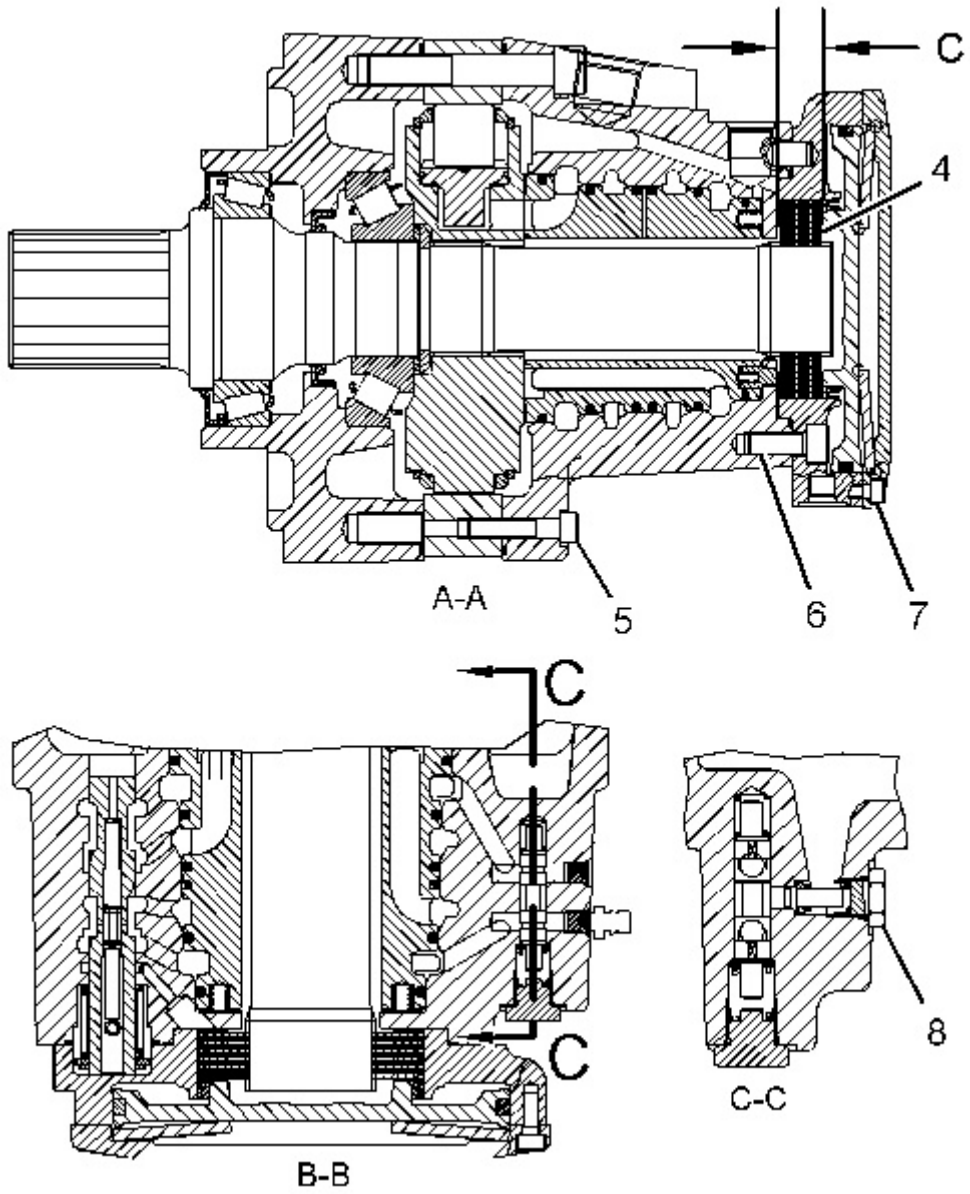


Illustration 2 g01431413

Displacement ... 408 to 750 cc/rev (24.9 to 45.8 cu in/rev)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 270 RPM

Full brake release pressure ... 2100 kPa (305 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

Spool actuation pressure for the two speed control valve ... 400 to 1900 kPa (58 to 275 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the O-ring plug ... 65 ± 5 N·m (48 ± 4 lb ft)

(3) Torque for the O-ring plug ... 65 ± 5 N·m (48 ± 4 lb ft)

(4) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 3
Thickness of one shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 20.20 ± 0.10 mm (0.795 ± 0.004 inch)

(5) Torque for the two bolts ... 35 to 39 N·m (26 to 29 lb ft)

(6) Torque for the five bolts ... 73.5 ± 3.5 N·m (55 ± 3 lb ft)

(7) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(8) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (20 ± 2 lb ft)

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i02869377

Piston Motor

SMCS - 4351

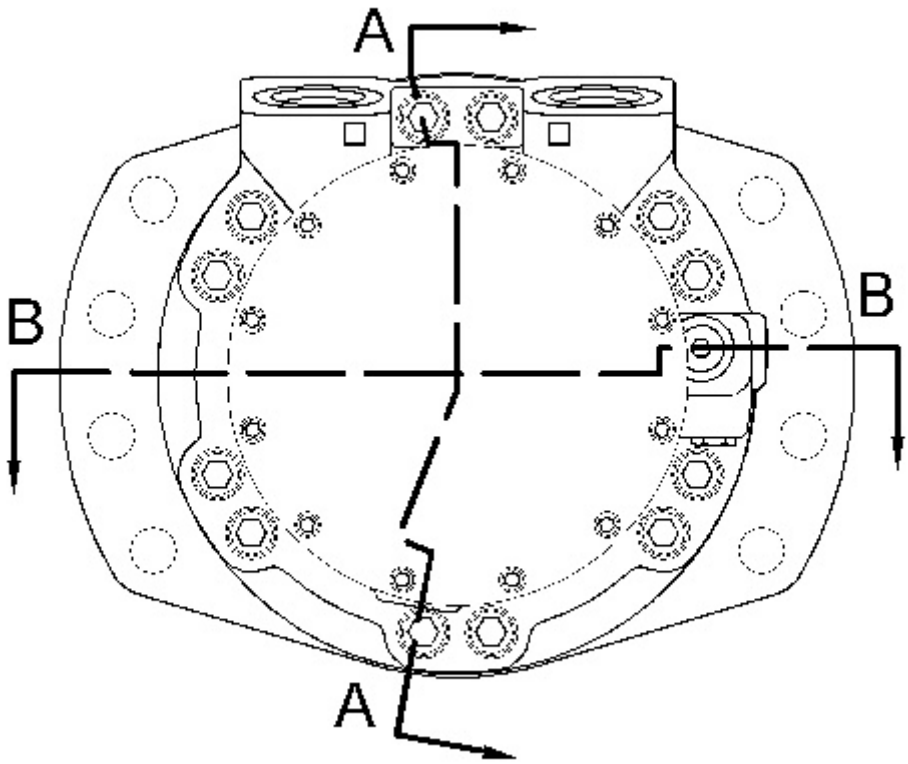


Illustration 1 g01429051

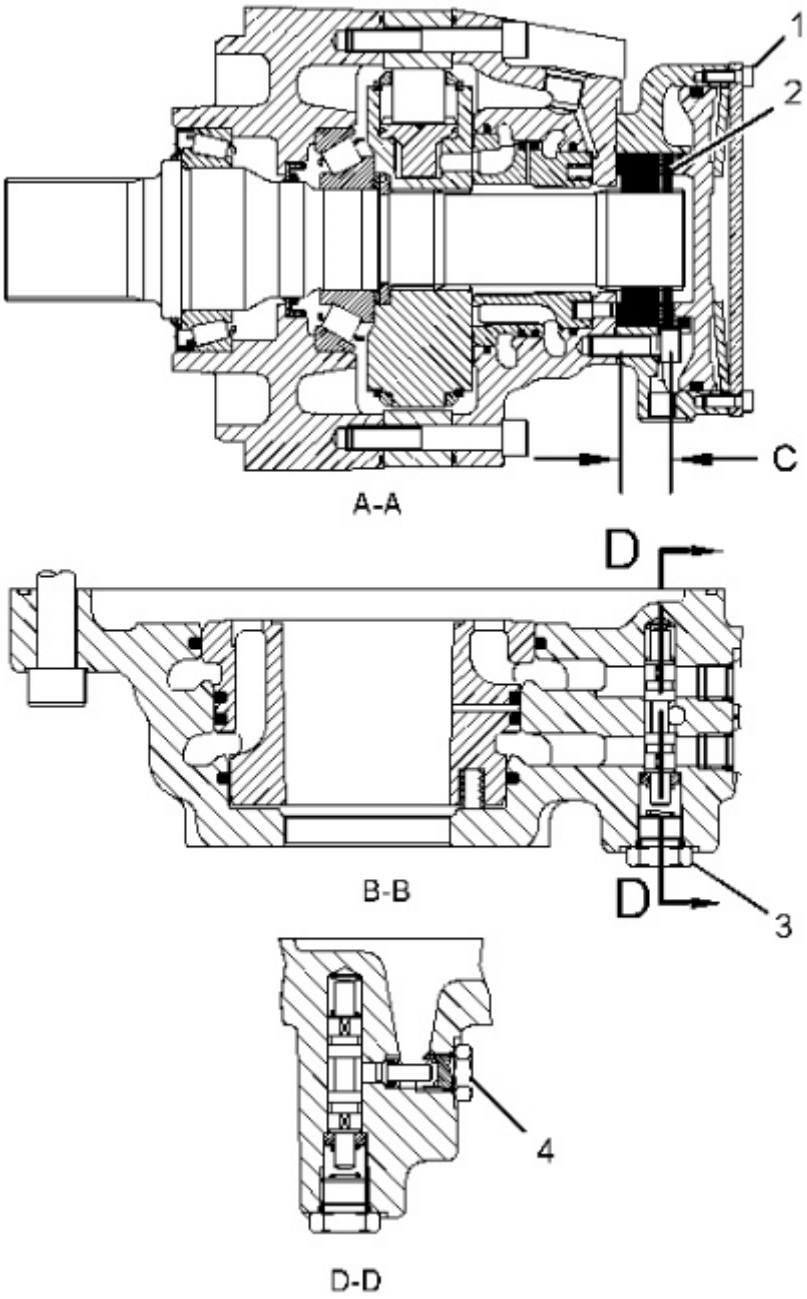


Illustration 2 g01429066

Displacement ... 750 cc (45.8 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 15 ± 1 N·m (135 ± 9 lb in)

(2) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.20 ± 0.10 mm (1.110 ± 0.004 inch)

(3) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (245 ± 22 lb in)

(4) Torque for the O-ring plug ... 12 to 15 N·m (105 to 135 lb in)

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Motor Mounting (Hydrostatic)

SMCS - 4351-MT

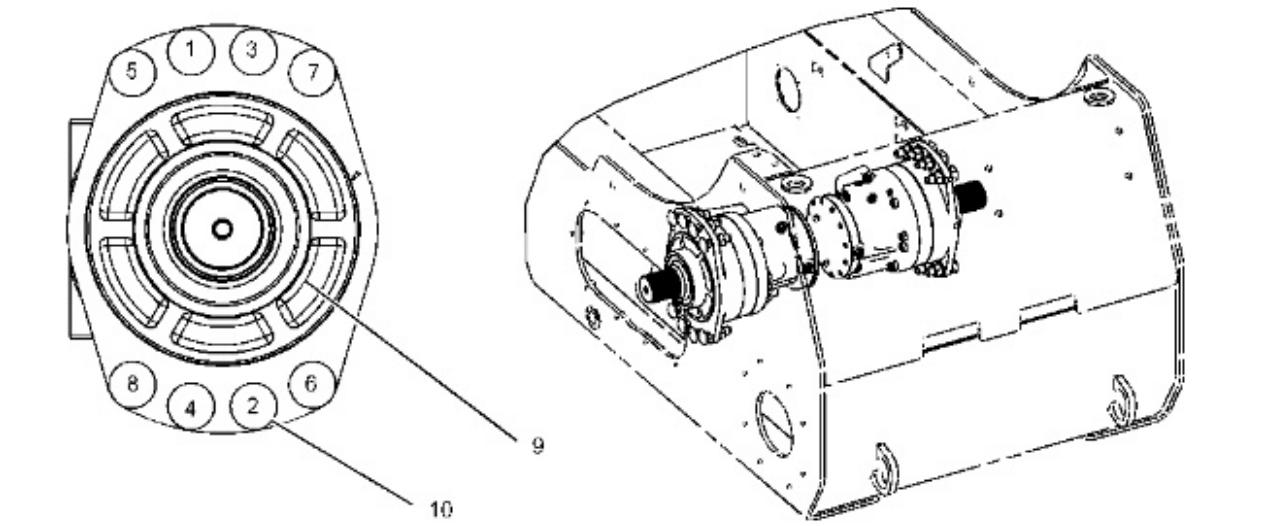


Illustration 1 g01421457

Note: When you assemble each piston motor group to the machine, orient the ports toward the rear of the machine.

Note: The mating surfaces of the piston motor group and the frame must be clean and the mating surfaces must be free from oil prior to the application of the silicone gasket.

1. Seal the piston motor group to the frame by applying a 4.0 ± 1.5 mm (0.16 ± 0.06 inch) continuous bead of **8T-9022** Silicone Gasket around the piston motor group at point (9) .

   Note: The piston motor group must be assembled to the frame within three minutes.

2. Around each bolt hole (10) , apply the **8T-9022** Silicone Gasket in a 4.0 ± 1.5 mm (0.16 ± 0.06 inch) wide continuous bead on the flange.

   Note: The flange of each bolt must be fully seated.

3. Tighten the nuts for each bolt in the numerical sequence that is shown in Illustration 1.

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Piston Motor

SMCS - 4351

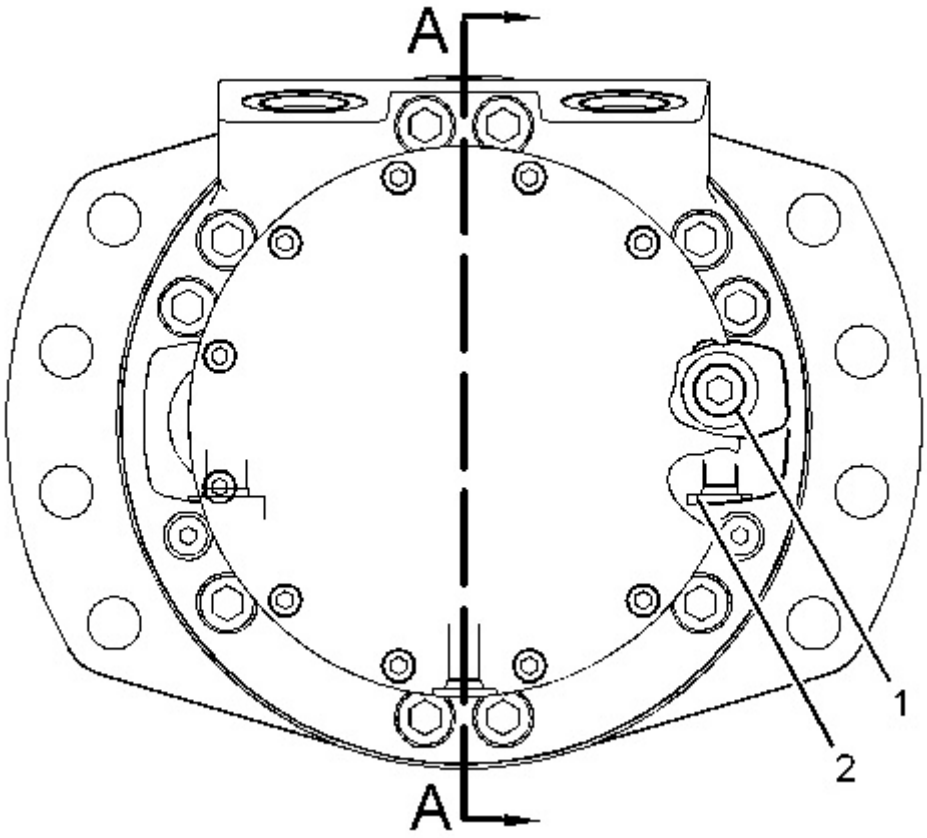


Illustration 1 g01429502

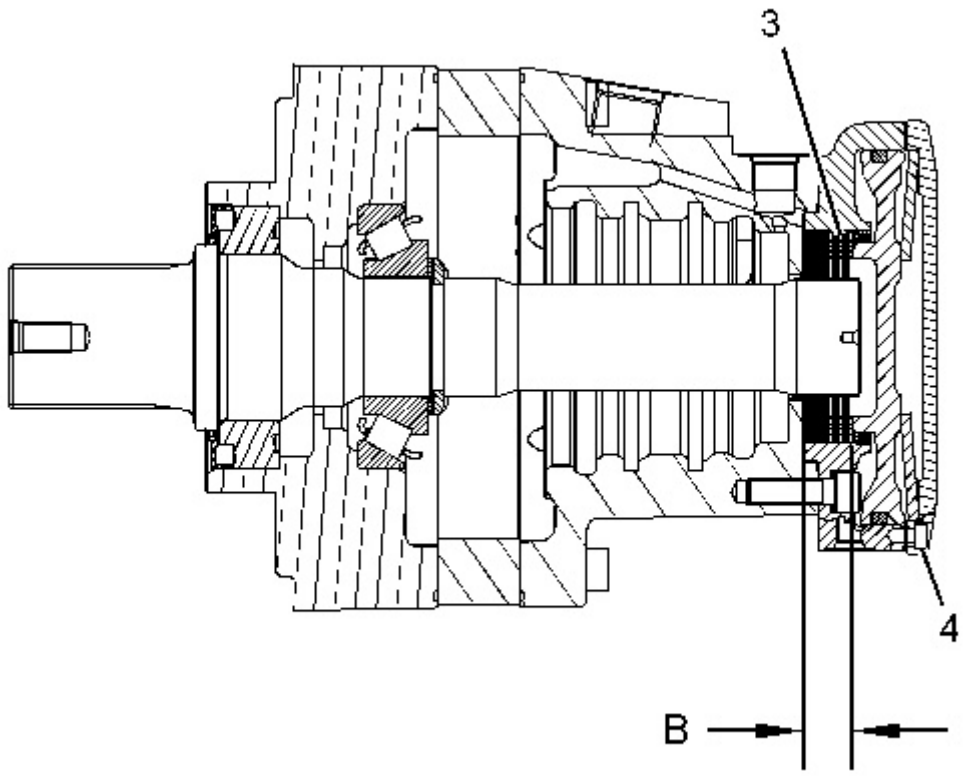


Illustration 2 g01429503

Section A-A

Displacement per revolution ... 410 cc (25.0 cu in)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 270 rpm

Full brake release pressure ... 2100 kPa (305 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

Spool actuation pressure for the two speed control valve ... 400 to 1900 kPa (58 to 275 psi)

(1) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (245 ± 22 lb in)

(2) Torque for the O-ring plug ... 13.5 ± 1.5 N·m (120 ± 13 lb in)

(3) As required, use the following shims in order to achieve the dimension (B) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 1
Thickness of shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(B) Thickness of the brake pack ... 20.20 ± 0.10 mm (0.795 ± 0.004 inch)

(4) Torque for the 12 bolts ... 15 ± 1 N·m (135 ± 9 lb in)

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Piston Motor

SMCS - 4351

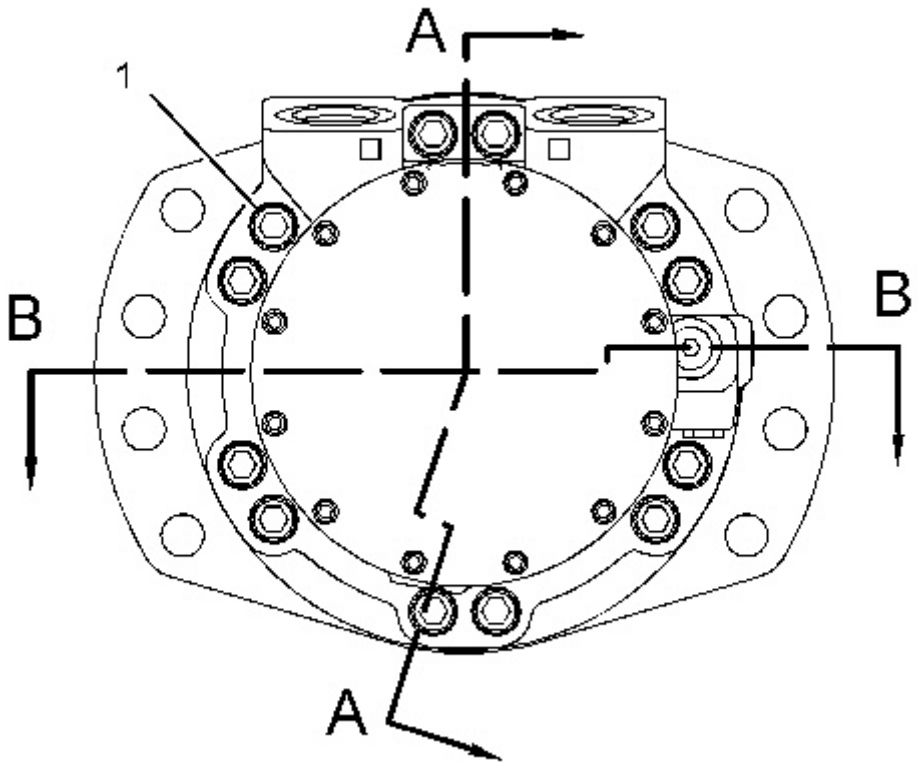


Illustration 1 g01431061

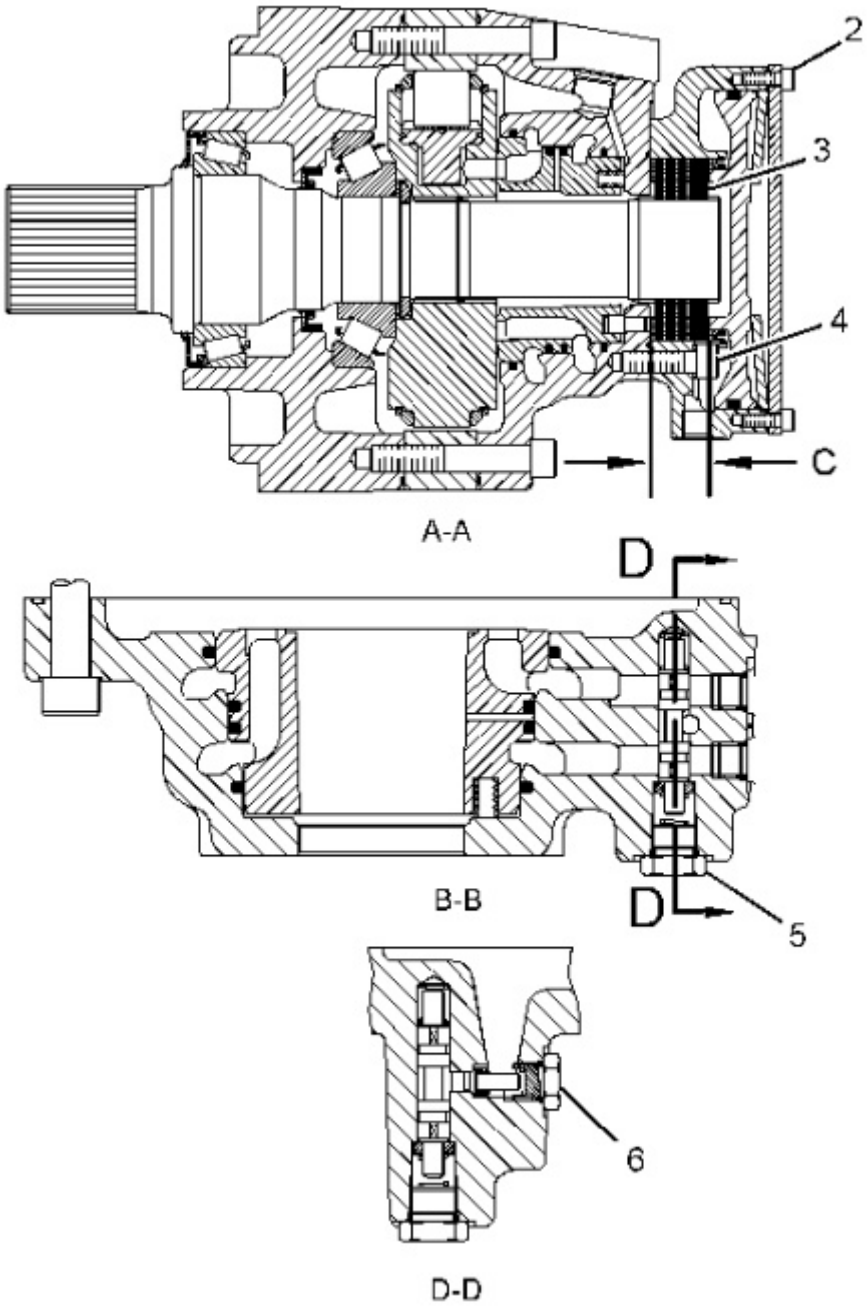


Illustration 2 g01431060

Displacement ... 750 cc (45.8 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(3) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 2
Thickness of one shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 1
Thickness of shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.40 ± 0.10 mm (1.118 ± 0.004 inch)

(4) Torque for the five bolts ... 73.5 ± 4.0 N·m (55 ± 3 lb ft)

(5) Torque for the O-ring plug ... 30.0 ± 1.5 N·m (22 ± 1 lb ft)

(6) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

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Piston Motor

SMCS - 4351

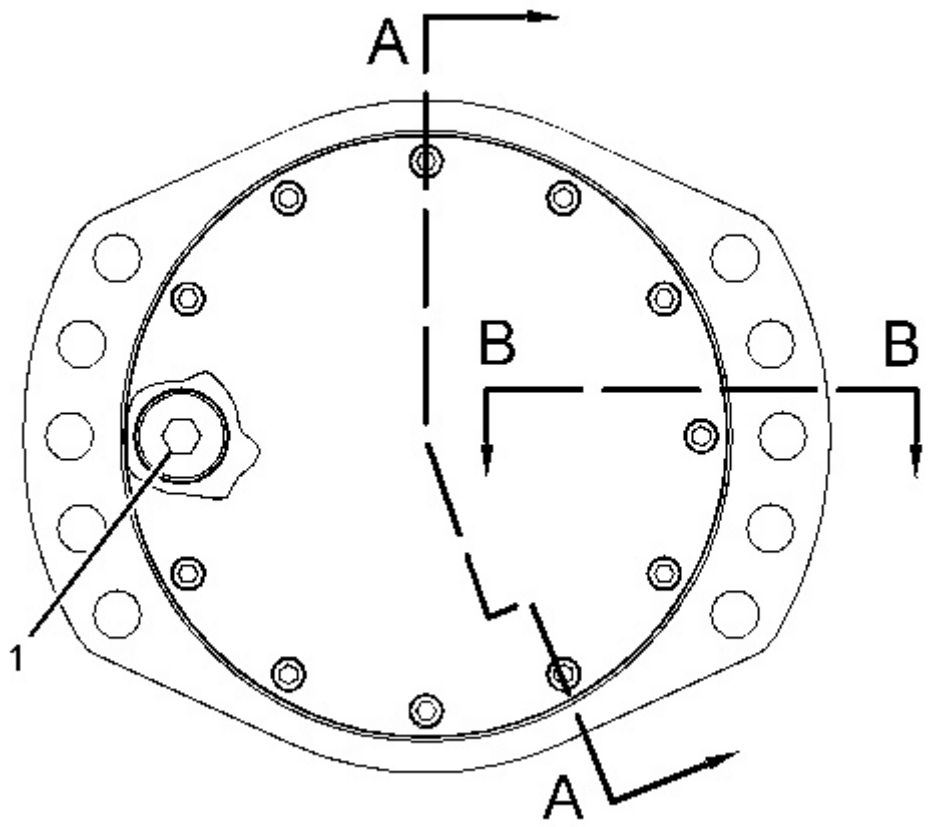


Illustration 1 g01430256

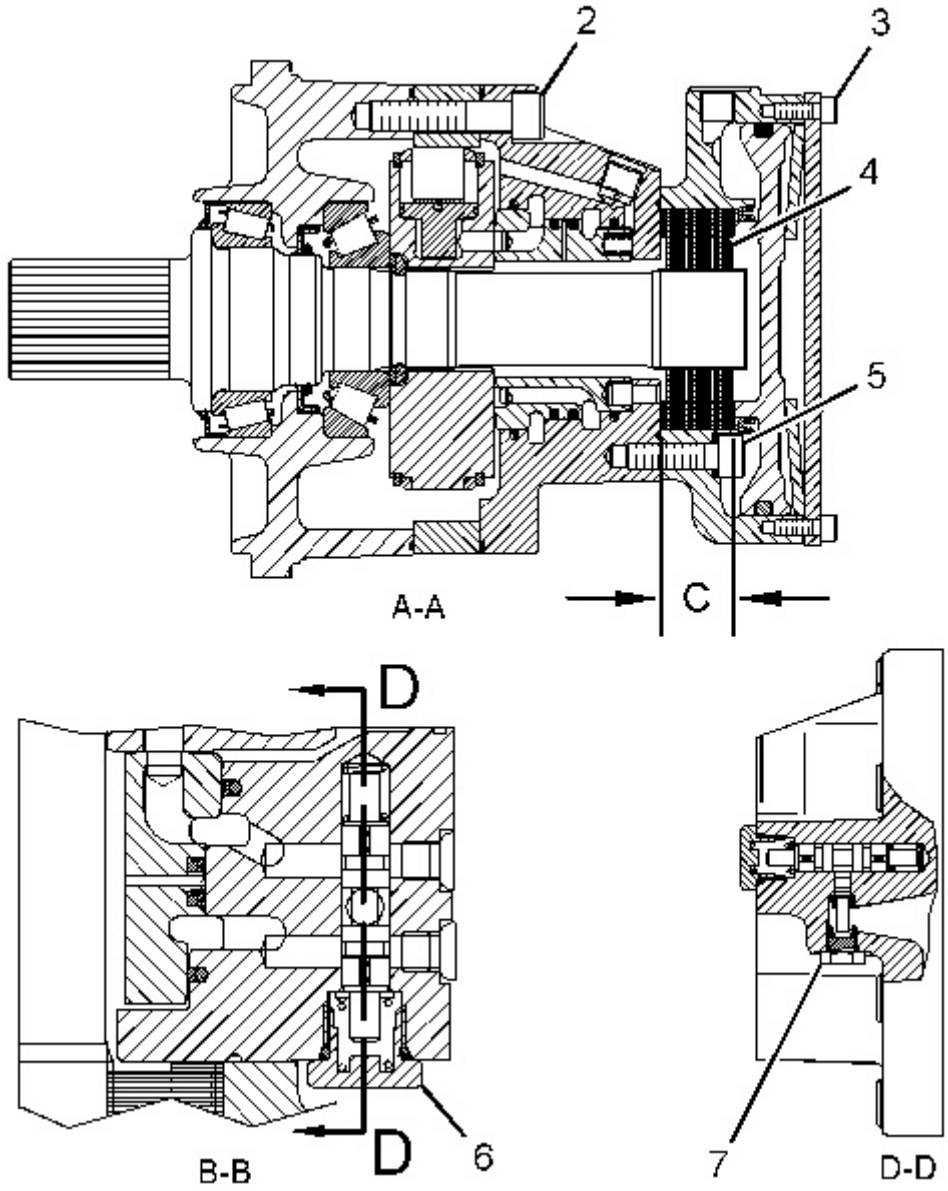


Illustration 2 g01430255

Displacement ... 400 cc (24.4 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the O-ring plug ... 70.0 ± 3.5 N·m (50 ± 3 lb ft)

(2) Torque for the six bolts ... 150 ± 5 N·m (110 ± 4 lb ft)

(3) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(4) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.20 ± 0.10 mm (1.110 ± 0.004 inch)

(5) Torque for the five bolts ... 73.5 ± 4.0 N·m (55 ± 3 lb ft)

(6) Torque for the O-ring plug ... 37.5 ± 2.5 N·m (28 ± 2 lb ft)

(7) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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i02871003

Piston Motor

SMCS - 4351

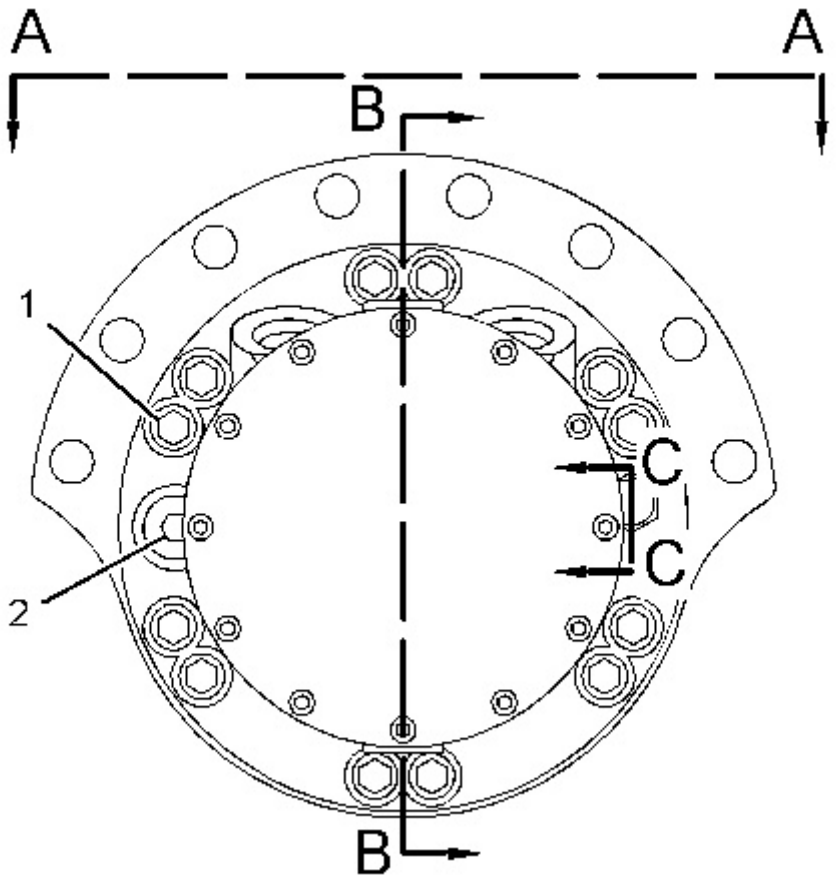


Illustration 1 g01429897

Rear view

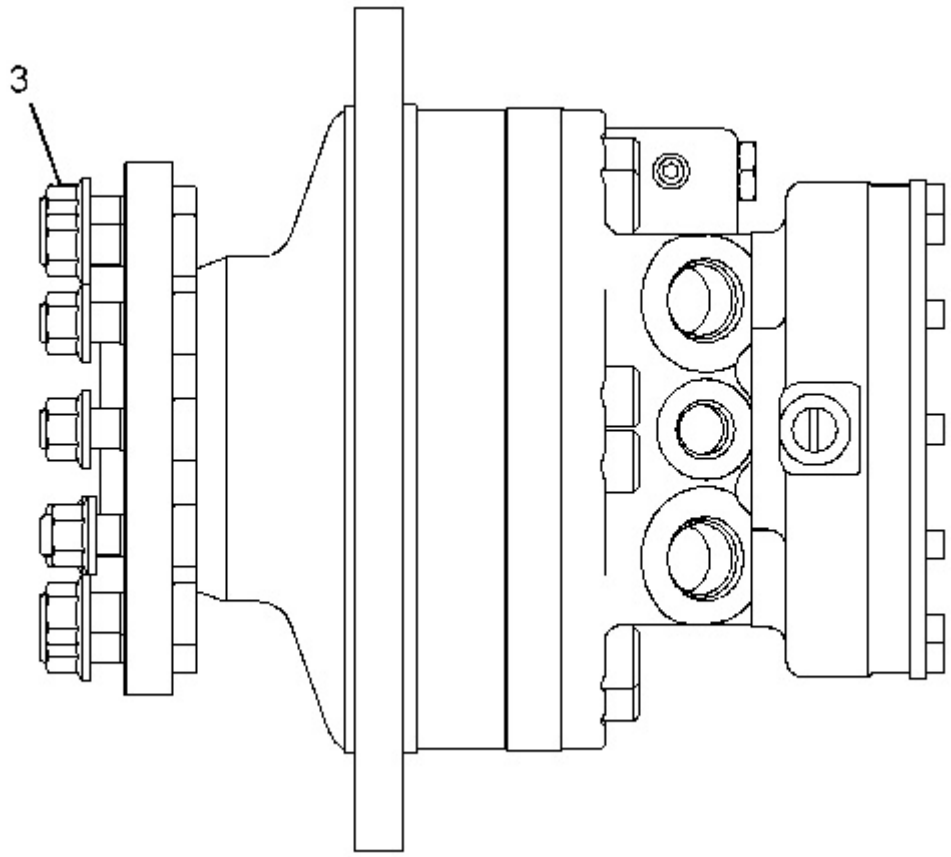


Illustration 2 g01429898

View A-A

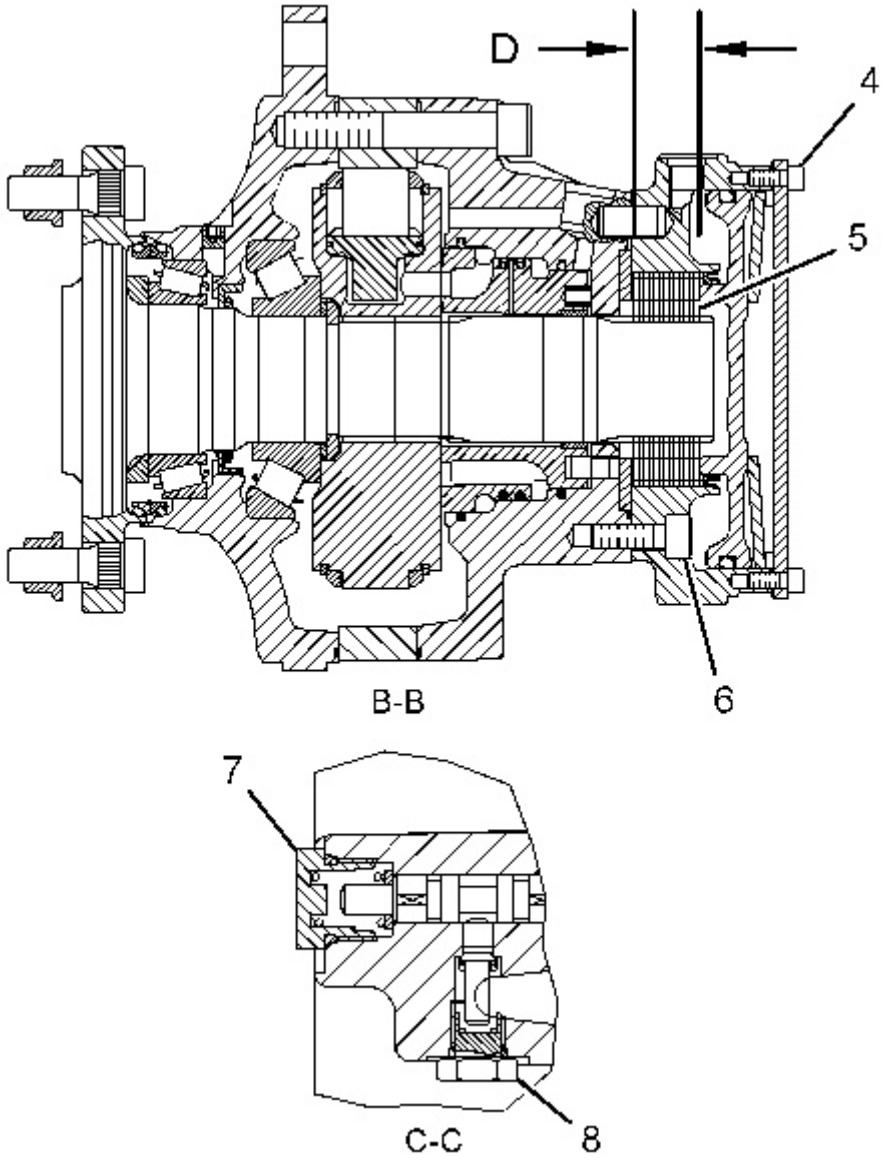


Illustration 3 g01429906

Displacement per revolution ... 620 cc (37.8 cu in)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 200 rpm

Full brake release pressure ... 1600 to 2000 kPa (230 to 290 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the O-ring plug ... 70 N·m (50 lb ft)

(3) Torque for the 12 nuts ... 175 N·m (130 lb ft)

(4) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(5) As required, use the following brake discs and inner plates in order to achieve the dimension (B) :

172-8173 Brake Disc
Quantity ... 14

268-1923 Inner Plate
Quantity ... 13
Thickness of one inner plate ... 1.00 ± 0.05 mm (0.039 ± 0.002 inch)

Note: Clamp the brake plates while you measure the brake pack.

