

JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER
EQUIPMENT DIVISION

Compact Utility Tractor
2210

TM2074 FEBRUARY 2008

TECHNICAL MANUAL



JOHN DEERE

North American Version
Litho In U.s.a.

INTRODUCTION

Manual Description

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

Note: Depending on the particular section or system being covered, not all of the above groups may be used.

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

Safety

Specifications and Information

Engine

Electrical

Power Train

Hydraulics

Steering

Brakes

Miscellaneous

All information, illustrations and specifications in this manual are based on the latest information at the time of publication. The right is reserved to make changes at any time without notice.

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Consumer Equipment Division

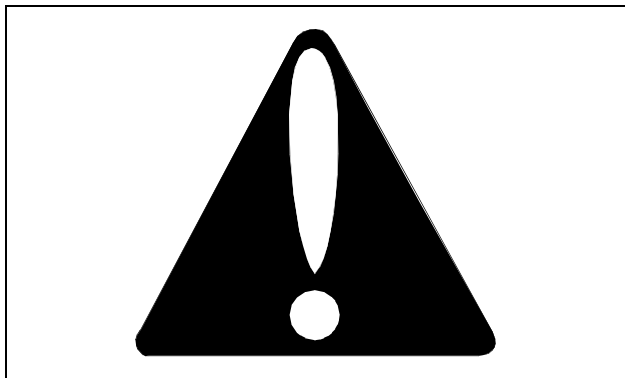
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Previous Editions

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SAFETY

Safety

Recognize Safety Information



MIF

This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

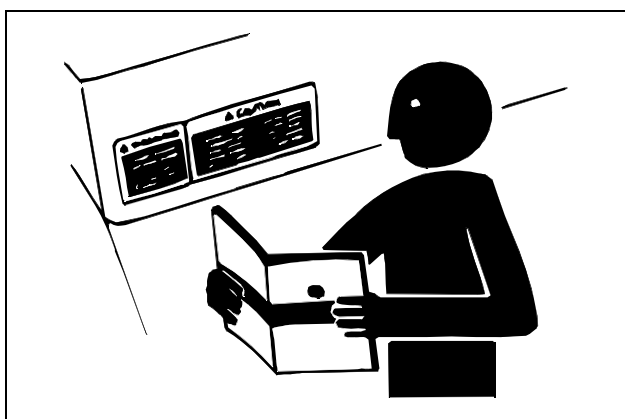
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word - DANGER, WARNING, or CAUTION - is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

Replace Safety Signs

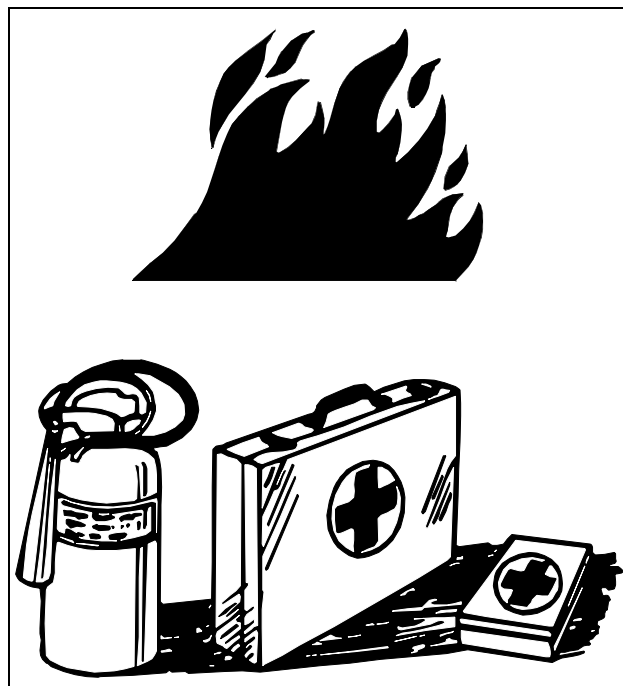


MIF

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

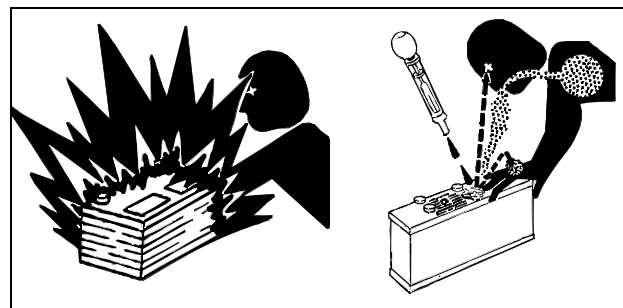
Be Prepared For Emergencies



MIF

- When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.
- Be prepared if a fire starts.
- Keep a first aid kit and fire extinguisher handy.
- Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

Use Care In Handling and Servicing Batteries



MIF

SAFETY

Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.
- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

Prevent Acid Burns

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid acid burns by:

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

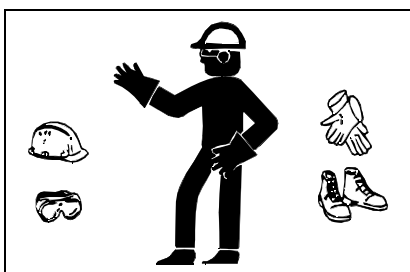
If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10 - 15 minutes.
4. Get medical attention immediately.

If acid is swallowed:

1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.

Wear Protective Clothing



MIF

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device

such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

Use Care Around High-pressure Fluid Lines

Avoid High-Pressure Fluids



MIF

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

Avoid Heating Near Pressurized Fluid Lines



MIF

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

SPECIFICATIONS & INFORMATION COOLANT SPECIFICATIONS

Coolant Specifications

Engine Coolant

The engine cooling system, when filled with a proper dilution mixture of anti-freeze and deionized or distilled water, provides year-round protection against corrosion, cylinder or liner pitting, and winter freeze protection down to -37°C (-34°F).

The following John Deere coolant is **PREFERRED**:

- PRE-DILUTED DIESEL ENGINE ANTI-FREEZE/SUMMER COOLANT™ (TY16036).

This coolant satisfies specifications for “Automobile and Light Duty Engine Service” and is safe for use in John Deere Lawn and Grounds Care/Golf and Turf Division equipment, including aluminum block gasoline engines and cooling systems.

The above preferred pre-diluted anti-freeze provides:

- adequate heat transfer
- corrosion-resistant chemicals for the cooling system
- compatibility with cooling system hose and seal material
- protection during extreme cold and extreme hot weather operations
- chemically pure water for better service life
- compliance with ASTM D4656 (JDM H24C2) specifications

If above preferred pre-diluted coolant is not available, the following John Deere concentrate is **recommended**:

- DIESEL ENGINE ANTI-FREEZE/SUMMER COOLANT CONCENTRATE™ (TY16034).