(D) Maximum thickness of the brake pack ... 28.2 mm (1.11 inch)

(6) Torque for the five bolts ... 73.5 N·m (55 lb ft)

(7) Torque for the plug ... 37.0 ± 2.5 N·m (27 ± 2 lb ft)

(8) Torque for the O-ring plug ... 25.0 ± 1.5 N·m (18 ± 1 lb ft)

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Specifications

236B2 and 252B2 Skid Steer Loaders Machine Systems

Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

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Piston Motor

SMCS - 4351

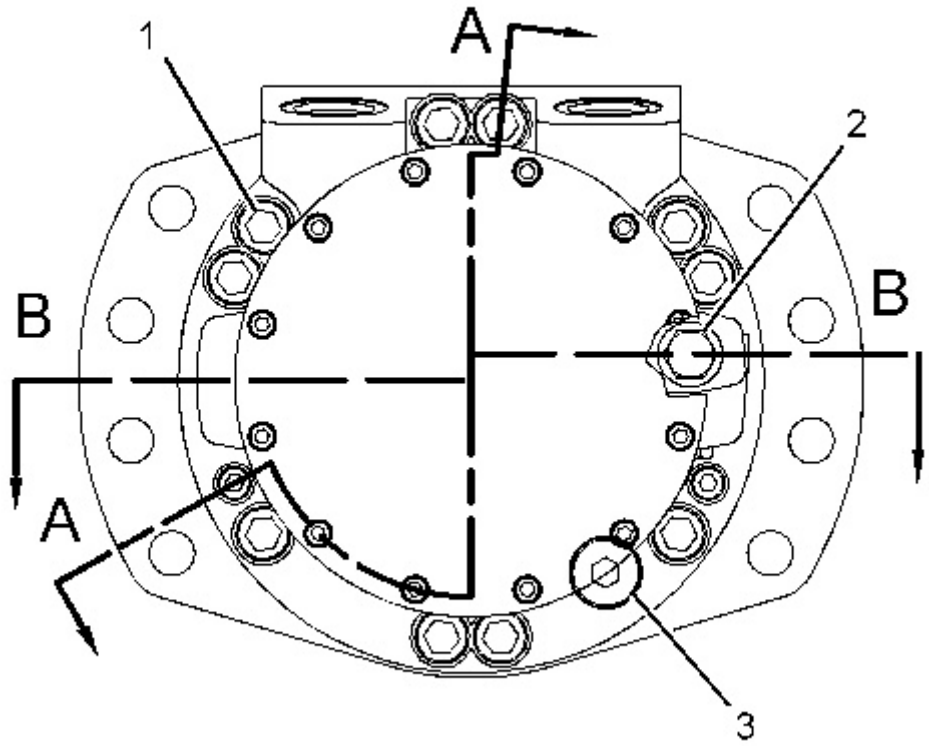


Illustration 1 g01431414

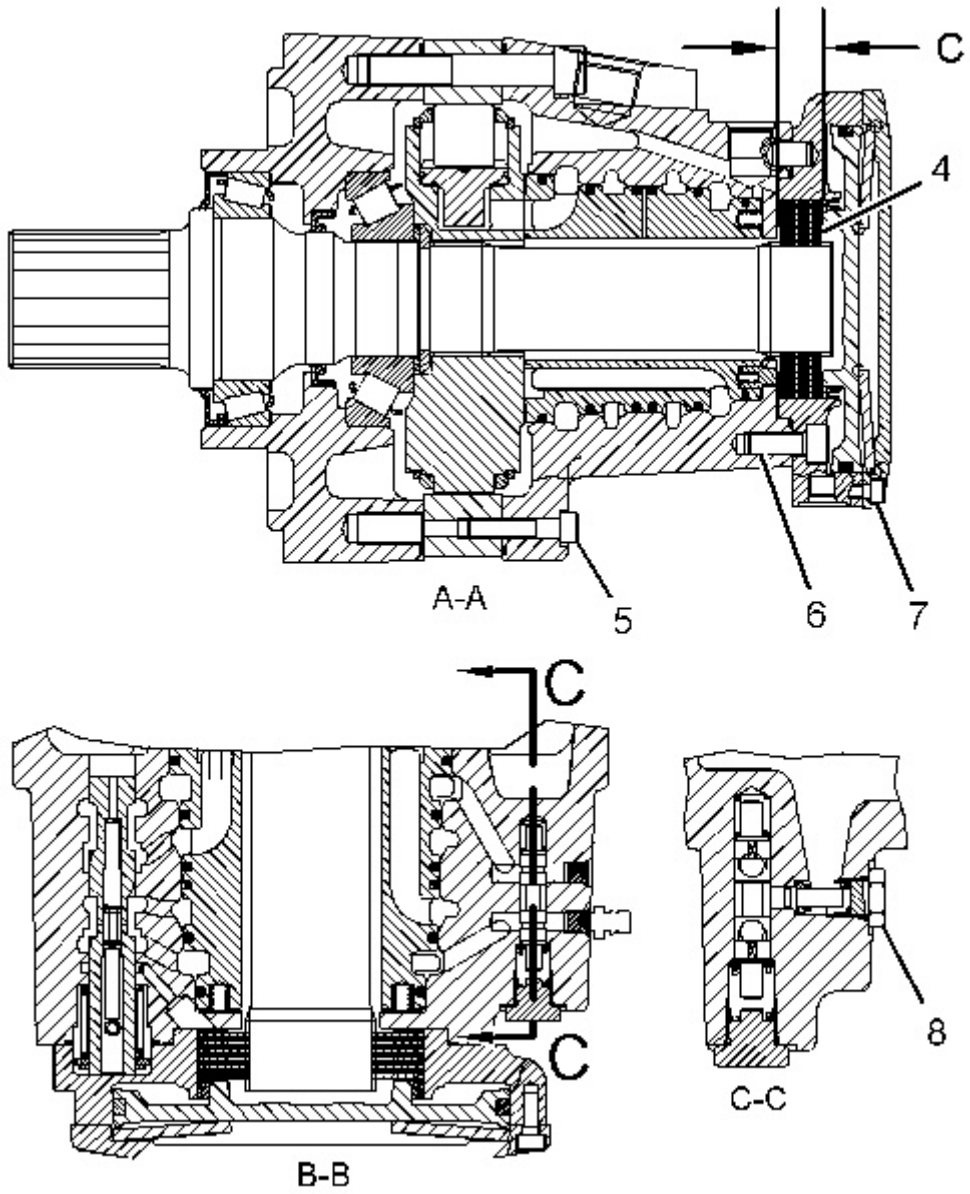


Illustration 2 g01431413

Displacement ... 408 to 750 cc/rev (24.9 to 45.8 cu in/rev)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 270 RPM

Full brake release pressure ... 2100 kPa (305 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

Spool actuation pressure for the two speed control valve ... 400 to 1900 kPa (58 to 275 psi)

(1) Torque for the 12 bolts ... 215 ± 5 N·m (160 ± 4 lb ft)

(2) Torque for the O-ring plug ... 65 ± 5 N·m (48 ± 4 lb ft)

(3) Torque for the O-ring plug ... 65 ± 5 N·m (48 ± 4 lb ft)

(4) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 3
Thickness of one shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 20.20 ± 0.10 mm (0.795 ± 0.004 inch)

(5) Torque for the two bolts ... 35 to 39 N·m (26 to 29 lb ft)

(6) Torque for the five bolts ... 73.5 ± 3.5 N·m (55 ± 3 lb ft)

(7) Torque for the 12 bolts ... 15 ± 1 N·m (11 ± 1 lb ft)

(8) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (20 ± 2 lb ft)

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Piston Motor

SMCS - 4351

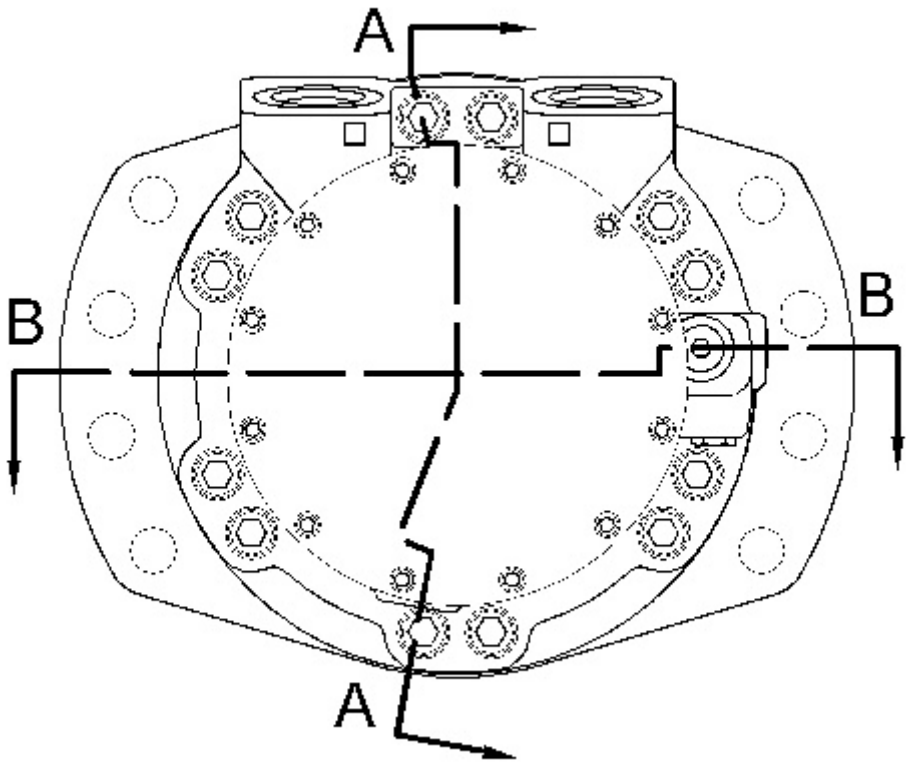


Illustration 1 g01429051

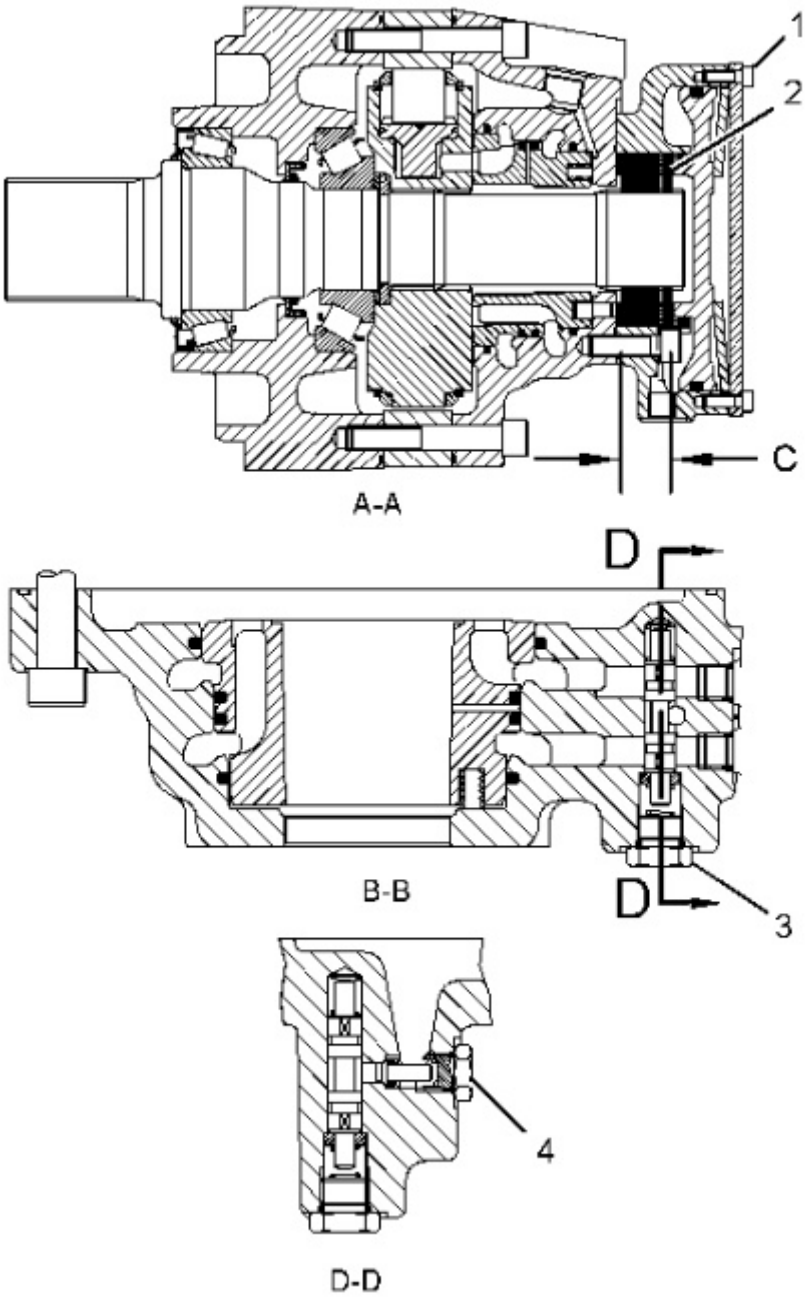


Illustration 2 g01429066

Displacement ... 750 cc (45.8 in^3)

Rotation ... Bidirectional

Nominal continuous pressure ... 25000 kPa (3650 psi)

Maximum intermittent pressure ... 40000 kPa (5800 psi)

Maximum intermittent speed ... 260 rpm

Full brake release pressure ... 1600 to 2070 kPa (230 to 300 psi)

Maximum pressure for the brake port ... 4000 kPa (580 psi)

Cracking pressure for the flushing valve ... 2500 kPa (365 psi)

(1) Torque for the 12 bolts ... 15 ± 1 N·m (135 ± 9 lb in)

(2) As required, use the following shims in order to achieve the dimension (C) :

140-2513 Shim
Quantity ... 1
Thickness of shim ... 0.10 mm (0.004 inch)

140-2514 Shim
Quantity ... 2
Thickness of one shim ... 0.30 mm (0.012 inch)

Note: Clamp the brake plates while you measure the brake pack.

(C) Thickness of the brake pack ... 28.20 ± 0.10 mm (1.110 ± 0.004 inch)

(3) Torque for the O-ring plug ... 27.5 ± 2.5 N·m (245 ± 22 lb in)

(4) Torque for the O-ring plug ... 12 to 15 N·m (105 to 135 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02854045

Motor Mounting (Hydrostatic)

SMCS - 4351-MT

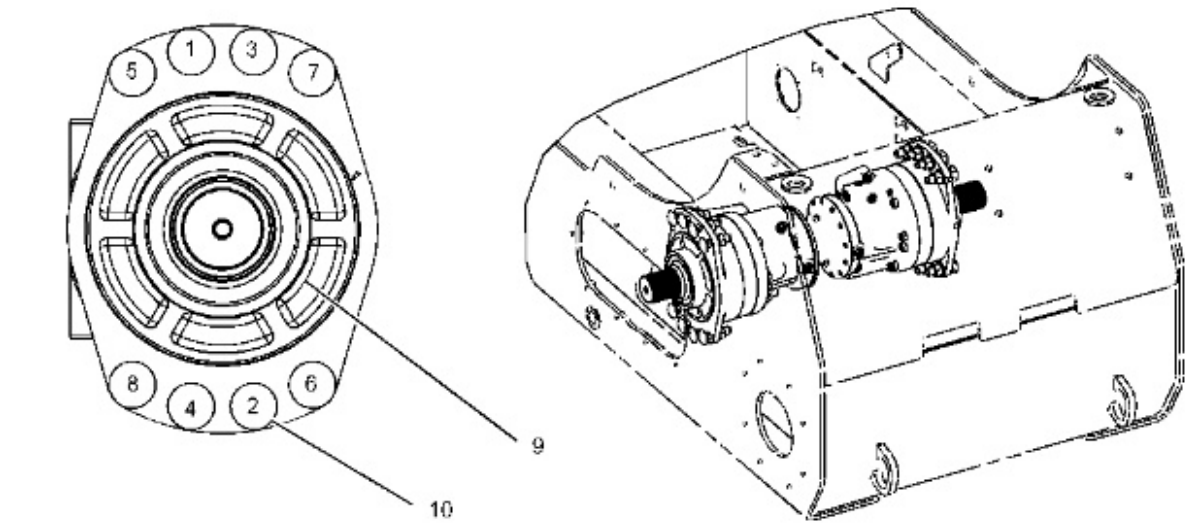


Illustration 1 g01421457

Note: When you assemble each piston motor group to the machine, orient the ports toward the rear of the machine.

Note: The mating surfaces of the piston motor group and the frame must be clean and the mating surfaces must be free from oil prior to the application of the silicone gasket.

1. Seal the piston motor group to the frame by applying a 4.0 ± 1.5 mm (0.16 ± 0.06 inch) continuous bead of **8T-9022** Silicone Gasket around the piston motor group at point (9) .

   Note: The piston motor group must be assembled to the frame within three minutes.

2. Around each bolt hole (10) , apply the **8T-9022** Silicone Gasket in a 4.0 ± 1.5 mm (0.16 ± 0.06 inch) wide continuous bead on the flange.

   Note: The flange of each bolt must be fully seated.

3. Tighten the nuts for each bolt in the numerical sequence that is shown in Illustration 1.

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i05418706

Piston Motor (Hydrostatic) - Remove

SMCS - 4351-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Loctite 7649 Primer N	-
B	-	Loctite Low Breakloose PST	-

Start By:

A. Release the pressure in the hydraulic system.
B. Remove the gear pump.
C. Remove the tire and rim.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

Personal injury or death can result without releasing all of the hydraulic pressure.

Release all the pressure from the hydraulic system before any lines are disconnected.

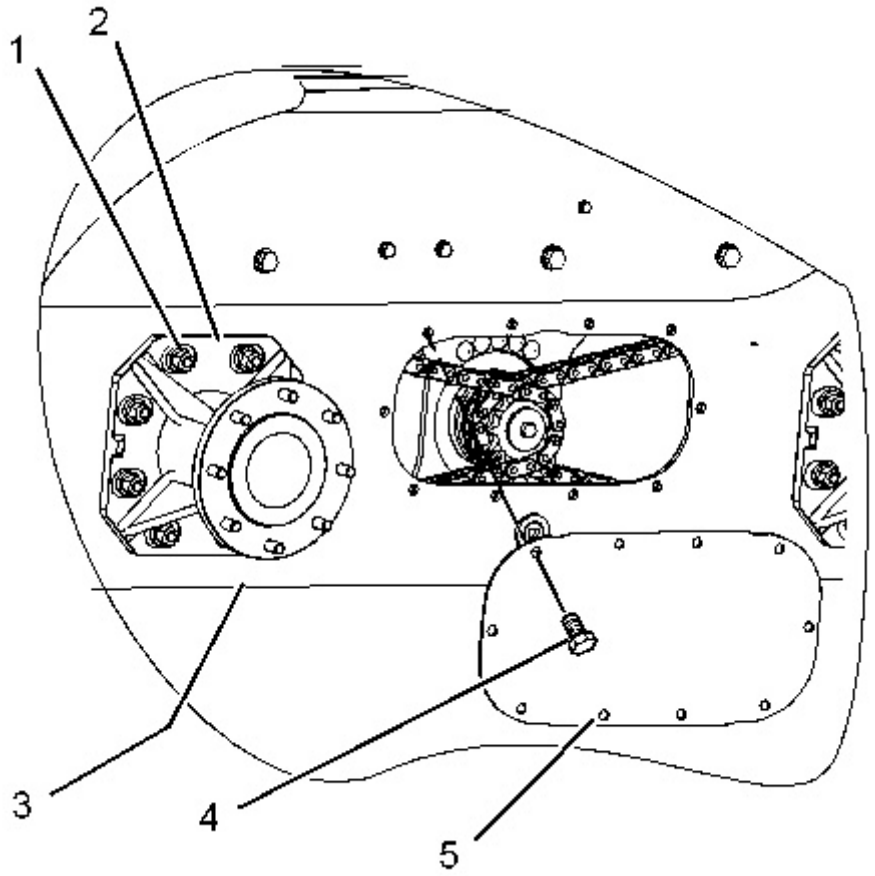


Illustration 1 g01051630

1. Remove plug (3) .
2. Drain the drive chain oil into a suitable container.
3. Apply Tooling (A) to plug (3) .
4. Apply Tooling (B) to plug (3) .
5. Install plug (3) .
6. Remove bolts (4) .

7. Remove cover (5) .
8. Loosen nuts (1) .
9. Slide axle (2) to the center of the machine.
10. Repeat Step 8 and Step 9 for the other axle.

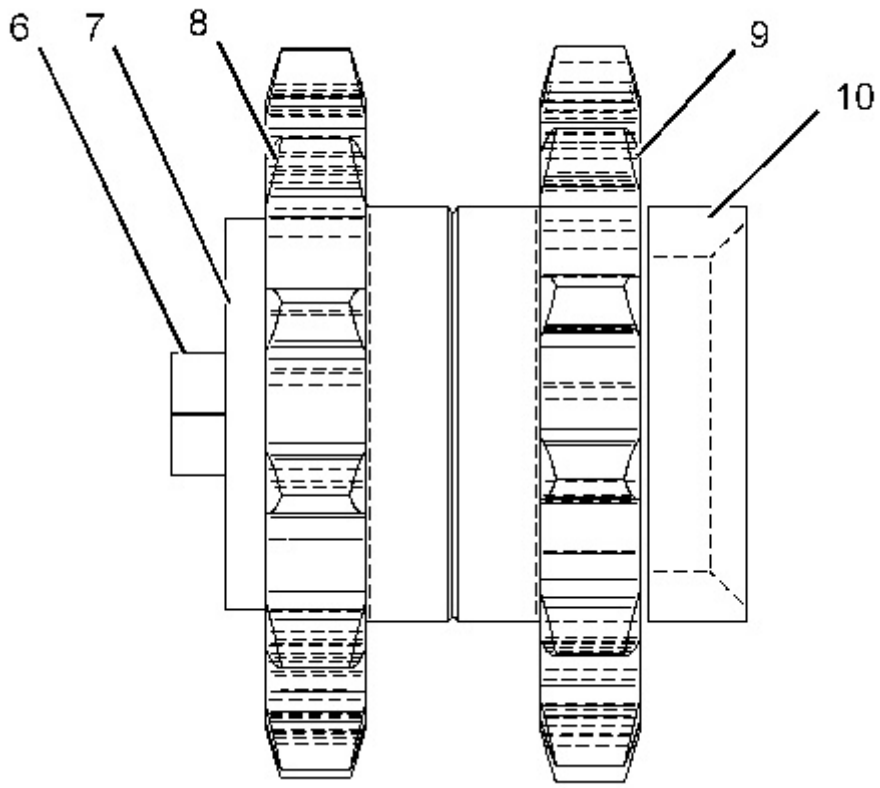


Illustration 2 g01092039

Note: Note the orientation of spacer (10) .

11. Remove bolt (6) .
12. Remove washer (7) .
13. Remove outer sprocket (8) .
14. Remove inner sprocket (9) .
15. Remove spacer (10) .

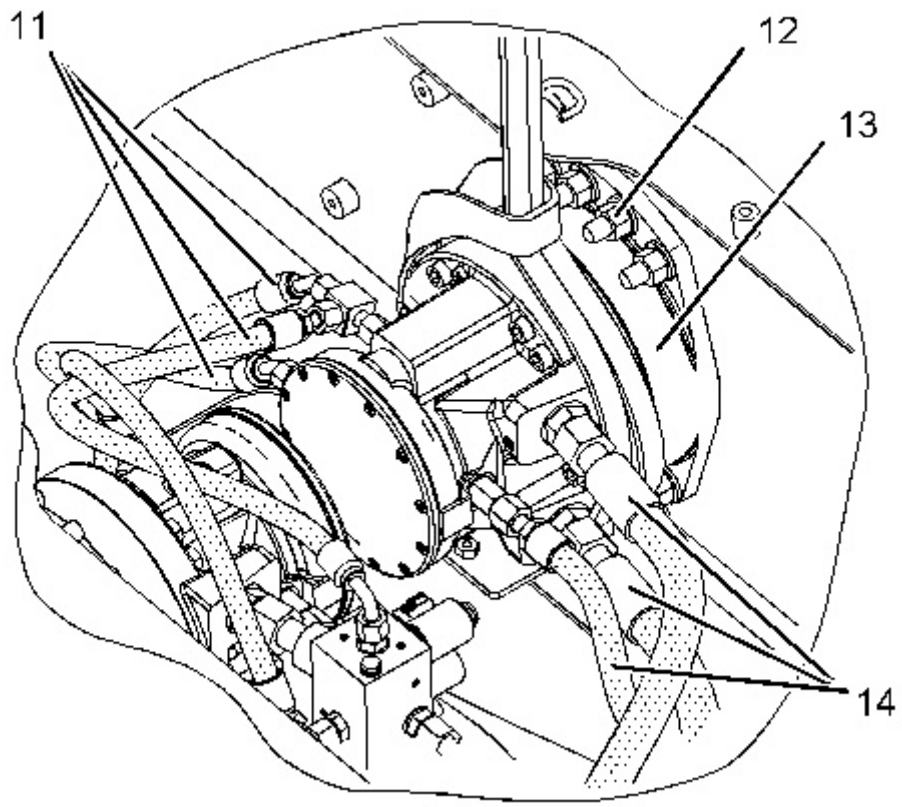


Illustration 3 g01092784

16. Disconnect hose assemblies (11) and (14) .
17. Use a suitable lifting device to support piston motor (13) . The weight of piston motor (13) is approximately 47 kg (104 lb).
18. Remove nuts (12) .
19. Remove piston motor (13) .
20. Repeat Step 1 to Step 19 for the other side.

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i02817235

Piston Motor (Hydrostatic) - Disassemble

SMCS - 4351-015

Disassembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	4S-5415	Puller Arm	2
	8H-0700	Plates	4
	1P-2327	Head	1
	1P-2328	Forcing Screw	1
	3H-0464	Bolt and Nut Group	4

Start By:

A. Remove the piston motor. Refer to Disassembly and Assembly, "Piston Motor (Hydrostatic) - Remove".

Note: Cleanliness is an important factor. Before the disassembly procedure, the exterior of the component should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.

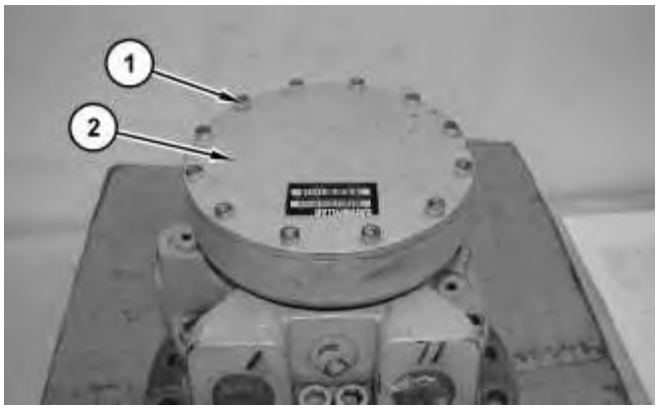


Illustration 1 g01405001

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

1. Remove bolts (1) and cover (2) .



Illustration 2 g01405004

2. Remove spring (3) .



Illustration 3 g01405019

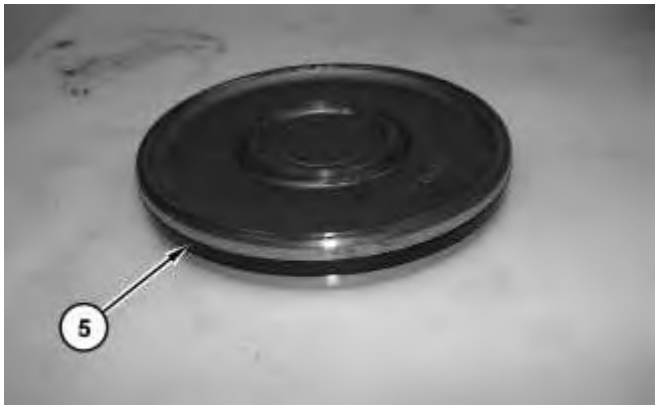


Illustration 4 g01405021

3. Use shop air in order to remove piston (4). Remove seals (5) from piston (4) .

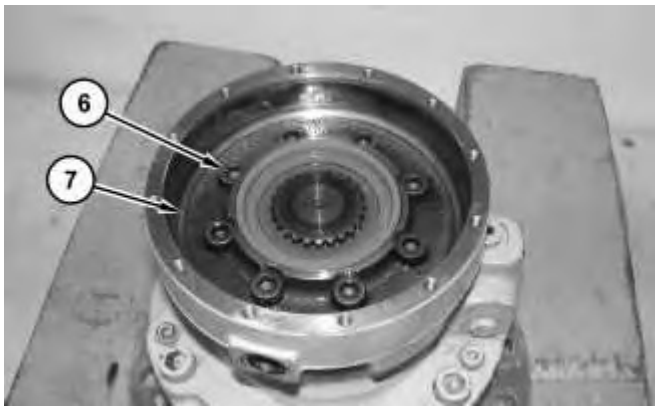


Illustration 5 g01405022

4. Remove bolts (6) and housing (7) .



Illustration 6 g01405023

5. Remove seal (8) from housing (7) .

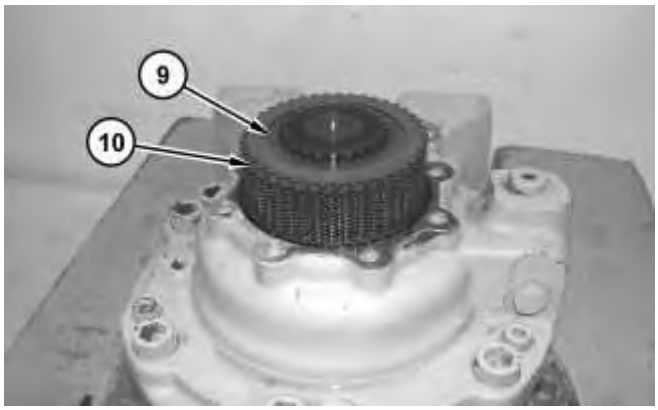


Illustration 7 g01405025

6. Remove discs (9) and plates (10) .



Illustration 8 g01405028

7. Remove shims (11) .

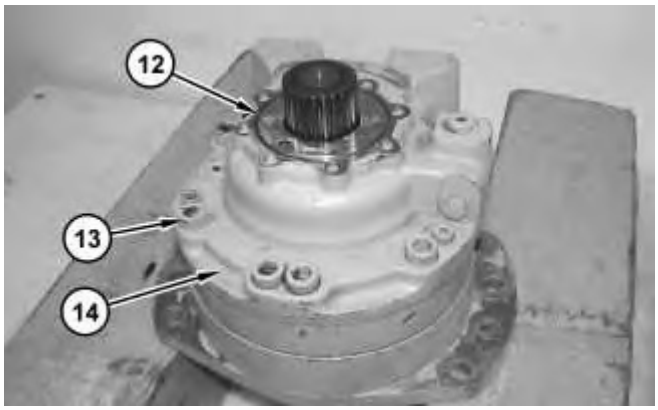


Illustration 9 g01405029

8. Remove O-ring seal (12). Remove bolts (13) and housing assembly (14) .

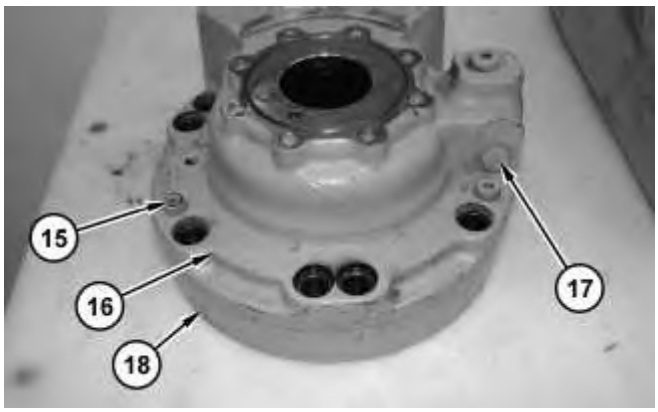


Illustration 10 g01405030

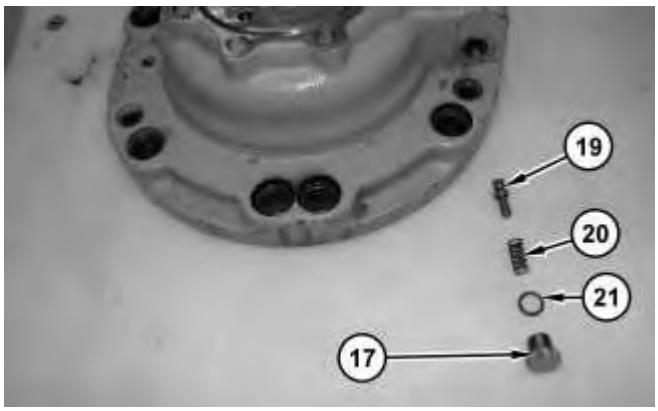


Illustration 11 g01405031

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

9. Remove bolts (15) and separate housings (16) and (18). Remove plug (17). Remove O-ring seal (21), spring (20), and piston (19) .

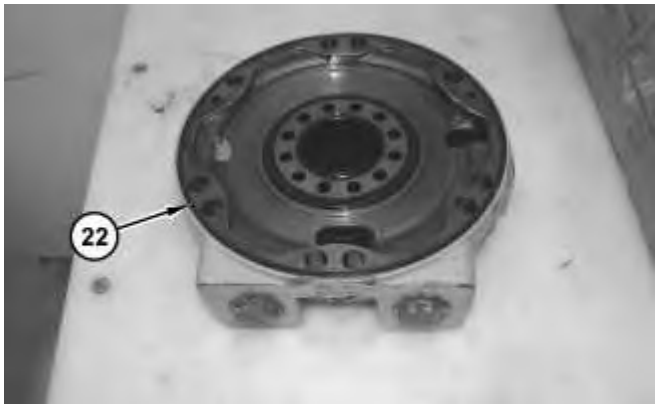


Illustration 12 g01405032

10. Remove seal (22) .

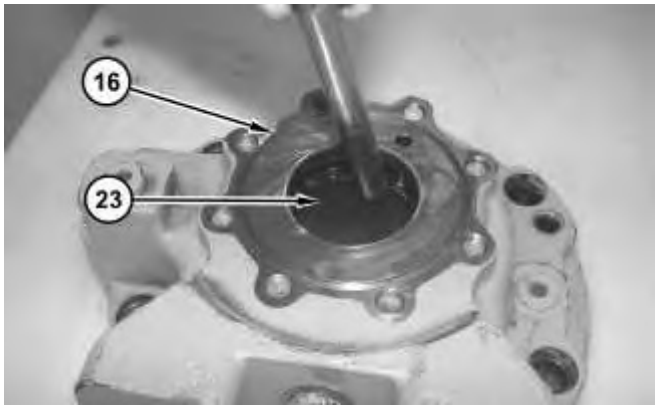


Illustration 13 g01405048

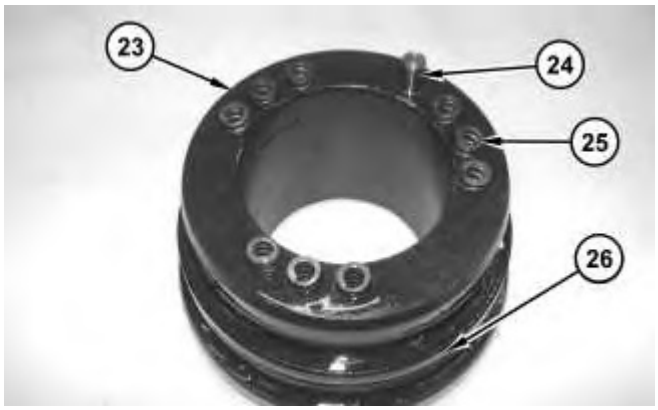


Illustration 14 g01405049

WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

11. Use a suitable brass punch in order to remove seal housing (23) from housing (16). Remove two seals (26) and springs (25) from seal housing (23). Remove dowel (24). Remove two seals (not shown) from inside housing (16) after seal housing (23) is removed.



Illustration 15 g01405052

12. Remove piston housing (27) .

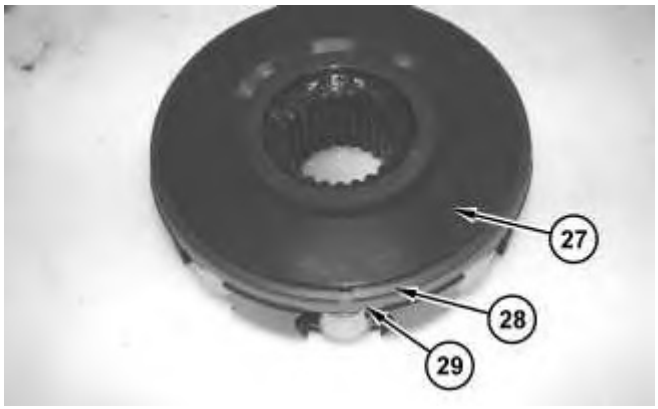


Illustration 16 g01405054

13. Remove ring (27). Remove spacer (28). Invert piston housing (27) and repeat for the other side.

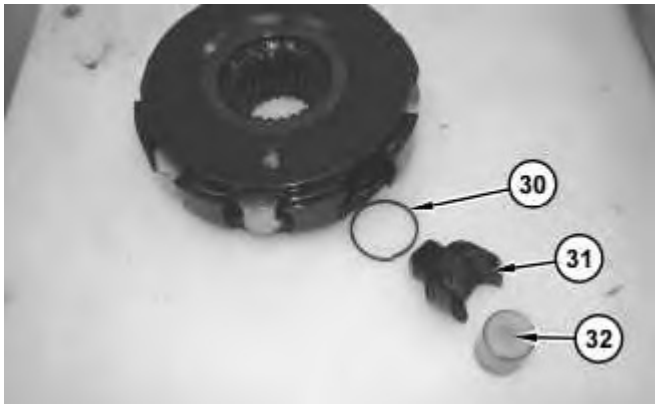


Illustration 17 g01405059

14. Remove roller (32). Remove piston (31) and O-ring seal (30). Repeat for the remaining pistons.

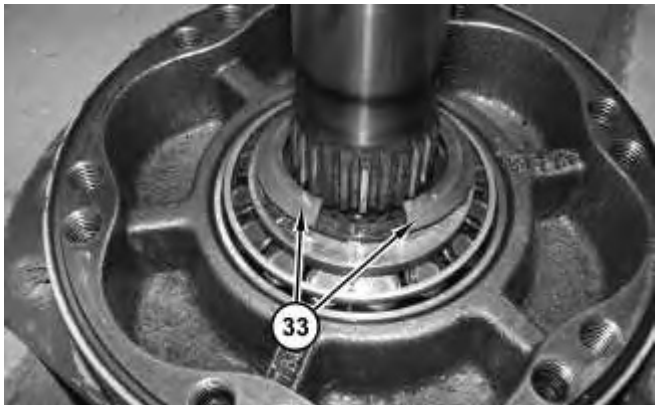


Illustration 18 g01405061

15. Use a suitable punch in order to remove retainers (33) .



Illustration 19 g01405062

16. Remove shim (34) .

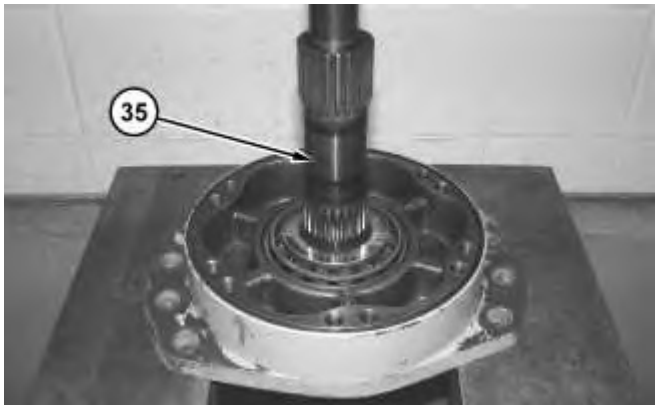


Illustration 20 g01405063

17. Use a suitable press in order to remove shaft assembly (35) .

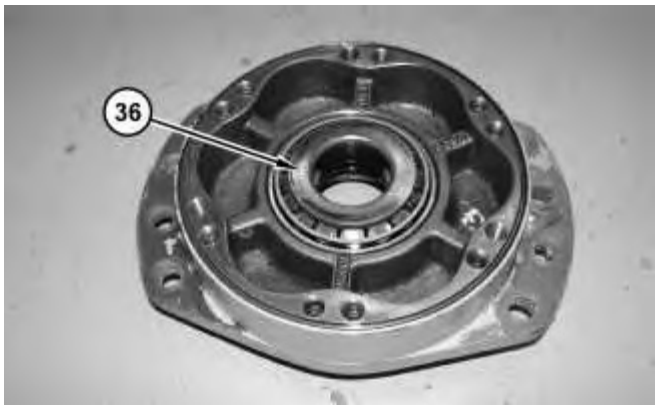


Illustration 21 g01408524

18. Remove bearing cone (36) .

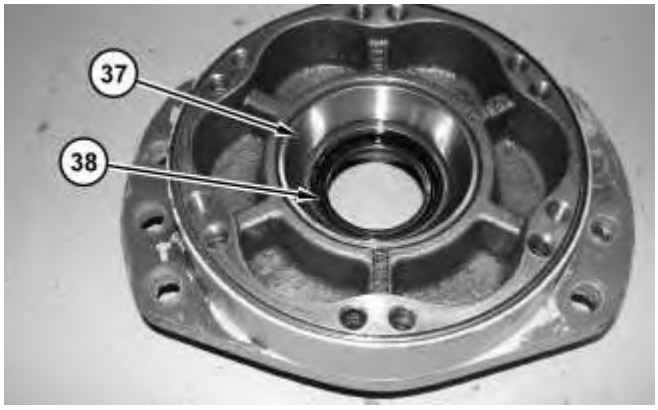


Illustration 22 g01409611

19. Remove bearing cup (37) and seal (38) .



Illustration 23 g01409613

20. Remove bearing cup (39) .



Illustration 24 g01409615

21. Remove seal (40) .

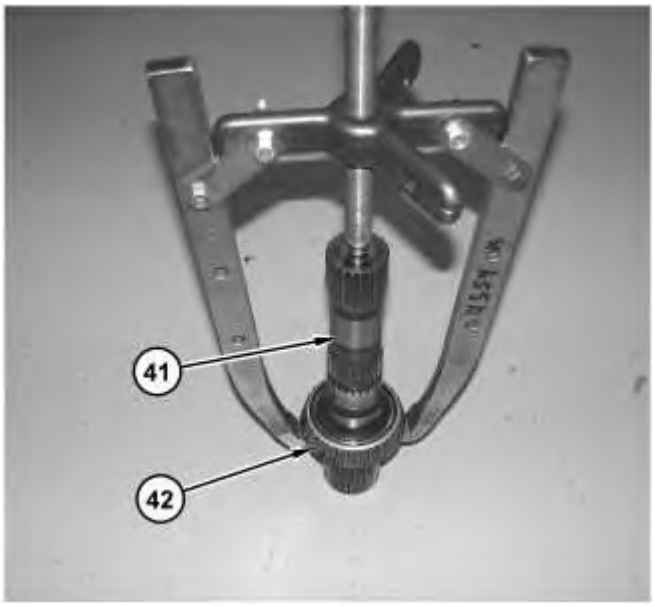


Illustration 25 g01409642

22. Use Tooling (A) in order to remove bearing cone (42) from shaft (41) .

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i03644882

Piston Motor (Hydrostatic) - Assemble

SMCS - 4351-016

Assembly Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	161-0970	Grease	1
B	318-1478	Sleeve	1

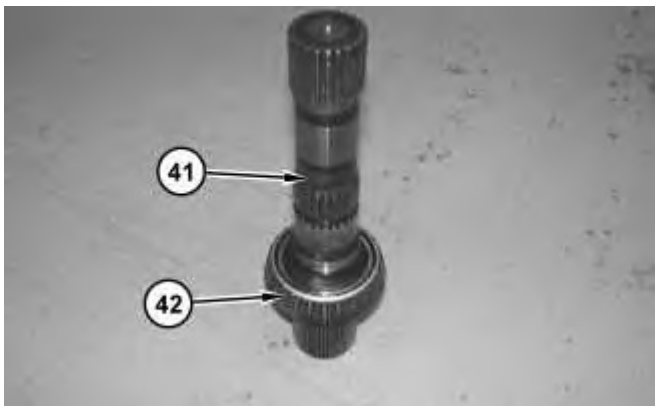


Illustration 1 g01409739

1. Raise the temperature of bearing cone (42) . Install bearing cone (42) onto shaft (41) .
2. Pack bearing (42) with Tooling (A) .



Illustration 2 g01409613

3. Lower the temperature of bearing cup (39) . Install bearing cup (39) .

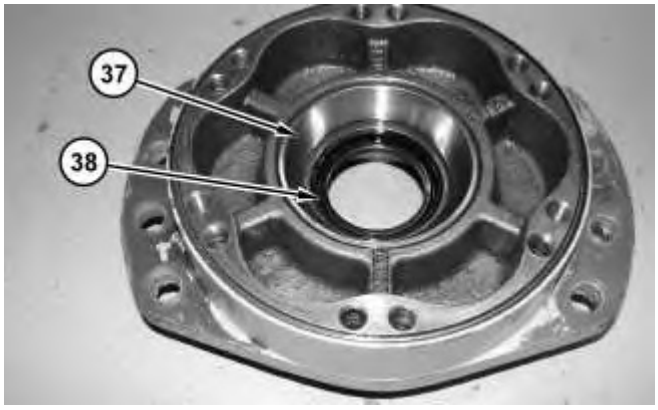


Illustration 3 g01409611

4. Install seal (38) . Lower the temperature of bearing cup (37) . Install bearing cup (37) .

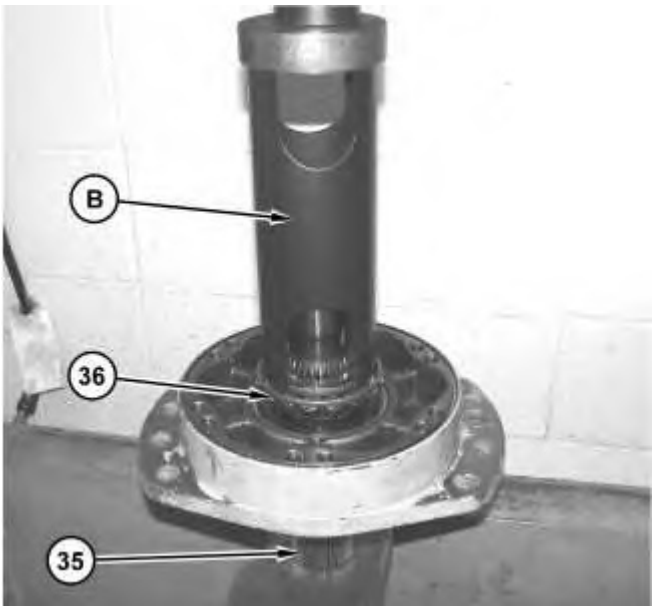


Illustration 4 g01409741

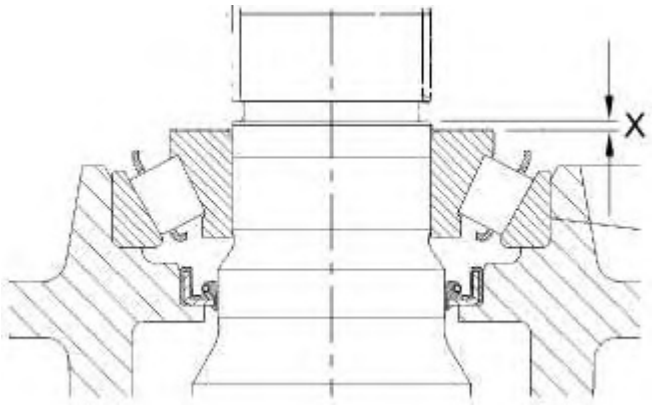


Illustration 5 g01409752

5. Support shaft assembly (35) , as shown. Install the housing onto shaft assembly (35) , as shown. Install bearing cone (36) over shaft assembly (35) . Use Tooling (B) and a suitable press in order to install bearing cone (36) onto shaft assembly (35) .

   Use the suitable press in order to maintain preload on bearing cone (36) . Measure the distance (X) between the face of bearing cone (36) and the face of the groove for the retainers. Select a shim that is between 0.1 mm (0.004 inch) and 0.2 mm (0.008 inch) more than the measurement of Dimension (X) .



Illustration 6 g01405062

6. Install shim (34) that was determined from the previous step.

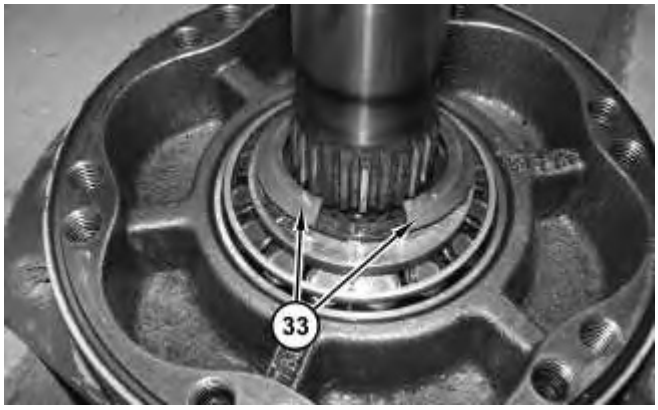


Illustration 7 g01405061

7. Use a suitable punch in order to install retainers (33) .

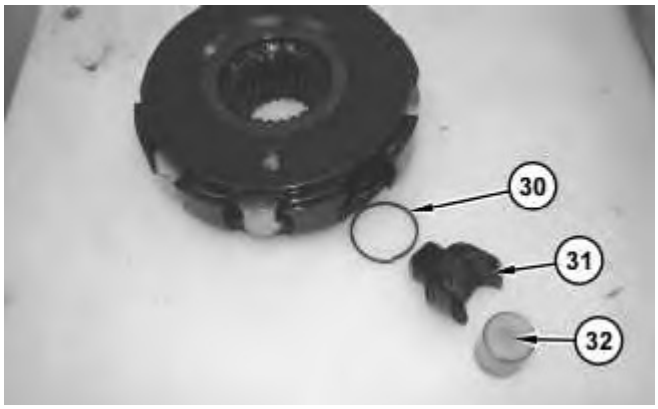


Illustration 8 g01405059

8. Install O-ring seal (30) onto piston (31) and install piston (31) . Repeat for the remaining pistons. Install roller (32) .

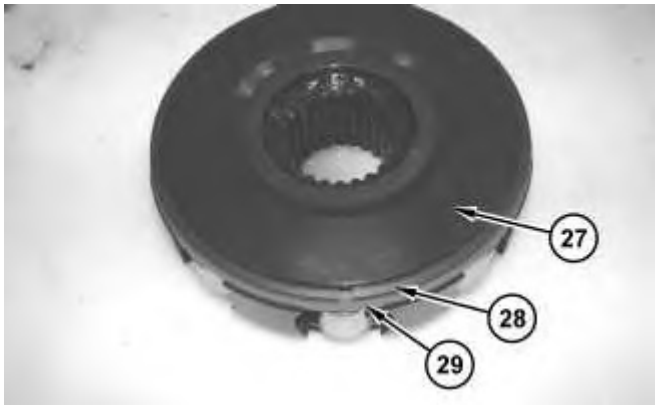


Illustration 9 g01405054

9. Install spacer (28) . Use Tooling (A) in order to install retaining ring (27) . Invert piston housing (27) and repeat for the other side.



Illustration 10 g01405052

10. Install piston housing (27) .

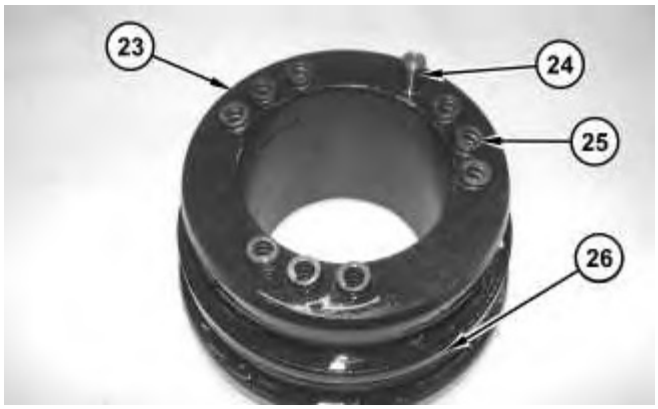


Illustration 11 g01405049

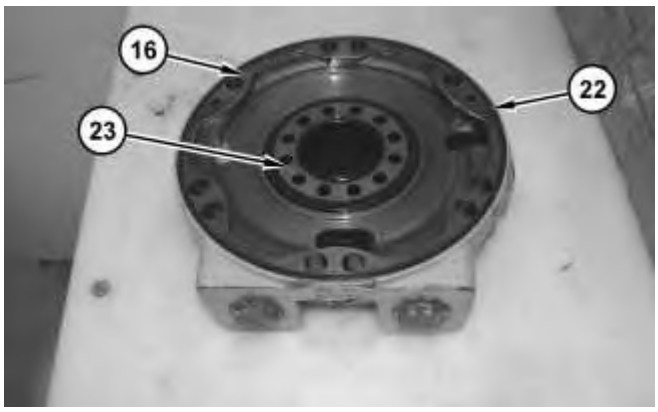


Illustration 12 g01409790

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

11. Install two seals (not shown) into the inside of housing (16) . Install dowel (24) . Install two seals (26) and springs (25) onto seal housing (23) . Install seal housing (23) into housing (16) . Install seal (22) .

    Note: Dowel (24) must fall into the slot that is located in housing (16) .

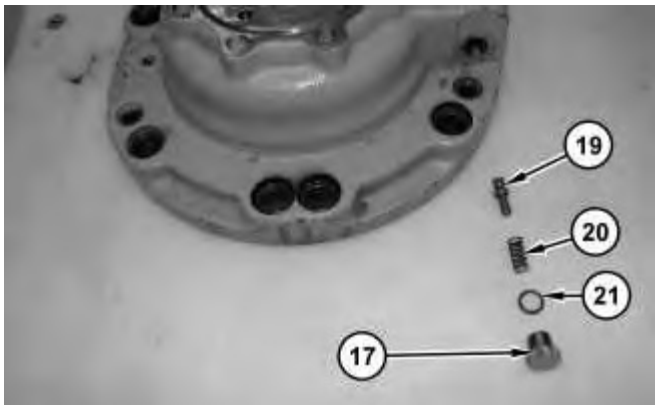


Illustration 13 g01405031

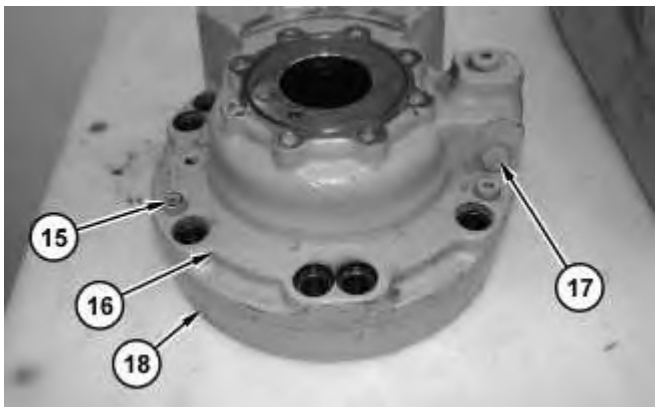


Illustration 14 g01405030

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

12. Install piston (19) , spring (20) , and O-ring seal (21) . Install plug (17) . Connect housings (16) and (18) . Install bolts (15) .

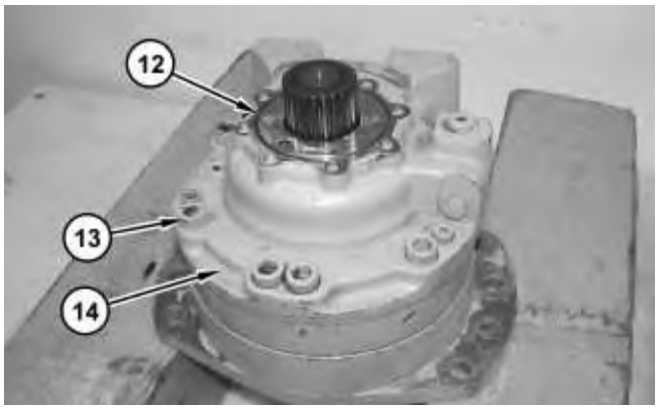


Illustration 15 g01405029

13. Install housing assembly (14) and bolts (13) . Install O-ring seal (12) .



Illustration 16 g01405023

14. Install seal (8) onto housing (7) .

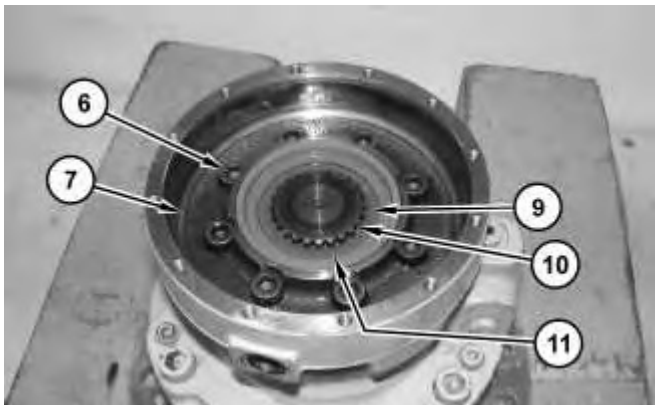


Illustration 17 g01409797

15. Install housing (7) and bolts (6) . Do not install discs (9) and plates (10) at this time.

16. Stack discs (9) and plates (10) . Begin with a disc (9) . Clamp discs (9) and plates (10) together and measure the thickness of the pack. Add shims (11) until the thickness of the pack measures 28.2 ± .1 mm (1.110 ± 0.004 inch).

17. Install the required amount of shims (11) . Install discs (9) and plates (10) . Begin with a disc (9) . There are 15 discs (9) and 13 plates (10) .

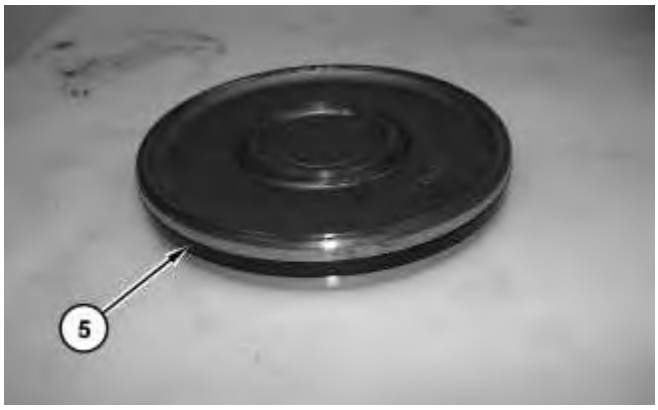


Illustration 18 g01405021



Illustration 19 g01405019

18. Install seals (5) onto piston (4) . Install piston (4) .



Illustration 20 g01405004

19. Install spring (3) .

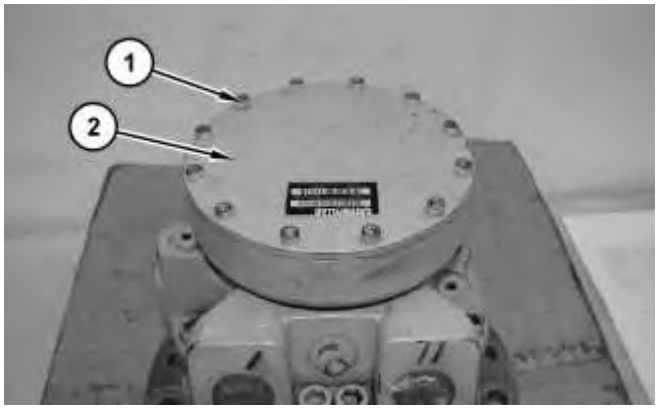


Illustration 21 g01405001

WARNING

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

20. Install cover (2) and bolts (1) .

End By: Install the piston motor. Refer to Disassembly and Assembly , "Piston Motor (Hydrostatic) - Install".

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i05418707

Piston Motor (Hydrostatic) - Install

SMCS - 4351-012

Installation Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
C	-	Loctite High Flex GM	-

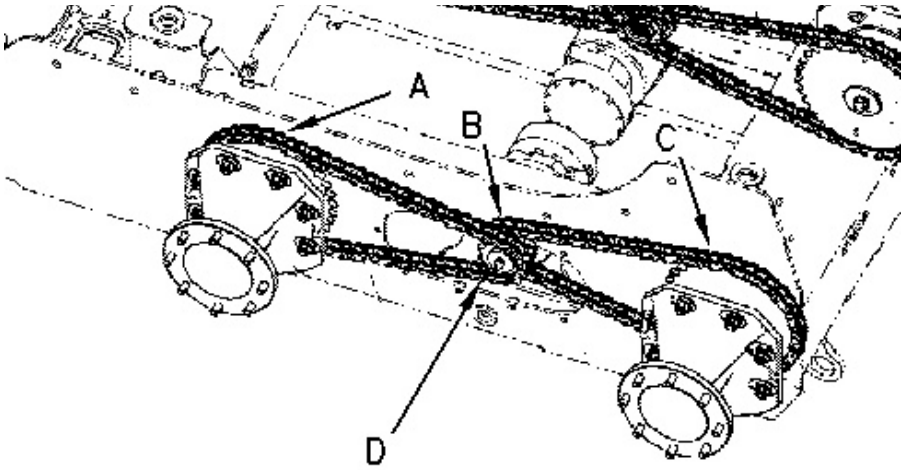


Illustration 1 g00577375

1. The front axle assemblies and the rear axle assemblies are driven by different drive chains. The drive chains are installed on Drive Sprocket (B) and Drive Sprocket (D) . The drive sprockets are mounted on the drive shaft of the hydrostatic piston motor. The two drive sprockets are the same component. The drive sprocket on the hydrostatic piston motor has sprocket drives on different planes. The drive sprockets on the front and rear axles are the same component. The sprockets on the front and rear axles are mounted at 180 degrees of opposite direction. Sprocket (A) is in line with Drive Sprocket (D) and that Sprocket (C) is in line with Drive Sprocket (B) . The drive sprockets are installed in a

manner that will allow the drive chains to turn in a straight line. If any of the sprockets are installed incorrectly the drive chains cannot be installed properly. Note the orientation of all of Drive Sprocket (B) and Drive Sprocket (D) . Note the orientation of Sprocket (A) and Sprocket (C) on the axles.

2. Clean the mating surfaces of the tandem drive and the piston motor.

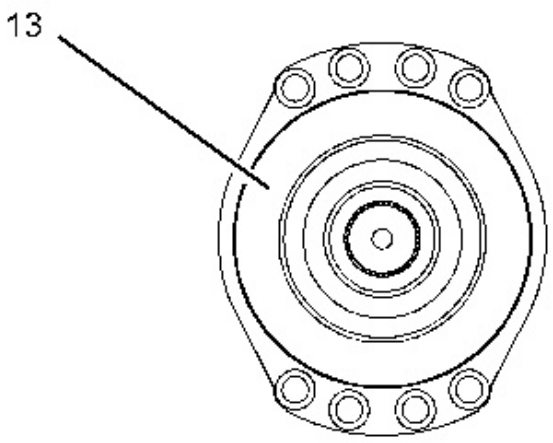


Illustration 2 g01052613

Typical Example 8 Bolt Flange Shown

Note: If you are replacing the studs, clean the mating surfaces, and apply Tooling (C) to the flange of the stud.

3. Apply Tooling (C) on the edge of piston motor (13) .

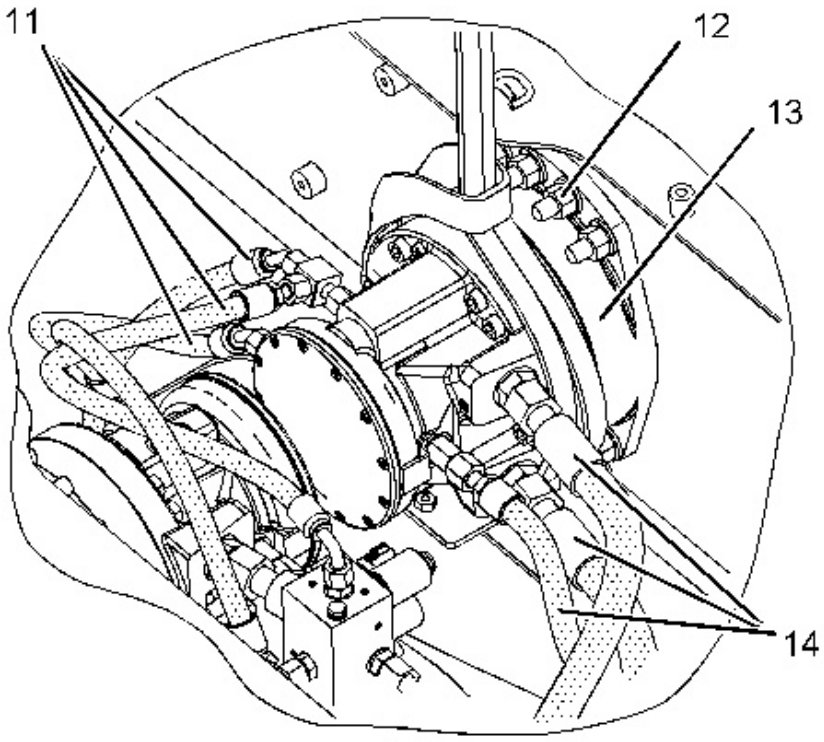


Illustration 3 g01092784

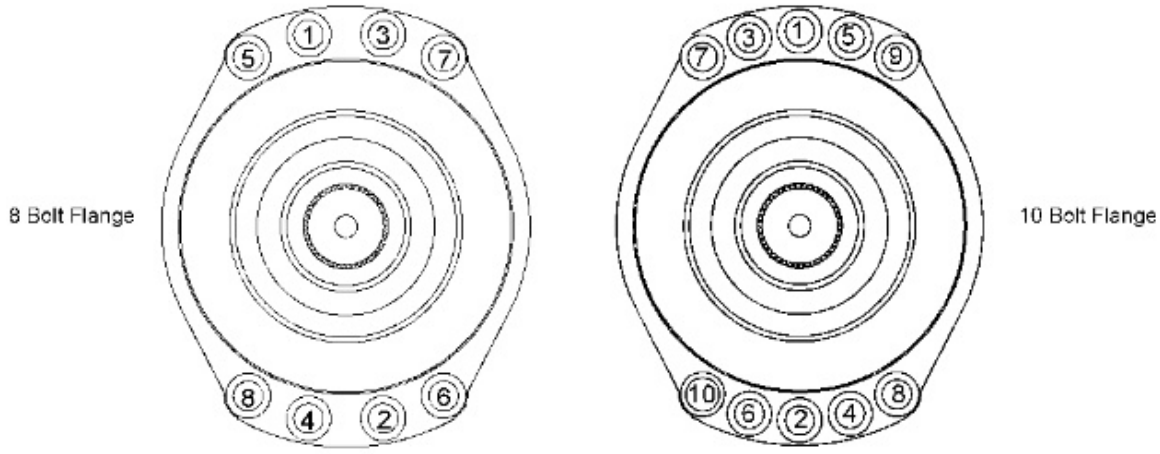


Illustration 4 g03420578

4. Use a suitable lifting device to install piston motor (13) . The weight of piston motor (13) is approximately 47 kg (104 lb). Install nuts (12) . Tighten the nuts according to the pattern in Illustration 4.

5. Connect hose assemblies (11) and (14) .

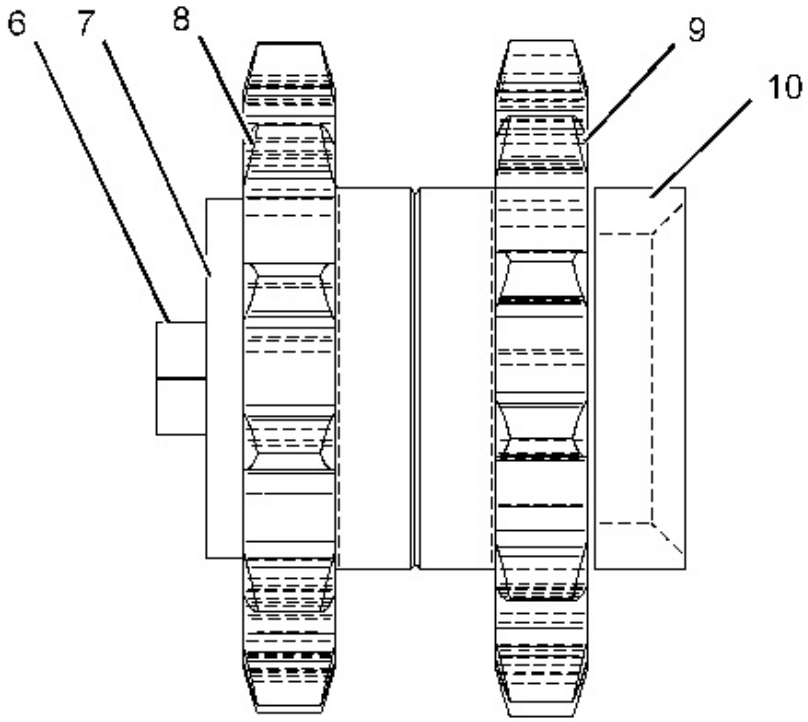


Illustration 5 g01092039

Note: The chamfered side of the spacer must face toward the piston motor.

6. Install spacer (10) .
7. Install inner sprocket (9) .
8. Install outer sprocket (8) .
9. Install washer (7) .
10. Install bolt (6) .
11. Refill the drive chain oil into the tandem housing. Refer to Operation and Maintenance Manual, "Drive Chain Case Oil - Change".

End By:

a. Adjust the drive chain tension.
b. Install the tire and rim.
c. Install the gear pump.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868235

Piston Pump

SMCS - 3203

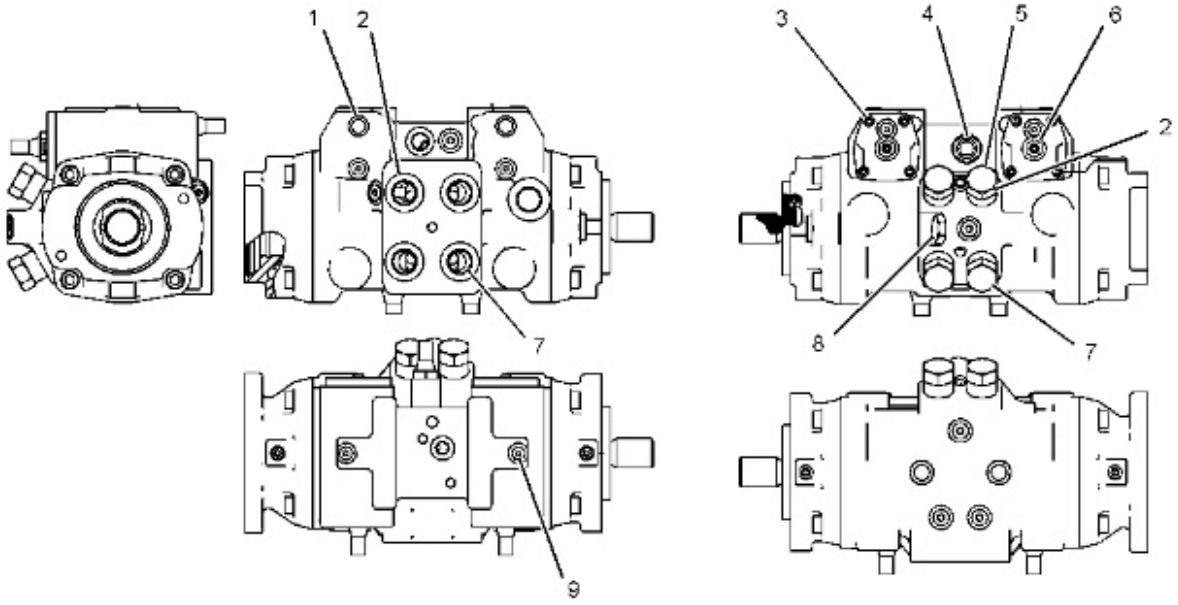


Illustration 1 g01428682

Rotation ... Clockwise when you view the piston pump from the shaft end.

Displacement ... 46 cc (2.8 in^3)

(1) Torque for the two locknuts ... 22.0 ± 1.1 N·m (195 ± 10 lb in)

(2) Relief valve pressure setting for the reverse port ... 35000 + 2000 - 4000 kPa (5100 + 290 - 580 psi)

(3) Torque for the eight bolts ... 10.40 ± 0.52 N·m (90 ± 5 lb in)

(4) Torque for the speed sensing valve group ... 50.0 ± 2.5 N·m (37 ± 2 lb ft)

(5) Torque for the four relief valve groups (crossover) ... 250 ± 10 N·m (185 ± 7 lb ft)

(6) Torque for the two hex nuts ... 30.0 ± 1.5 N·m (265 ± 13 lb in)

(7) Relief valve pressure setting for the forward port ... 35000 ± 2000 kPa (5100 ± 290 psi)

(8) Torque for the relief valve group (charge) ... 70.0 ± 3.5 N·m (50 ± 3 lb ft)

(9) Torque for the two O-ring plugs ... 15.00 ± 0.75 N·m (135 ± 7 lb in)

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i02869368

Piston Pump

SMCS - 3203

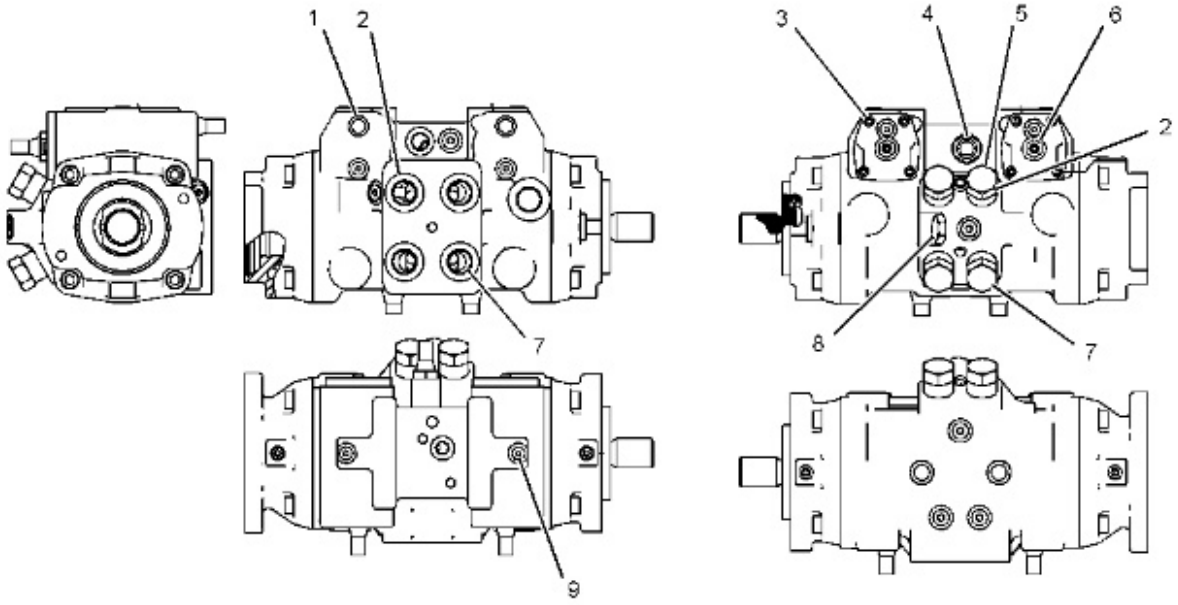


Illustration 1 g01428682

Rotation ... Clockwise when you view the piston pump from the shaft end.

Displacement ... 38.5 + 0.5 - 0.7 cc (2.35 + 0.03 - 0.04 in^3)

(1) Torque for the two locknuts ... 22.0 ± 1.1 N·m (195 ± 10 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868255

Piston Pump

SMCS - 3203

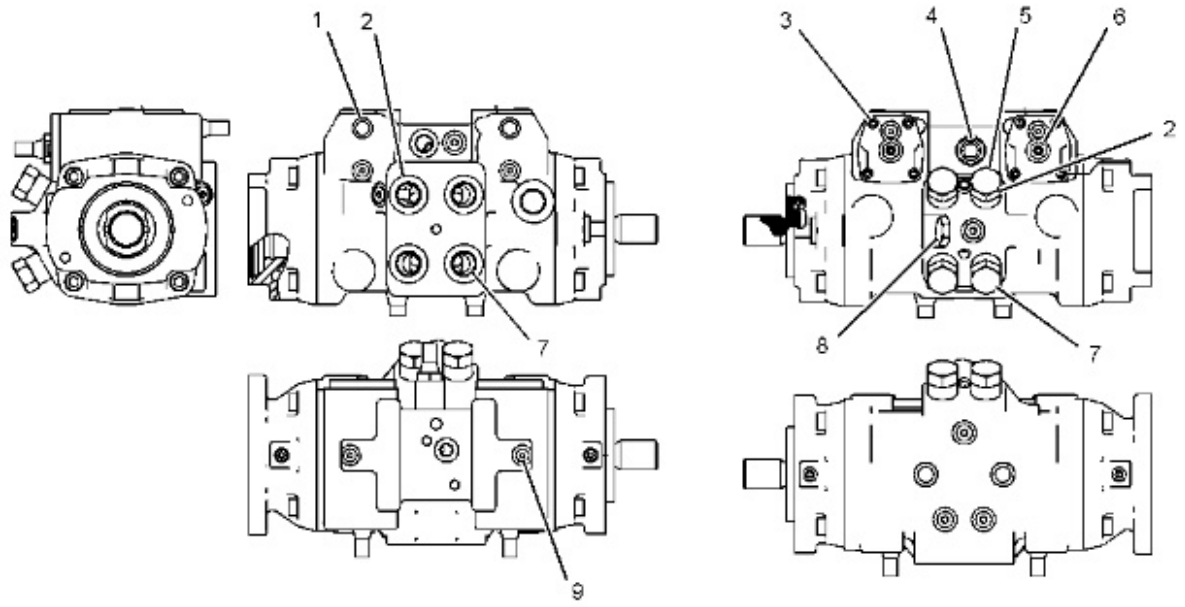


Illustration 1 g01428682

Rotation ... Clockwise when you view the piston pump from the shaft end.

Displacement ... 46.0 + 0.5 - 0.7 cc (2.81 + 0.03 - 0.04 in^3)

(1) Torque for the two locknuts ... 22.0 ± 1.1 N·m (195 ± 10 lb in)

(2) Relief valve pressure setting for the reverse port ... 35000 + 2000 - 4000 kPa (5100 + 290 − 580 psi)

(3) Torque for the eight bolts ... 10.40 ± 0.52 N·m (90 ± 5 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868235

Piston Pump

SMCS - 3203

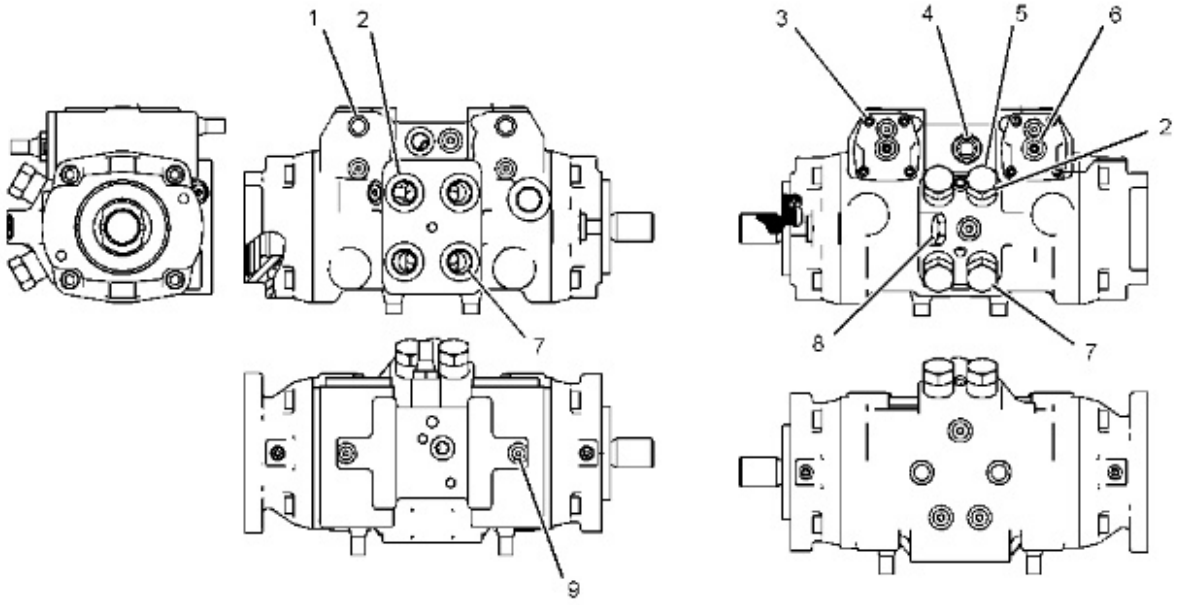


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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02869368

Piston Pump

SMCS - 3203

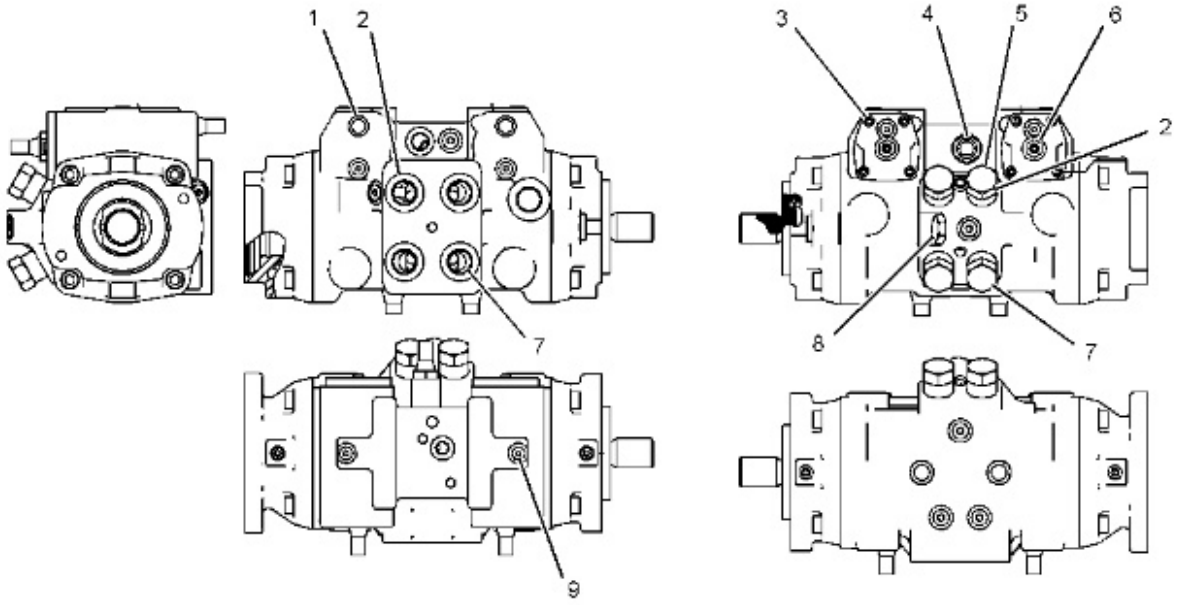


Illustration 1 g01428682

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(9) Torque for the two O-ring plugs ... 15.00 ± 0.75 N·m (135 ± 7 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02868255

Piston Pump

SMCS - 3203

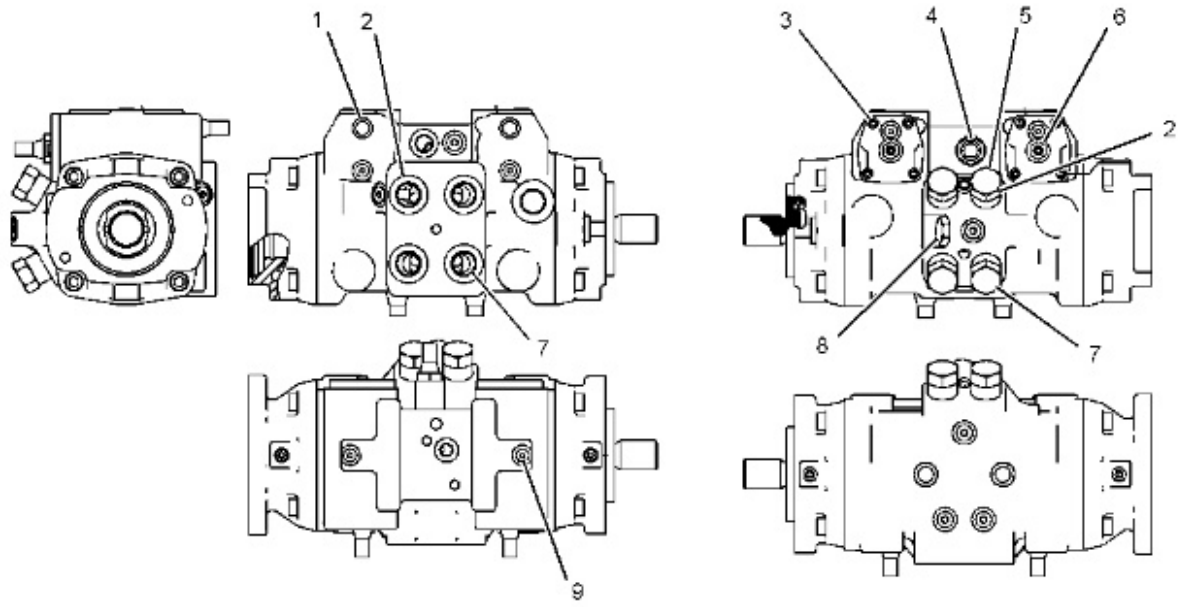


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i02485616

Piston Pump (Hydrostatic) - Remove

SMCS - 3203-011

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	247-4296	Pump Support	1
B	138-7575	Link Bracket	1
C	159-3327	Wrench Adapter	1
ZZ	6V-9507	Face Seal Plug	5
	6V-9828	Cap As	5
	6V-9508	Face Seal Plug	2
	6V-9829	Cap As	2
	6V-9509	Face Seal Plug	1
	6V-9830	Face Seal Plug	1
	6V-9511	Plug	4
	6V-9832	Cap As	4
	9U-7080	Tapered Cap/Plug	2

Start By:

A. Remove the hydraulic tank. Refer to Disassembly and Assembly, "Hydraulic Tank - Remove".
B. Remove the gear pump. Refer to Disassembly and Assembly, "Gear Pump - Remove and Install".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

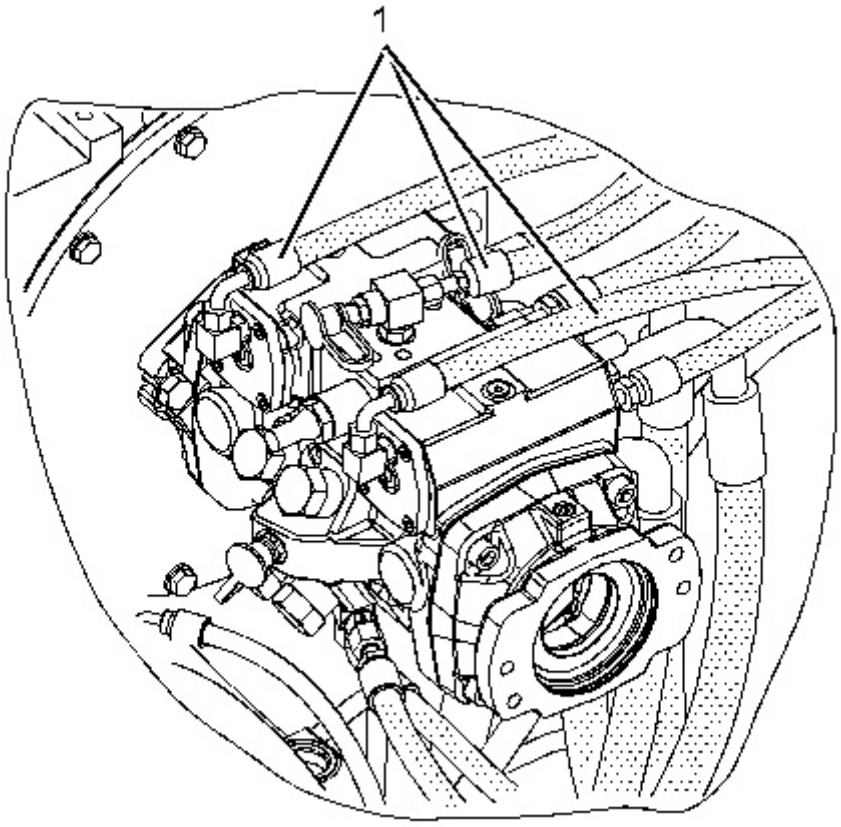


Illustration 1 g01092729

1. Disconnect hose assemblies (1) .

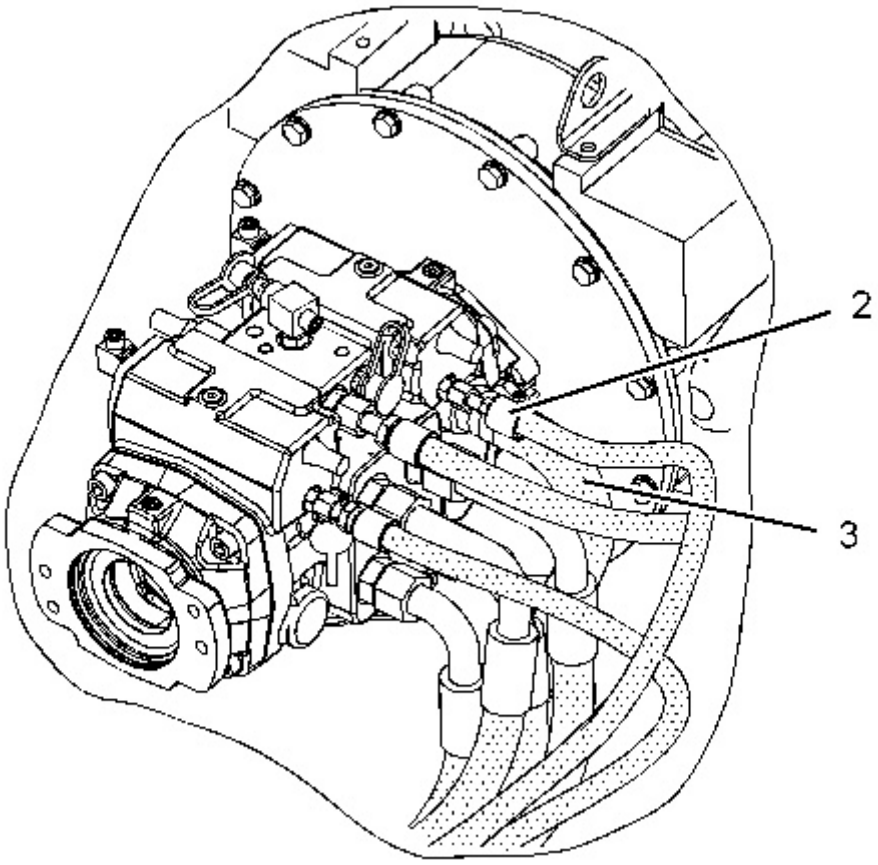


Illustration 2 g01092739

2. Disconnect seven hose assemblies (2) . Disconnect hose (3) .

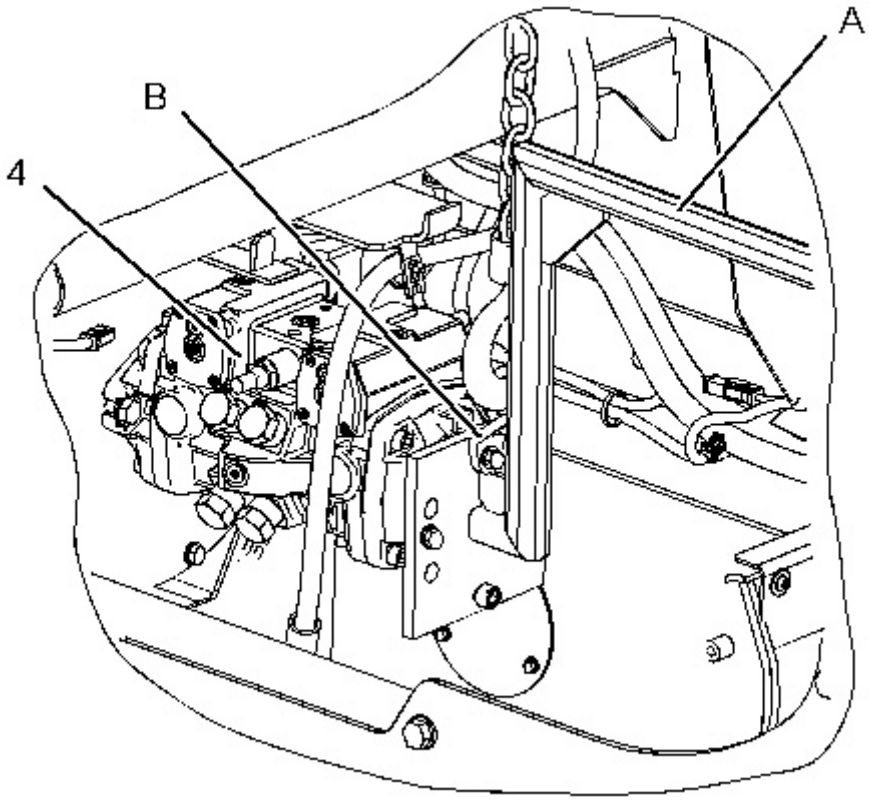


Illustration 3 g01092747

3. Use a suitable lifting device, Tooling (A) and Tooling (B) to support piston pump (4) . The weight of the piston pump is approximately 61 kg (134 lb).