If either of above recommended engine coolants are not available use any Automobile and Light Duty Engine Service **ethylene glycol base coolant**, meeting the following specification:

- ASTM D3306 (JDM H24C1).

Read container label completely before using and follow instructions as stated.

Important: Avoid Damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze mixture in the cooling system. DO NOT mix or add any additives/conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality—clean, clear, potable water (low in chloride and hardness—Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is ideal to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Max.	170 ppm (10 grns/gal)
Chloride (as Cl), Max.	40 ppm (2.5 grns/gal)
Sulfate (as SO ₄), Max.	100 ppm (5.8 grns/gal)

Mix 50 percent anti-freeze concentrate with 50 percent distilled or deionized water. This mixture and the prediluted mixture (TY16036) will protect the cooling system down to -37°C (-34°F) and up to 108°C (226°F).

Certain geographical areas may require lower air temperature protection. See the label on your anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Engine Coolant Drain Interval

When using **John Deere Pre-Diluted (TY16036)** Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every **36 months or 3,000 hours** of operation, whichever comes first.

When using **John Deere Concentrate (TY16034)** Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every **24 months or 2,000 hours** of operation, whichever comes first.

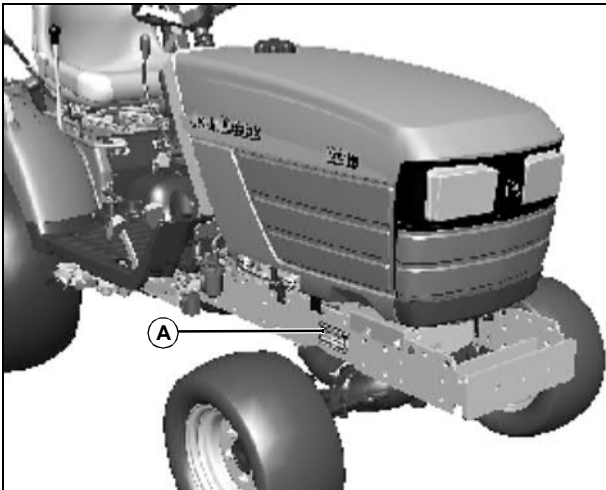
If above John Deere Automobile and Light Duty Engine Service coolants **are not** being used, drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator’s manual or technical manual.

SPECIFICATIONS & INFORMATION SERIAL NUMBER LOCATIONS

Serial Number Locations

Machine Product Identification Number

When ordering parts or submitting a warranty claim, it is **IMPORTANT** that the machine product identification number (PIN) and component serial numbers are included. The location of the PIN and component serial numbers are shown.



Located on right-hand side of frame beneath the front of the engine.

Engine Serial Number



Located on top of the engine rocker cover.

ENGINE - DIESEL TABLE OF CONTENTS

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ENGINE - DIESEL SPECIFICATIONS

Specifications

General Specifications

Specifications:

Make	Yanmar
Model	2210
Type	4-Cycle Diesel
Gross Power @ 3000 rpm	17.1 kW (23 HP)
Torque @ 2100 rpm	62.4 N•m (46.0 lb-ft)
Number of Cylinders	3
Bore	74 mm (2.91 in.)
Stroke	78 mm (3.07 in.)
Displacement	1.006 L (61.4 cu in.)
Firing Order	1 - 3 - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect Injection Type
Compression Ratio	23 to 1
Cooling	Liquid
Oil Capacity (w/filter)	Approximately 2.0 L (2.1 qt)
Governor	Centrifugal
Slow Idle (no-load)	1400 rpm
High Idle (no-load)	3275 rpm

Repair Specifications

Valve Train:

Rocker Arm Shaft OD	11.966 - 11.984 mm (0.471 - 0.472 in.)
Wear Limit	11.95 mm (0.470 in.)
Rocker Arm and Shaft Support Bushings ID	12.00 - 12.02 mm (0.472 - 0.473 in.)
Wear Limit	12.09 mm (0.476 in.)
Oil Clearance	0.016 - 0.054 mm (0.0006 - 0.0021 in.)
Wear Limit	0.14 mm (0.006 in.)
Push Rod Bend (maximum)	0.0 - 0.03 mm (0.0 - 0.001 in.)

Cylinder Head:

Cylinder Head Distortion	0.000 - 0.05 mm (0.000 - 0.002 in.)
Wear Limit	0.15 mm (0.006 in.)

Valve Seat Width (Non-Removable):

Intake	1.44 mm (0.057 in.)
Wear Limit	1.98 mm (0.078 in.)
Exhaust	1.77 mm (0.070 in.)
Wear Limit	2.27 mm (0.089 in.)

Valve Seat Angles:

Exhaust Valve	45°
Intake Valve	30°
Lower Seat Surface	70°

ENGINE - DIESEL SPECIFICATIONS

Upper Seat Surface	15°
Intake Valve Head Margin	0.99 - 1.29 mm (0.004 - 0.005 in.)
Exhaust Valve Head Margin	0.95 - 1.25 mm (0.004 - 0.005 in.)
Wear Limit	0.50 mm (0.002 in.)

Valves:

Intake Valve Recession	0.40 - 0.60 mm (0.016 - 0.024 in.)
Exhaust Valve Recession	0.75 - 0.95 mm (0.030 - 0.0374 in.)
Wear Limit (Intake and Exhaust)	1.0 mm (0.039 in.)
Intake Valve Stem Diameter	6.960 - 6.975 mm (0.274 - 0.274 in.)
Exhaust Valve Stem Diameter	6.945 - 6.960 mm (0.273 - 0.276 in.)
Wear Limit (Intake and Exhaust)	6.90 mm (0.272 in.)

Valve Guide:

ID	7.005 - 7.020 mm (0.275 - 0.276 in.)
Wear Limit	7.08 mm (0.279 in.)
Installed Height	9 mm (0.354 in.)

Valve Stem-To-Guide Oil Clearance:

Intake	0.030 - 0.060 mm (0.001 - 0.002 in.)
Exhaust	0.045 - 0.075 mm (0.002 - 0.003 in.)
Wear Limit	0.18 mm (0.007 in.)

Valve Springs:

Free Length	37.4 mm (1.472 in.)
Maximum Inclination	1.0 mm (0.032 in.)
Tension Measured With Spring Compressed 1.0 mm (0.039)	2.37 - 1.87 kg (5.22 - 4.12 lb)

Connecting Rod:

Large End Bearing ID	43.000 - 43.016 mm (1.693 - 1.694 in.)
Large End Bearing Thickness	1.487 - 1.500 mm (0.058 - 0.059 in.)
0.25 mm (0.010 in.) Oversize Bearing Thickness	1.625 mm (0.064 in.)
Large End Bearing Oil Clearance	0.033 - 0.059 mm (0.001 - 0.002 in.)
Large End Bearing Wear Limit	0.15 mm (0.006 in.)
Connecting Rod Side Play	0.20 - 0.40 mm (0.008 - 0.016 in.)
Twist and Parallelism	0.00 - 0.03 mm per 100 mm (0.00 - 0.001 in. per 6 in.)
Wear Limit	0.08 mm per 100 mm (0.005 in. per 6 in.)