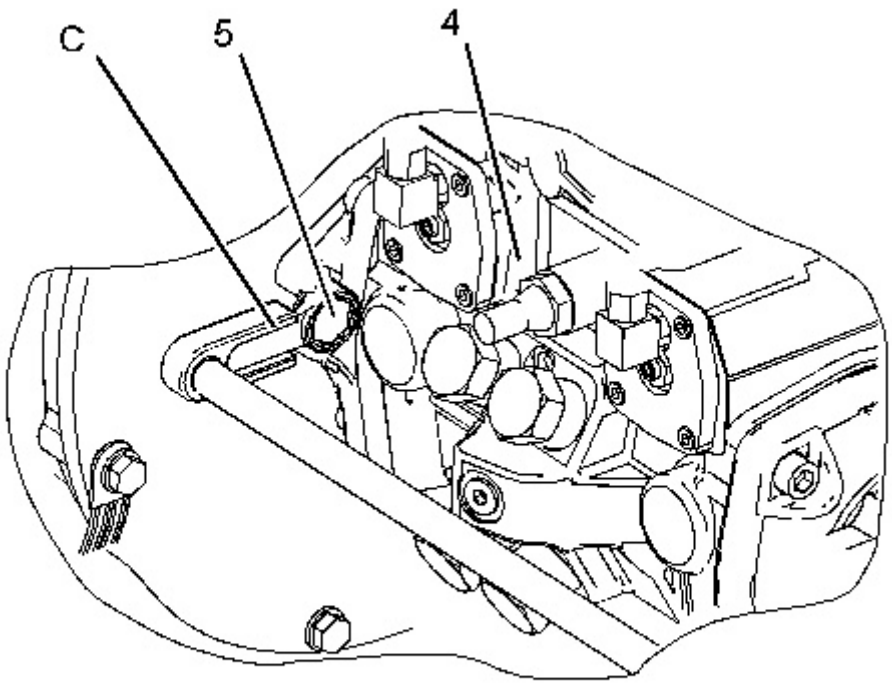


Illustration 4 g01092751

4. Use Tooling (C) to remove bolt (5) .
5. Repeat Step 4 for the other side.
6. Remove piston pump (4) .

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i02485618

Piston Pump (Hydrostatic) - Install

SMCS - 3203-012

Installation Procedure

Table 1

Required Tool			
Tool	**Part Number**	**Part Description**	**Qty**
A	247-4296	Pump Support	1
B	138-7575	Link Bracket	1
C	159-3327	Wrench Adapter	1

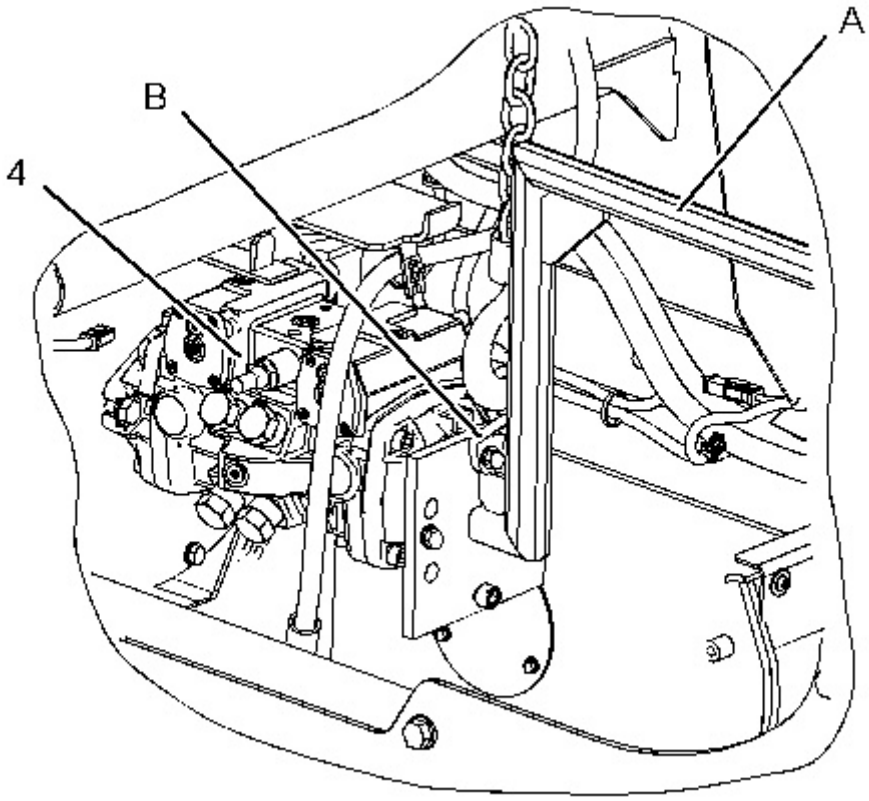


Illustration 1 g01092747

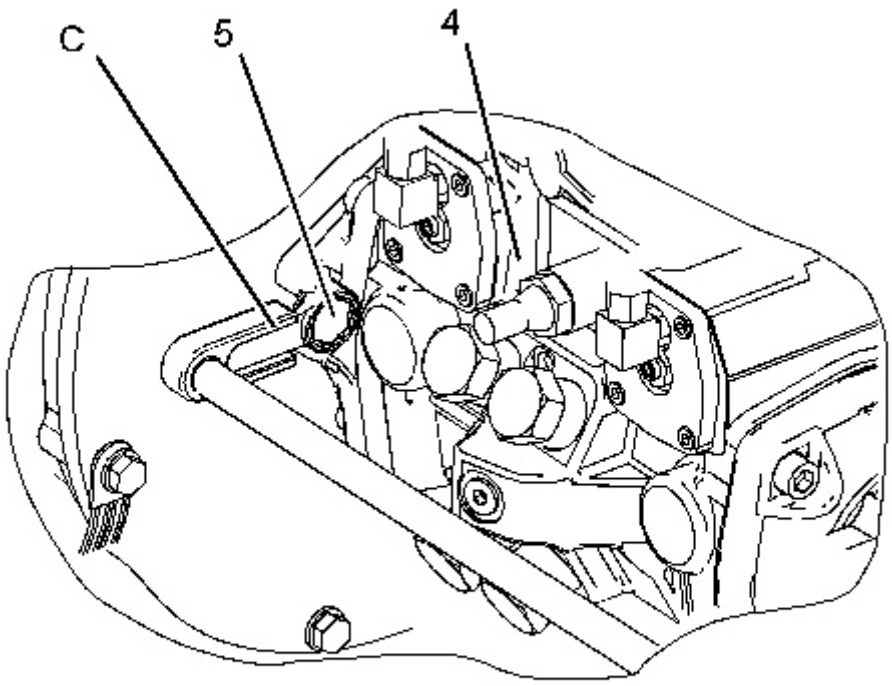


Illustration 2 g01092751

1. Use Tooling (A) and Tooling (B) in order to install piston pump (4) . The weight of piston pump (4) is approximately 61 kg (134 lb). Use Tooling (C) to install bolt (5) on both sides of pump (4) .

2. Remove the suitable lifting device, Tooling (B) and Tooling (A) from piston pump (4) .

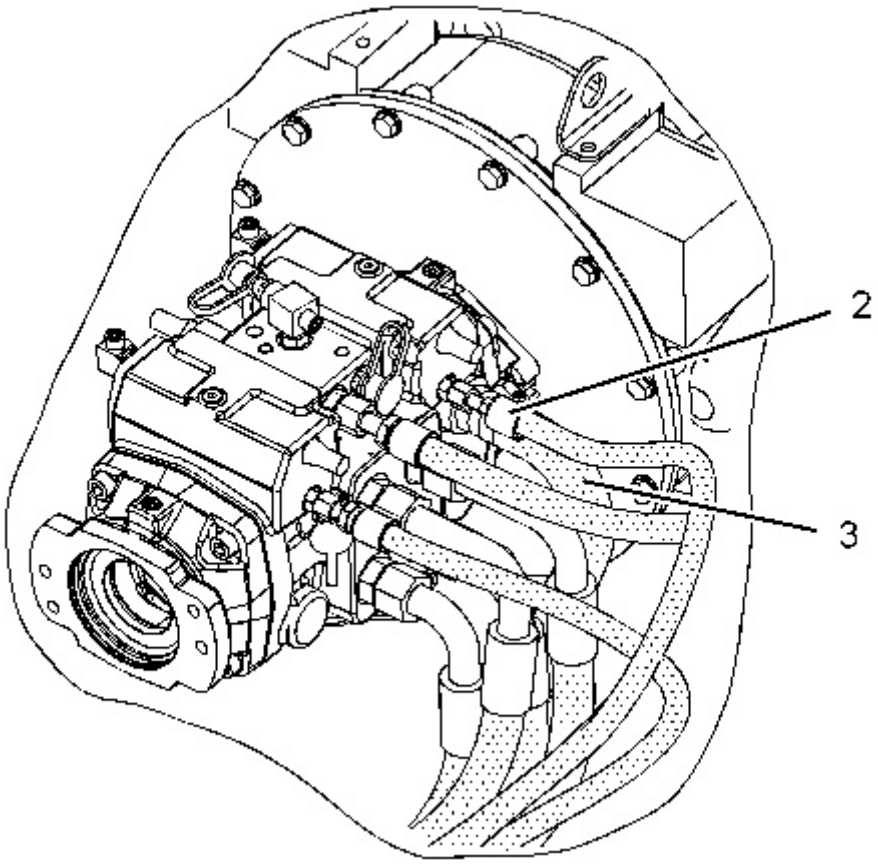


Illustration 3 g01092739

3. Connect seven hose assemblies (2) . Connect hose (3) .

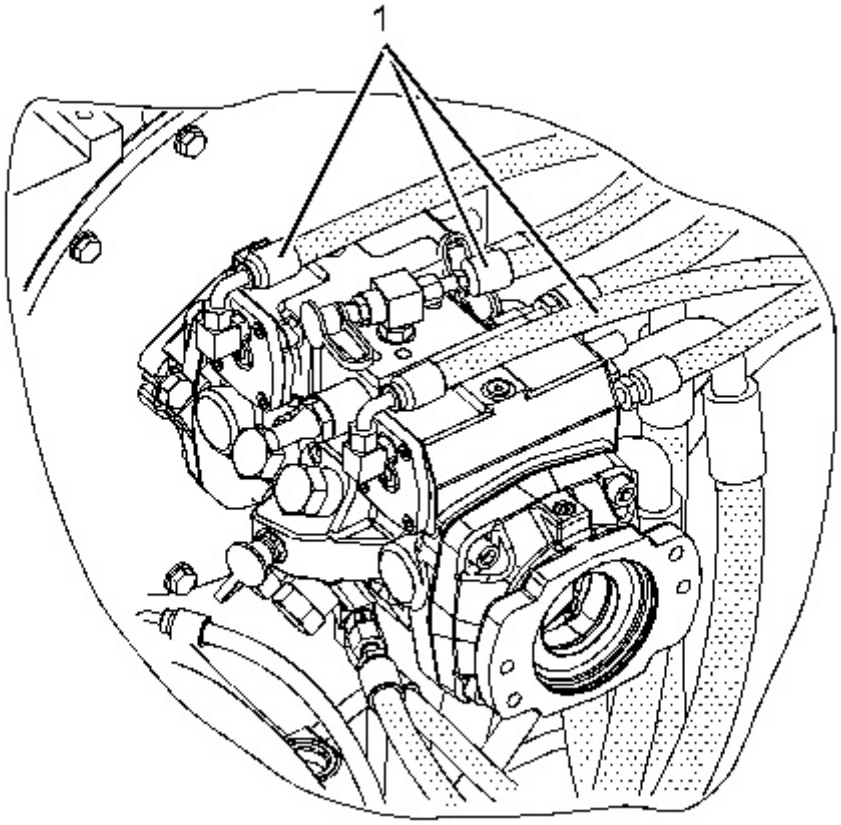


Illustration 4 g01092729

4. Connect hose assemblies (1) .

End By:

a. Install the gear pump. Refer to Disassembly and Assembly, "Gear Pump - Install".
b. Install the hydraulic tank. Refer to Disassembly and Assembly, "Hydraulic Tank - Install".

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i02369929

Pump Mounting - Remove and Install

SMCS - 3203-010-MT; 5062-010; 5070-010-MT

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

Start By:

A. Remove the engine. Refer to Disassembly and Assembly, "Engine - Remove".

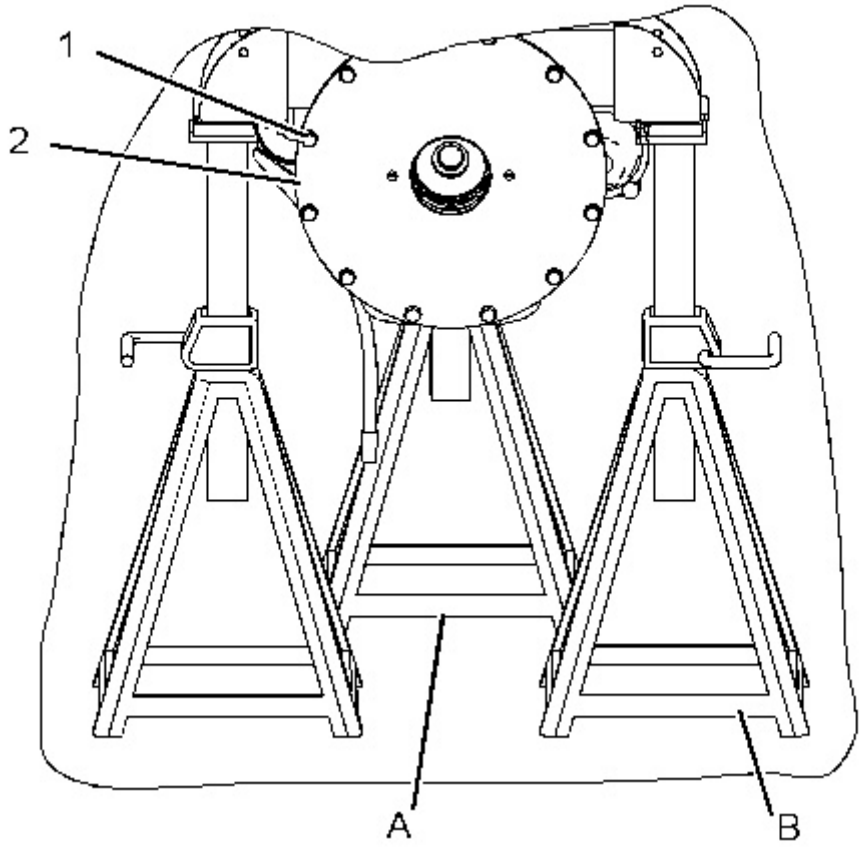


Illustration 1 g01091327

1. Use Tooling (A) and Tooling (B) to support the engine. Remove bolts (1) . Remove adapter plate (2) .

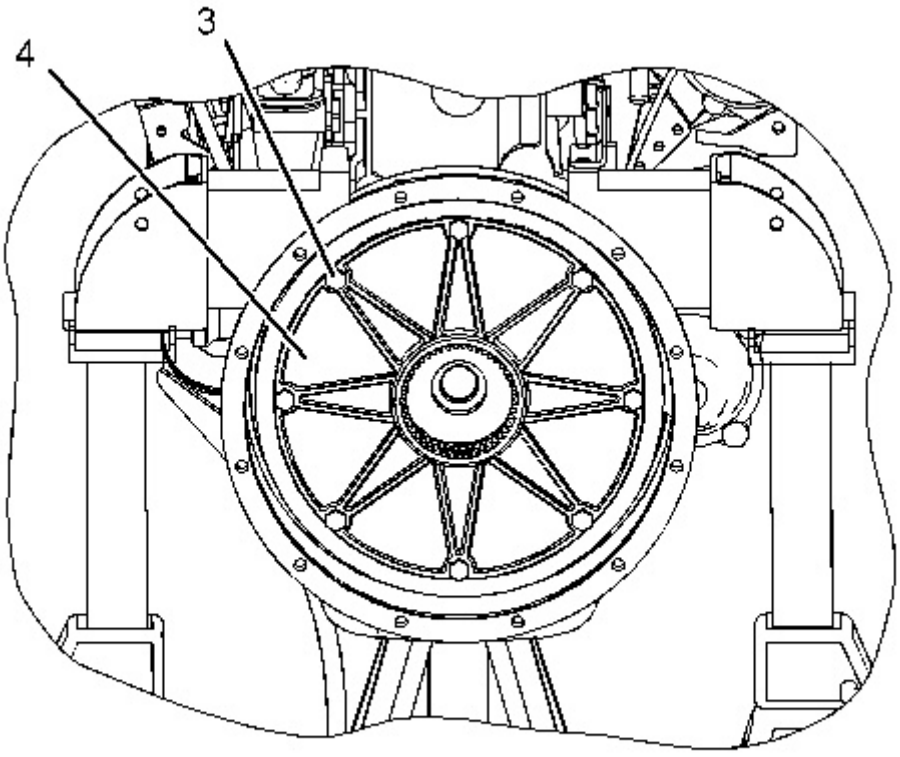


Illustration 2 g01091328

2. Remove bolts (3) . Remove nylon flange (4) .

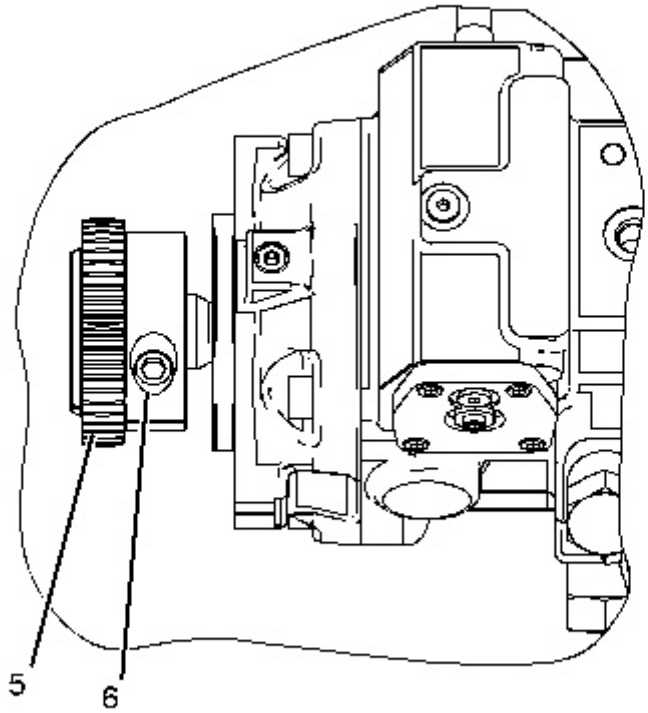


Illustration 3 g01093859

3. Remove bolt (6) . Discard bolt (6) . Remove hub (5) .

Installation Procedure

Table 2

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	180-3033	Stand	1
B	180-3034	Stand	2

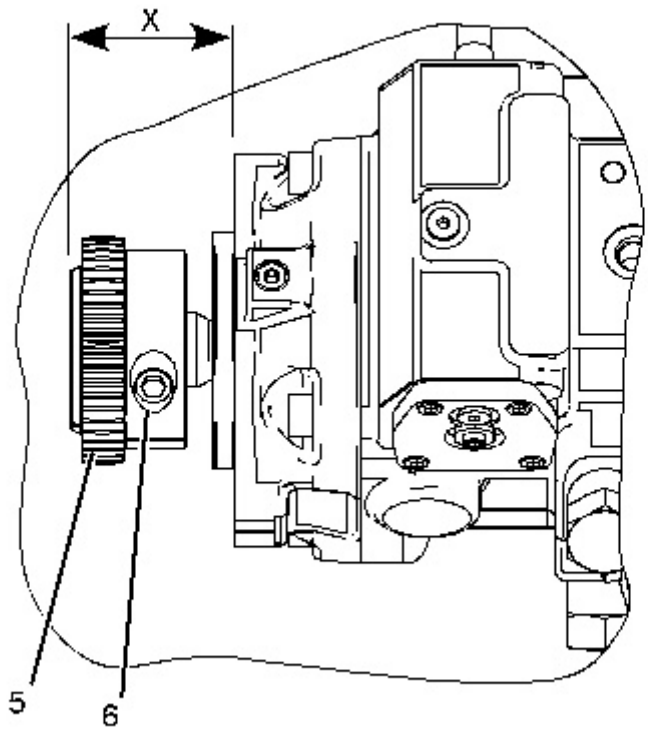


Illustration 4 g01041240

1. Install hub (5) . The face of hub (5) must be installed to a dimension of 70.9 ± 2 mm (2.80 ± .078 inch) from the face of the pump. This dimension is shown in the graphic above as Dimension (X) . Install new bolt (6) . Tighten the bolt to 102 ± 5 N·m (75 ± 4 lb ft).

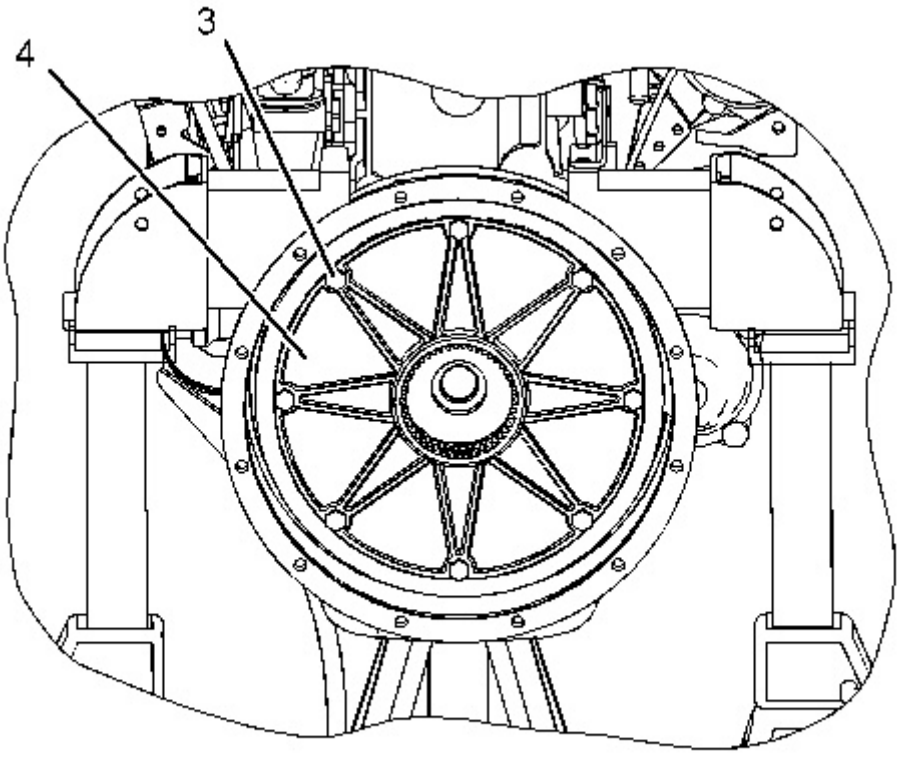


Illustration 5 g01091328

2. Install nylon flange (4) . Install bolts (3) .

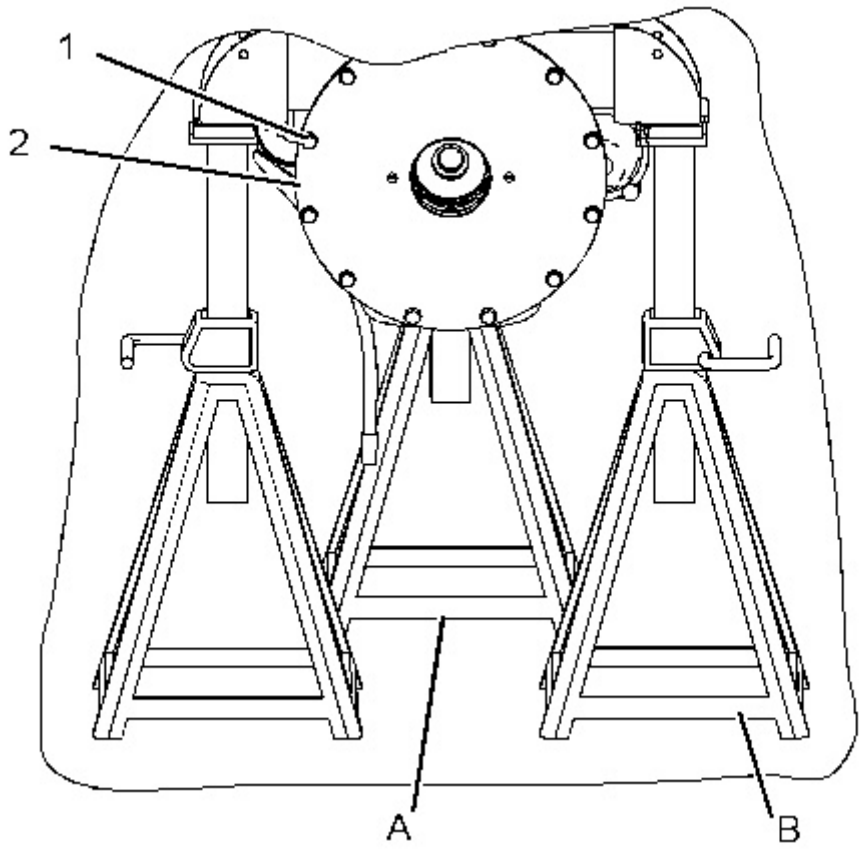


Illustration 6 g01091327

3. Install adapter plate (2) . Install bolts (1) .

End By: Install the engine. Refer to Disassembly and Assembly, "Engine - Install".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

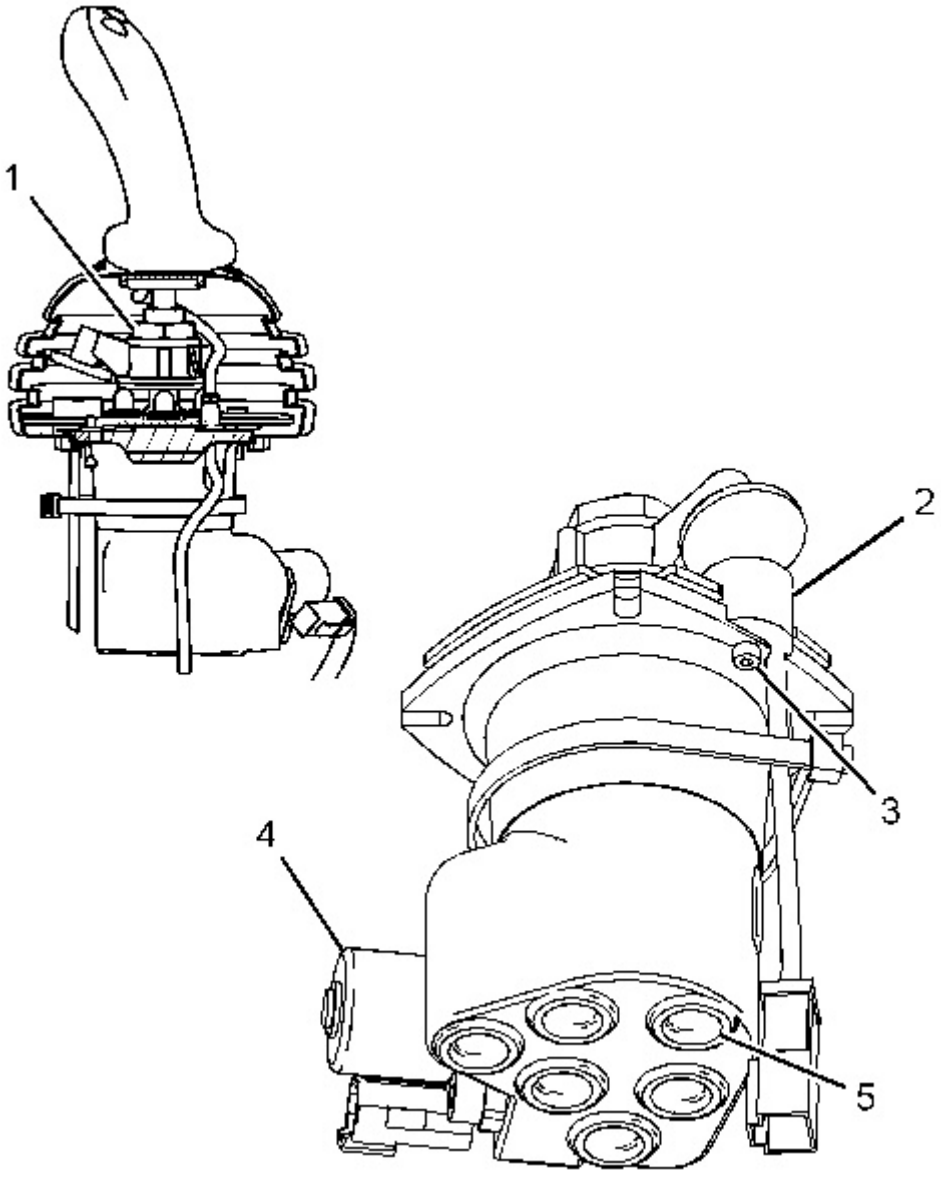


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

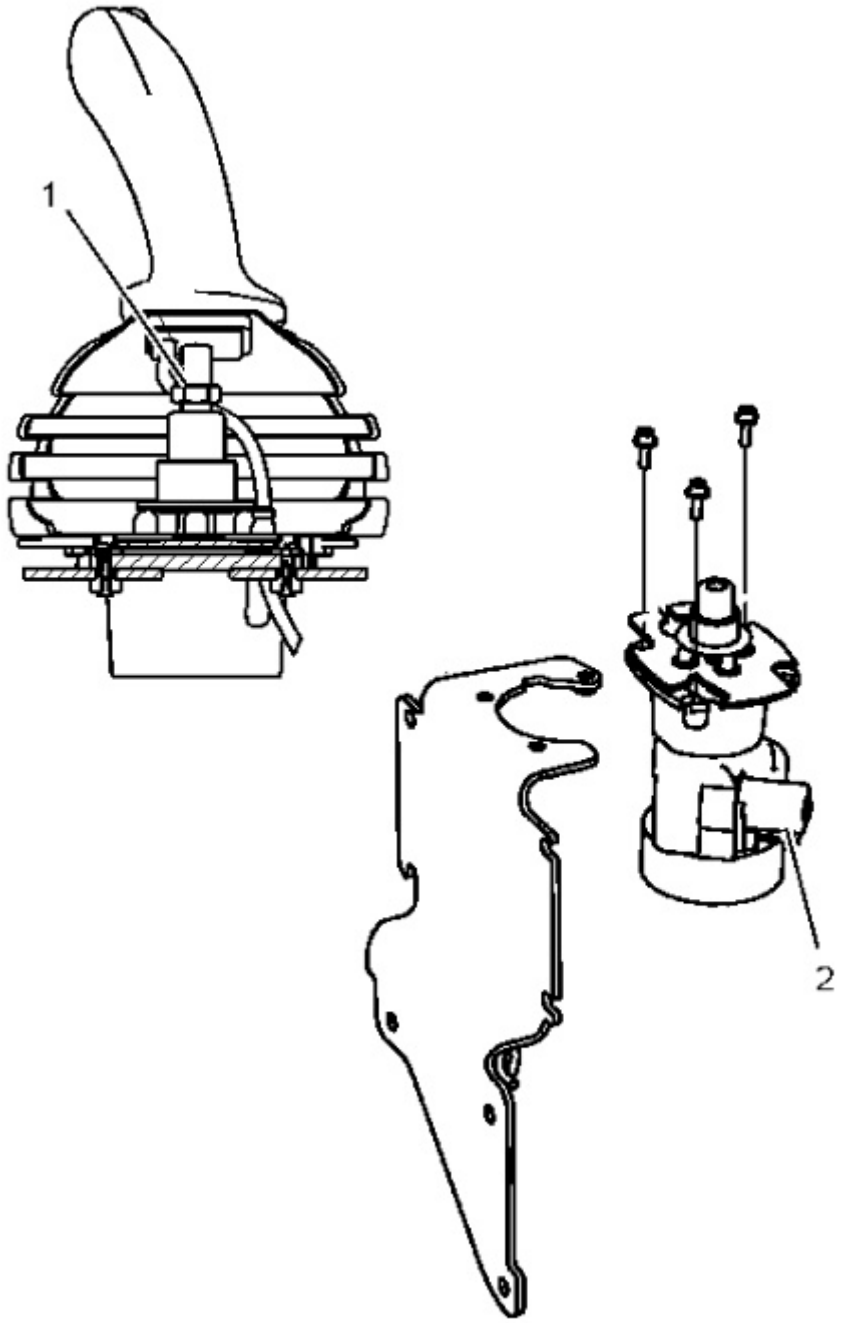


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN1-6749

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-4599

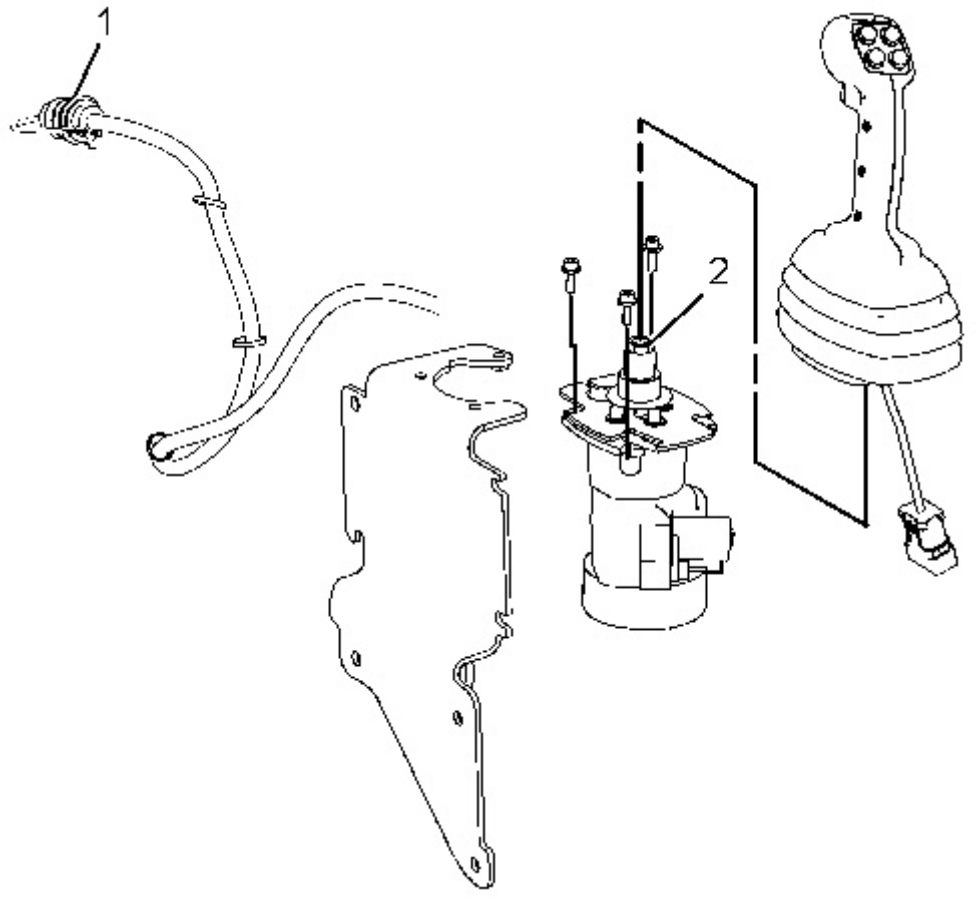


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

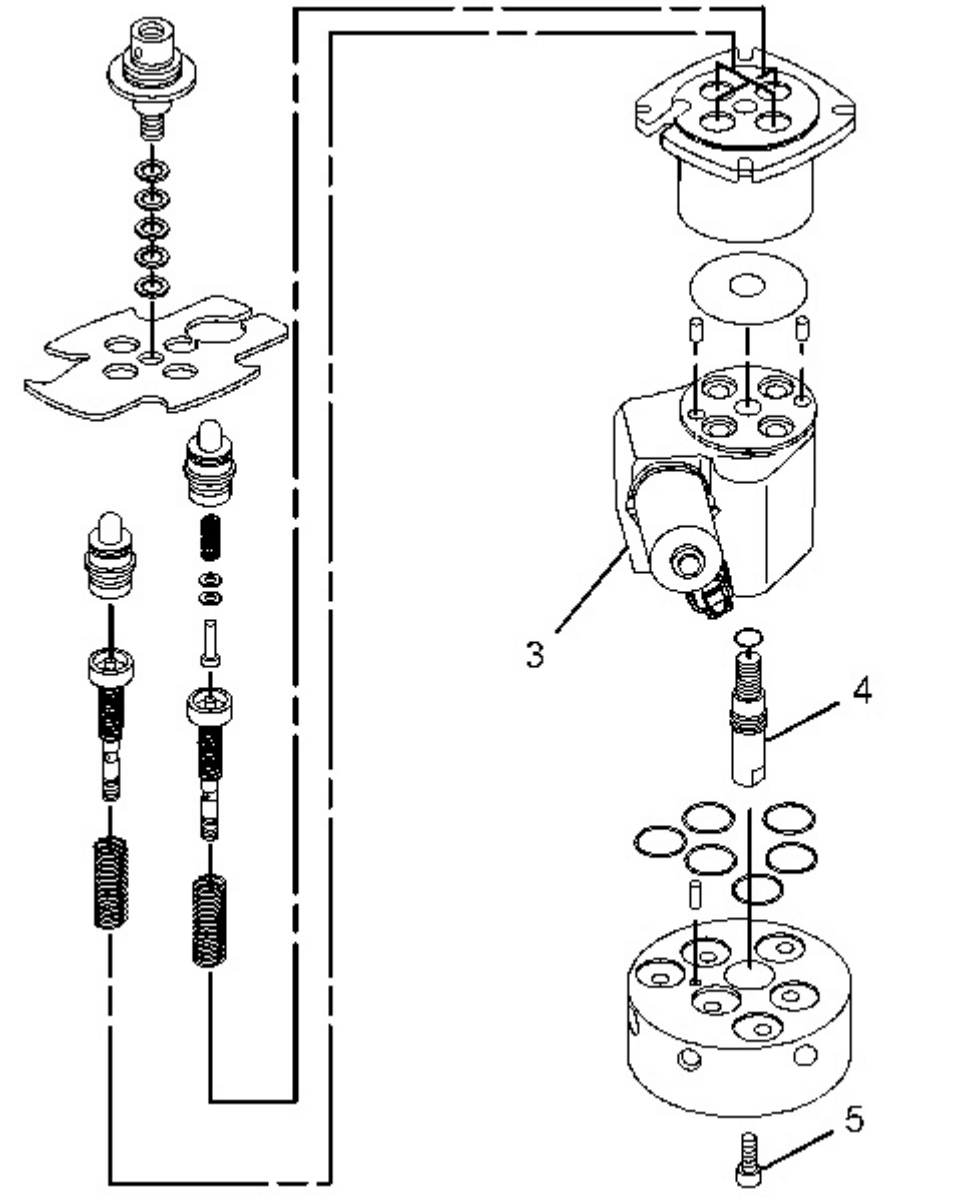


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC

Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852422

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

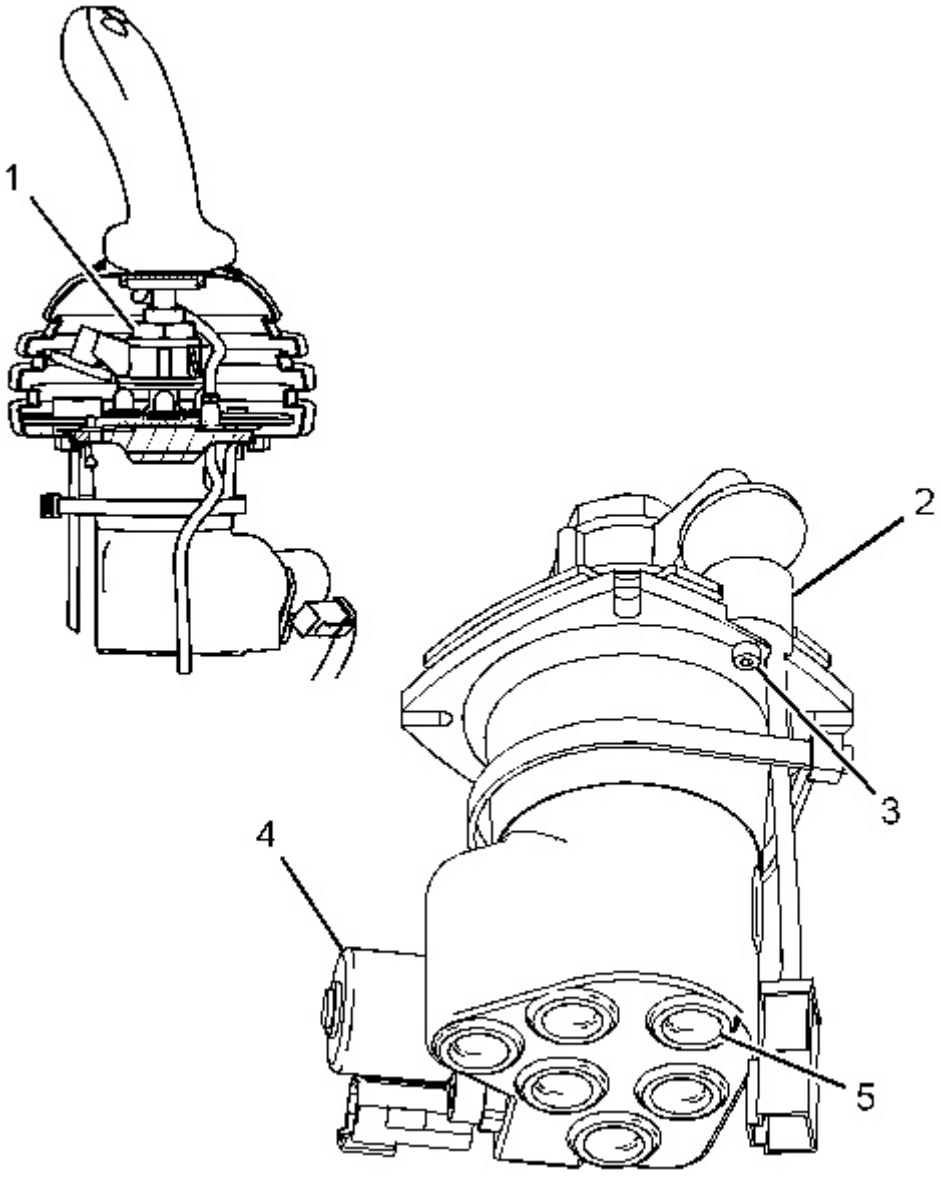


Illustration 1 g01420797

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut.

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **172-0970** Coil

Minimum operating temperature ... -20 °C (-4 °F)
Maximum operating temperature at the maximum voltage ... 121 °C (250 °F)
Nominal operating voltage ... 12 VDC
Maximum operating voltage ... 14.5 VDC
Minimum operating voltage ... 9.8 VDC
Nominal current at 20 °C (68 °F) of winding temperature ... 1.2 Amperes
Maximum current at -20 °C (-4 °F) of winding temperature ... 1.8 Amperes
Resistance at 25 °C (77 °F) ... 9.4 Ohms

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt.

(3) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

(4) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

Note: The electric control module must be configured to accept the pulse width modulation from the handle.

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852438

Pilot Operated Hydraulic Control

SMCS - 5059; 5705

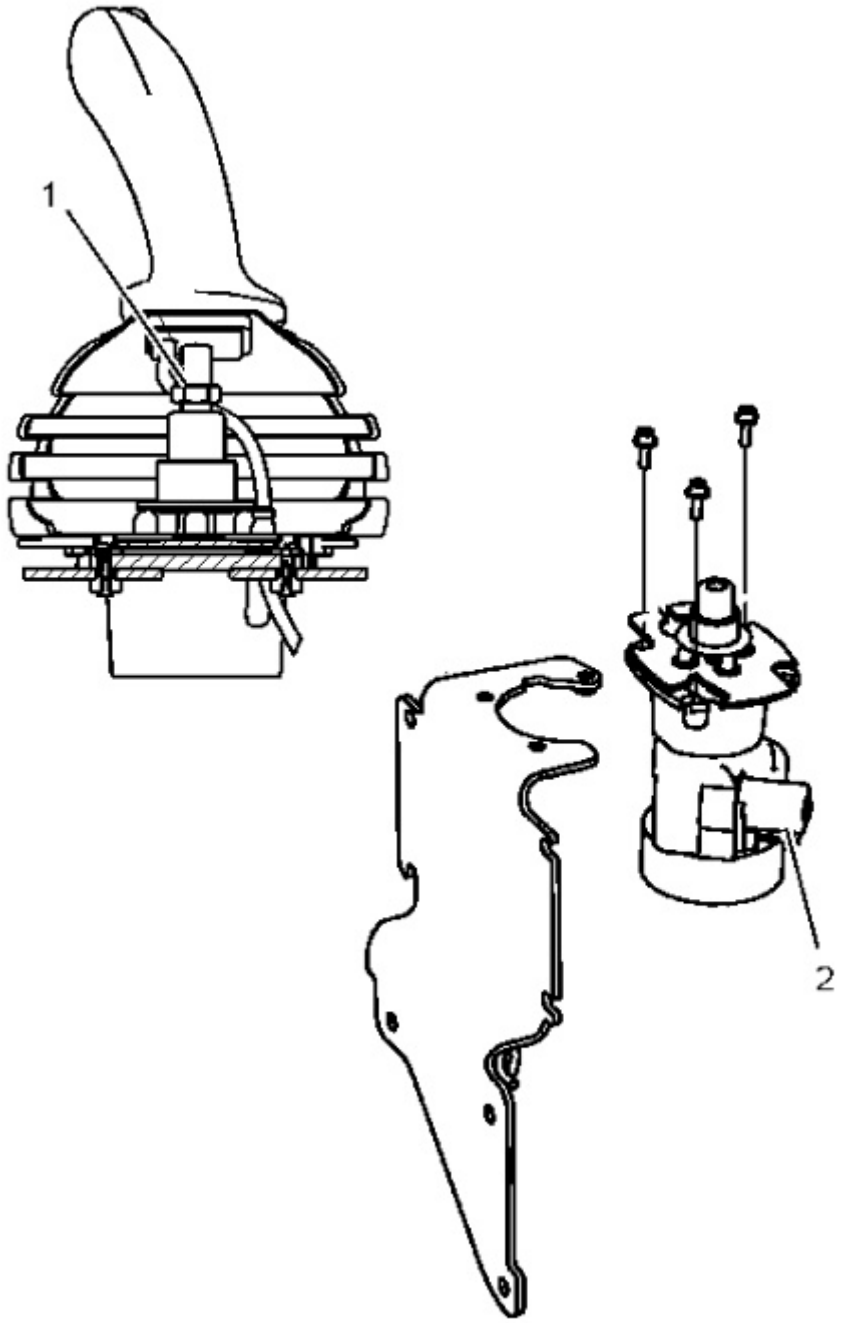


Illustration 1 g01420807

(1) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

(2) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02852445

Pilot Operated Hydraulic Control - Hydrostatic

SMCS - 5059; 5705

S/N - HEN6750-UP

S/N - SCP4600-UP

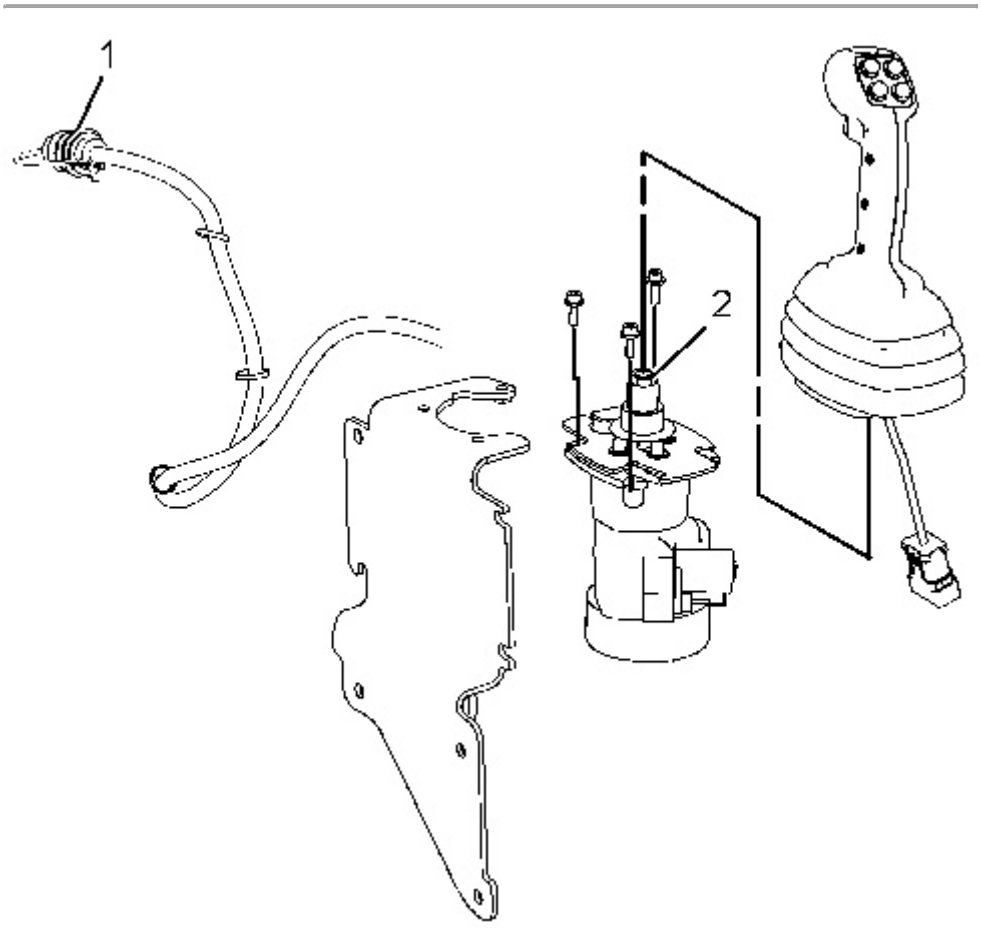


Illustration 1 g01420814

Left rear view

(1) Torque for the nut ... 29.0 to 31.5 N·m (21 to 23 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the nut (2) .

(2) Torque for the nut ... 40 ± 5 N·m (30 ± 4 lb ft)

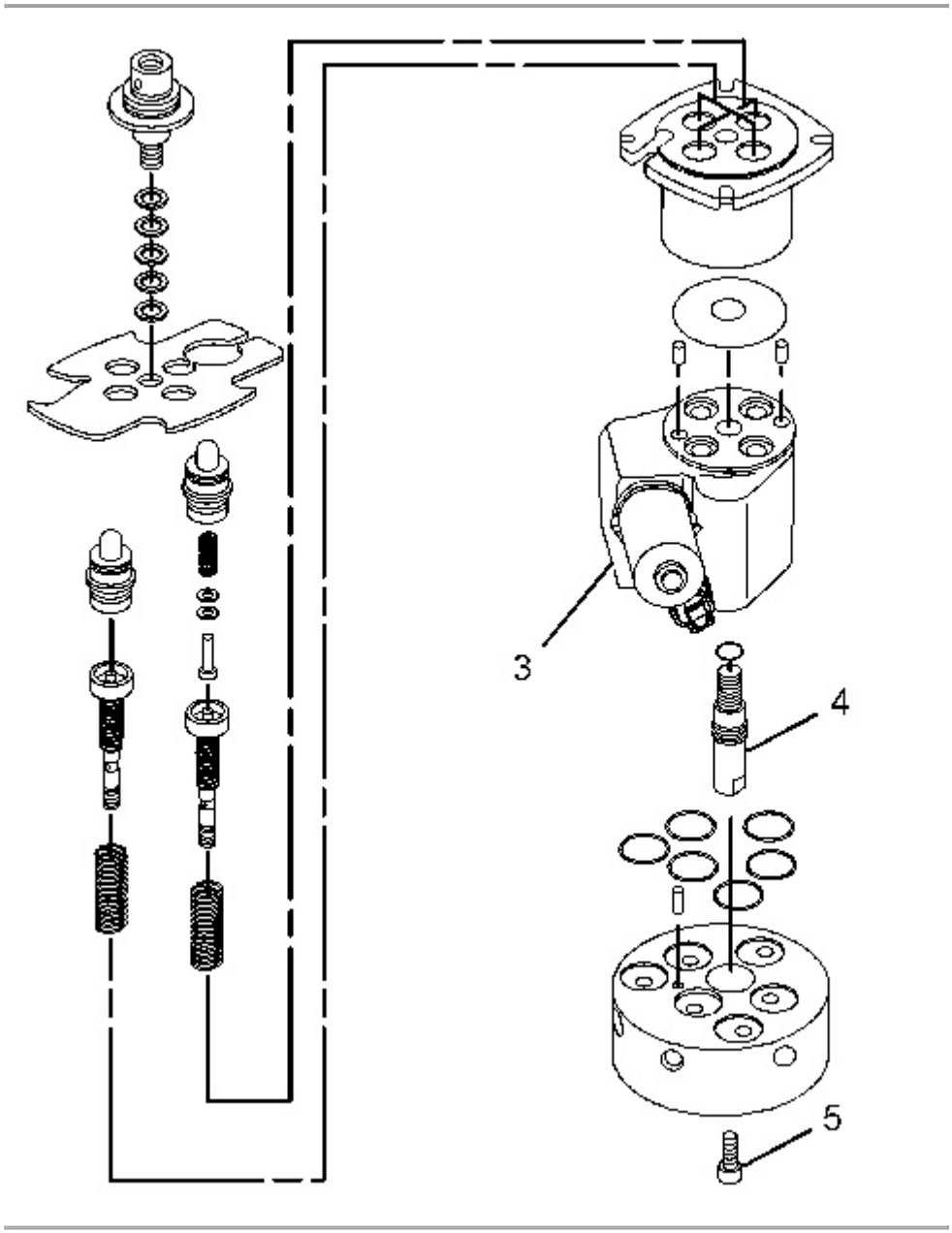


Illustration 2 g01435384

(3) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC
Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... -40 to 121 °C (-40 to 250 °F)

(4) Torque for the bolt ... 50 ± 5 N·m (37 ± 4 lb ft)

Note: Apply **154-9731** Thread Lock Compound to the threads of the bolt (5) .

(5) Torque for the bolt ... 18 ± 2 N·m (13 ± 1 lb ft)

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i02049704

Pilot Operated Hydraulic Control - Remove

SMCS - 5059-011; 5705-011

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

Table 1

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
ZZ	6V-9507	Face Seal Plug (9/16 - 18 THD)	5
	6V-9828	Cap As (9/16 - 18 THD)	5
	9U-7071	Tapered Cap/Plug	2

Start By:

A. Release the hydraulic system pressure. Refer to Disassembly and Assembly, "Hydraulic System Pressure - Release".
B. Raise the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

Note: SERVICE DATA: TOOLING (ZZ) WILL NOT BE IDENTIFIED IN PHOTOGRAPHS IN THE REMOVAL OR THE INSTALLATION. THIS TOOLING IS SHOWN IN ORDER TO ASSIST THE EXPERIENCED SERVICEMAN.

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Note: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and this helps to keep contaminants from entering the system.

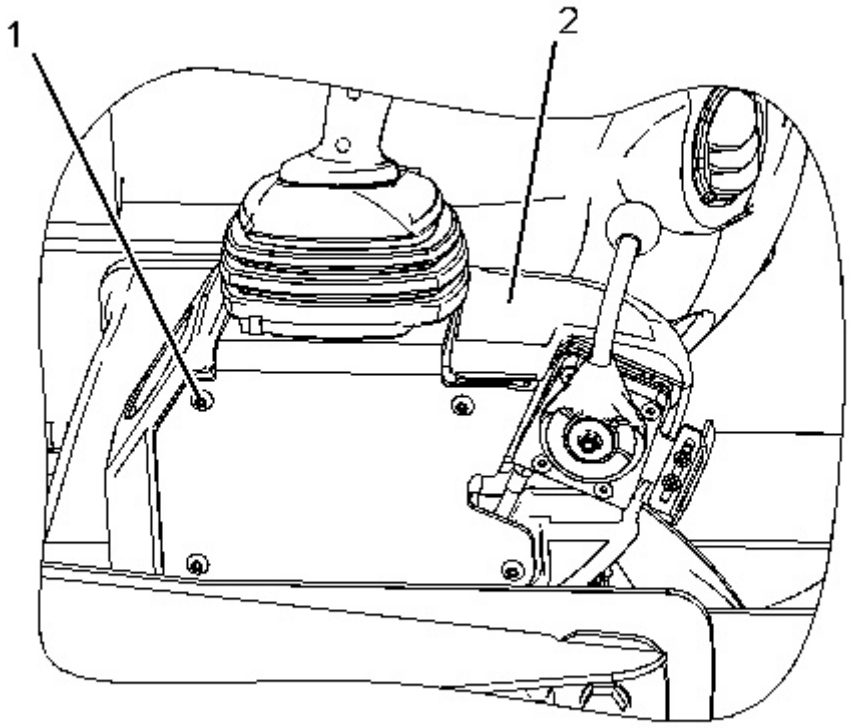


Illustration 1 g01051360

1. Remove screws (1) and remove console (2) .

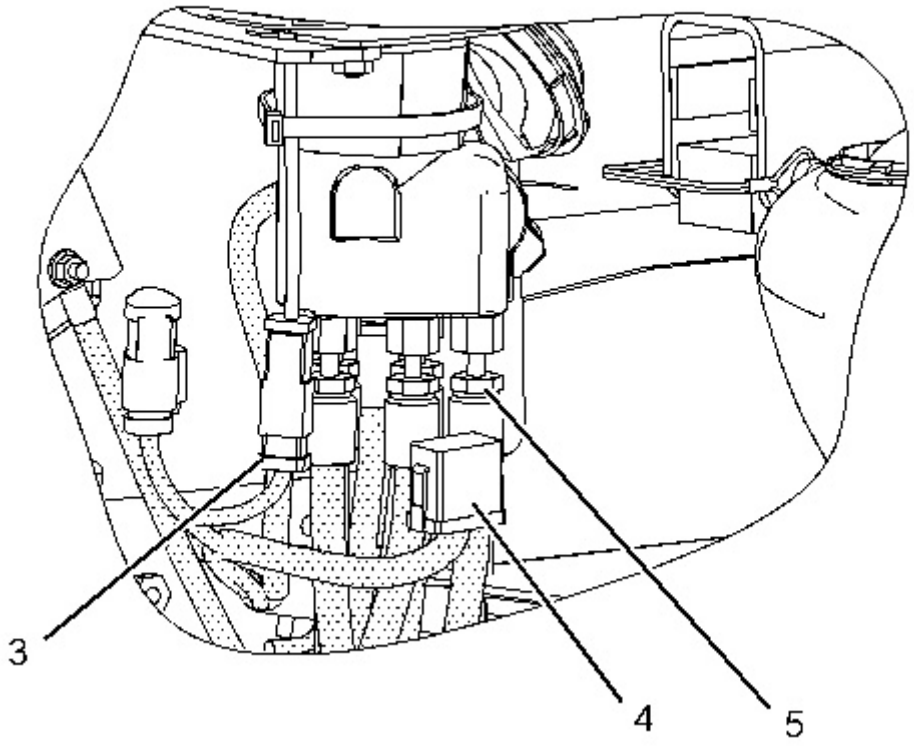


Illustration 2 g01051364

2. Disconnect harness assemblies (3) and (4). Disconnect hose assemblies (5) .

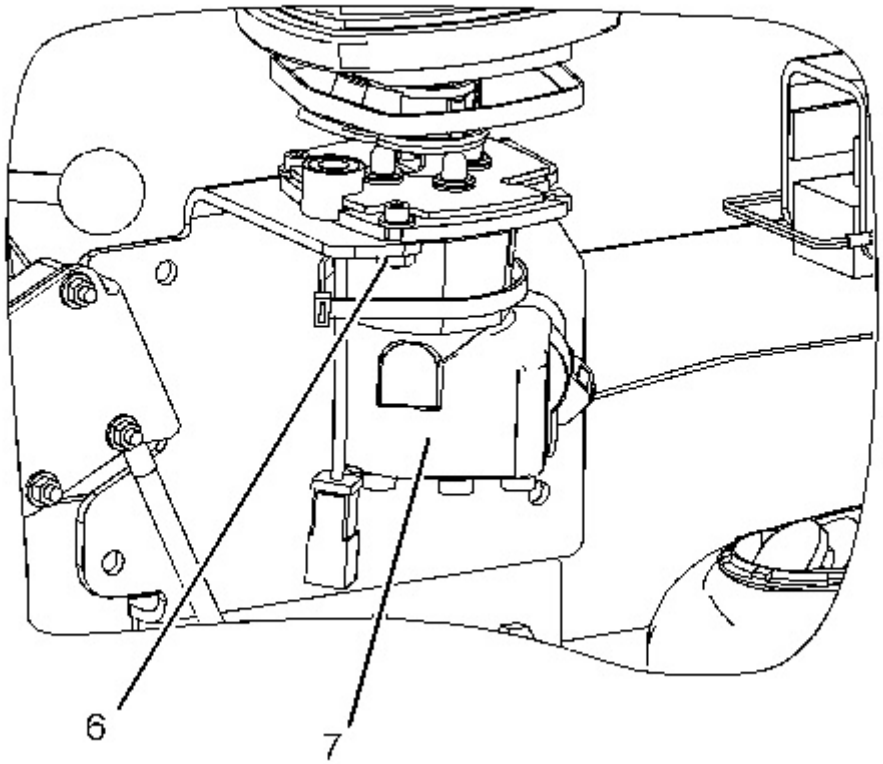


Illustration 3 g01051372

3. Remove bolts (6). Remove pilot operated hydraulic control (7) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117426

Pilot Operated Hydraulic Control - Disassemble

SMCS - 5059-015; 5705-015

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Disassembly Procedure

Start By:

A. Remove the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Remove".

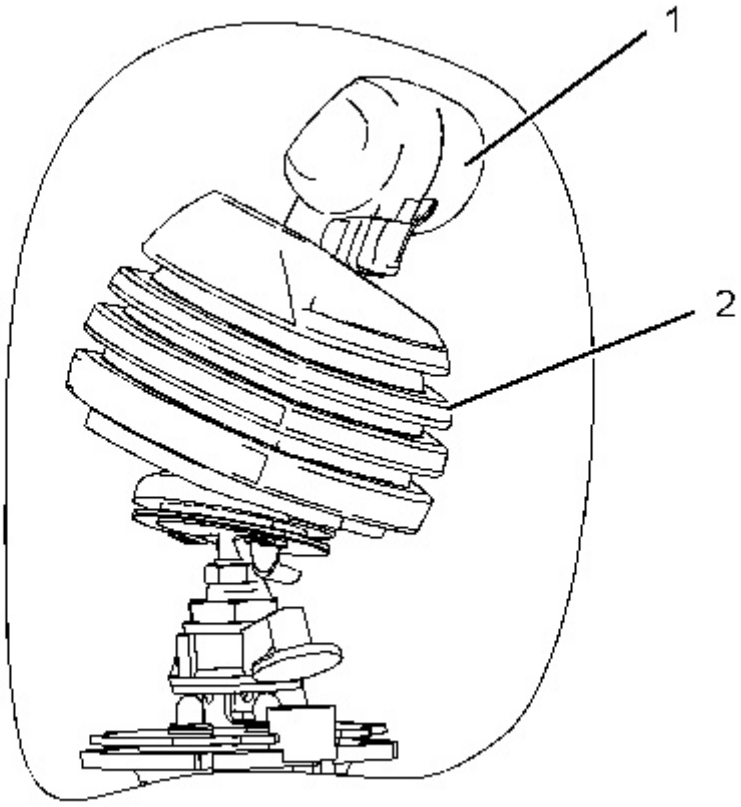


Illustration 1 g01078512

1. Lift rubber boot (2) from the joystick. Remove the screws on the side of joystick handle (1) and remove the joystick handle.

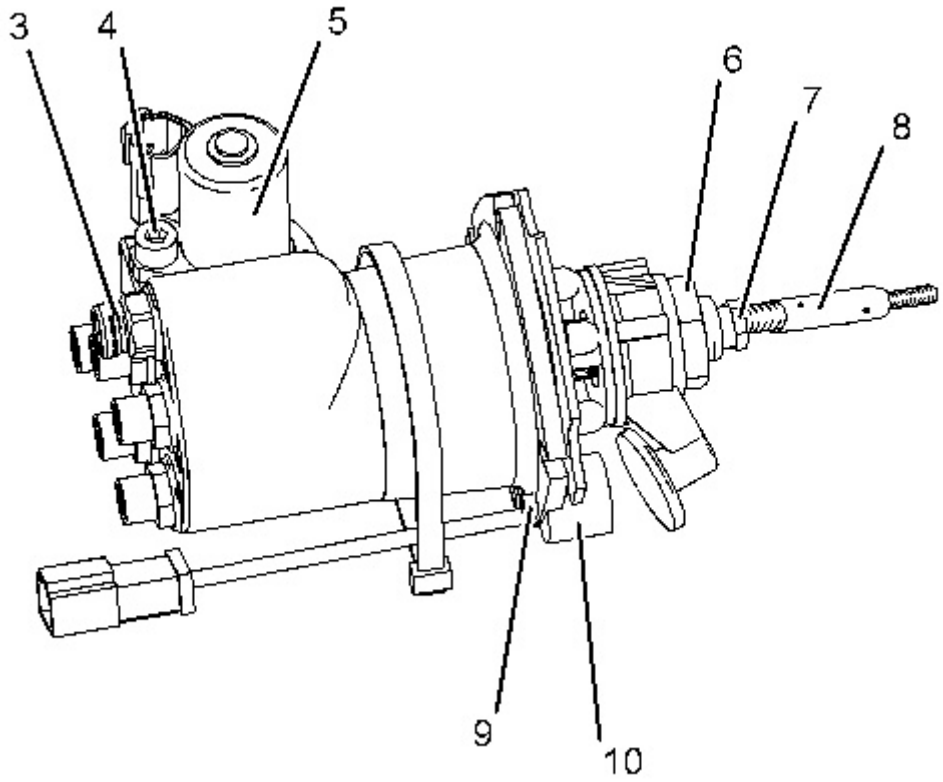


Illustration 2 g01078513

2. Remove fittings (3). Remove bolt (4) and solenoid (5). Remove bolt (9) and coil assembly (10). Note the orientation of nut (6), nut (7) and lever (8) for installation purposes. Loosen nut (7). Remove lever (8). Remove nut (6) .

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02117461

Pilot Operated Hydraulic Control - Assemble

SMCS - 5059-016; 5705-016

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Assembly Procedure

Note: Cleanliness is an important factor. Before assembly, all parts should be thoroughly cleaned in cleaning fluid. Allow the parts to air dry. Wiping cloths or rags should not be used to dry parts. Lint may be deposited on the parts which may cause later trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement.

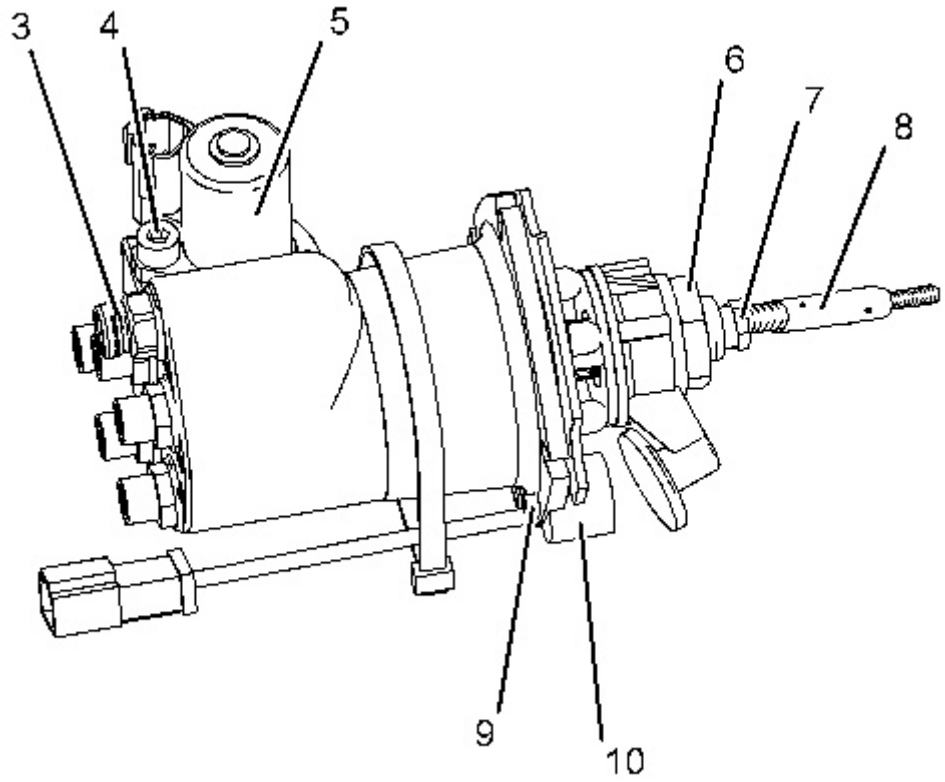


Illustration 1 g01078513

1. Install nut (6). Install lever (8). Tighten nut (7). Install fittings (3). Install solenoid (5) and bolt (4). Install coil assembly (10) and bolt (9).

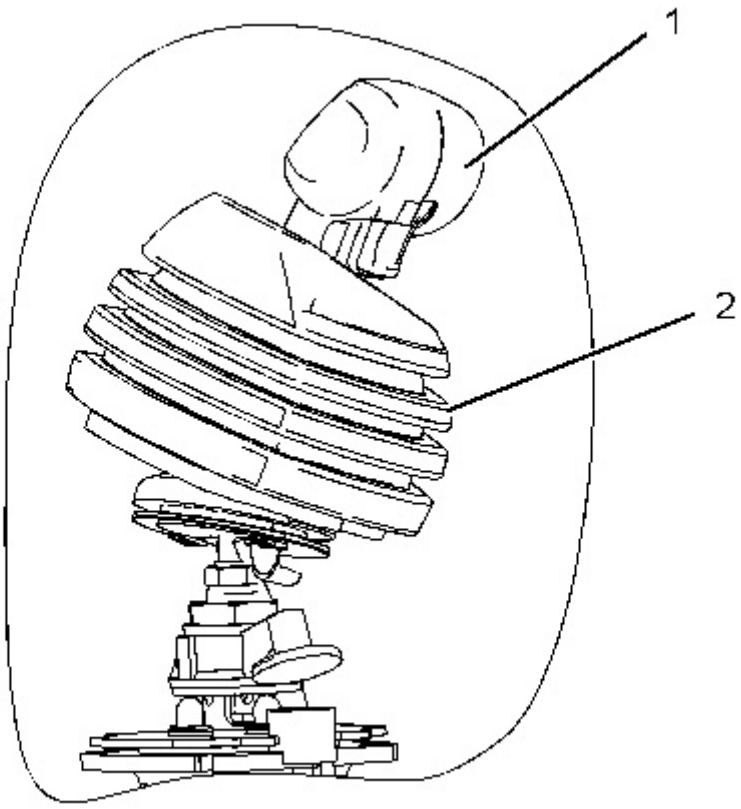


Illustration 2 g01078512

2. Install rubber boot (2) onto the joystick. Install the joystick handle (1). Install the screws on the side of joystick handle.

End By: Install the pilot operated hydraulic control. Refer to Disassembly and Assembly, "Pilot Operated Hydraulic Control - Install".

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Disassembly and Assembly
236B, 236B2, 246B, 252B, 252B2 and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4868-04 **Publication Date -01/04/2010** **Date Updated -14/04/2010**

i02049737

Pilot Operated Hydraulic Control - Install

SMCS - 5059-012; 5705-012

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Installation Procedure

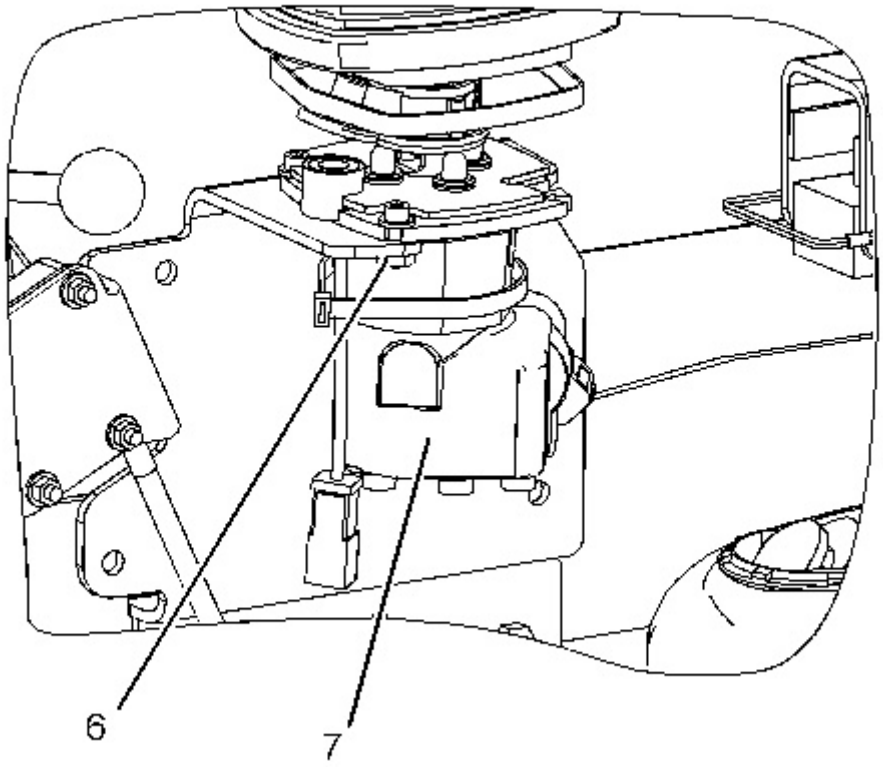


Illustration 1 g01051372

1. Install pilot operated hydraulic control (7). Install bolts (6) .

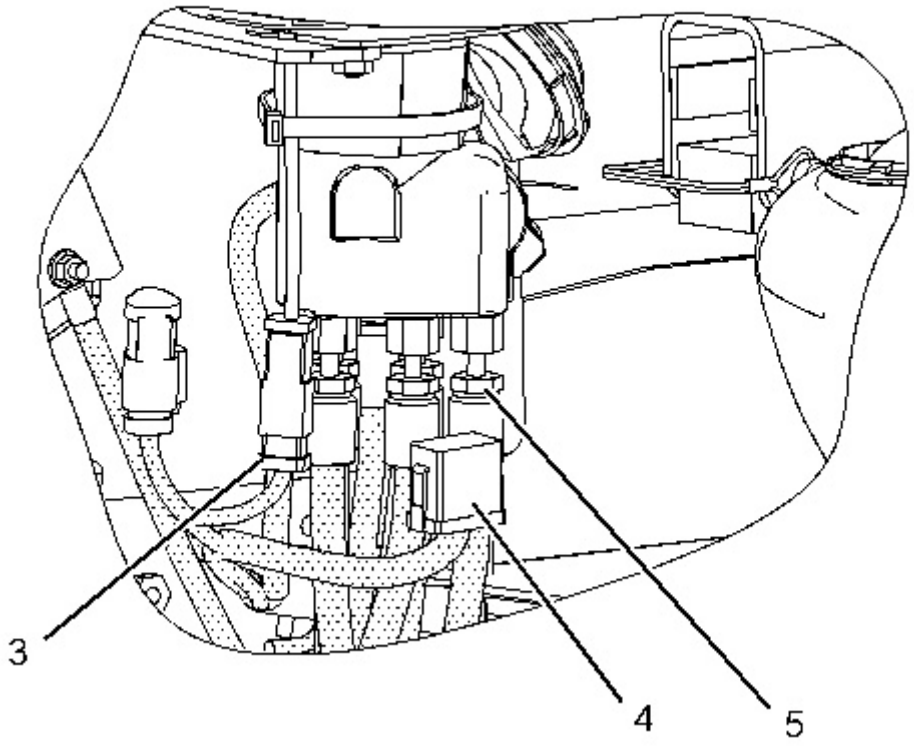


Illustration 2 g01051364

2. Connect harness assemblies (3) and (4). Connect hose assemblies (5) .

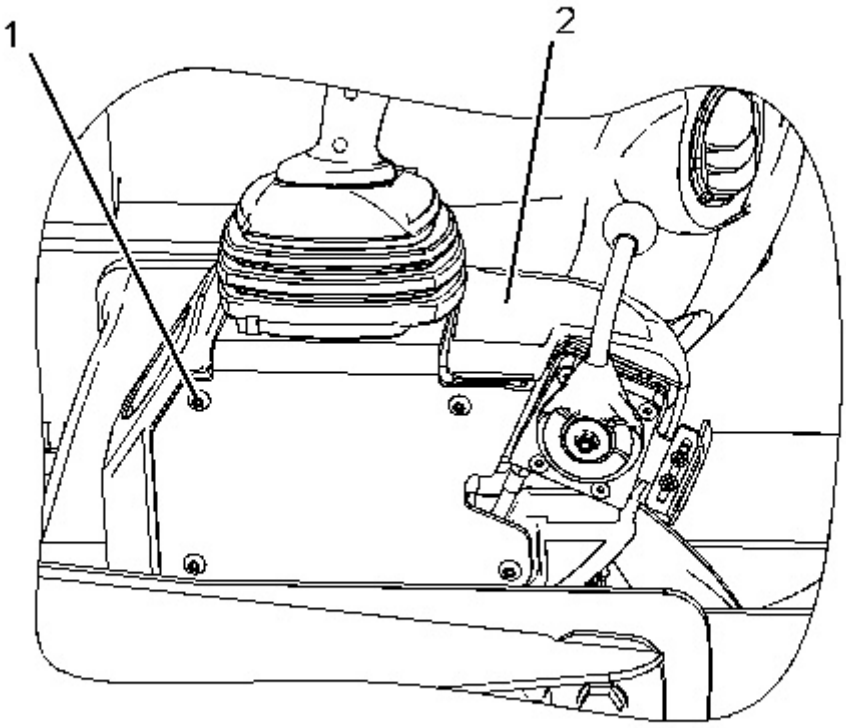


Illustration 3 g01051360

3. Install console (2). Remove screws (1). Tighten the screws (1) to a torque of 2.25 ± .25 N·m (20 ± 2 lb in).

End By: Lower the cab. Refer to Disassembly and Assembly, "Cab - Tilt".

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02879873

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

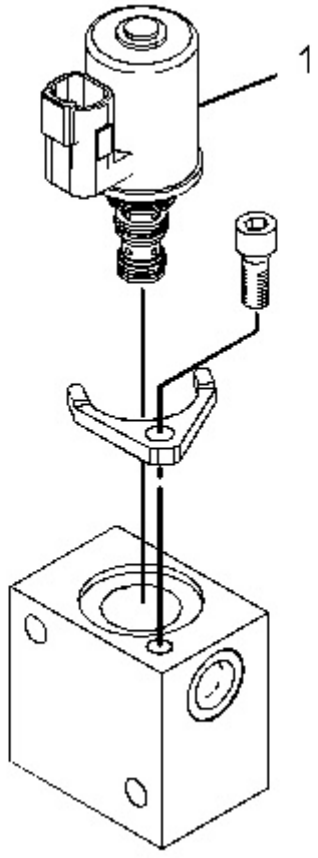


Illustration 1 g01433342

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of the coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02888178

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

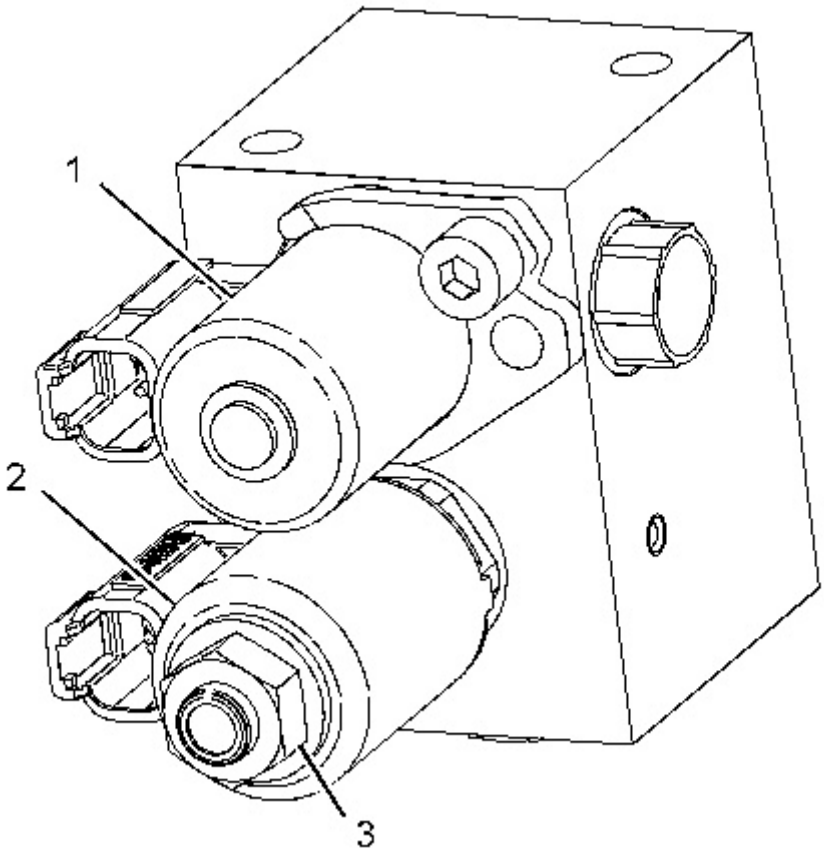


Illustration 1 g01437825

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

(2) **216-0610** Solenoid Valve Gp

Torque for installing the solenoid valve group ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the nut (3) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)
Operating voltage ... 12 VDC
Current at a maximum temperature of 121 °C (250 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02879873

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

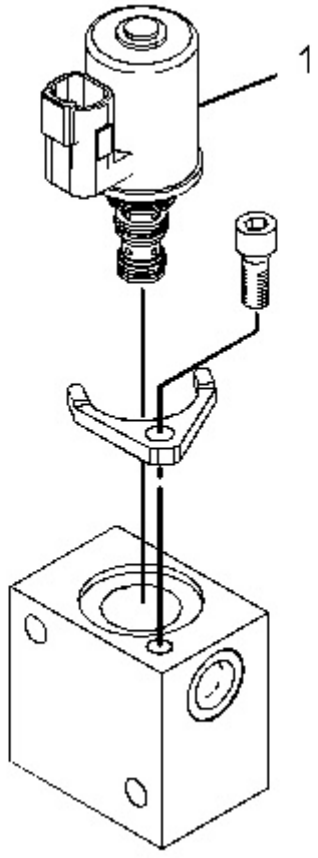


Illustration 1 g01433342

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of the coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02888178

Control Manifold and Solenoid (Parking Brake and 2-Speed)

SMCS - 5264; 5479

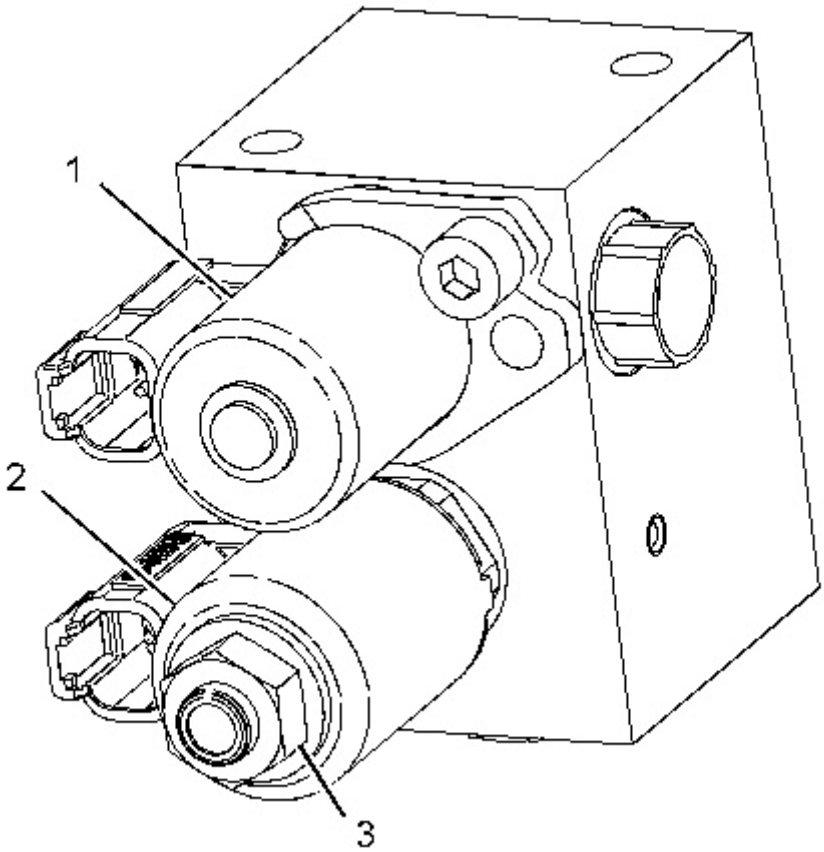


Illustration 1 g01437825

(1) **195-9700** Solenoid Valve Gp

Nominal operating voltage ... 12 VDC
Maximum operating voltage at 121 °C (250 °F) ... 14.5 VDC
Minimum voltage for actuation at 25 °C (77 °F) of coil temperature ... 9 VDC

Maximum wattage for continuous duty at 121 °C (250 °F) of coil temperature ... 13.3 Watts
Resistance at 20 ± 5 °C (68 ± 9 °F) ... 9.88 ± 0.49 Ohms
Operating temperature range ... −40 to 121 °C (−40 to 250 °F)

(2) **216-0610** Solenoid Valve Gp

Torque for installing the solenoid valve group ... 40 ± 5 N·m (30 ± 4 lb ft)
Torque for the nut (3) ... 13.0 ± 1.5 N·m (115 ± 13 lb in)
Operating voltage ... 12 VDC
Current at a maximum temperature of 121 °C (250 °F) ... 2 Amperes
Resistance at 25 °C (77 °F) ... 2.2 ± 0.2 Ohms

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865326

Tire and Rim

SMCS - 4202; 4209

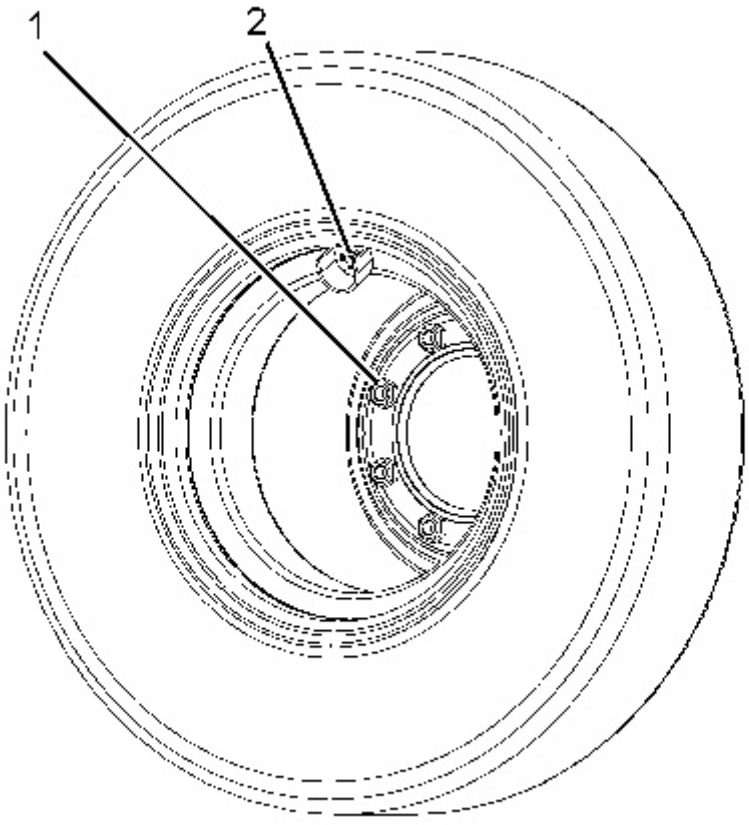


Illustration 1 g01427293

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 163 ± 7 N·m (120 ± 5 lb ft)

Note: Torque the lug nuts (1) again in an alternate pattern after one hour of operation.