(For Connecting Rod Small End Specifications, See "Piston Pin" Below)

Top Piston Ring Specifications:

Ring Groove Width	1.550 - 1.570 mm (0.061 - 0.062 in.)
Ring Width	1.470 - 1.490 mm (0.058 - 0.059 in.)
Minimum Side Clearance	0.060 - 0.100 mm (0.002 - 0.004 in.)
Ring End Gap	0.200 - 0.400 mm (0.008 - 0.016 in.)

2nd Piston Ring Specifications:

Piston Groove Width	1.520 - 1.535 mm (0.059 - 0.060 in.)
Ring Width	1.410 - 1.430 mm (0.055 - 0.056 in.)
Minimum Side Clearance	0.090 - 0.125 mm (0.004 - 0.005 in.)

ENGINE - DIESEL SPECIFICATIONS

Ring End Gap 0.200 - 0.400 mm (0.008 - 0.015 in.)

Oil Control Ring Specifications:

Piston Groove Width 3.010 - 3.025 mm (0.118 - 0.119 in.)
 Ring Width 2.970 - 2.990 mm (0.117 - 0.118 in.)
 Minimum Side Clearance 0.020 - 0.055 mm (0.0008 - 0.002 in.)
 Ring End Gap 0.150 - 0.350 mm (0.006 - 0.014 in.)
 Ring End Gap Wear Limit (All Rings) 1.5 mm (0.059 in.)

Piston Pin Specifications:

Piston Pin OD 20.99 - 21.00 mm (0.826 - 0.827 in.)
 Wear Limit 20.90 mm (0.823 in.)

Connecting Rod:

Connecting Rod Bushing ID 21.025 - 21.038 mm (0.828 - 0.828 in.)
 Wear Limit 21.10 mm (0.831 in.)

Piston Pin-To-Rod Bushing:

Oil Clearance 0.025 - 0.047 mm (0.001 - 0.002 in.)
 Wear Limit 0.2 mm (0.008 in.)

Piston Pin:

Piston Pin Bore (In Piston) ID 21.000 - 21.008 mm (0.827 - 0.827 in.)
 Wear Limit 21.02 mm (0.828 in.)
 Piston Pin-To-Piston Oil Clearance 0.000 - 0.017 mm (0 - 0.0007 in.)
 Wear Limit 0.12 mm (0.005 in.)

Piston (Measured 24 mm (0.945 in.) up from bottom of piston skirt, perpendicular to piston pin.):

Standard Piston OD 73.955 - 73.980 mm (2.912 - 2.913 in.)
 Wear Limit 73.90 mm (2.909 in.)
 Oversize Piston - 0.25 mm (0.010 in.) OD 74.205 - 74.230 mm (2.921 - 2.922 in.)
 Wear Limit 74.15 mm (2.919 in.)

Cylinder Bore:

Standard ID 74.00 - 74.03 mm (2.913 - 2.915 in.)
 Wear Limit 74.20 mm (2.921 in.)
 Oversize Bore - 0.25 mm (0.010 in.) ID 74.25 - 74.28 mm (2.923 - 2.924 in.)
 Clearance (Piston-To-Cylinder) 0.030 - 0.060 mm (0.001 - 0.002 in.)
 Cylinder Roundness 0.00 - 0.01 mm (0 - 0.0004 in.)
 Cylinder Roundness Wear Limit 0.03 mm (0.001 in.)
 Cylinder Taper 0.00 - 0.01 mm (0 - 0.0004 in.)
 Cylinder Taper Wear Limit 0.03 mm (0.001 in.)
 Deglazing 30 - 40° crosshatch pattern
 Reboring 30 - 40° crosshatch pattern

Crankshaft:

OD 39.97 - 39.98 mm (1.573 - 1.574 in.)
 Wear Limit 39.91 mm (1.571 in.)

ENGINE - DIESEL SPECIFICATIONS

Connecting Rod Bearing:

Inside Diameter	43.000 - 43.016 mm (1.693 - 1.694 in.)
Thickness	1.487 - 1.500 mm (0.058 - 0.059 in.)
0.25 mm (0.010 in.) Oversize Bearing Thickness	1.625 mm (0.064 in.)
Oil Clearance	0.033 - 0.059 mm (0.001 - 0.002 in.)
Wear Limit	0.15 mm (0.006 in.)

Main Bearing Journal:

Outside Diameter	43.970 - 43.980 mm (1.728 - 1.732 in.)
Wear Limit	43.90 mm (1.728 in.)

Main Bearing:

Insert Thickness	1.987 - 2.000 mm (0.078 - 0.079 in.)
0.25 mm (0.010 in.) Under Size Bearing Thickness	2.125 mm (0.084 in.)
Oil Clearance	0.033 - 0.059 mm (0.001 - 0.002 in.)
Wear Limit	0.15 mm (0.006 in.)

Crankshaft:

Thrust Bearing Insert Thickness	1.93 - 1.98 mm (0.076 - 0.078 in.)
0.25 mm (0.010 in.) Oversize Thrust Bearing Thickness	2.125 mm (0.084 in.)
Crankshaft Maximum Bend	0.02 mm (0.0008 in.)
Crankshaft End Play	0.090 - 0.271 mm (0.004 - 0.011 in.)

Camshaft:

Camshaft End Play	0.05 - 0.25 mm (0.002 - 0.010 in.)
Maximum Camshaft Bend	0 - 0.02 mm (0 - 0.0008 in.)
Camshaft Wear Limit	0.05 mm (0.002 in.)

Front Journal:

OD (Camshaft Gear Side)	35.940 - 35.960 mm (1.572 - 1.573 in.)
Wear Limit	39.85 mm (1.569 in.)
Oil Clearance	0.040 - 0.085 mm (0.002 - 0.003)

Intermediate Journals:

OD	39.910 - 39.935 mm (1.571 - 1.572 in.)
Wear Limit	39.85 mm (1.569 in.)
Oil Clearance	0.065 - 0.115 mm (0.002 - 0.005 in.)

Rear Journal:

OD (Flywheel Side)	39.940 - 39.960 mm (1.572 - 1.573 in.)
Wear Limit	39.85 mm (1.569 in.)
Oil Clearance	0.040 - 0.125 mm (0.002 - 0.005 in.)

Bushing:

ID	40.075 - 40.140 mm (1.578 - 1.580 in.)
Wear Limit	40.18 mm (1.582 in.)
Clearance	0.040 - 0.125 mm (0.002 - 0.005 in.)