(2) Torque for the tire valve ... 5.6 ± 0.6 N·m (50 ± 5 lb in)

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i02864542

Tire and Rim

SMCS - 4202; 4209

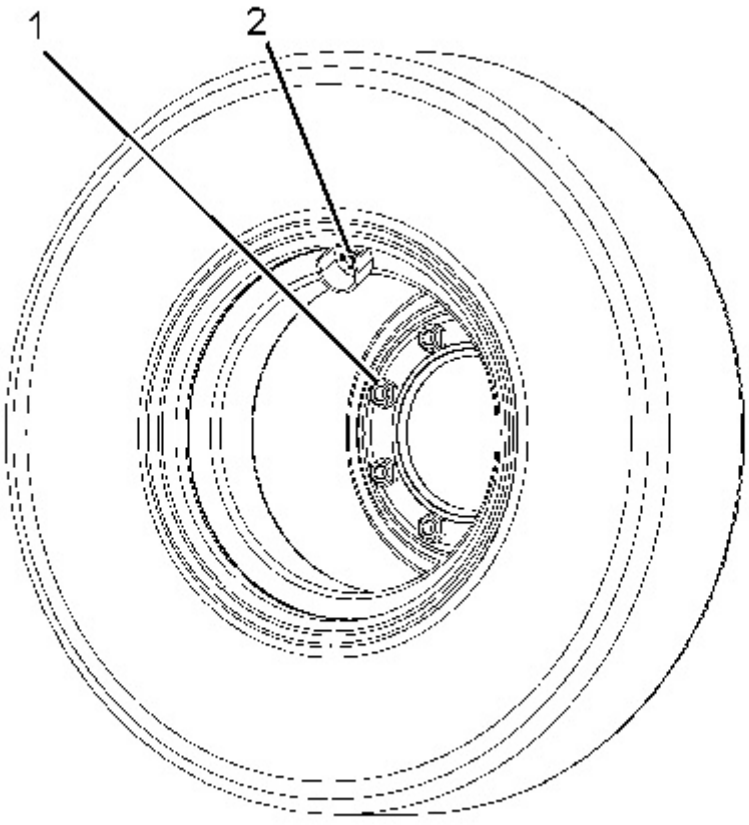


Illustration 1 g01427011

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 150 N·m (110 lb ft)

Note: Torque the lug nuts (1) again in an alternate pattern after one hour of operation.

(2) Torque for the tire valve ... 5.6 ± 0.6 N·m (50 ± 5 lb in)

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Specifications
236B, 246B, 252B and 262B Skid Steer Loaders Machine Systems
Media Number -RENR4865-02 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02865329

Tire and Rim

SMCS - 4202; 4209

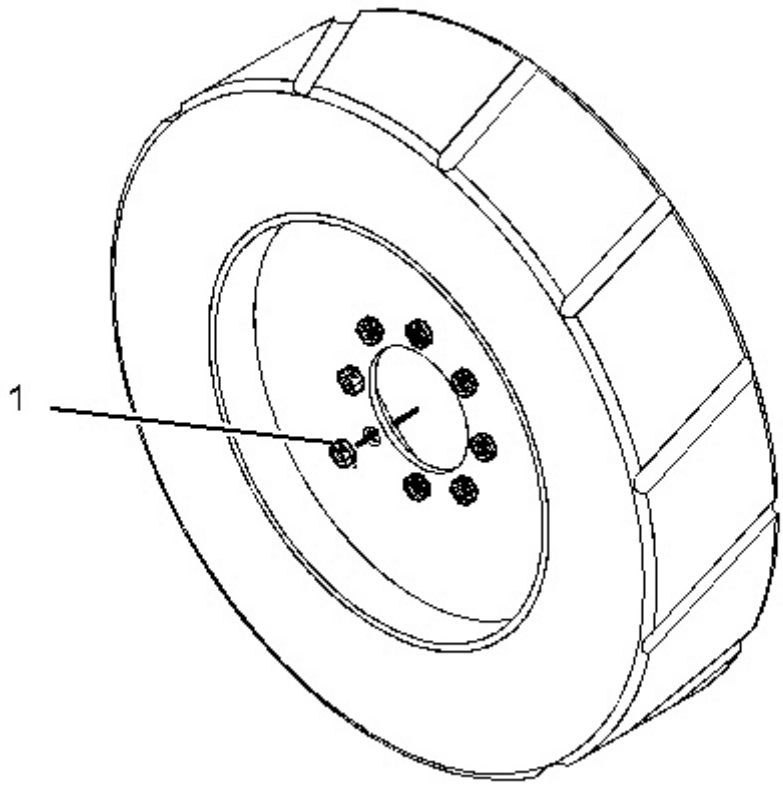


Illustration 1 g01427299

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 163 ± 7 N·m (120 ± 5 lb ft)

Note: Torque the lug nuts (1) at one hour intervals in an alternate pattern until the nuts remain tight.

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i02865326

Tire and Rim

SMCS - 4202; 4209

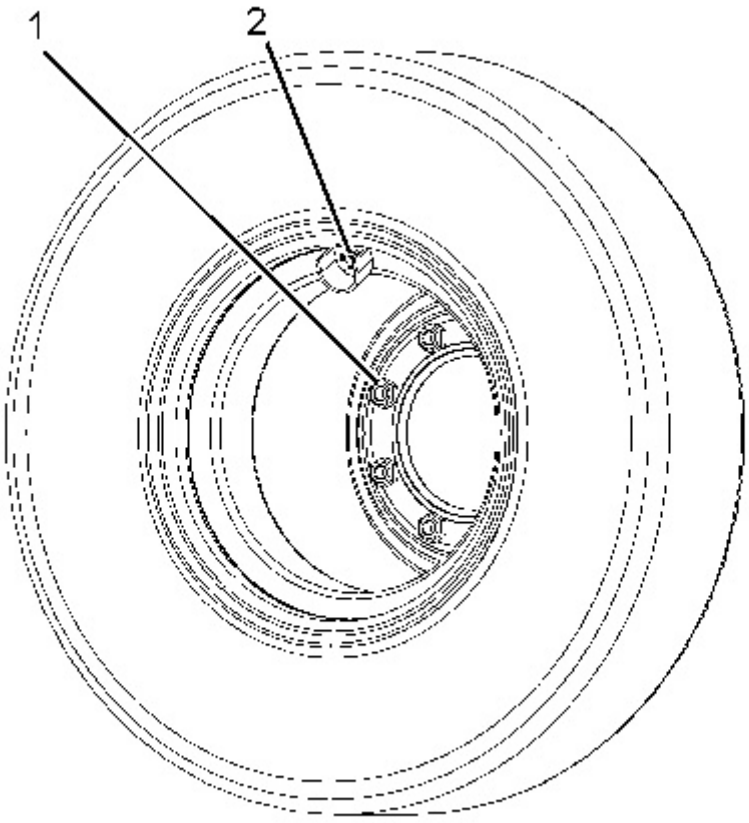


Illustration 1 g01427293

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 163 ± 7 N·m (120 ± 5 lb ft)

Note: Torque the lug nuts (1) again in an alternate pattern after one hour of operation.

(2) Torque for the tire valve ... 5.6 ± 0.6 N·m (50 ± 5 lb in)

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Specifications
236B2 and 252B2 Skid Steer Loaders Machine Systems
Media Number -KENR8821-00 **Publication Date -01/02/2008** **Date Updated -18/02/2008**

i02864542

Tire and Rim

SMCS - 4202; 4209

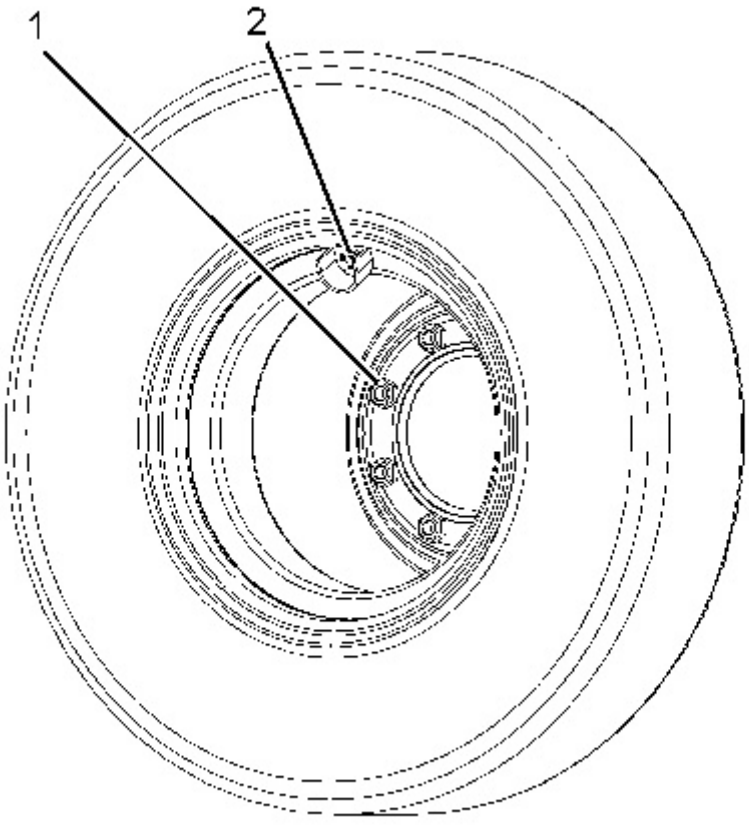


Illustration 1 g01427011

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 150 N·m (110 lb ft)

Note: Torque the lug nuts (1) again in an alternate pattern after one hour of operation.

(2) Torque for the tire valve ... 5.6 ± 0.6 N·m (50 ± 5 lb in)

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Tire and Rim

SMCS - 4202; 4209

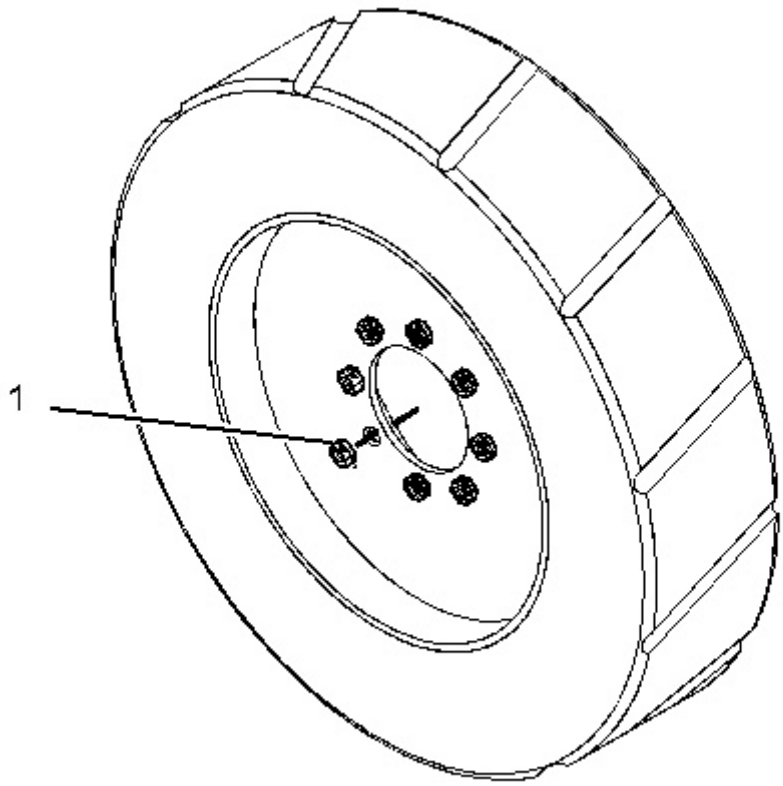


Illustration 1 g01427299

Note: The mounting surfaces of the spindles, lug nuts and wheels must be clean and free of foreign material.

(1) Torque for the 32 lug nuts ... 163 ± 7 N·m (120 ± 5 lb ft)

Note: Torque the lug nuts (1) at one hour intervals in an alternate pattern until the nuts remain tight.

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i02050940

Tire and Rim - Remove and Install

SMCS - 4202-011

Removal Procedure

Table 1

Tool	Part Number	Part Description	Qty
A	180-3033	Repair Stand Set	2

WARNING

Follow the recommended procedure for removal and installation of tires and or wheel assemblies.

Ensure that the machine and tire and or wheel assembly are properly supported at all times.

Improper procedures that are used to remove and install tires and or wheel assemblies can result in personal injury or death.

1. Use a suitable lifting device to raise the machine.
2. Install Tooling (A) .

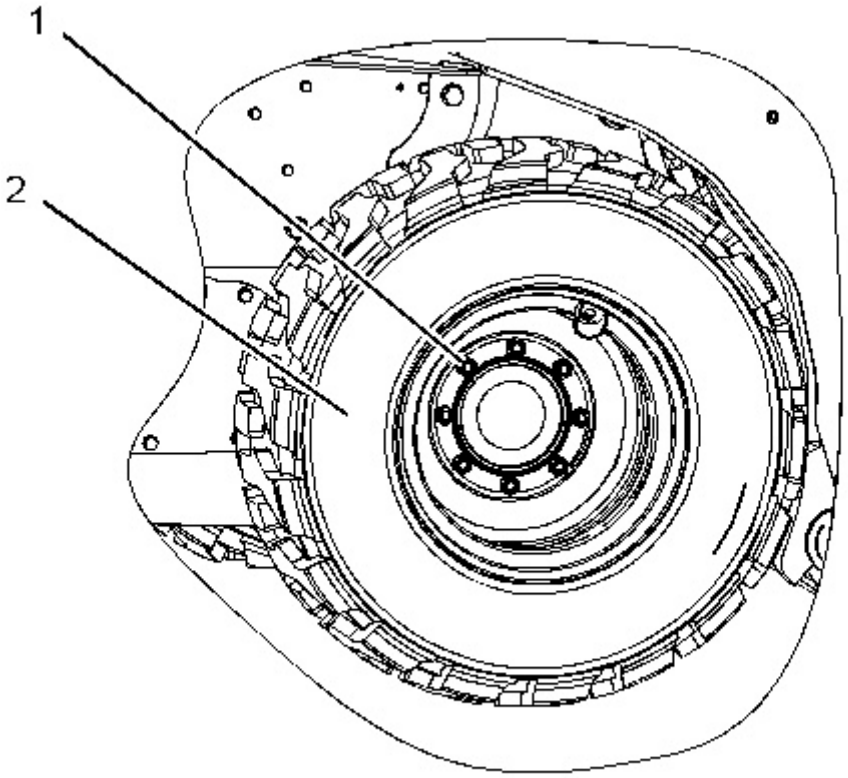


Illustration 1 g01051702

3. Use a suitable lifting device to support the tire. Remove lug nuts (1). Remove tire (2). The weight of the tire is approximately 51 kg (113 lb).
4. Repeat Step 3 for the other tires.

Installation Procedure

Table 2

Tool	Part Number	Part Description	Qty
A	180-3033	Repair Stand Set	2

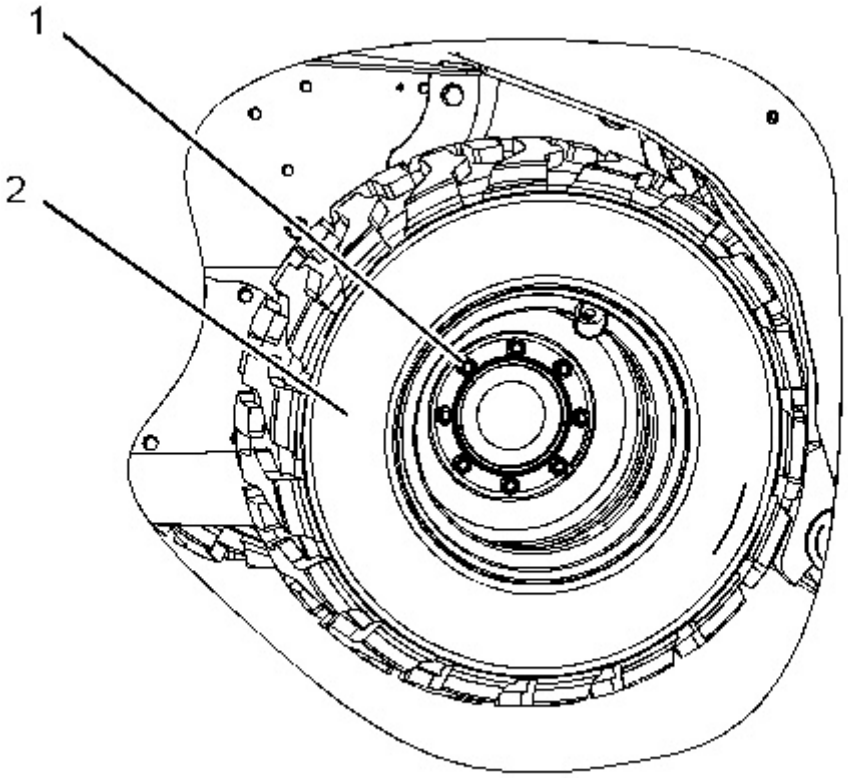


Illustration 2 g01051702

1. Use a suitable lifting device to install tire (2). The weight of the tire is approximately 51 kg (113 lb). Install lug nuts (1) .

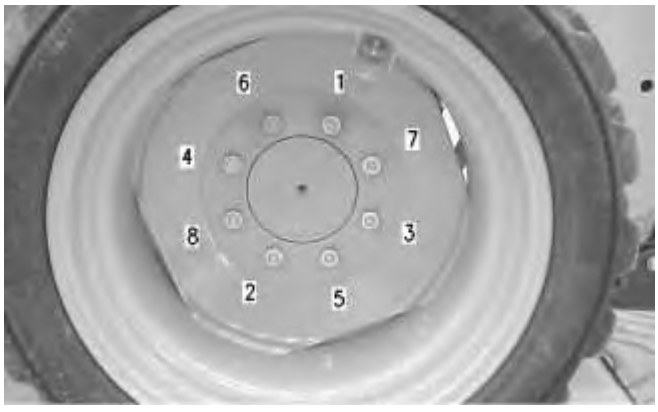


Illustration 3 g00790401

2. Tighten the lug nuts according to the pattern in Illustration 3. Torque the lug nuts to 150 N·m (111 lb ft).

3. Repeat Step 1 and Step 2 for the other tires.

4. Repeat Step 2 after one hour of operation.
5. Use a suitable lifting device to support the machine.
6. Remove Tooling (A) .

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Systems Operation
All Products Air Conditioning and Heating R134a for All Caterpillar Machines
Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i02991866

Cab Pressurization and Filtration System

SMCS - 7320; 7342

Caterpillar machines with an enclosed cab area need to provide adequate air flow to the operator inside the cab area so that a standard air pressure is met. Maintaining a proper air pressure level is accomplished by ensuring that the appropriate seals are used. When the appropriate seals are correctly installed, the cab will be pressurized by the ventilation system. See Troubleshooting, SENR5664, "Troubleshooting Cab Pressurization and Filtration System" for tips on resolving problems.

Maintaining the proper pressurization level in the cab area is important to the health of the operator because changes to the air pressure may lead to problems with breathing. Low pressure can cause dust to enter the cab and the Heating Ventilation Air Conditioning (HVAC) system, which can lead to premature system deterioration. Low pressure is often caused by improper sealing of the cab. Poor sealing of the cab requires an increase in the fresh air flow to maintain pressurization. The increase in fresh air flow will lead to a lower air conditioning and heater performance. The increase in fresh air flow will also lead to increased intervals in filter service. Additional noise that is entering the cab can also result from poor sealing of the cab.

Cab sealing objectives for the operator cab environment are for the cab to pressurize to a minimum of 50 Pa (0.2 inch of H_2O) with no more than 76 m^3/hr (45 cfm) () of fresh air flow. The minimum cab fresh air flow while the ventilation system is operating on any fan speed is 43 m^3/hr (25 cfm). This objective satisfies the requirements for fresh air flow from SAE J1503 and ISO 10263-4. In HVAC systems with a mode door that controls the balance of fresh air and recirculation air, the control shall be set to minimum fresh air flow while measuring cab pressure.

The air flow of a HVAC system is used to pressurize a cab as the air flow passes through different components. First, outside air is drawn into the HVAC compartment after being filtered for dust particles. Air is drawn in with the help of a blower fan. The blower fan pulls air or pushes air across the heater and/or the evaporator coil. The air flow is then directed into the ventilation ducts of the system. The air flow travels into the environment of the cab through the directional louvers. Finally, the air inside the cab area returns to the HVAC system through the recirculation filter.

Some ventilation systems can be enhanced by using different options. One option that is available for a wide variety of Caterpillar machines is the inclusion of a powered precleaner unit. As part of the pressurized system of the cab, a precleaner removes additional dirt/dust from the fresh air flow that is entering the cab. This provides extended life for the filter to the fresh air filter. These precleaners are coupled with higher efficiency fresh air filters in order to prevent finer particles of

dirt from entering the cab area. In addition to the precleaner, some newer systems may include filters that are low restriction. A media filter that is low restriction can filter dust effectively, and offer more air flow through the HVAC system.

Cab Air Filters

Most Caterpillar machines with the R134a system have two cab air filters. One type of air filter is the fresh air filter and the other type of filter is a recirculation filter inside the cab. Some of the machines have a third air filter that is made of foam. The third filter is designed to remove large debris before the air reaches the fresh air filter.

Some Caterpillar machines are equipped with a precleaner for the cab. The system is designed to remove excessive dust and dirt from the air that is entering the cab. The precleaner is part of the pressurized cab.

There are optional replacement filters that are available for use in the field with certain machine applications. Carbon impregnated filters are used for improved odor reduction in place of the fresh air filter. High efficiency filters are also used as a replacement for the fresh air filter in environments with high concentrations of dust. High efficiency filters also provide better filtering efficiencies in order to reduce the intake of dust into the cab. Filters that are low restriction are also available for certain applications as a way to reduce the system restriction through the filter. Filters that are low restriction reduce the restriction that is in the system, and the filters continue to maintain efficiencies in filtering dust.

ReferenceFor optional replacement of filters, see Datasheet, PEHJ0092, "Cat Cabin Air Filters Datasheet".

Air filters for Caterpillar cabs are not intended for filtering out hazardous materials. When you are working in an environment with potentially hazardous materials, all of the safety precautions for working with that material should be followed. As the requirements are defined by the local agencies, additional personal protection equipment may be required for the operator.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03862454

Manifold Gauge Set (Refrigerant) - Install

SMCS - 7465-012

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

1. Use the **138-6629** Refrigerant Identifier in order to verify that the refrigerant that is in the air conditioning system is R134a.

2. Connect the manifold gauge set to the service ports near the refrigerant compressor. The service ports for charging are located on the refrigerant lines. Connect the low pressure hose to the service port on the suction side of the compressor. Connect the high pressure hose to the service port on the discharge side of the compressor. Make sure that the valved couplings are turned counterclockwise for installation. Then, turn the valved couplings clockwise in order to open the valves.

3. Turn the pressure valves clockwise and make sure that both pressure valves on the manifold gauge set are closed.

4. Place a clean rag over the charging hose fitting that is loosened at the manifold gauge set. This will prevent the spraying of compressor oil. Open the low pressure valve on the gauge set about 1/2 turn. Keep the valve open for 2 to 3 seconds in order to flush air from the low pressure hose. This will also flush air from the gauge set. Close the low pressure valve on the gauge set. Repeat this process for the high pressure valve. Tighten the charging hose fitting at the manifold gauge set.

Note: Use the refrigerant identifier. The refrigerant identifier will prevent refrigerants that are not R134a from contaminating the recovery and charging tools.

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i03863033

Manifold Gauge Set (Refrigerant) - Remove

SMCS - 7465-011

WARNING

Personal injury can result from contact with refrigerant.

This system is under pressure at all times, even if the engine is not running. Heat should never be applied to a charged system.

Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.

Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system is empty of refrigerant.

Always use caution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, evacuate the system recovering the refrigerant before removing the fitting.

Personal injury or death can result from inhaling refrigerant through a lit cigarette.

Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.

Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.

Before any checks of the air conditioning and heating system are made, move the machine to a smooth horizontal surface. Lower all implements to the ground. Make sure the transmission is in neutral or park and that the parking brake is engaged. Keep all other personnel away from the machine or where they can be seen.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Remove charging hoses properly. A low system charge will result from charging hoses that are not removed correctly. In order to ensure accuracy of the refrigerant charge, the refrigerant should be removed from the charging hoses. Refer to the following steps in order to remove the refrigerant from the charging hoses:

1. Allow the compressor to continue operating. Close the valve on the high pressure side. The valve is located near the charging ports on the compressor. Disconnect the high pressure hose from the air conditioning system.

2. Open the high pressure valve and open the low pressure valve at the gauge set . The refrigerant that is in the hoses will be removed by the compressor through the low pressure hose.

3. Close the valve on the low pressure side. This valve is located near the charging ports on the compressor. Disconnect the low pressure hose from the air conditioning system. The system is now charged.

Note: After the manifold gauge set is removed, it is necessary to cap the charging valves.

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Media Number -SENR5664-22 **Publication Date -01/08/2012** **Date Updated -13/08/2012**

i03607159

Heating and Air Conditioning Service Publications

SMCS - 7000; 7320

Table 1

Publication Number	Products	Title of Publication
Data Sheets		
PEHJ0092	All Products	"Cat Cabin Air Filters"
PEHJ0148	All Products	"Cat Air Conditioning Kits"
Information Release Memo		
PELJ0374	All Products	"Air Conditioning Kits for Caterpillar Equipment"
PELM0992	Integrated Toolcarrier Wheel Loader Motor Grader Track-Type Tractor	"CAT Field Installed Air Conditioning Kits (R134a)"
Special Instructions		
REHS1692	D10R, D11R	"Procedure to Replace the Water Valve for the Climate Control System"
REHS1715	Articulated Trucks	"Procedure to Replace the Control Assembly and Water Valve Assembly in the Air Conditioner Group"
REHS1716	Wheel Tractor-Scrapers	"Procedure to Replace the Water Valve for the Climate Control System"
REHS1717	Wheel Dozer Wheel Loader	"Installation Procedure for the New Water Valve for the Climate Control System"
REHS1798	Multi Terrain Loader	"Installing the 233-5870 Installation Arrangement (Air Conditioner Conversion)(Kit)"

REHS1799	Multi Terrain Loader	"Installing the 233-5873 Installation Arrangement (Air Conditioner, Heater)(Kit)"
REHS1801	Skid Steer Loader	"Installing the 218-6747 Installation Arrangement (Air Conditioner, Heater)(Kit)"
REHS1802	Skid Steer Loader	"Installing the 218-6749 Installation Arrangement (Air Conditioner Conversion)(Kit)"
REHS2488	All Products	"Refrigerant Compressor Functional Test for All Caterpillar Machines"
REHS3093	Large Track-Type Tractor	"Improving the Cab Environment for the Operator of Track-Type Tractors"
REHS3678	All Products	"Refrigerant Dryer Functional Test"
REHS4025	Wheel Loader Integrated Toolcarriers	"Replacement of the Blower Assembly on Certain Wheel Loaders"
REHS4100	D10T, D9T, D8T	"Improvement to the Case of the Air Cleaner"
REHS4138	Integrated Toolcarriers Wheel Loader Excavator Industrial Tractor Track Feller Buncher Wheel Feller Buncher	"Assembly Instructions for Installing The Air Mix Door"
REHS4499	All Products	"Testing the Refrigerant Compressor Protection Module"
SEHS9088	Earthmoving Compactor Excavator Motor Grader Track-Type Loader Track-Type Tractor Wheel Loader Wheel Tractor-Scraper	"Installation Instructions for the 174-1508 Electric Motor"
SEHS9098	Track-Type Loader Articulated Truck Excavator Track-Type Tractor Wheel Loader	"Instructions for the Installation of the 174-1508 Electric Motor"

	Wheel Tractor-Scraper	
SEHS9734	All Products	"Retrofitting Caterpillar R-12 Air Conditioning Systems to R134a Refrigerant"
SMHS7059	D7G, D8K, D9H	"Installation of 9P4752, 9P4753, and 9P4754 Air Conditioner Arrangements"
Specifications, Systems Operation, Testing and Adjusting, Disassembly and Assembly		
SENR3334	All Products	"Air Conditioning and Heating R-12 All Caterpillar Machines"
SENR5664	All Products	"Air Conditioning and Heating R-134a for All Caterpillar Products"
Service Magazine		
SEPD0306	Challenger	"Improvements to Challenger Agricultural Tractors Air Conditioning Available"
SEPD0353	Wheel Loader Soil Compactor Landfill Compactor	"New Heating Ventilation and Air Conditioning (HVAC) Electronic Control Troubleshooting Procedure Available"
SEPD0418	D5M, D6M Track-Type Tractor	"New, Air Conditioner Tubes Increase Service Life of Condenser Coil"
SEPD0473	All Products	"Air Conditioner Service Tips"
SEPD0559	All Products	"Material for Sound Suppression in the Cab is Available"
SEPD0559	All Products	"Part Numbers for Electric Motors that are Used in HVAC Have Changed"
SEPD0653	Off-Highway Truck	"New Components Improve the Air Conditioning System on Certain Off-Highway Truck/Tractor"
SEPD0665	Combine Excavator Track Feller Buncher Integrated Toolcarrier Paving Compactor Road Reclaimer	"Checking the Motor Rotation after Replacing the Blower Motor Can Increase Service Life"
SEPD0723	Off-Highway Truck Wheel Loader	"The Fan Drive Groups Have Changed"
SEPD0730	Off-Highway Truck	"New Mounting Brackets for the Air Conditioner Compressor are Now Available"

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Required Tools

SMCS - 7309

Table 1

Required Tools	
Part Number	**Part Description**
Recovery, Recycling, and Recharging Systems	
285-7352	Refrigerant Service Unit (Recovery/Recyling/Recharging) (115 V / 60 Hz)
285-7353	Refrigerant Service Unit (Recovery/Recyling/Recharging) (220-240 V / 50 Hz)
208-1338	Refrigerant Service Unit (Recovery)
197-1915	Refrigerant Service Unit (230 V / 50/60 Hz)
208-1317	Refrigerant Filter-Dryer
Charging Scales and Manifold Gauges	
168-1959	Electronic Charging Scale (115 V / 60 Hz)
168-1961	Electronic Charging Scale (220-240 V / 50 Hz)
168-1958	Electronic Charging Scale (Battery)
208-1341	Manifold Gauge Set
Tanks and Hoses	
300-3526	Refrigerant Tank (22.7 kg (50 lb))
208-1352	Heater Blanket As
272-3090	Refrigerant Charging Hose
208-1332	Refrigerant Hose

208-1333	Refrigerant Hose
208-1339	Refrigerant Coupler (Low Pressure)
208-1340	Refrigerant Coupler (High Pressure)
Vacuum Pumps and Accessories	
208-1381	Vacuum Pump (1.2 CFM, 110 V / 60 Hz)
208-1356	Vacuum Pump (4 CFM, 110V / 60Hz)
208-1357	Vacuum Pump (4 CFM, 220-250 V / 50-60 Hz)
208-1353	Thermistor Gauge
1U-9763	Vacuum Pump Oil
Miscellaneous Air Conditioning Tools	
208-1378	Refrigerant Analyzer Tool Gp
262-4934	Refrigerant Identifier (110/220 V 60/50 Hz)
153-8537	Air Conditioner Flushing Unit (Cart)
153-8538	Refrigerant Flushing Solution
153-9033	Adapter Kit (Air Conditioner Flushing)
208-1374	Leak Detector Kit
9U-6494	Refrigerant Oil Injector
208-1375	Orifice Tool Gp
144-0235	Belt Tension Gauge
208-1350	Radiator Tool Gp
9U-5325	Thermometer
270-1540	O-ring Kit
383-3518	Air Conditioner Kit
Miscellaneous Tools	
233-8583	Eye Protection Goggles (Vented)
5P-7277	Voltage Tester
8T-0500	Continuity Tester
269-3123	Pen Light UV Leak Detection
146-4080	Digital Multimeter Gp
1U-8590	Spanner Wrench

Note: The schrader valves used in the high and low-pressure sides of the A/C system are located in **149-2491** Air Conditioner Fitting As which contains **3E-4051** Seal Cap and **3E-4057** Valve As for the low-pressure side. **236-9888** Air Conditioner Fitting As which contains **3E-4052** Seal Cap and **3E-4058** Valve As for the high-pressure side.

Note: Use of a portable flushing unit is permissible only if **153-8538** Refrigerant Flushing Solution is used and all procedures are followed per Testing and Adjusting, SENR5664, "Refrigerant System - Flush". The refrigerant flushing solution can ONLY be reused after being filtered.

Note: The **383-3518** Air Conditioner Kit provides the valves and caps required when replacing the lines group air conditioner. The kit includes the following: one **3E-4051** Seal Cap , one **3E-4052** Seal Cap , one **3E-4057** Valve As and one **3E-4058** Valve As .

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Disassembly and Assembly
236B, 246B, 246C, 252B, 256C,
262B, 262C, 262C2 and 272C
Skid Steer Loaders Engine Supplement
Media Number -KENR5114-03 **Publication Date -01/04/2011** **Date Updated -19/04/2011**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1261-010; 1263-010

S/N - HEN1-UP

S/N - PAT1-UP

S/N - PDT1-UP

S/N - SCP1-UP

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

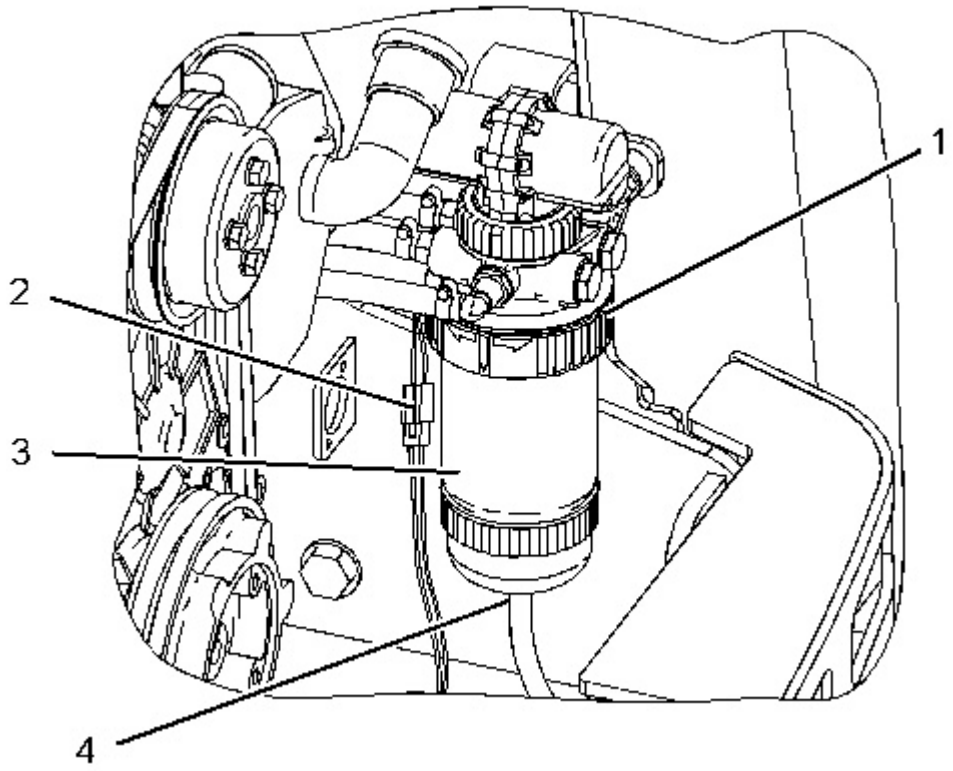


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

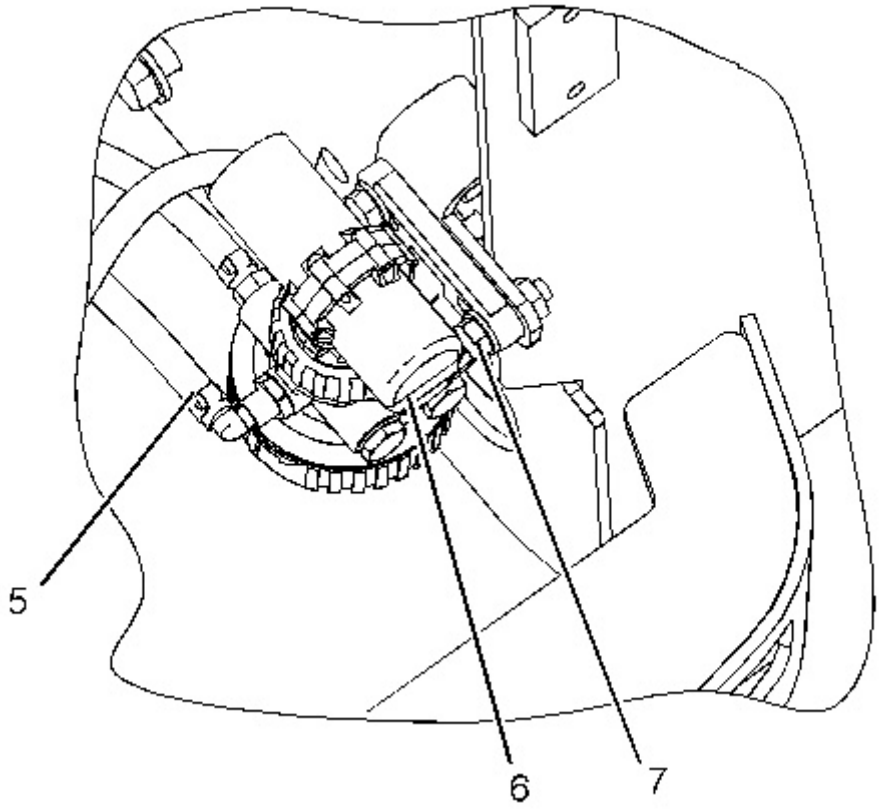


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

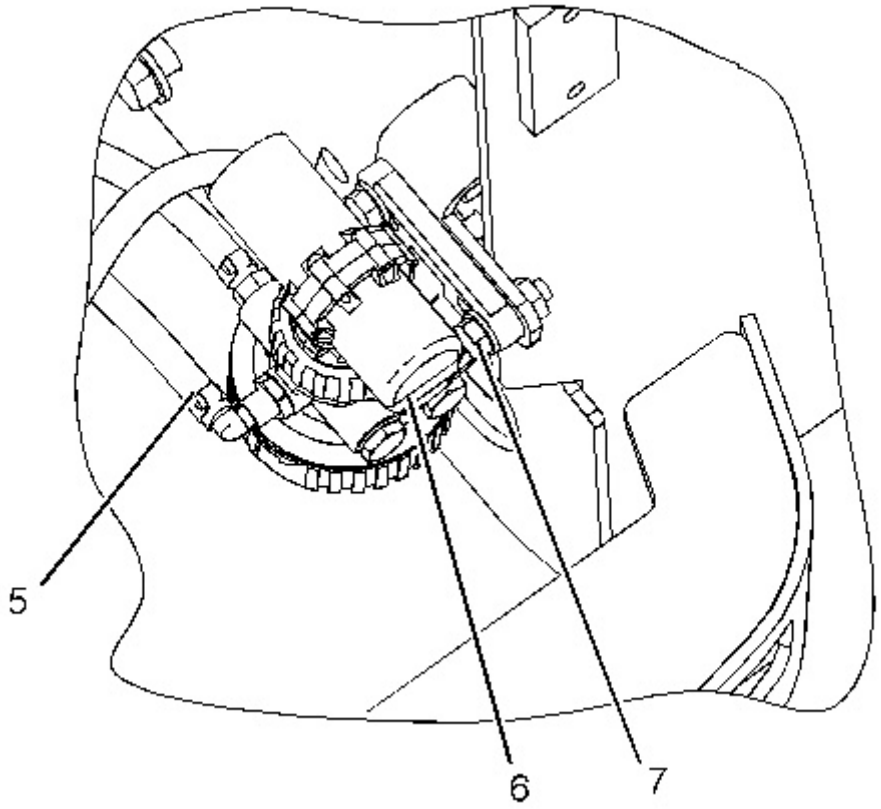


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

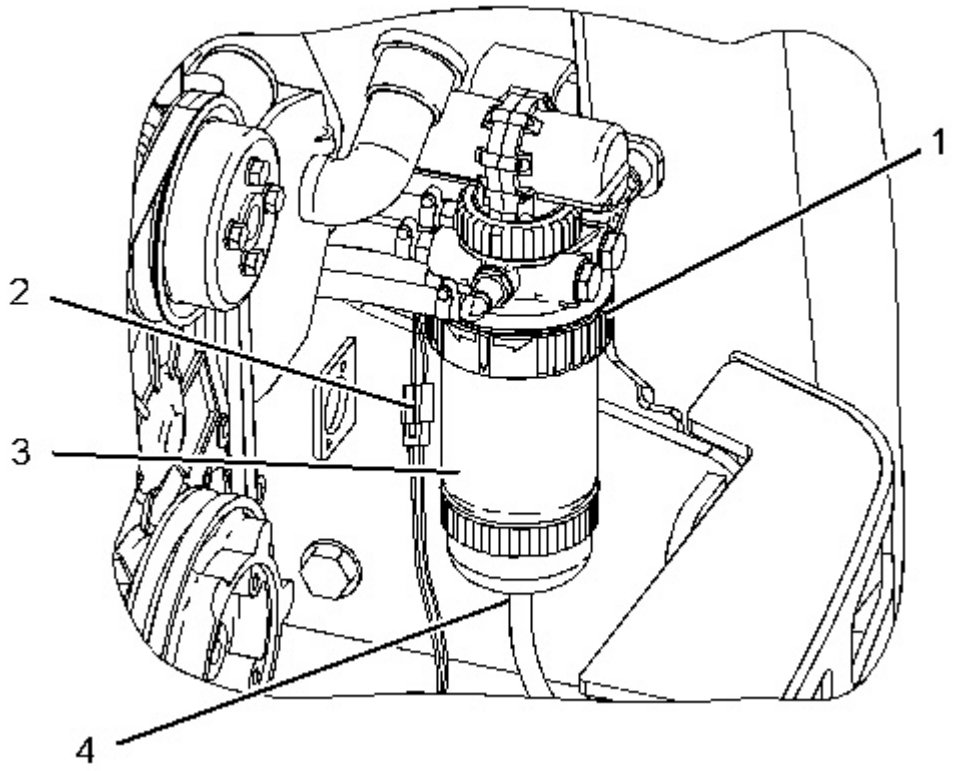


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Disassembly and Assembly
236B, 246B, 252B and 262B
Skid Steer Loaders Engine Supplement
Media Number -RENR4863-02 **Publication Date -01/11/2009** **Date Updated -12/11/2009**

i02014426

Fuel Priming Pump and Primary Filter (Water Separator) - Remove and Install

SMCS - 1258-010; 1260-010; 1263-010

Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

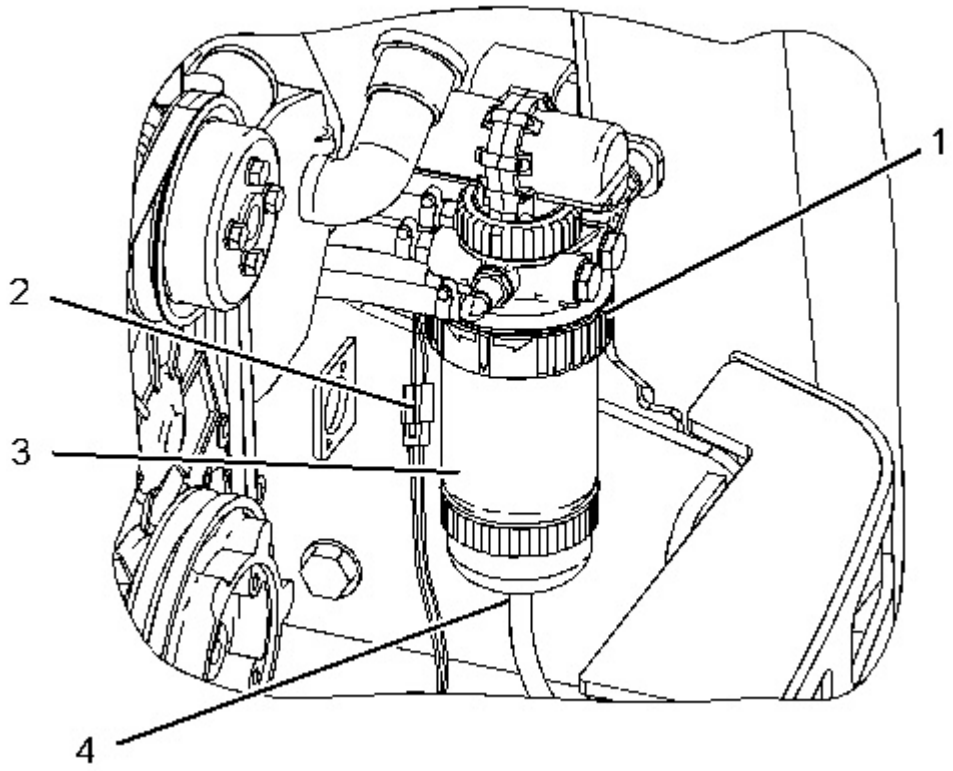


Illustration 1 g01041452

1. Open drain valve (4). Drain the fuel into a suitable container. Loosen ring (1) and remove the fuel filter and water separator (3). Disconnect harness assembly (2) .

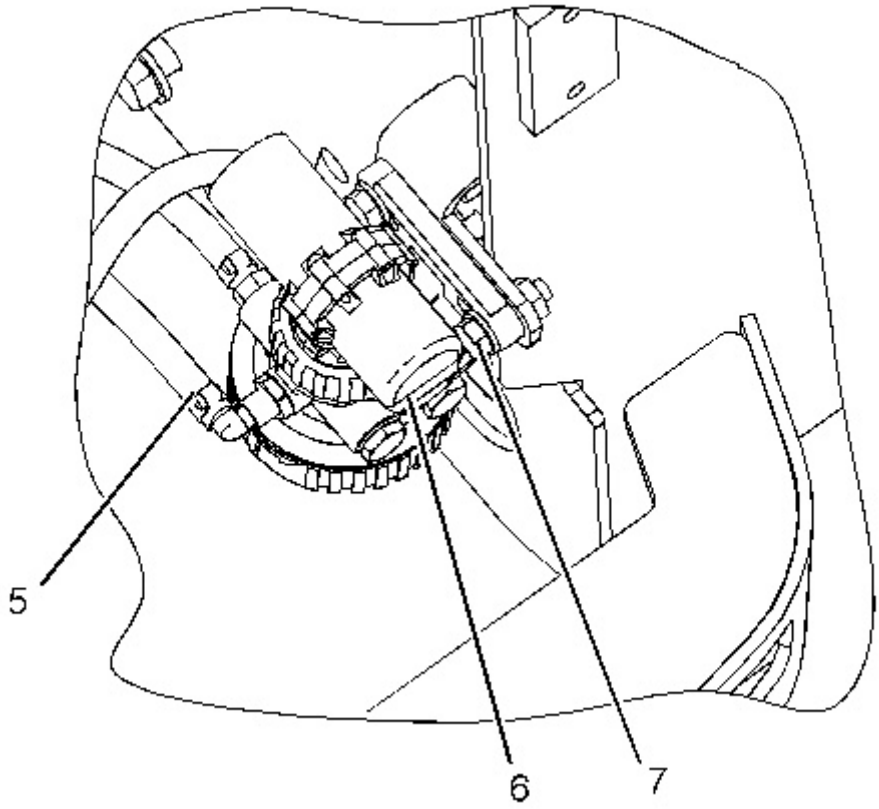


Illustration 2 g01041458

2. Disconnect three hoses (5). Remove bolts (7) and remove fuel priming pump (6) .

Installation Procedure

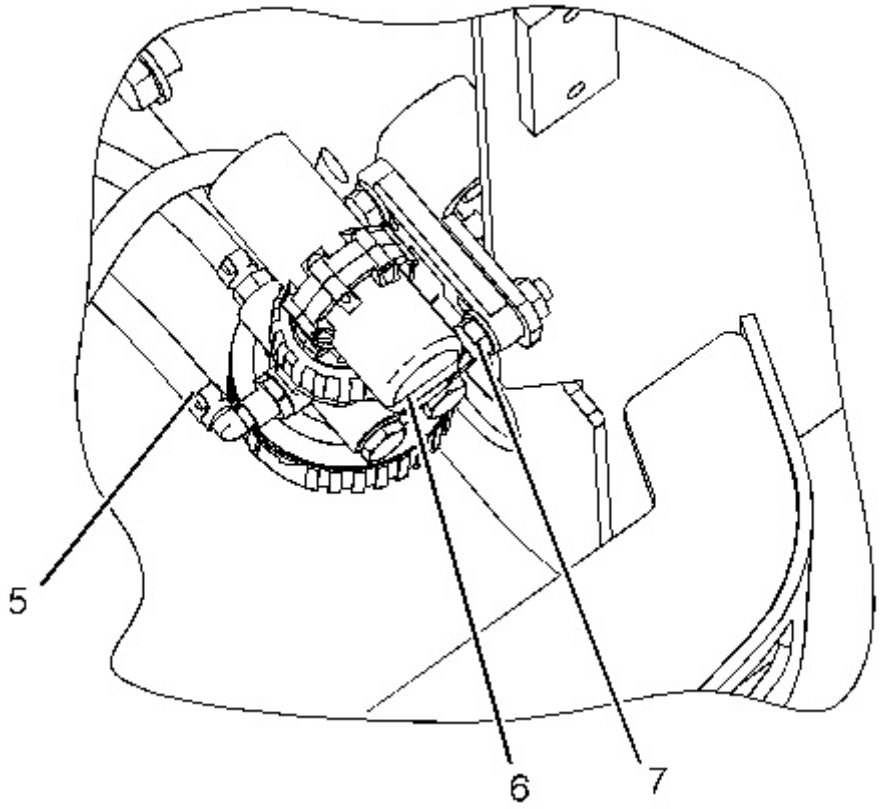


Illustration 3 g01041458

1. Install fuel priming pump (6). Install bolts (7) and connect three hoses (5).

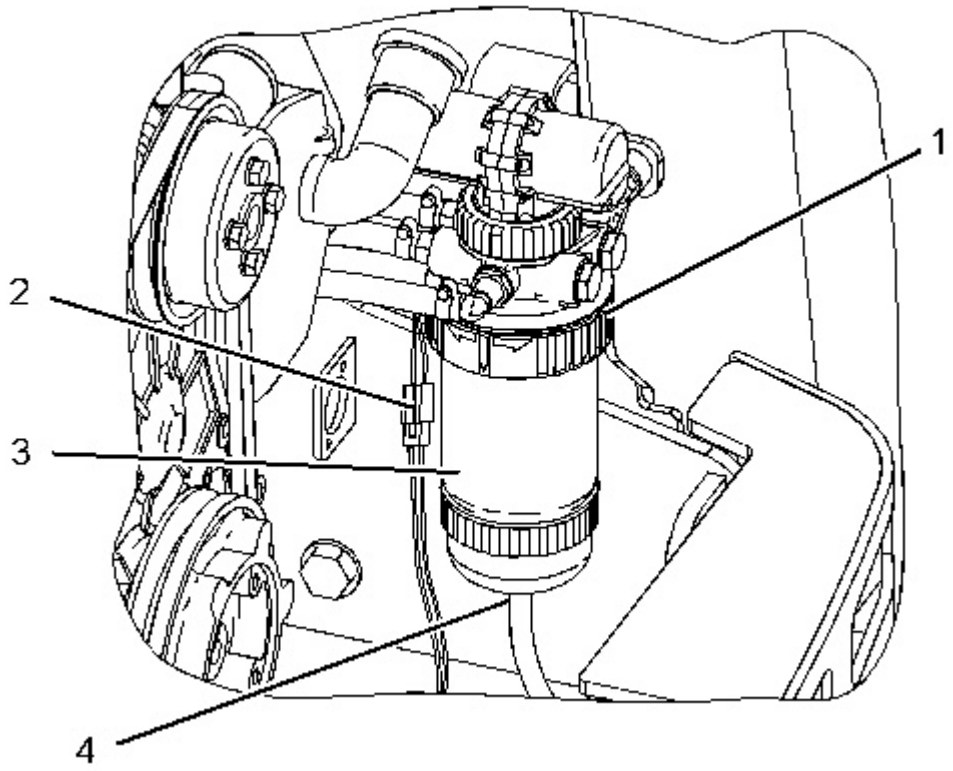


Illustration 4 g01041452

2. Close drain valve (4). Install the fuel filter and water separator (3). Tighten ring (1). Connect harness assembly (2) .

3. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System Priming Pump - Operate".

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Torque Specifications

Torque Specifications

Media Number -SENR3130-14 **Publication Date -01/01/2013** **Date Updated -09/01/2013**

i02357647

General Information

SMCS - 7553

WARNING

Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.

Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.

Introduction to Torque

"Torque" is measured in terms of force and distance. Force is the amount of pushing or pulling applied at the end of the lever. Distance is the length of the lever that is being used. Torque values are given in the following units: NEWTON meters (N·m), pound inches (lb in) and pound feet (lb ft)

This manual is intended to provide the operator with a reference. This manual will provide the standard torque settings for the following: bolts, nuts, plugs, fittings and clamps.

Exceptions to these torques are given in the Service Manual, if necessary.

Be sure to use a torque wrench that has the proper range. Torque wrenches must be used properly in order to ensure that the correct torque is applied. Always use a smooth pull for torque wrenches. Do not jerk a torque wrench. Do not use adapters that change the length of the torque wrench. For the correct use of your torque wrench, refer to the instructions that were packaged with your torque wrench. For more information on the correct use of torque wrenches, refer to Special Publication, SEBV0516, "An Introduction to Torque".

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean reused fasteners with a noncorrosive cleaner. Lightly lubricate

the threads of reused fasteners. Lightly lubricate the mating surface of the head of reused fasteners. Other applications for lubricating fasteners may also be specified in the Service Manual. The Service Manual may also specify the use of sealants and compounds.

Note: Do not use sealants that are not specified in the Service Manual. Do not use compounds that are not specified in the Service Manual. Clean old compound from the bolt and from the hole before installation.

Torque-Turn

The torque-turn method is used when precise control over clamping force is required. There is an initial torque and an additional turn. The initial torque is required to bring all parts of the joint into contact. The additional turn provides the desired clamping force. Ensure that all fasteners have been torqued before you perform the additional turns. Turn the fastener according to the specified amount. The specified amount will normally be equal to or greater than 90°. The specified amount will normally be in 30° increments. Turns of 120° or 180° are preferred. Turns of 120° or 180° are easily measured by the points of the hex head of the fastener. Lubrication may be specified in order to reduce the effort that is required for the final turn. The use of the torque-turn method will allow the following:

- Increase the life of the fastener.
- Maximize the potential clamping force of a fastener.

Typical applications are the following:

- Track bolts
- Sprocket bolts
- Connecting rod bolts
- Engine Cylinder Heads
- Drive Shaft bolts

Note: Too much tension on the bolt will cause the bolt to be stretched beyond the point of yield. The bolt will be permanently stretched. The bolt will loosen the grip on the parts that are being fastened. If the bolt is tightened again, the bolt will break. Do not reuse bolts that have been permanently stretched.

Torque Sequence

Unless the bolt tightening sequence is specified by the Service Manual, the fasteners should be tightened in a cross pattern. Use Step 1 through Step 5 unless the tightening sequence is specified:

1. Hand tighten all fasteners. Larger fasteners may require the use of a small hand wrench.
2. Torque all fasteners to 40% of full torque.
3. Torque all fasteners to 70% of full torque.

4. Torque all fasteners to full torque by using a cross pattern. Large flanges may require additional passes.

5. Apply at least one final full torque to all fasteners in a clockwise direction until all torque is uniform. Large flanges may require additional passes.

Note: Final torque may be a turn.

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Metric (ISO) Fasteners

SMCS - 7553

Metric (ISO) Nuts and Bolts

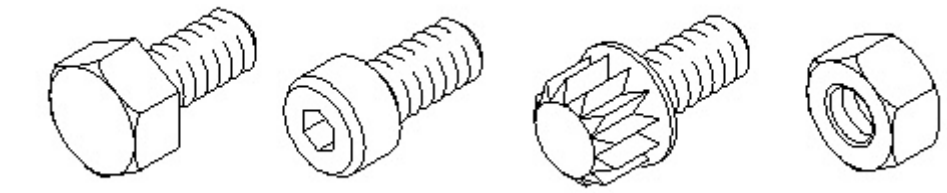


Illustration 1 g00909614

Note: The following table has the recommended standard torque values for metric nuts and bolts for use on all Caterpillar equipment and Mitsubishi engines.

Table 1

Thread Size mm	Torque
M6	12 ± 3 N·m (105 ± 27 lb in)
M8	28 ± 7 N·m (250 ± 62 lb in)
M10	55 ± 10 N·m (41 ± 7 lb ft)
M12	100 ± 20 N·m (75 ± 15 lb ft)
M14	

	160 ± 30 N·m (120 ± 22 lb ft)
M16	240 ± 40 N·m (175 ± 30 lb ft)
M20	460 ± 60 N·m (340 ± 44 lb ft)
M24	800 ± 100 N·m (590 ± 75 lb ft)
M30	1600 ± 200 N·m (1180 ± 150 lb ft)
M36	2800 ± 350 N·m (2060 ± 260 lb ft)

Note: The following table has the recommended standard torque values for metric nuts and bolts for use on Perkins engines.

Table 2

Thread Size mm	**Torque**
M6	5 N·m (44 lb in)
M8	22 N·m (195 lb in)
M10	44 N·m (32 lb ft)
M12	78 N·m (60 lb ft)
M14	124 N·m (90 lb ft)
M16	177 N·m (130 lb ft)
M18	200 N·m (150 lb ft)
M20	400 N·m (300 lb ft)
M24	790 N·m (580 lb ft)

Note: The difference between Caterpillar standard torque values and Perkins standard torque values are due to different classes of fasteners. Caterpillar uses class 10.9 fasteners. Perkins uses class 8.8 fasteners. The different class of fasteners have different tensile strengths.

Metric (ISO) Taperlock Studs

Note: The following table has the recommended standard torque values for metric taperlock studs for use on all Caterpillar equipment and Mitsubishi engines.

Table 3

Thread Size mm	Torque
M6	8 ± 3 N·m (71 ± 27 lb in)
M8	17 ± 5 N·m (150 ± 44 lb in)
M10	35 ± 5 N·m (26 ± 4 lb ft)
M12	65 ± 10 N·m (48 ± 7 lb ft)
M16	110 ± 20 N·m (80 ± 15 lb ft)
M20	170 ± 30 N·m (125 ± 22 lb ft)
M24	400 ± 60 N·m (300 ± 44 lb ft)
M30	750 ± 80 N·m (550 ± 60 lb ft)
M36	1200 ± 150 N·m (880 ± 110 lb ft)

Note: The following table has the recommended standard torque values for Metric taperlock studs for use on Perkins engines.

Table 4

Thread Size mm	Torque
M6	5 N·m (44 lb in)
M8	11 N·m (97 lb in)
M10	18 N·m (160 lb in)
M12	25 N·m (220 lb in)

Metric (ISO) Machine Screws

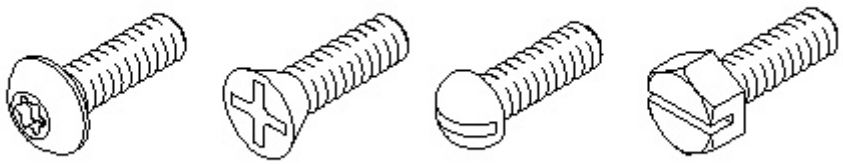


Illustration 2 g00908932

Table 5

Thread Size mm	Torque
M1.6	0.10 ± 0.01 N·m (0.9 ± 0.1 lb in)
M2	0.15 ± 0.01 N·m (1.3 ± 0.1 lb in)
M2.5	0.35 ± 0.05 N·m (3.1 ± 0.4 lb in)
M3	0.50 ± 0.05 N·m (4.4 ± 0.4 lb in)
M4	1.70 ± 0.25 N·m (15.0 ± 2.2 lb in)
M5	2.25 ± 0.25 N·m (19.9 ± 2.2 lb in)

Hex Button Head Screw and Set Screws

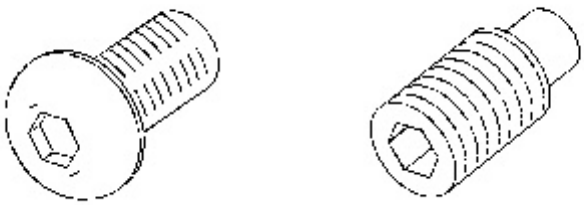


Illustration 3 g01186742

Table 6

Thread Size mm	**Torque**
M3	.6 ± .1 N·m (5 ± 0.9 lb in)
M4	2 ± .3 N·m (18 ± 3 lb in)
M5	4 ± .5 N·m (35 ± 4 lb in)
M6	6 ± 1 N·m (55 ± 9 lb in)
M8	15 ± 2 N·m (135 ± 18 lb in)
M10	30 ± 7 N·m (265 ± 62 lb in)
M12	50 ± 10 N·m (37 ± 7 lb ft)
M14	80 ± 15 N·m (60 ± 11 lb ft)
M16	125 ± 20 N·m (90 ± 15 lb ft)
M20	250 ± 40 N·m (185 ± 30 lb ft)
M24	425 ± 50 N·m (310 ± 37 lb ft)
M30	850 ± 100 N·m (620 ± 75 lb ft)
M36	1500 ± 200 N·m (1100 ± 150 lb ft)

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i03517320

English (SAE) Fasteners

SMCS - 7553

English (SAE) Nuts and Bolts

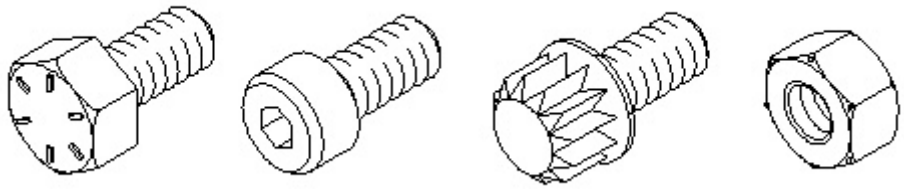


Illustration 1 g00908911

Table 1

Thread Size Inch	Torque
1/4	12 ± 3 N·m (105 ± 27 lb in)
5/16	25 ± 6 N·m (220 ± 53 lb in)
3/8	47 ± 9 N·m (35 ± 7 lb ft)
7/16	70 ± 15 N·m (50 ± 11 lb ft)
1/2	105 ± 20 N·m (75 ± 15 lb ft)

9/16	160 ± 30 N·m (120 ± 22 lb ft)
5/8	215 ± 40 N·m (160 ± 30 lb ft)
3/4	370 ± 50 N·m (275 ± 37 lb ft)
7/8	620 ± 80 N·m (460 ± 60 lb ft)
1	900 ± 100 N·m (660 ± 75 lb ft)
1 1/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/4	1800 ± 200 N·m (1320 ± 150 lb ft)
1 3/8	2400 ± 300 N·m (1780 ± 220 lb ft)
1 1/2	3100 ± 350 N·m (2280 ± 260 lb ft)

English (SAE) Taperlock Studs

Table 2

Thread Size Inch	Standard Torque
1/4	8 ± 3 N·m (70 ± 27 lb in)
5/16	17 ± 5 N·m (150 ± 44 lb in)
3/8	35 ± 5 N·m (26 ± 4 lb ft)
7/16	45 ± 10 N·m (33 ± 7 lb ft)
1/2	65 ± 10 N·m (48 ± 7 lb ft)
5/8	110 ± 20 N·m (80 ± 15 lb ft)
3/4	170 ± 30 N·m (125 ± 22 lb ft)
7/8	260 ± 40 N·m (190 ± 30 lb ft)

1	400 ± 60 N·m (300 ± 44 lb ft)
1 1/8	525 ± 60 N·m (390 ± 44 lb ft)
1 1/4	750 ± 80 N·m (550 ± 60 lb ft)
1 3/8	950 ± 125 N·m (700 ± 90 lb ft)
1 1/2	1200 ± 150 N·m (880 ± 110 lb ft)

English (SAE) Machine Screws

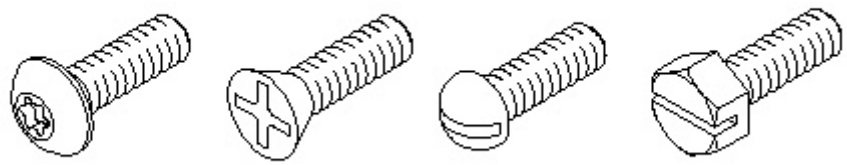


Illustration 2 g00908932

Table 3

Thread Size No.	Torque
0-80	**0.10 ± 0.01 N·m (0.9 ± 0.1 lb in)**
1-64	**0.15 ± 0.01 N·m (1.3 ± 0.1 lb in)**
2-56	**0.25 ± 0.02 N·m (2.2 ± 0.2 lb in)**
3-48	**0.35 ± 0.05 N·m (3.1 ± 0.4 lb in)**
4-40	**0.50 ± 0.05 N·m (4.4 ± 0.4 lb in)**
5-40	**0.70 ± 0.10 N·m (6.2 ± 0.9 lb in)**
6-32	

	0.90 ± 0.10 N·m (8.0 ± 0.9 lb in)
8-32	**1.70 ± 0.25 N·m (15.0 ± 2.2 lb in)**
10-24	**2.25 ± 0.25 N·m (19.9 ± 2.2 lb in)**
12-24	3.40 ± 0.60 N·m (30.1 ± 5.3 lb in)

Hex Button Head Screw and Set Screws

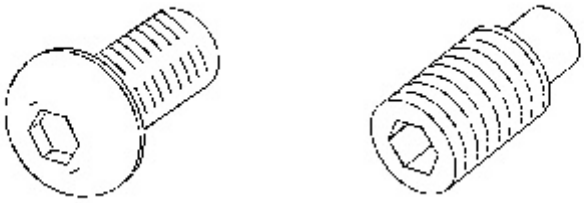


Illustration 3 g01186972

Table 4

Thread Size inch	**Torque**
# 4 & #5	.6 ± .1 N·m (5 ± 0.9 lb in)
#6 & #8	2 ± .3 N·m (18 ± 3 lb in)
#10 & #12	4 ± .5 N·m (35 ± 4 lb in)
1/4	6 ± 1 N·m (55 ± 9 lb in)
5/16	13 ± 3 N·m (115 ± 27 lb in)
3/8	25 ± 6 N·m (220 ± 53 lb in)
7/16	40 ± 8 N·m (20 ± 6 lb ft)
1/2	

	60 ± 12 N·m (44 ± 9 lb ft)
9/16	85 ± 15 N·m (65 ± 11 lb ft)
5/8	115 ± 20 N·m (85 ± 15 lb ft)
3/4	200 ± 40 N·m (150 ± 30 lb ft)
7/8	325 ± 40 N·m (240 ± 30 lb ft)
1	500 ± 65 N·m (370 ± 48 lb ft)
1 1/8	700 ± 90 N·m (520 ± 65 lb ft)
1 1/4	1000 ± 125 N·m (740 ± 90 lb ft)
1 3/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/2	1700 ± 200 N·m (1260 ± 150 lb ft)

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Ground Engaging Tool (G.E.T.) Fasteners

SMCS - 7553

Ground Engaging Tools (G.E.T.) are secured by many types of bolts. Refer to Table 1 for the correct torque for the following combinations of fasteners for G.E.T.:

- Plow bolts and nuts
- Hex head bolts and nuts

Table 1

Thread Size Inch	Torque [1]	
	N·m	lb ft
5/8 inch	270 ± 40	200 ± 30
3/4 inch	475 ± 60	350 ± 45
7/8 inch	750 ± 90	550 ± 65
1 inch	1150 ± 150	850 ± 110
1 1/4 inch	2300 ± 300	1700 ± 220

(1) These values are only for Caterpillar bolts for cutting edges.

WARNING

Personal injury can result when installing plow bolts. The appropriate safety equipment must be worn when striking the plow bolts. To avoid injury to your eyes and ears, wear protective glasses and hearing protection during this procedure.

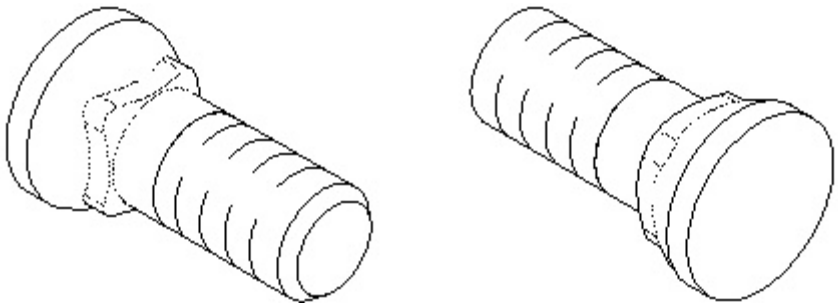


Illustration 1 g00909058

View of a typical plow bolt

Plow bolts must be installed properly. Refer to the following procedure for the correct installation of plow bolts.

1. Clean all surfaces that contact the bolt. Remove all occurrences of the following conditions:rust, paint, nicks and burrs
2. Tighten the nut to the correct torque. Refer to Table 1 for the correct torque.
3. Use a hammer to strike the head of the bolt. The bolt must be struck with significant force.

   Note: The head of the bolt may be recessed below the mounting surface. Use a suitable punch in order to transfer the hammer blow to the bolt head.
4. Tighten the nut to the correct torque. Refer to Table 1 for the correct torque.

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Installation of Fittings

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Note: The tightening sequence of the threaded adapters that attaches a tube assembly or hose assembly to the machine is critical to the proper function of the machine. The sealing surfaces of the tube assembly or hose assembly should be secured squarely. The sealing surfaces of the tube assembly or hose assembly should be tightened to the serviced component (control valve, cylinder, hydraulic motor, etc.). Perform this procedure prior to the final tightening of any clamps or clips that are used in order to fasten the tube assembly or the hose assembly to the machine.

Fittings have different connections. Fittings may have two different ends. Be sure to use the proper torque for the end of the fitting that is used. The following list contains some common types of fittings.

Protective caps and plugs should not be removed until the connector is ready to be assembled. All sealing surfaces should be free of contamination and damage. If a connector is damaged before or after assembly, it should be replaced.

- Straight Thread O-Ring (STOR)
- O-Ring Face Seal (ORFS)
- Tapered Pipe Thread (NPT and NPTF)
- 37 Degree Flare Fitting
- 45 Degree Flare Fitting
- Inverted Flare Fitting
- Hydraulic Four Bolt Flange

Installation of Hydraulic Four Bolt Flange

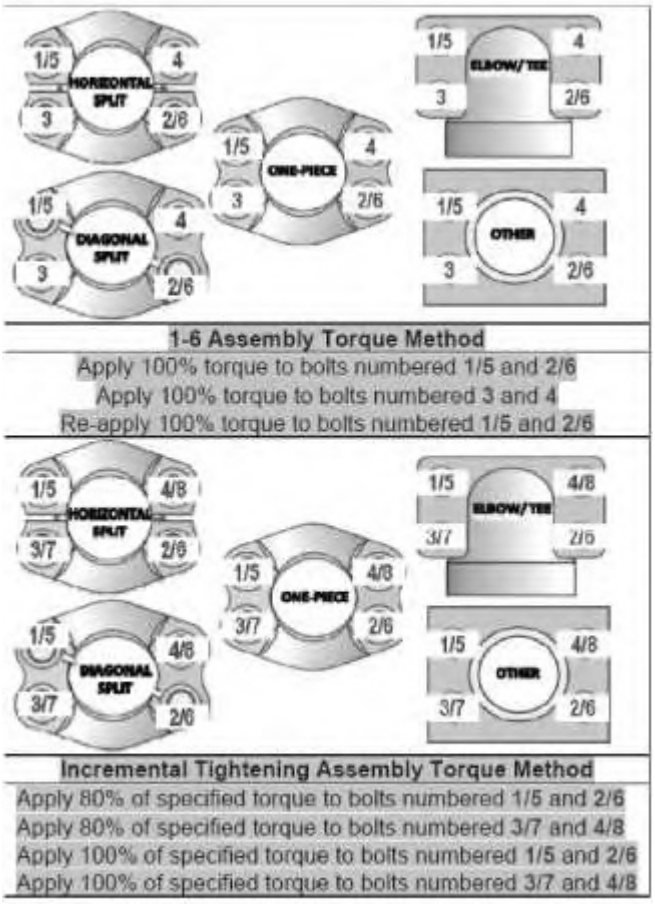


Illustration 1 g02724217

1. Position the flanges parallel over the port.
2. Evenly install bolts hand-tight, keeping the gap between flanges at a minimum.
3. Put the hose in a position so that the hose does not contact the machine or with another hose.
4. Tighten using one of the assembly torque values for bolts, used in Illustration 1 for proper torque sequence of various flange fittings.
5. Start the engine.
6. Move the implement control levers to all of the positions.
7. Look at the hose during movement of the implement. Ensure that the hose is not in contact with the machine or with other hoses.

   Note: For hoses that cross an articulation hitch, check for contact during articulation. For hoses that connect to the steering system, check for contact during steering.
8. Shut off the engine.

9. If the hose contacts other hoses or the machine during the test, loosen the bolts and reposition the hose. Repeat steps 3 through 8 until there is no contact.

Installation of Adjustable STOR Fittings

This type of fitting is used in many applications. One end of the fitting will be an adjustable STOR fitting. The other end will be different. Always use the same installation procedure for the STOR end. Adjustable STOR fittings can be positioned before tightening.

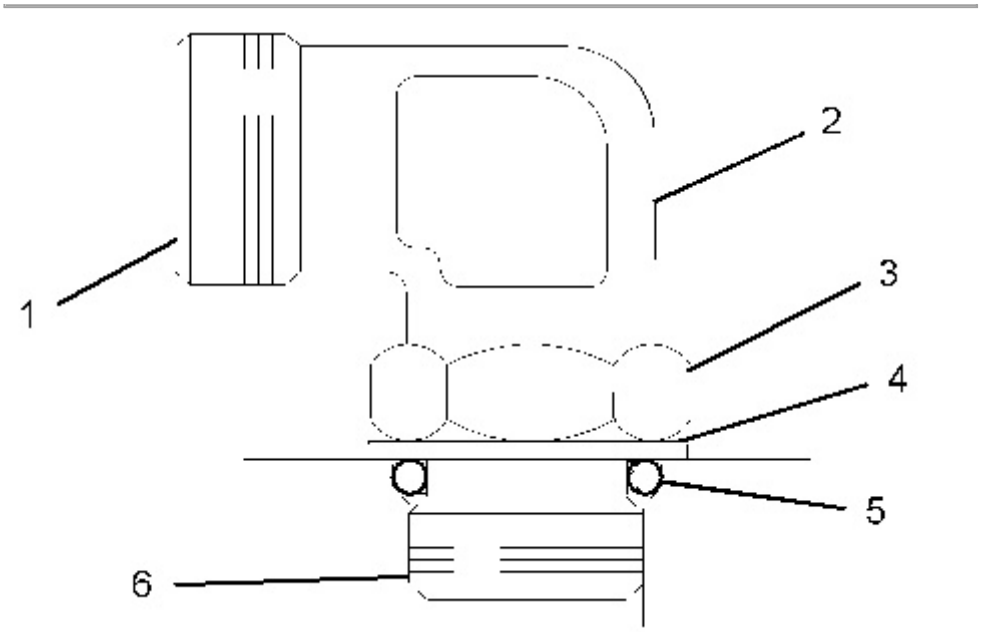


Illustration 2 g01848653

Elbow body assembly

(1) End that connects to the tube or hose

(2) Fitting body

(3) Locknut

(4) Backup washer

(5) O-ring seal

(6) End that is assembled to the mating part

1. Put locknut (3) , backup washer (4) and O-ring seal (5) as far away from the threads as possible. Hold these components in this position. Turn the fitting into the mating part. Turn the fitting until backup washer (4) contacts the surface of the mating part.

   Note: Excessive use of the wrench will distort the washer. Distortion of the washer will prevent proper sealing.

2. Put the fitting assembly in the correct position. loosen fitting (2) until the correct assembly position is achieved. Do not loosen the fitting more than 360 degrees. Install the tube or

hose hand tight in order to verify the orientation of the fitting. Tighten the fitting (2) to the torque that is shown in the correct chart for the fitting that is used. Tighten locknut (3) to the torque that is shown in the correct chart for the fitting that is used. Use a backup wrench, when the locknut is tightened.

Note: Torque the fitting prior to the locknut.

Note: If the fitting is not adjustable, the hex on the body replaces the locknut. To install this type of fitting, tighten the hex against the face of the mating part.

Excessive tightening of the connectors can cause failure. Connectors that are under tightened can also cause failures. The following failures occur:

- Excessive tightening can expand a loose ferrule into the nut. This will cause the ferrule to lock up in the nut and the nut will not function properly.
- Excessive tightening can split the nut on the end of the tube or can split the ferrule.
- Excessive tightening can gall or excessive tightening can strip the threads of the nut.

Note: If the above conditions occur due to excessive tightening, the damaged fluid connector must be scrapped and the fluid connectors must be replaced.

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Straight Thread O-Ring Fittings

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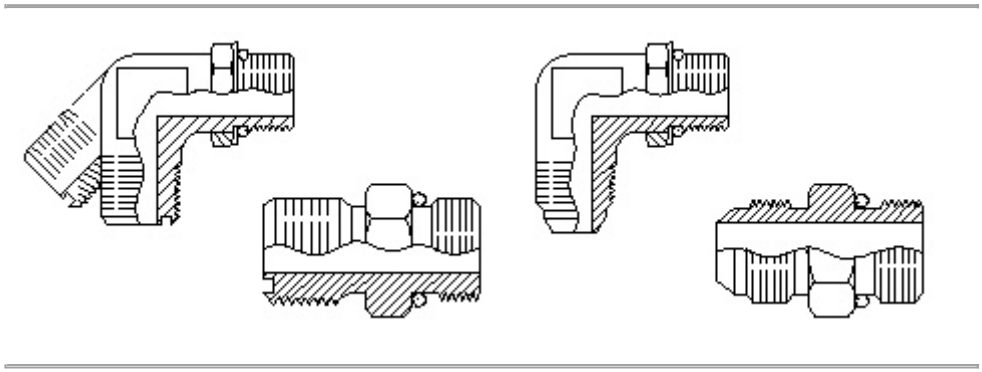


Illustration 1 g00911924

Note: For torques for plugs, refer to Specifications, "Plugs".

Note: Straight Thread O-Ring fittings for medium pressure usage will have shorter threaded ends than high-pressure fittings. The torque value for medium pressure Straight Thread O-Ring fittings will be lower than the torque values that are required for Straight Thread O-Ring fittings for high-pressure fittings.

Table 1

Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials Medium Pressure use Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16 - 24	10 ± 2 N·m (89 ± 18 lb in)
4.76 mm (0.188 inch)	3/8 - 24	13 ± 2 N·m (115 ± 18 lb in)
	7/16 - 20	

6.35 mm (0.250 inch)		30 ± 5 N·m (266 ± 44 lb in)
7.94 mm (0.312 inch)	1/2 - 20	30 ± 5 N·m (266 ± 44 lb in)
9.52 mm (0.375 inch)	9/16 - 18	40 ± 6 N·m (30 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4 - 16	80 ± 12 N·m (59 ± 9 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	110 ± 17 N·m (81 ± 13 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	130 ± 20 N·m (96 ± 15 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	200 ± 30 N·m (148 ± 22 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	180 ± 27 N·m (133 ± 20 lb ft)
31.75 mm (1.250 inch)	1 5/8 - 12	300 ± 45 N·m (221 ± 33 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	350 ± 53 N·m (258 ± 39 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	420 ± 63 N·m (310 ± 46 lb ft)

Note: Use 50 percent of the torque values from Table 1 when the fitting or the port material is nonferrous.

Note: Straight Thread O-Ring fittings for high-pressure usage will have longer threaded ends than medium pressure fittings. The torque value for high-pressure Straight Thread O-Ring fittings will be higher than the torque values that are required for Straight Thread O-Ring fittings for medium pressure fittings.

Table 2

Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
4.76 mm (0.188 inch)	3/8 - 24	20 ± 3 N·m (177 ± 27 lb in)
6.35 mm (0.250 inch)	7/16 - 20	30 ± 5 N·m (266 ± 44 lb in)
	1/2 - 20	

7.94 mm (0.312 inch)		45 ± 7 N·m (33 ± 5 lb ft)
9.52 mm (0.375 inch)	9/16 - 18	55 ± 8 N·m (41 ± 6 lb ft)
12.7 mm (0.500 inch)	3/4 - 16	100 ± 15 N·m (74 ± 11 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	140 ± 21 N·m (103 ± 15 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	220 ± 33 N·m (162 ± 24 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	260 ± 39 N·m (192 ± 29 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	350 ± 53 N·m (258 ± 39 lb ft)
31.75 mm (1.250 inch)	1 5/8 -12	400 ± 60 N·m (295 ± 44 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	420 ± 63 N·m (310 ± 46 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 2 when the fitting or the port material is nonferrous.

Table 3

Metric Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials Medium Pressure use Fittings		
Ref Nominal Outer Diameter of the Tube	**Thread Size**	**Standard Torque Tolerance**
4 mm	M8 X 1	10 ± 2 N·m (89 ± 18 lb in)
5 mm	M10 X 1	17 ± 3 N·m (150 ± 27 lb in)
6 mm	M12 X 1.5	30 ± 5 N·m (266 ± 44 lb in)
8 mm	M14 X 1.5	35 ± 5 N·m (26 ± 4 lb ft)
10 mm	M16 X 1.5	45 ± 7 N·m (33 ± 5 lb ft)

12 mm	M18 X 1.5	50 ± 8 N·m (37 ± 6 lb ft)
16 mm	M22 X 1.5	80 ± 12 N·m (59 ± 9 lb ft)
20 mm	M27 X 2	120 ± 18 N·m (89 ± 13 lb ft)
22 mm	M30 X 2	160 ± 24 N·m (118 ± 18 lb ft)
25 mm	M33 X 2	180 ± 27 N·m (133 ± 20 lb ft)
30 mm	M42 X 2	260 ± 39 N·m (192 ± 29 lb ft)
38 mm	M48 X 2	300 ± 45 N·m (221 ± 33 lb ft)
50 mm	M60 X 2	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 3 when the fitting or the port material is nonferrous.

Table 4

Metric Ferrous Straight Thread O-Ring Fittings Torques for Mating with Ferrous Materials High Pressure use Fittings		
Ref Nominal Outer Diameter of the Tube	**Thread Size**	**Standard Torque Tolerance**
5 mm	M10 X 1	20 ± 3 N·m (177 ± 27 lb in)
6 mm	M12 X 1.5	40 ± 6 N·m (30 ± 4 lb ft)
8 mm	M14 X 1.5	50 ± 8 N·m (37 ± 6 lb ft)
10 mm	M16 X 1.5	60 ± 9 N·m (44 ± 7 lb ft)
12 mm	M18 X 1.5	80 ± 12 N·m (59 ± 9 lb ft)

16 mm	M22 X 1.5	140 ± 21 N·m (103 ± 15 lb ft)
20 mm	M27 X 2	220 ± 33 N·m (162 ± 24 lb ft)
22 mm	M30 X 2	260 ± 39 N·m (192 ± 29 lb ft)
25 mm	M33 X 2	350 ± 53 N·m (258 ± 39 lb ft)
30 mm	M42 X 2	400 ± 60 N·m (295 ± 44 lb ft)
38 mm	M48 X 2	420 ± 63 N·m (310 ± 46 lb ft)
50 mm	M60 X 2	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 4 when the fitting or the port material is nonferrous.

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Plugs

SMCS - 7553

Straight Thread O-Ring Plugs

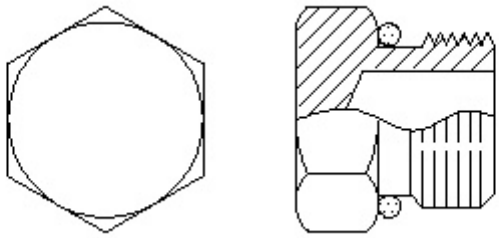


Illustration 1 g00911999

Table 1

Ferrous Straight Thread O-Ring Plug Torques for Mating with Ferrous Materials		
Thread Size Inch	**Internal Hex Plug Torque**	**External Hex Plug Torque**
5/16	7 ± 1 N·m (62 ± 9 lb in)	13 ± 2 N·m (115 ± 18 lb in)
3/8	13 ± 2 N·m (115 ± 18 lb in)	20 ± 3 N·m (177 ± 27 lb in)
7/16	20 ± 3 N·m (177 ± 27 lb in)	40 ± 6 N·m (30 ± 4 lb ft)
1/2	25 ± 4 N·m (221 ± 35 lb in)	45 ± 7 N·m (33 ± 5 lb ft)

9/16	45 ± 7 N·m (33 ± 5 lb ft)	60 ± 9 N·m (44 ± 7 lb ft)
3/4	80 ± 12 N·m (59 ± 9 lb ft)	100 ± 15 N·m (74 ± 11 lb ft)
7/8	110 ± 17 N·m (81 ± 13 lb ft)	130 ± 20 N·m (96 ± 15 lb ft)
1 1/16	180 ± 27 N·m (133 ± 20 lb ft)	220 ± 33 N·m (162 ± 24 lb ft)
1 3/16	220 ± 33 N·m (162 ± 24 lb ft)	260 ± 39 N·m (192 ± 29 lb ft)
1 5/16	300 ± 45 N·m (221 ± 33 lb ft)	350 ± 53 N·m (258 ± 39 lb ft)
1 5/8	350 ± 53 N·m (258 ± 39 lb ft)	400 ± 60 N·m (295 ± 44 lb ft)
1 7/8	420 ± 63 N·m (310 ± 46 lb ft)	420 ± 63 N·m (310 ± 46 lb ft)
2 1/2	500 ± 75 N·m (369 ± 55 lb ft)	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 1 when the fitting or the port material is nonferrous.

Table 2

Metric Ferrous Straight Thread O-Ring Plug Torques for Mating with Ferrous Materials		
Thread Size Metric	**Internal Hex Plug Torque**	**External Hex Plug Torque**
M8	10 ± 2 N·m (89 ± 18 lb in)	10 ± 2 N·m (89 ± 18 lb in)
M10	17 ± 3 N·m (150 ± 27 lb in)	20 ± 3 N·m (177 ± 27 lb in)
M12	25 ± 4 N·m (221 ± 35 lb in)	35 ± 5 N·m (26 ± 4 lb ft)
M14	45 ± 7 N·m (33 ± 5 lb ft)	45 ± 7 N·m (33 ± 5 lb ft)
M16	55 ± 8 N·m (41 ± 6 lb ft)	55 ± 8 N·m (41 ± 6 lb ft)
M18	70 ± 11 N·m (52 ± 8 lb ft)	90 ± 13 N·m (66 ± 10 lb ft)
M20	80 ± 12 N·m (59 ± 9 lb ft)	110 ± 17 N·m (81 ± 13 lb ft)

M22	100 ± 15 N·m (74 ± 11 lb ft)	130 ± 20 N·m (96 ± 15 lb ft)
M27	180 ± 27 N·m (133 ± 20 lb ft)	220 ± 33 N·m (162 ± 24 lb ft)
M30	220 ± 33 N·m (162 ± 24 lb ft)	260 ± 39 N·m (192 ± 29 lb ft)
M33	300 ± 45 N·m (221 ± 33 lb ft)	350 ± 53 N·m (258 ± 39 lb ft)
M42	350 ± 53 N·m (258 ± 39 lb ft)	400 ± 60 N·m (295 ± 44 lb ft)
M48	420 ± 63 N·m (310 ± 46 lb ft)	420 ± 63 N·m (310 ± 46 lb ft)
M60	500 ± 75 N·m (369 ± 55 lb ft)	500 ± 75 N·m (369 ± 55 lb ft)

Note: Use 50 percent of the torque values from Table 2 when the fitting or the port material is nonferrous.