Cam Lobes:

Lobe Height (Intake and Exhaust Lobes)	33.950 - 34.050 mm (1.33 - 1.34 in.)
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ENGINE - DIESEL SPECIFICATIONS

Wear Limit 33.75 mm (1.329 in.)

Tappets:

OD 20.927 - 20.960 mm (0.824 - 0.825 in.)

Wear Limit 20.90 mm (0.823 in.)

Cylinder Block Guide Hole ID 21.000 - 21.021 mm (0.827 - 0.828 in.)

Wear Limit 21.05 mm (0.829 in.)

Oil Clearance 0.040 - 0.094 mm (0.002 - 0.004 in.)

Wear Limit 0.15 mm (0.006 in.)

Timing Gear Backlash:

All Except Crankshaft Gear-to-Oil Pump Gear 0.04 - 0.12 mm (0.0016 - 0.0047 in.)

Crankshaft Gear-to-Oil Pump Gear 0.11 - 0.19 mm (0.004 - 0.008 in.)

Idler Gear:

Shaft Outside Diameter 19.959 - 19.980 mm (0.786 - 0.787 in.)

Shaft Wear Limit 19.93 mm (0.785 in.)

Bushing Inside Diameter 20.000 - 20.021 mm (0.787 - 0.788 in.)

Oil Clearance 0.020 - 0.062 mm (0.0008 - 0.002 in.)

Oil Clearance Wear Limit 0.15 mm (0.006 in.)

Flywheel:

Maximum Distortion 0.02 mm (0.0008 in.)

Oil Pump:

Rotor Shaft OD-to-Back Plate ID Clearance 0.013 - 0.043 mm (0.0005 - 0.002 in.)

Wear Limit 0.20 mm (0.008 in.)

Outer Rotor-to-Pump Body Clearance 0.10 - 0.16 mm (0.004 - 0.006 in.)

Wear Limit 0.25 mm (0.010 in.)

Inner Rotor-to-Outer Rotor Clearance Wear Limit 0.15 mm (0.006 in.)

Inner and Outer Rotor-to-Back Plate Side Clearance 0.03 - 0.09 mm (0.001 - 0.004 in.)

Inner and Outer Rotor-to-Back Plate Side Clearance Wear Limit 0.13 mm (0.005 in.)

Oil Pressure Regulating Valve:

Spring Compressed Length 14.70 mm (0.580 in.) @12 N (2.7 lb)

Spring Free Length 21.90 - 24.50 mm (0.860 - 0.960 in.)

Fuel Injection Pump:

Fuel Pump Pressure 29 kPa (4.3 psi)

Fuel Pump Flow Volume 118 cm³/minute (4 ounces/minute)

Fuel Injection Pump Camshaft:

Bearing Retaining Screw Torque 20 N·m (180 lb-in.)

Minimum Lobe Height 30.90 mm (1.217 in.)

Fuel Control and Governor Linkage:

Governor Shaft OD (Minimum) 7.90 mm (0.311 in.)

Sleeve ID (Maximum) 8.25 mm (0.325 in.)

Injection Pump Camshaft OD (Minimum) 7.90 mm (0.311 in.)

ENGINE - DIESEL SPECIFICATIONS

Fuel Injection Nozzles:

Separator Plate Nozzle Contact Surface Maximum Wear 0.10 mm (0.0039 in.)

Cooling System:

Coolant Temperature Switch Continuity (Closing) Temperature 107 - 113 °C (225 - 235 °F)

Radiator Bubble Test (Maximum Air Pressure Into Cylinder) 2448 kPa (355 psi)

Tests and Adjustment

Specifications:

Valve Clearance 0.15 - 0.25 mm (0.006 - 0.010 in.)

Connecting Rod Side Play 0.2 - 0.4 mm (0.008 - 0.016 in.)

Connecting Rod Bearing Clearance 0.03 - 0.06 mm (0.001 - 0.002 in.)

Crankshaft End Play 0.09 - 0.27 mm (0.004 - 0.011 in.)

Crankshaft Main Bearing Clearance 0.04 - 0.09 mm (0.002 - 0.004 in.)

Camshaft End Play 0.05 - 0.25 mm (0.002 - 0.010 in.)

Fuel Injection Nozzle:

Opening Pressure 11700 + 980/ - 0 kPa (1700 + 140/ - 0 psi)

Leakage at 11032 kPa (1600 psi) None for a minimum of 10 seconds

Chatter and Spray Pattern at 11700 ± 980kPa (1700 ± 140 psi):

Slow Hand Lever Movement Chatter Sound

Slow Hand Lever Movement Fine Stream

Fast Hand Lever Movement Fine Atomized Spray; 150° Spray Pattern

Alternator Drive Belt Deflection @ 98 N (22 lb) Applied Force 10 - 15 mm (0.4 - 0.6 in.)

Operational Tests

Specifications:

Cylinder Compression Pressure @250 RPM Cranking Speed 3432 kPa (498 psi)

(Minimum) 2746 kPa (398 psi)

Difference Between Cylinders 245 kPa (36 psi)

Radiator Cap Opening Pressure 0.9 ± 0.15 kg/cm², 88.3 ± 14.7 kPa, (12.8 ± 2.2 psi)

Cooling System Pressure Test 0.9 ± 0.15 kg/cm², 88.3 ± 14.7 kPa, (12.8 ± 2.2 psi)

Thermostat:

Thermostat Opening Temperature 69.5 - 72.5 °C (157 - 163 °F)

Thermostat Minimum Lift Height above 85 °C (185 °F) 8 mm (0.315 in.)

Oil Pressure:

Rated Speed 290 ± 50 kPa (42 ± 7 psi)

Slow Idle (Minimum) 60 kPa (9 psi)

Oil Relief Valve Opening Pressure 294 - 392 kPa (43 - 57 psi)

Oil Pressure Switch Opening Pressure 3 - 4 kPa (6 - 9 psi)

ENGINE - DIESEL SPECIFICATIONS

Tightening Torques

Torque Specifications:

Cylinder Head Bolts (Lubricating Oil Applied)	59 - 64 N•m (44 - 47 lb-ft)
Connecting Rod Bolts (Lubricating Oil Applied)	23 - 28 N•m (17 - 20 lb-ft)
Crankshaft Pulley Cap Screw (Lubricating Oil Applied)	83 - 93 N•m (61 - 69 lb-ft)
Engine Back Plate Mounting Cap Screw	91 N•m (67 lb-ft)
Engine Isolator Mounting Cap Screws	23 - 30 N•m (17 - 22 lb-ft)
Exhaust Manifold Mounting Cap Screw and Nut	25 N•m (221 lb-in.)
Fan Mounting Cap Screw	11 N•m (97 lb-in.)
Flywheel Mounting Bolts (Lubricating Oil Applied)	78 - 88 N•m (58 - 65 lb-ft)
Fuel Injection Nozzle Torque	50 N•m (37 lb-ft)
Fuel Injection Nozzle Fitting Torque	40 N•m (30 lb-ft)
Glow Plugs	15 - 20 N•m (11 - 15 lb-ft)
Governor Weight Support Nut	69 - 74 N•m (51 - 55 lb-ft)
Injector Pump-to-Timing Cover Cap Screw	20 N•m (15 lb-ft)
Intake Manifold Mounting Cap Screw	11 N•m (97 lb-in.)
Main Bearing Bolts (Lubricating Oil Applied)	58 - 61 N•m (43 - 45 lb-ft)
Oil Pan-to-Block	11 N•m (97 lb-in.)
Oil Pan-to-Seal Case	9 N•m (80 lb-in.)
Oil Pan-to-Timing Gear Housing	9 N•m (80 lb-in.)
Oil Pump Housing-to-Valve Body Retaining Nut	30 N•m (22 lb-ft)
Oil Strainer-to-Block	11 N•m (97 lb-in.)
Rocker Arm Cover Special Nut	18 N•m (159 lb-in.)
Rear Crankcase Oil Seal Case-to-Block Cap Screw	11 N•m (97 lb-in.)
Shaft Nut	27 N•m (20 lb-ft)
Timing Cover Mounting Cap Screw	9 N•m (78 lb-in.)

ENGINE - DIESEL TOOLS AND MATERIALS

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to pressurize injector nozzles for testing diesel fuel systems.
Adapter Set	D01110AA	Allows various diesel fuel injectors to be connected to a diesel fuel injection nozzle tester.
Straight Adapter	23622	Serves as a straight extension for testing diesel fuel injection nozzles.
Compression Gauge Assembly	JT01682	Tests cylinder compression pressure.
Adapter	JDG472	Allows a compression tester to be connected to a diesel engine cylinder injection port.
Belt Tension Gauge	JDG529 or JDST28	Applies measured pressure to drive belts to allow deflection measurements.
Cooling System Pressure Pump	D05104ST	Used to pressurize cooling system to check for leaks.
Radiator Pressure Test Kit.(Adapters)	JDG692	Allows various cooling systems and radiator caps to be pressurized with a pump and tested for leaks.
Hose Assembly	JT03017	Connects a pressure gauge to an oil pressure sending unit fitting.
Pressure Gauge (100 psi)	JT05577	Measures an engine's oil pressure.
Connector	JT03349	Used for connecting a pressure gauge to the engine oil pressure switch fitting.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Fuel Pump Pressure Test Kit	JDG356	Measures transfer pump pressure.
Valve Spring Compressor	JDE138	Compresses valve springs for removal and installation of cylinder head valves.
Valve Guide Driver	JDE504	Used for removal and installation of cylinder head valve guides.
Plastigage	Obtain Locally	Measuring bearing clearances.

Other Materials

Other Material

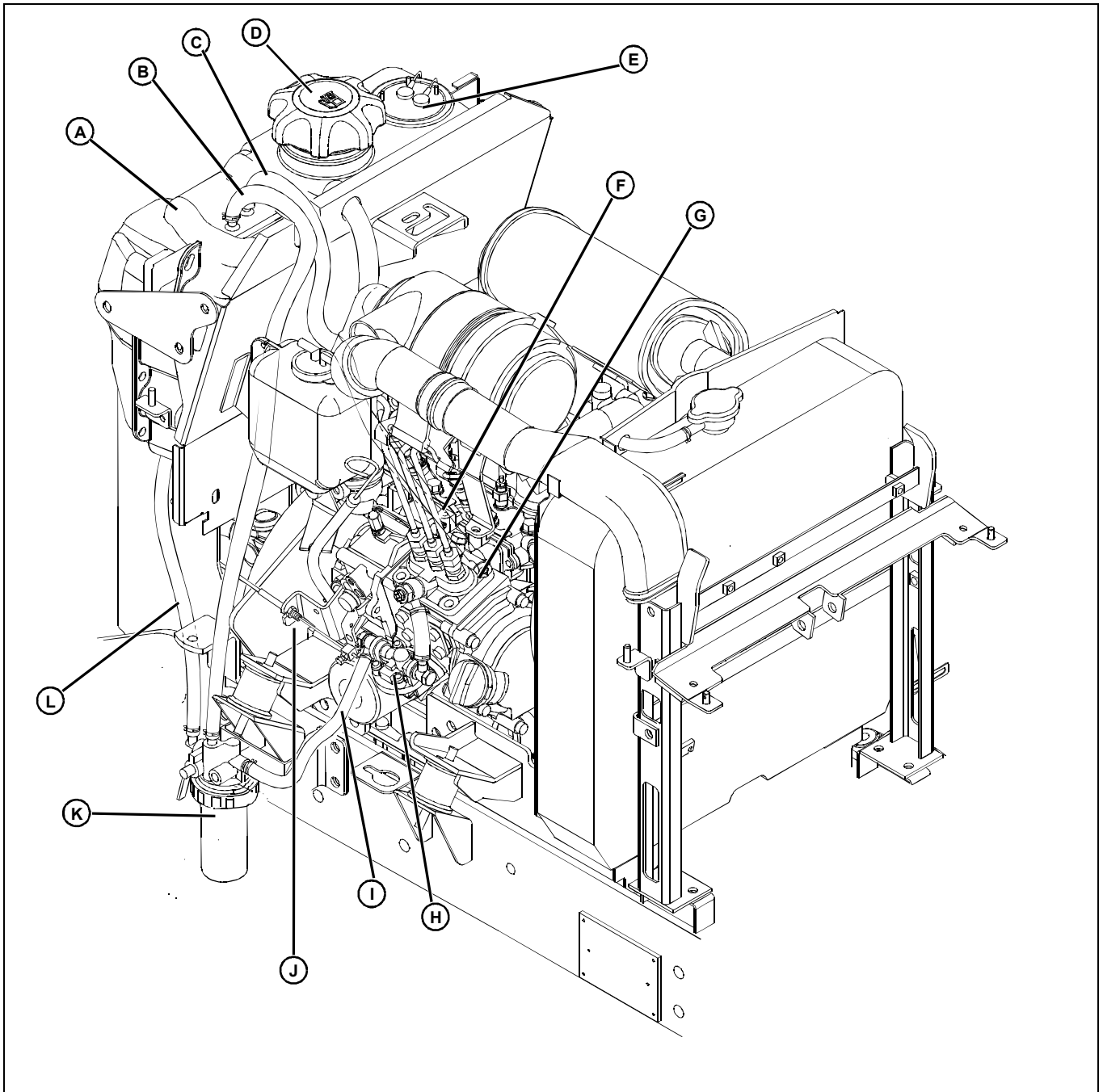
Part No.	Part Name	Part Use
PM37565 LOCTITE 587 Canada PM38616	RTV Silicone Form-in-Place Gasket	Seals crankcase extension housing, rear oil seal case and flywheel housing to engine block. Seals oil pan to timing gear housing and engine block.
PM37418 LOCTITE 242	Thread Lock and Sealer (Medium Strength)	Apply to threads of crankshaft pulley cap screw.

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ENGINE - DIESEL COMPONENT LOCATION

Component Location

Fuel System Component Location



MIF

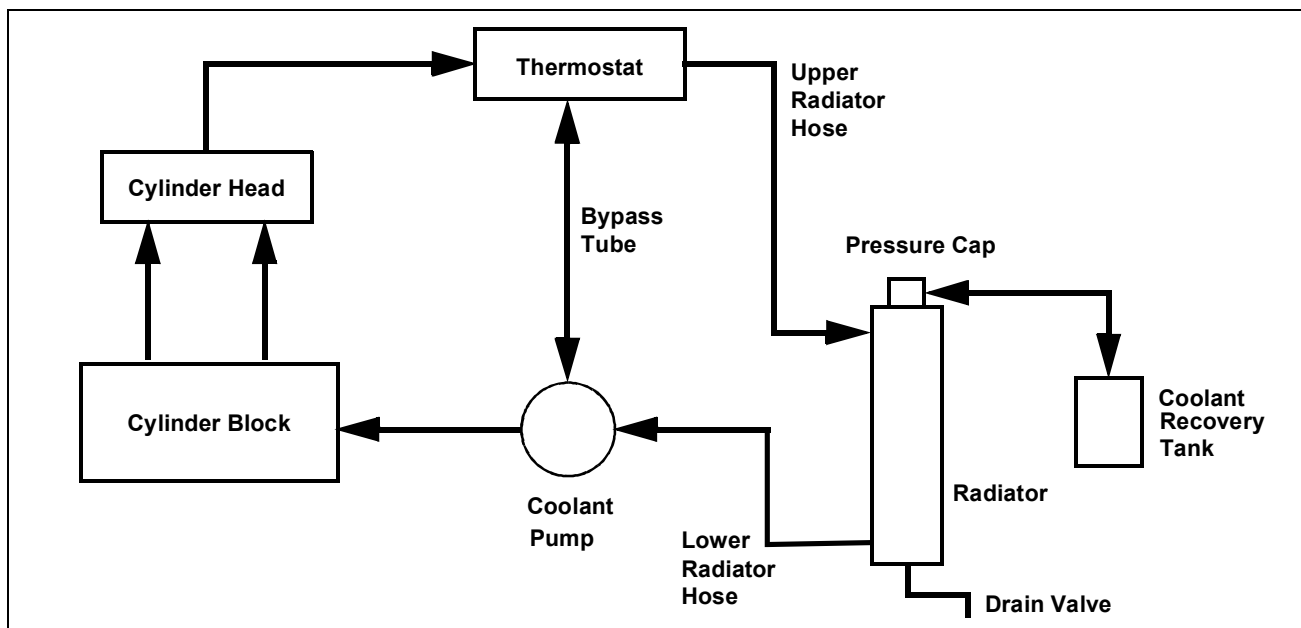
- A- Fuel Tank
- B- Air Bleed Line - Fuel Filter to Tank
- C- Fuel Return Line
- D- Fuel Cap
- E- Fuel Level Sensor
- F- High Pressure Fuel Injector Lines

- G- Fuel Injector Pump
- H- Fuel Transfer Pump
- I- Fuel Inlet Line to Transfer Pump
- J- Throttle Cable
- K- Fuel Filter/Water Separator
- L- Fuel Line - Tank to Filter Inlet

ENGINE - DIESEL THEORY OF OPERATION

Theory of Operation

Cooling System Theory of Operation



MIF

Function:

The cooling system allows the engine to rise to full operating temperature when engine is started cold, but keeps the engine from overheating once engine reaches operating temperature. The thermostat opens when operating temperature has been reached, circulating coolant from the hot engine to the radiator to prevent engine overheating. The cooling system is pressurized, which raises the boiling point of the coolant, and allows more heat to be carried away from the engine.

Theory of Operation:

The cooling system includes the following components: radiator, radiator cap, upper and lower radiator hoses, coolant pump, fan, thermostat, coolant recovery tank, drain hoses and drain valve.

When the engine is started cold, the thermostat is closed. The impeller type coolant pump pulls coolant from the cylinder head and through the bypass tube inside the water pump housing. The water pump then pushes the coolant into the cylinder block water jacket. The coolant absorbs heat from the cylinder walls, and is then pushed up into the cylinder head, and sucked back into the water pump. This provides a fast warm-up period, as engine heat is retained and evenly distributed throughout the engine.

As the engine has reaches operating temperature, 69.5 - 72.5°C (157 - 163°F), the thermostat opens, and the hot coolant from the cylinder head passes through the thermostat and into the top tank of the radiator. As coolant flows down through the tubes of the radiator core, heat is

transferred from the coolant to the air stream being drawn through the core by the engine fan. When the coolant reaches the bottom radiator tank, it is sucked through the lower radiator hose and into the water pump, and pushed back into the cylinder block.

When coolant system pressure exceeds 88.3 ± 14.7 kPa (12.8 ± 2.2 psi), the spring in the radiator cap pushes open to allow coolant to discharge into the coolant recovery tank. As the engine cools after shutdown, a vacuum is produced in the cooling system, and coolant is drawn back out of the coolant recovery tank through a small valve in the bottom of the radiator cap.