Drain Plugs with Straight Threads

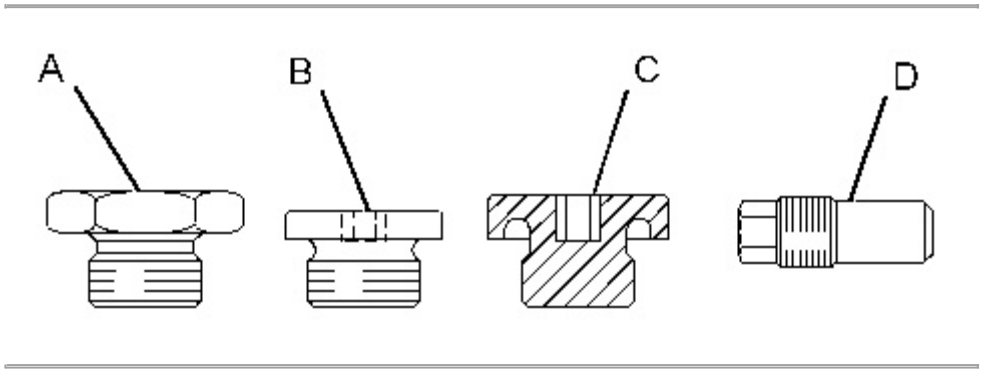


Illustration 2 g01848045

Note: Plug (A) , plug (B) and plug (C) are used with a gasket. Conical seal plug (D) does not use a gasket.

Table 3

Type of Plug	**Thread Size Inch**	**Torque**
A	1/2 - 13	20 ± 3 N·m (177 ± 27 lb in)
	5/8 - 11	35 ± 5 N·m (26 ± 4 lb ft)

	3/4 - 12 3/4 - 16	50 ± 8 N·m (37 ± 6 lb ft)
	7/8 - 14 1 1/8 - 12	70 ± 11 N·m (52 ± 8 lb ft)
B	1 5/16 - 12 1 1/2 - 12	90 ± 13 N·m (66 ± 10 lb ft)
	2 - 12	130 ± 20 N·m (96 ± 15 lb ft)
C	1 1/8 - 12	70 ± 11 N·m (52 ± 8 lb ft)
	1 5/16 - 12	90 ± 13 N·m (66 ± 10 lb ft)
D	1/2 - 20	13 ± 2 N·m (115 ± 18 lb in)
	7/8 -14	55 ± 8 N·m (41 ± 6 lb ft)
	1 3/8 -13	90 ± 13 N·m (66 ± 10 lb ft)
	1 1/2 - 12	110 ± 17 N·m (81 ± 13 lb ft)

Note: Use 50 percent of the torque values from Table 3 when the fitting or the port material is nonferrous.

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O-Ring Face Seal Fittings

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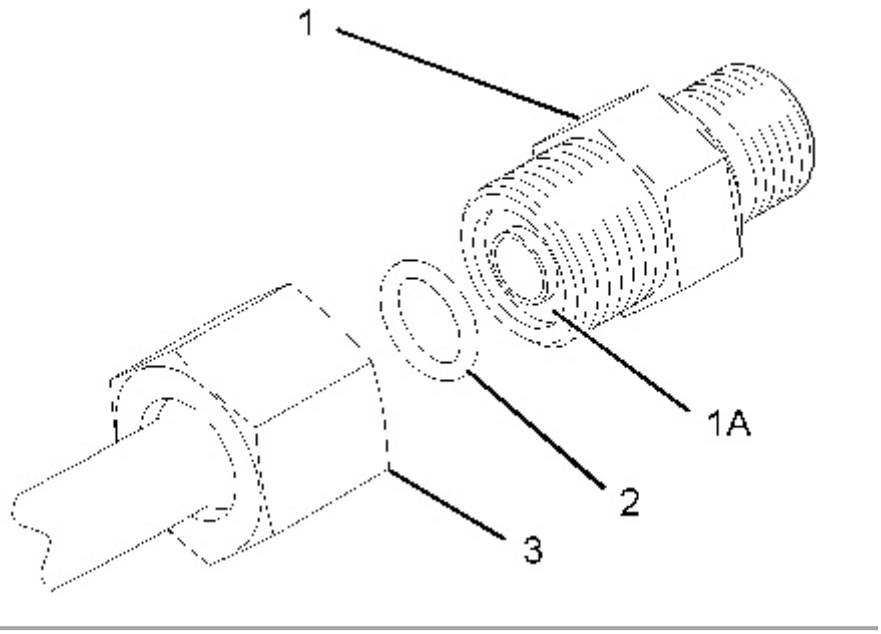


Illustration 1 g01848710

O-ring face seal fitting (ORFS fitting)

(1) O-ring face seal connector

(1A) O-ring groove

(2) O-ring seal

(3) Nut for the O-ring face seal

Table 1

Ferrous ORFS Fitting	
	Torque

Thread Size Inch	
9/16 - 18	27 ± 4 N·m (239 ± 35 lb in)
11/16 - 16	45 ± 5 N·m (33 ± 4 lb ft)
13/16 - 16	65 ± 10 N·m (48 ± 7 lb ft)
1 - 14	110 ± 17 N·m (81 ± 13 lb ft)
1 13/16 - 12	140 ± 21 N·m (103 ± 15 lb ft)
1 7/16 - 12	220 ± 33 N·m (162 ± 24 lb ft)
1 11/16 - 12	300 ± 45 N·m (221 ± 33 lb ft)
2 - 12	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 1 when the fitting or the port material is nonferrous.

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Bulkhead Nuts

SMCS - 7553

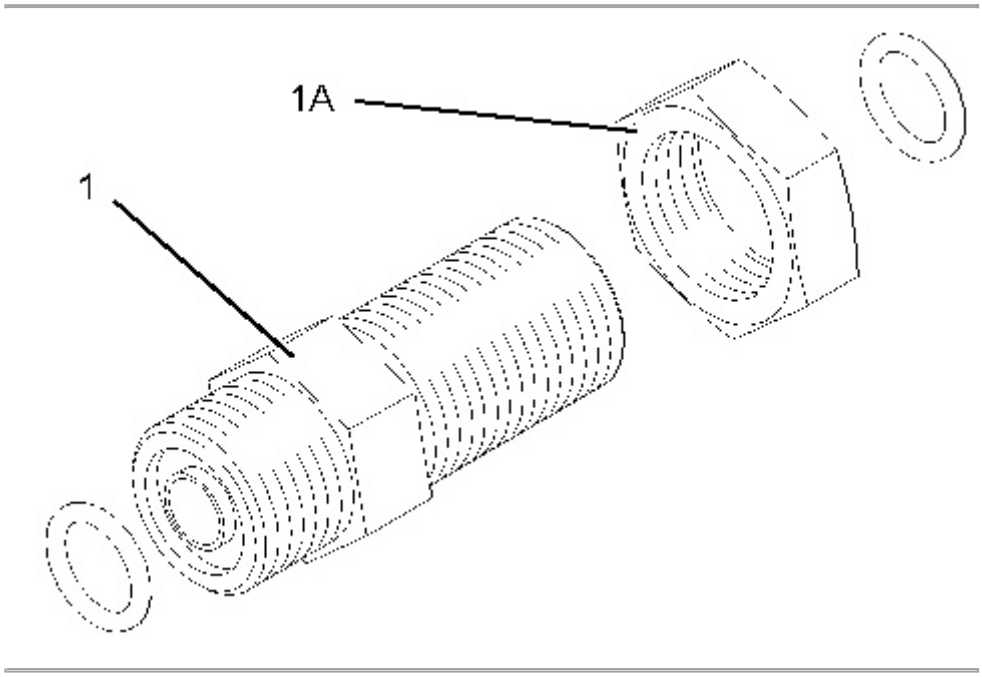


Illustration 1 g01848733

(1) Bulkhead connector

(1A) Bulkhead nut

Note: The bulkhead connector may have different connections. The type of fluid connection does not affect the torque for nut (1A) .

Note: When you assemble the fluid connection, do not use the bulkhead nut (1A) as leverage for a backup wrench. Use the hex on the body (1) of the connector for leverage.

Table 1

Thread Size Inch	Torque for O-ring Face Bulkhead Nuts

9/16	45 ± 7 N·m (33 ± 5 lb ft)
11/16	80 ± 12 N·m (59 ± 9 lb ft)
13/16	100 ± 15 N·m (74 ± 11 lb ft)
1	130 ± 20 N·m (96 ± 15 lb ft)
1 3/16	180 ± 27 N·m (133 ± 20 lb ft)
1 7/16	350 ± 53 N·m (258 ± 39 lb ft)
1 11/16	420 ± 63 N·m (310 ± 46 lb ft)
2	500 ± 75 N·m (369 ± 55 lb ft)

Table 2

Thread Size Inch	**Torque for 37 degree Flare Bulkhead Nuts**
5/16	13 ± 2 N·m (115 ± 18 lb in)
3/8	17 ± 3 N·m (150 ± 27 lb in)
7/16	30 ± 5 N·m (266 ± 44 lb in)
1/2	35 ± 5 N·m (26 ± 4 lb ft)
9/16	40 ± 6 N·m (30 ± 4 lb ft)
3/4	70 ± 11 N·m (52 ± 8 lb ft)
7/8	100 ± 15 N·m (74 ± 11 lb ft)
1 1/16	160 ± 24 N·m (118 ± 18 lb ft)
1 3/16	180 ± 27 N·m (132 ± 20 lb ft)
1 5/16	

	260 ± 39 N·m (192 ± 29 lb ft)
1 5/8	350 ± 53 N·m (258 ± 39 lb ft)
1 7/8	400 ± 60 N·m (295 ± 44 lb ft)
2 1/2	500 ± 75 N·m (369 ± 55 lb ft)

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Flare Fittings

SMCS - 7553

The torques in Table 1 are for 37 degree flare fittings. The torques in Table 2 are for 45 degree flare fittings and 45 degree inverted flare fittings.

37 Degree Flare Fittings

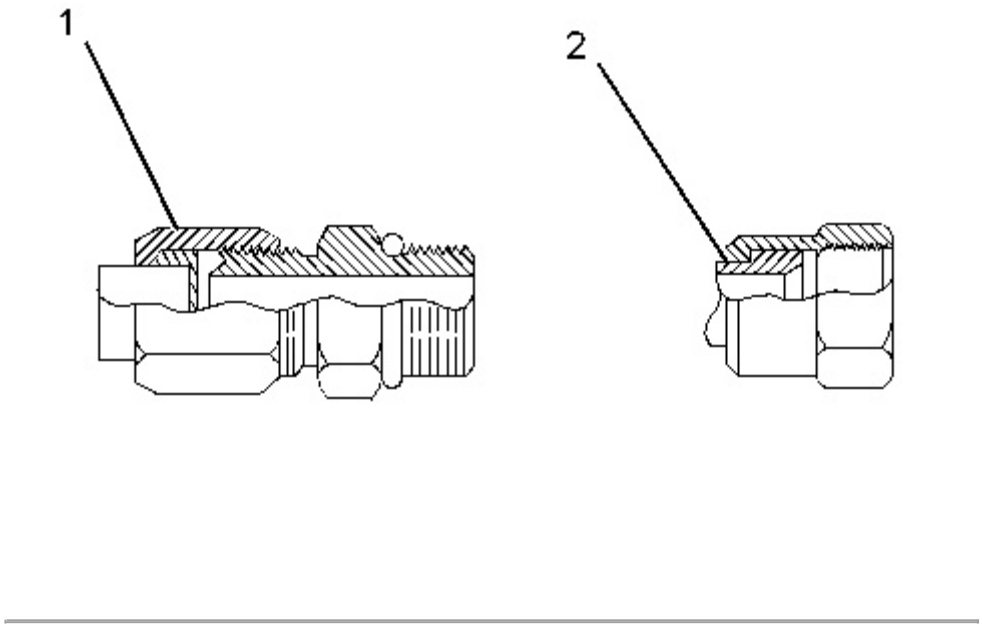


Illustration 1 g01848048

(1) 37 degree flare fitting

(2) Swivel nuts

Table 1

Nuts for 37 Degree Flare Fittings

Nominal Outer Diameter of the Tube	Thread Size Inch	Standard Torque
3.18 mm (0.125 inch)	5/16 - 24	10 ± 2 N·m (89 ± 18 lb in)
4.76 mm (0.188 inch)	3/8 - 24	13 ± 2 N·m (115 ± 18 lb in)
6.35 mm (0.250 inch)	7/16 - 20	20 ± 3 N·m (177 ± 27 lb in)
7.94 mm (0.312 inch)	1/2 - 20	25 ± 4 N·m (221 ± 35 lb in)
9.52 mm (0.375 inch)	9/16 - 18	30 ± 5 N·m (266 ± 44 lb in)
12.70 mm (0.500 inch)	3/4 - 16	60 ± 9 N·m (44 ± 7 lb ft)
15.88 mm (0.625 inch)	7/8 - 14	90 ± 13 N·m (66 ± 10 lb ft)
19.05 mm (0.750 inch)	1 1/16 - 12	120 ± 18 N·m (89 ± 13 lb ft)
22.22 mm (0.875 inch)	1 3/16 - 12	130 ± 20 N·m (96 ± 15 lb ft)
25.40 mm (1.000 inch)	1 5/16 - 12	160 ± 24 N·m (118 ± 18 lb ft)
31.75 mm (1.250 inch)	1 5/8 - 12	260 ± 39 N·m (192 ± 29 lb ft)
38.10 mm (1.500 inch)	1 7/8 - 12	260 ± 39 N·m (192 ± 29 lb ft)
50.80 mm (2.000 inch)	2 1/2 - 12	350 ± 53 N·m (258 ± 39 lb ft)

Note: Use 50 percent of the torque values from Table 1 when the fitting or the port material is nonferrous.

45 Degree Flare and Inverted Flare Fittings

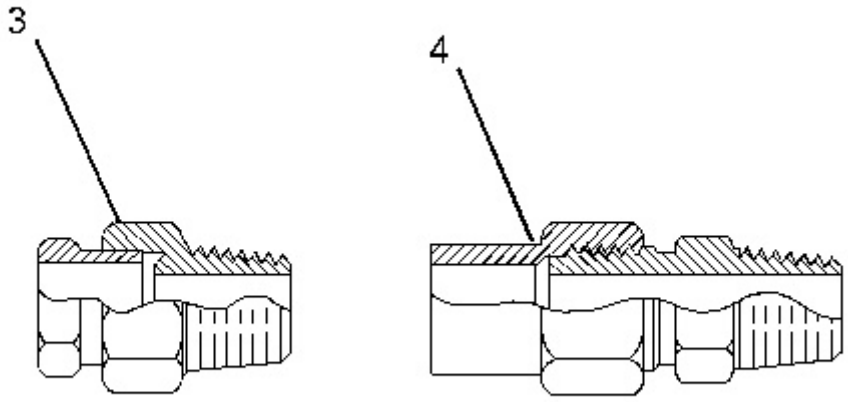


Illustration 2 g03335997

(3) Inverted Flare Fittings

(4) 45 Degree Flare Fittings

Table 2

45 Degree Flare Fittings and 45 Degree Inverted Flare Fittings		
Nominal Outer Diameter of the Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16	7 ± 1 N·m (62 ± 9 lb in)
4.76 mm (0.188 inch)	3/8	10 ± 2 N·m (89 ± 18 lb in)
6.35 mm (0.250 inch)	7/16	13 ± 2 N·m (115 ± 18 lb in)
7.94 mm (0.312 inch)	1/2	20 ± 3 N·m (177 ± 27 lb in)
9.52 mm (0.375 inch)	5/8	35 ± 5 N·m (26 ± 4 lb ft)
11.11 mm (0.438 inch)	11/16	35 ± 5 N·m (26 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4	40 ± 6 N·m (30 ± 4 lb ft)
15.88 mm (0.625 inch)	7/8	55 ± 8 N·m (41 ± 6 lb ft)
	1 1/16	

19.05 mm (0.750 inch)		100 ± 15 N·m (74 ± 11 lb ft)
22.22 mm (0.875 inch)	1 1/4	110 ± 17 N·m (81 ± 13 lb ft)

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Air Conditioning Fittings

SMCS - 7553

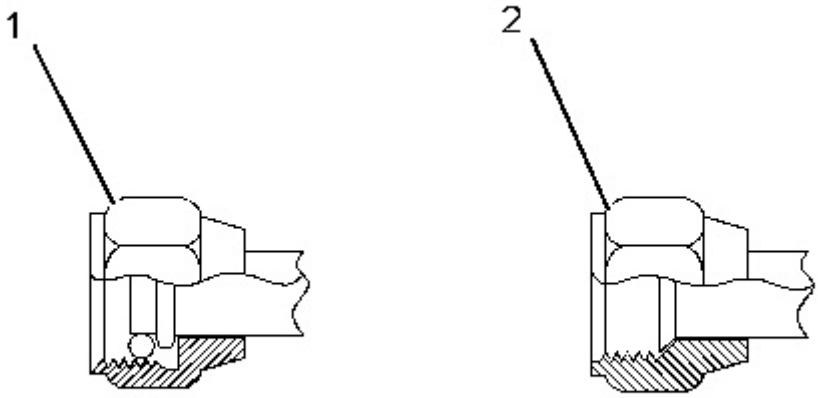


Illustration 1 g01848052

(1) O-ring seal

(2) 45 degree flare fitting

Table 1

Air Conditioning Fittings			
Thread Size Inch	O-Ring Fitting End	45 Degree Flare Fitting End	
	Torque	Torque for Steel Tubes	Torque for Aluminum Tubes
5/8			

	13 ± 2 N·m (115 ± 18 lb in)	30 ± 5 N·m (266 ± 44 lb in)	25 ± 4 N·m (221 ± 35 lb in)
3/4	25 ± 4 N·m (221 ± 35 lb in)	50 ± 8 N·m (37 ± 6 lb ft)	35 ± 5 N·m (26 ± 4 lb ft)
7/8 1	40 ± 6 N·m (30 ± 4 lb ft)	60 ± 9 N·m (44 ± 7 lb ft)	40 ± 6 N·m (30 ± 4 lb ft)
1 1/16	45 ± 7 N·m (33 ± 5 lb ft)	70 ± 11 N·m (51 ± 8 lb ft)	50 ± 8 N·m (37 ± 6 lb ft)

Table 2

Quick Disconnect Air Conditioning Fittings	
Thread Size Inch	**Torque**
7/8	45 ± 7 N·m (33 ± 5 lb ft)
1 1/4	60 ± 9 N·m (44 ± 7 lb ft)

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Air Brake Fittings

SMCS - 7553

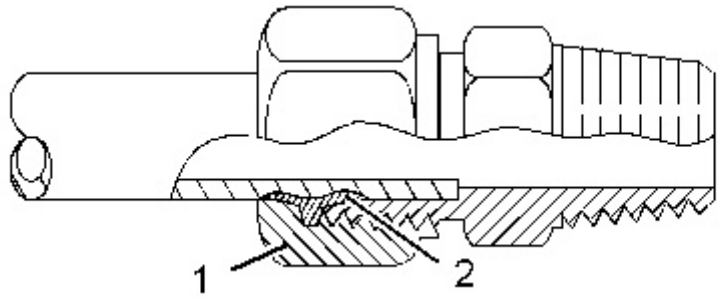


Illustration 1 g01848737

Put nut (1) and sleeve (2) over the tube. Push the tube into the counterbore of the fitting body as far as possible. There are two methods that may be used to tighten the nut. Tighten the nut with one of two methods.

- Tighten nut (1) to the torque that is specified in Table 1.
- Tighten nut (1) by the number of turns that is specified in Table 1. The number of turns is for the turns after the nut is finger tight.

Table 1

Nominal Outer Diameter of the Tube	Torque	Turn Tightening	
		Nonmetallic Tubing	Copper Tubing
6.35 mm (0.250 inch)	11 ± 3 N·m (97 ± 27 lb in)	3	2
9.53 mm (0.375 inch)	20 ± 3 N·m (175 ± 27 lb in)	4	2

12.70 mm (0.500 inch)	35 ± 6 N·m (26 ± 4 lb ft)	4	2
15.88 mm (0.625 inch)	40 ± 6 N·m (30 ± 4 lb ft)	3 1/2	3
19.05 mm (0.750 inch)	50 ± 6 N·m (37 ± 4 lb ft)	3 1/2	3

Note: Clean the connectors and the seals and lubricate the connectors and seals by using Refrigerant Mineral Oil. This is a special oil that is compatible with R−134a.

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Tapered Pipe Thread Fittings

SMCS - 7553

Torque is based on the diameter of the thread. The torque values are identical for coarse threads and fine threads.

Note: The following table has the recommended standard torque value for tapered pipe thread fitting for use on all Caterpillar equipment and Mitsubishi engines. Use Table 1 as a general recommendation only. Actual values may vary due to variations in the material of the connector. Actual values may vary due to variations in the characteristics of the threads.

Table 1

Tapered Pipe Thread Fittings		
	Standard Torque	
Diameter of the Pipe Thread (Inch)	**Assembly Turns after Hand Tight**	**Torque**
1/16	2	10 ± 2 N·m (89 ± 18 lb in)
1/8	2	17 ± 3 N·m (150 ± 27 lb in)
1/4	2	25 ± 4 N·m (221 ± 35 lb in)
3/8	2	40 ± 6 N·m (30 ± 4 lb ft)
1/2	2	55 ± 8 N·m (41 ± 6 lb ft)
3/4	2	

		70 ± 11 N·m (52 ± 8 lb ft)
1	1 1/2	100 ± 15 N·m (74 ± 11 lb ft)
1 1/4	1 1/2	110 ± 17 N·m (81 ± 13 lb ft)
1 1/2	1 1/2	120 ± 18 N·m (89 ± 13 lb ft)
2	1 1/2	160 ± 24 N·m (118 ± 18 lb ft)

Note: Use 50 percent of the torque values from Table 1 when fitting, plug, or the port material is nonferrous.

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Miscellaneous Fittings

SMCS - 7553

Hi Duty Tube Fittings (Shear Sleeve)

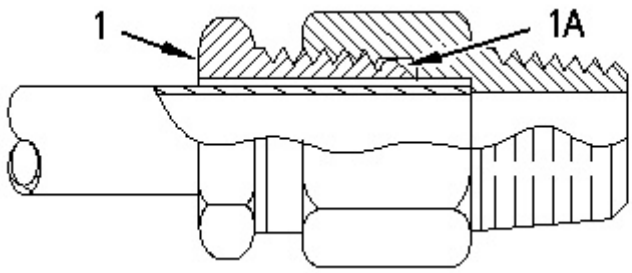


Illustration 1 g00909648

Put nut (1) over the tube and push the tube into the counterbore of the fitting body as far as possible. Turn the nut with a wrench until a small decrease in torque is felt. The small decrease in torque indicates that the sleeve (1A) has been broken off the nut. Hold the tube in order to prevent the tube from turning. Tighten the nut for an additional 1 1/2 turns.

SAE Flareless Fittings

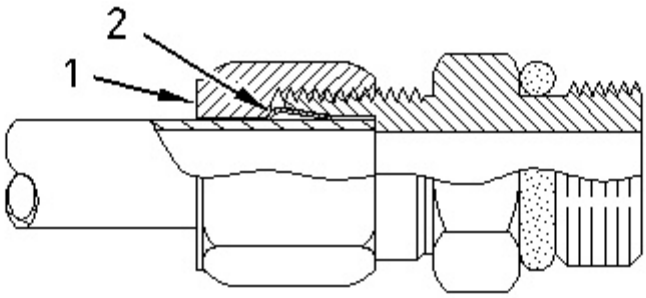


Illustration 2 g00909647

Installing a New Flareless Fitting

Put nut (1) and sleeve (2) over the tube. The head end of the sleeve should be next to the nut. The head end has a shoulder. The nut will be seated against this shoulder when the nut is tightened. Push the tube into the counterbore of the fitting body as far as possible. Turn nut (1) clockwise until the sleeve grips the tube. The sleeve must prevent all movement of the tube. Tighten the nut for an additional 1 1/4 turns. The sleeve should be seated and the sleeve should give a locking action.

Installing a Used Flareless Fitting

Less turns are required for a used fitting. Put nut (1) and sleeve (2) over the tube. The head of the sleeve should be next to the nut. Push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until a sudden increase in torque is felt. Next, tighten the fitting for an additional 1/6 to 1/3 turn in order to seat the sleeve.

Flex Fittings

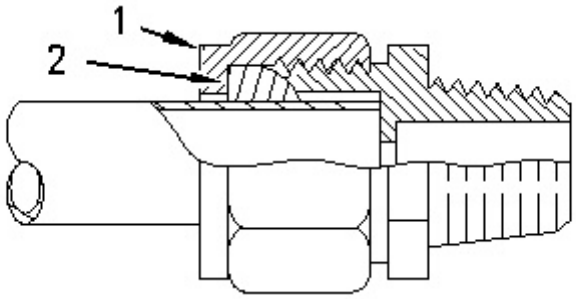


Illustration 3 g00909645

Put nut (1) and sleeve (2) over the tube and push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until the nut is against the hex part of the fitting body.

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Hose Clamps

SMCS - 7553

Worm Drive Band Type Clamps

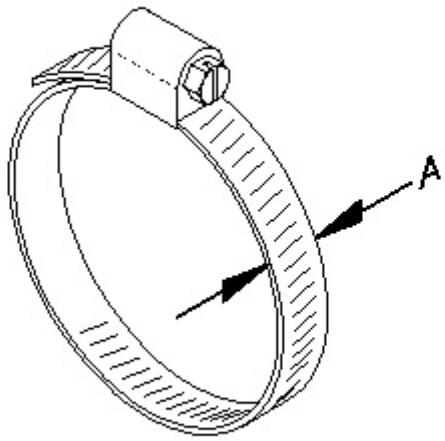


Illustration 1 g00910017

Table 1

Width (A) of Clamp	Torque for New Hose
7.5 mm (0.3 inch) or greater	1.4 ± 0.3 N·m (12 ± 3 lb in)
12 mm (0.5 inch) or greater	4.5 ± 0.7 N·m (40 ± 6 lb in)

14 mm (0.6 inch) or greater	7.5 ± 1 N·m (66 ± 9 lb in)
Width (A) of Clamp	**Torque for Reused Hose [1]**
7.5 mm (0.3 inch) or greater	0.8 ± 0.3 N·m (7 ± 3 lb in)
12 mm (0.5 inch) or greater	3.0 ± 0.5 N·m (27 ± 4 lb in)
14 mm (0.6 inch) or greater	4.5 ± 0.7 N·m (40 ± 6 lb in)

[1] Use this value when the hose is reused. The clamp may be new or reused.

Constant Torque Hose Clamps

Use a constant torque hose clamp in place of any worm drive band type clamp. Ensure that the constant torque hose clamp is the same size as the worm drive band type clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause worm drive band type clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by worm drive band type clamps that have loosened. The constant torque hose clamp will help prevent these failures.

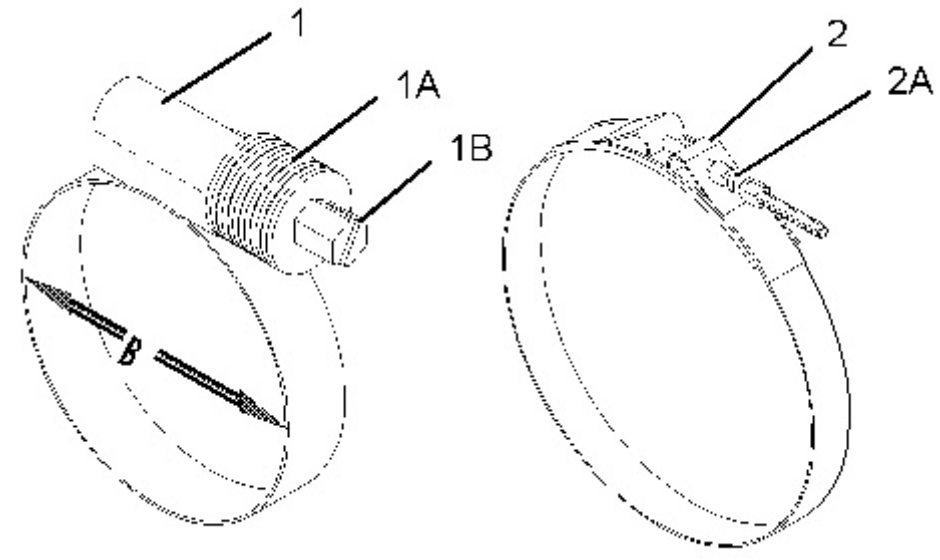


Illustration 2 g03076961

(1) Constant Torque Hose Clamp (Belleville Washer)

(2) Constant Torque Hose Clamp (Tee bolt and Spring)

Use a torque wrench for proper installation of all constant torque hose clamps. There are two types of constant torque hose clamps: Belleville washer (1) and Tee bolt and spring (2)

When the constant torque hose clamp (Belleville washer) (1) is assembled correctly, the Belleville washers (1A) are nearly collapsed flat. The proper torque for screw (1B) is based on the diameter (B) of the clamp. Refer to the following table for the correct torque.

Table 2

Diameter (B)	Standard Torque
Up to 50.8 mm (2 inch)	7.5 ± 1 N·m (65 ± 10 lb in)
Greater than 50.8 mm (2 inch)	11 ± 1 N·m (95 ± 10 lb in)

The correct torque for the constant torque hose clamp (tee bolt and spring) (2) is 7.5 ± 1 N·m (65 ± 10 lb in).

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Coupler Cylinder

SMCS - 5133

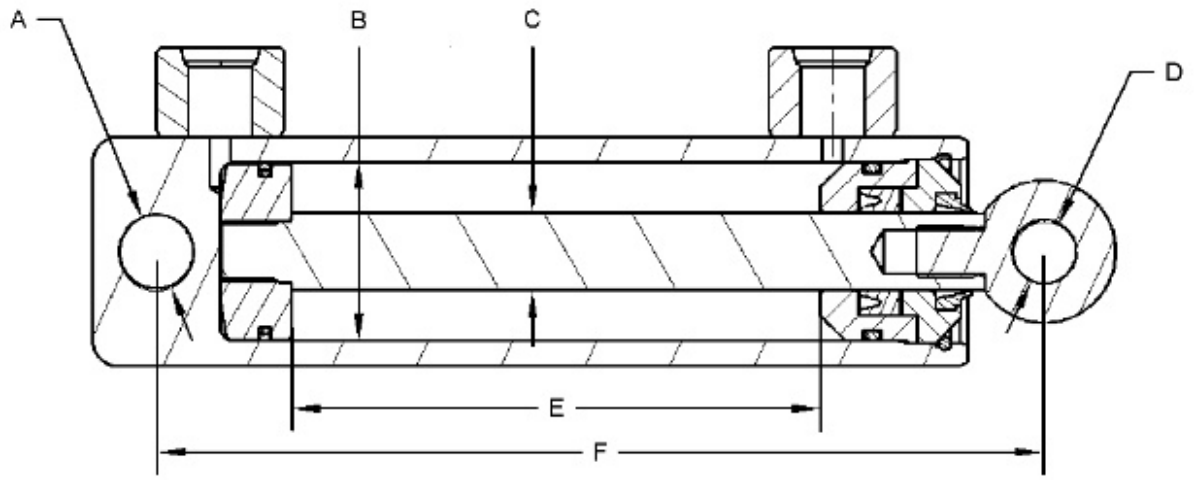


Illustration 1 g01543134

Note: Before assembly, all bores must be free of paint. Apply **5P-0960** Grease Cartridge to all the bores.

(A) Bore of the cap end ... 14.50 to 14.60 mm (0.571 to 0.575 inch)

(B) Bore of the cylinder assembly ... 35 mm (1.4 inch)

(C) Outside diameter of the rod assembly ... 15 mm (0.6 inch)

(D) Bore of the rod eye ... 12.50 to 12.60 mm (0.492 to 0.496 inch)

(E) Length of stroke ... 103.5 ± 1.5 mm (4.07 ± 0.06 inch)

(F) Closed length ... 174.0 ± 1.2 mm (6.85 ± 0.05 inch)

Extended length ... 277.5 ± 2.5 mm (10.93 ± 0.10 inch)

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Quick Coupler

SMCS - 6129

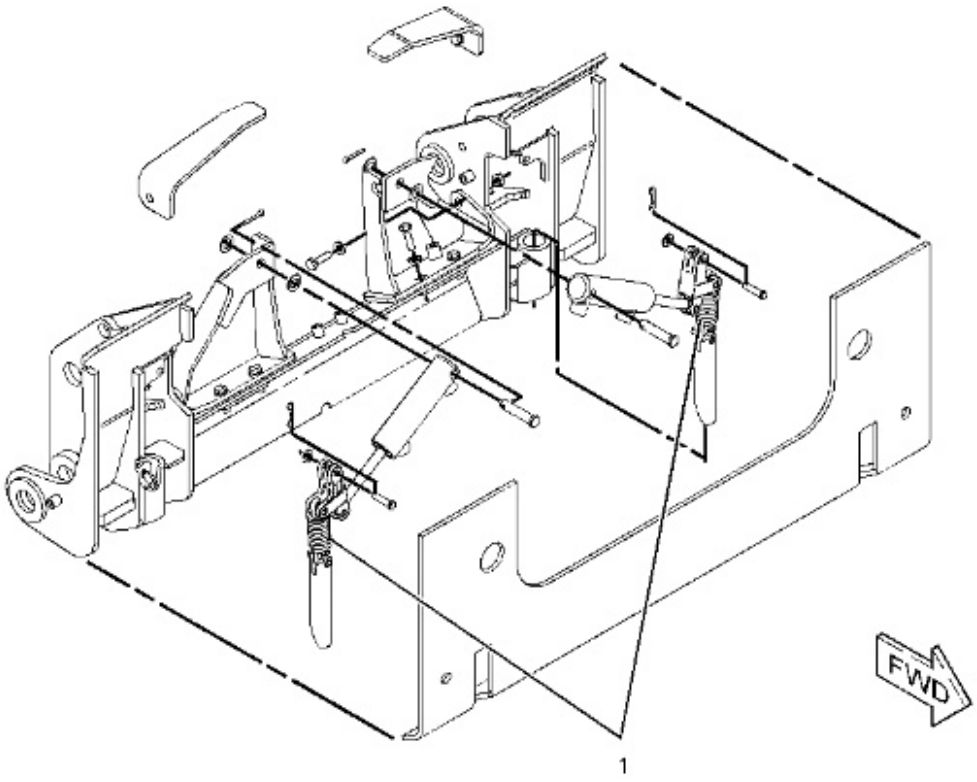


Illustration 1 g01422579

Note: Use a **5P-0960** Grease Cartridge in order to coat all pin bores.

(1) **238-7693** Spring

Quantity ... 2
Free length after test ... 88.9 mm (3.50 inch)

Outside diameter ... 32.1 mm (1.26 inch)

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Quick Coupler

SMCS - 6129

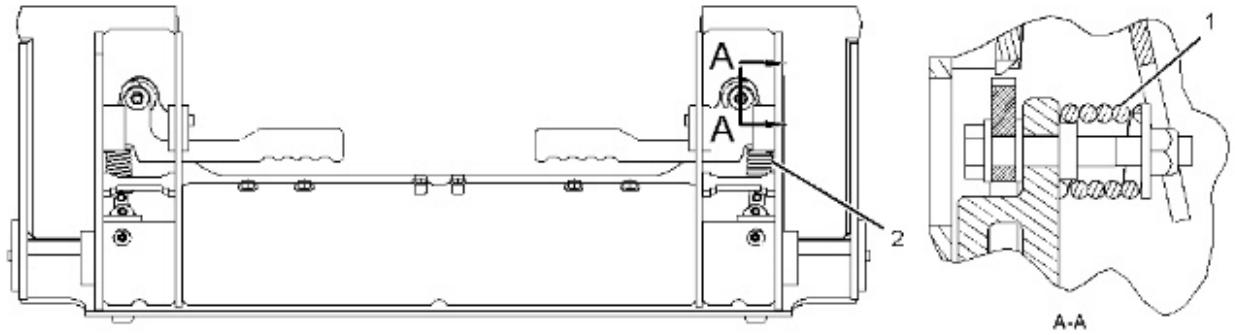


Illustration 1 g01422583

Note: Use a **5P-0960** Grease Cartridge in order to coat all pin bores.

(1) **159-5797** Spring

Quantity ... 2
Free length after test ... 36.2 mm (1.43 inch)
Outside diameter ... 31.75 mm (1.250 inch)

(2) **238-7693** Spring

Quantity ... 2
Free length after test ... 88.9 mm (3.50 inch)
Outside diameter ... 32.1 mm (1.26 inch)

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Coupler Cylinder

SMCS - 5133

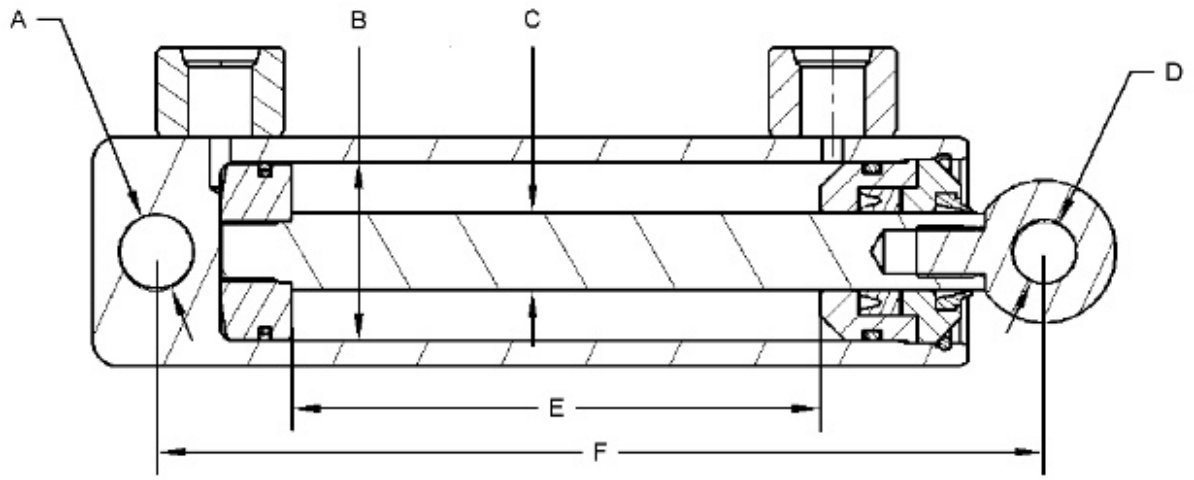


Illustration 1 g01543134

Note: Before assembly, all bores must be free of paint. Apply **5P-0960** Grease Cartridge to all the bores.

(A) Bore of the cap end ... 14.50 to 14.60 mm (0.571 to 0.575 inch)

(B) Bore of the cylinder assembly ... 35 mm (1.4 inch)

(C) Outside diameter of the rod assembly ... 15 mm (0.6 inch)

(D) Bore of the rod eye ... 12.50 to 12.60 mm (0.492 to 0.496 inch)

(E) Length of stroke ... 103.5 ± 1.5 mm (4.07 ± 0.06 inch)

(F) Closed length ... 174.0 ± 1.2 mm (6.85 ± 0.05 inch)

Extended length ... 277.5 ± 2.5 mm (10.93 ± 0.10 inch)

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Quick Coupler

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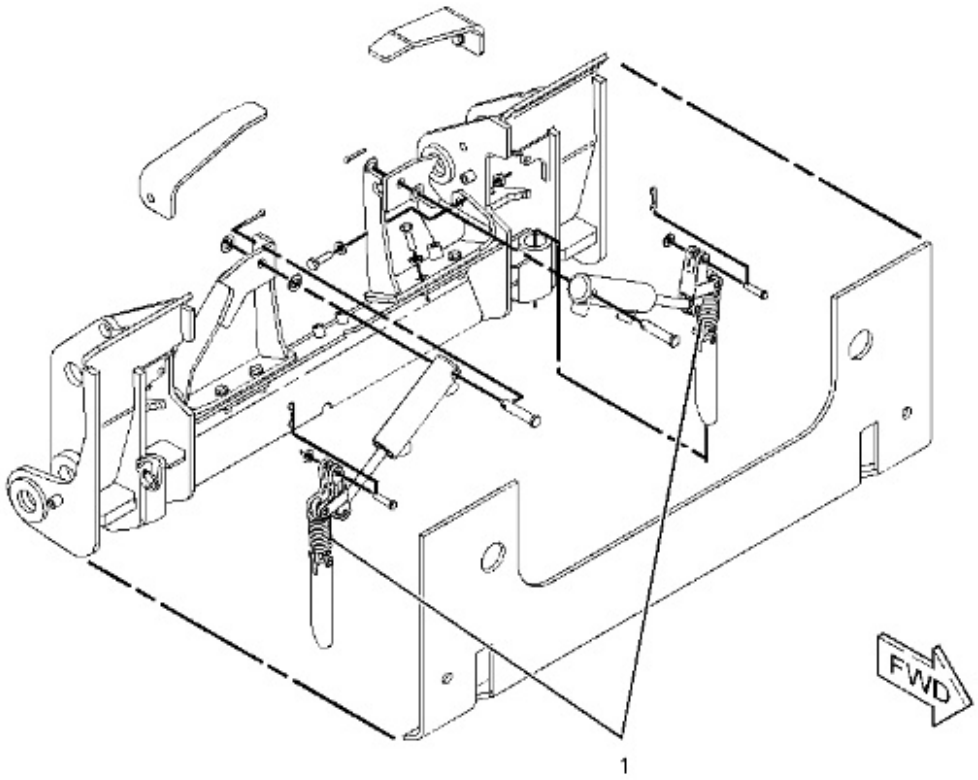


Illustration 1 g01422579

Note: Use a **5P-0960** Grease Cartridge in order to coat all pin bores.

(1) **238-7693** Spring

Quantity ... 2
Free length after test ... 88.9 mm (3.50 inch)

Outside diameter ... 32.1 mm (1.26 inch)

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Quick Coupler

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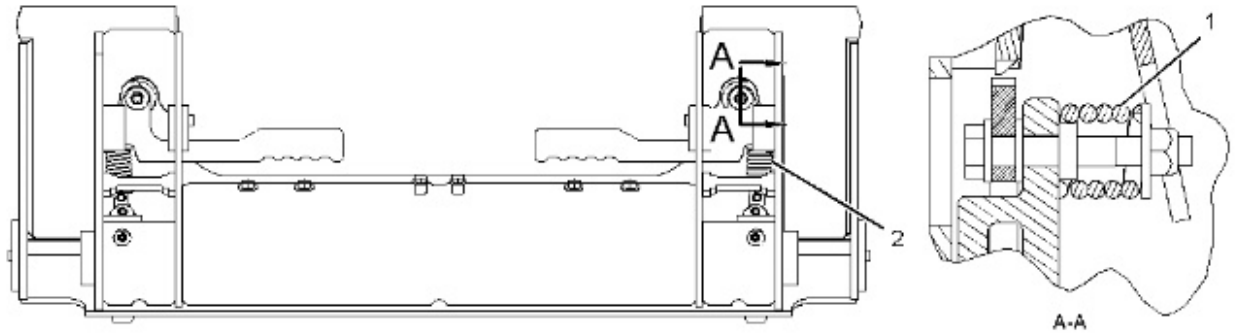


Illustration 1 g01422583

Note: Use a **5P-0960** Grease Cartridge in order to coat all pin bores.

(1) **159-5797** Spring

Quantity ... 2
Free length after test ... 36.2 mm (1.43 inch)
Outside diameter ... 31.75 mm (1.250 inch)

(2) **238-7693** Spring

Quantity ... 2
Free length after test ... 88.9 mm (3.50 inch)
Outside diameter ... 32.1 mm (1.26 inch)

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