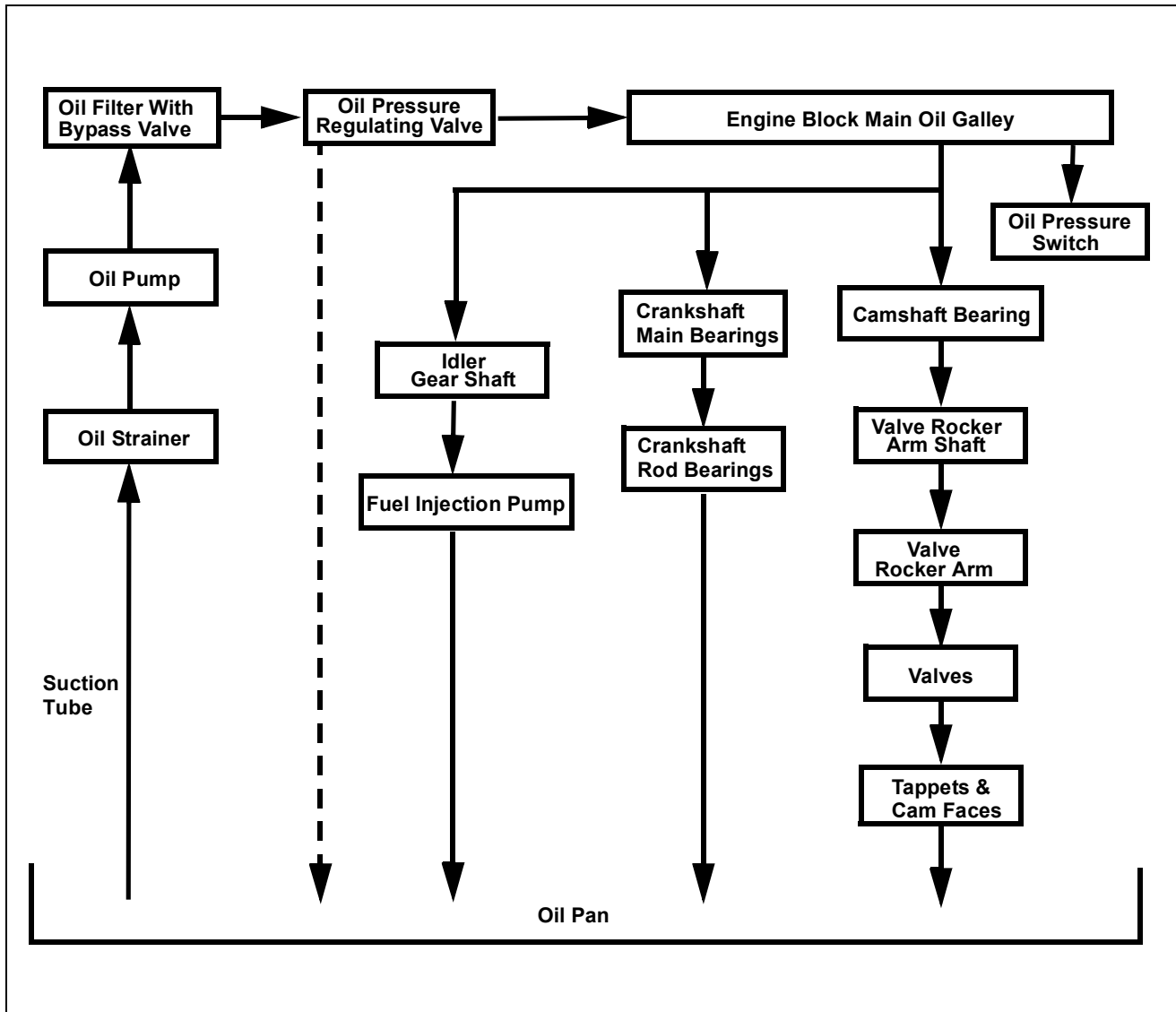
Air is pulled by the engine fan through a removable debris guard on the front of the radiator, through the radiator and fan, and back over engine block. The engine fan belt drives both the water pump and the cooling fan.

An electrical coolant temperature switch is located in the thermostat housing. When the coolant temperature reaches 107 - 113°C (225 - 235°F), the coolant temperature switch closes, lighting the coolant warning lamp on the instrument panel. This informs the operator of the high temperature condition.

The radiator can be drained with a drain valve on the bottom right side of the engine. The coolant recovery tank can be drained from a removable rubber plug on the bottom of the recovery tank.

ENGINE - DIESEL THEORY OF OPERATION

Lubrication System Theory of Operation



MIF

Function:

A full pressure system lubricates engine parts with clean oil.

Theory of Operation:

The pressure lubrication system consists of a positive displacement gear-driven pump, oil strainer, full flow oil filter, oil pressure regulating valve, and an electrical oil pressure warning switch.

The oil pump is mounted on the front plate of the engine, under the engine front cover, and is driven by the crankshaft. The oil pump draws oil from the oil pan through the strainer and suction tube. The oil is then pumped through an oil passage to the oil filter, oil pressure regulating valve, and through the engine block main oil galley.

From the main oil galley, oil is pushed to the crankshaft main bearing journals and idler gear shaft. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to the connecting rod bearing journals.

Lube oil holes in the main bearing oil grooves send oil through drilled passages to the camshaft bearings.

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft. The hollow rocker shaft distributes oil to the rocker arms, tappets and valves.

If oil pressure drops below specification, a pressure switch activates the engine oil pressure light to alert the operator to shut down the engine.

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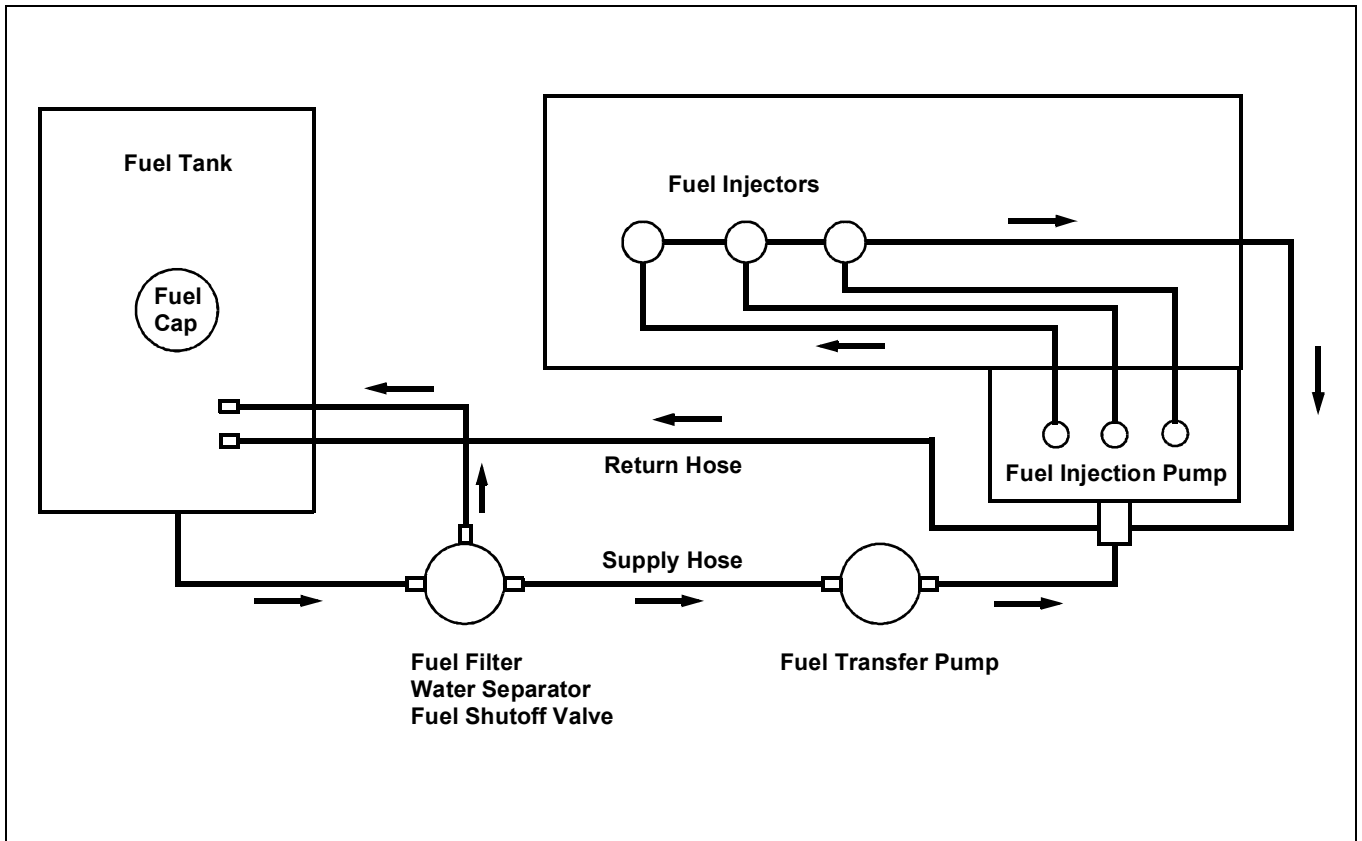


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ENGINE - DIESEL THEORY OF OPERATION

Fuel System Theory of Operation



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Function:

The fuel system supplies clean fuel to injection pump and nozzles, and circulates unused fuel back to the tank. An instrument panel mounted electric fuel gauge shows the operator amount of fuel remaining.

Theory of Operation:

Fuel flows from the outlet on the bottom of the tank to the combination glass bowl fuel filter/water separator/fuel shutoff valve. The filter is self priming and excess air is returned to the tank through a return hose. If the fuel valve is on, the engine driven mechanical fuel transfer pump draws fuel from the fuel filter bowl, to the fuel injection pump. After the injection pump housing is full, excess fuel is returned, along with excess leakoff fuel from the injectors, through the return line to the fuel tank.

The engine speed is controlled by the hand throttle lever. The throttle linkage is connected to the injection pump/governor control lever.

The fuel shutoff solenoid controls the flow of fuel inside the injection pump. When the solenoid is energized (ignition key to START position), the solenoid pulls in and allows fuel to be pumped to the injectors. When the key is turned off, return springs on the shutoff shaft extend the solenoid,

moving the shutoff linkage to the shutoff position. The fuel shutoff solenoid stops the flow of fuel inside the fuel injector pump by forcing the governor rack linkage to the NO FUEL position, causing the fuel injector pump to stop supplying fuel to the injectors.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles. The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the pre-combustion swirl chamber. Injection lines have trapped fuel inside whenever injection is not taking place.

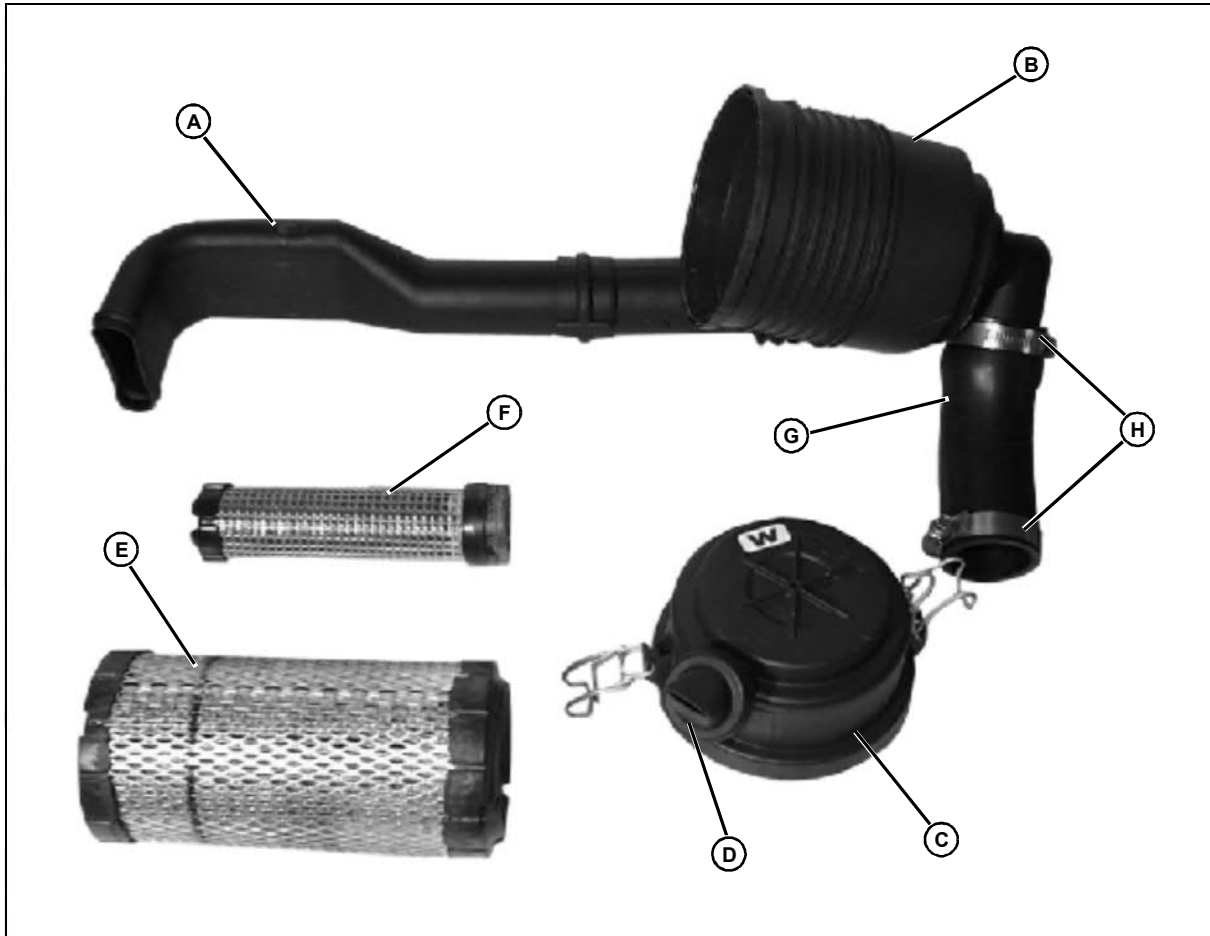
A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

A float-type fuel level sensor mounted on the top of the tank drives a instrument panel mounted gauge, informing the operator of the fuel level.

The fuel shutoff solenoid has two coils inside; one pull-in, and one hold-in coil. The hold-in coil is energized whenever the key switch is in the ON or START position. The pull-in coil is energized only when in the START position.

ENGINE - DIESEL THEORY OF OPERATION

Air System Theory of Operation



MX19209

Function:

The air intake system filters air needed for combustion. The system components include: air inlet tube (A), air cleaner housing (B) and cover (C), unloader valve (D) (and rubber clean-out valve), primary air filter element (E), secondary (or safety) air cleaner element (F), outlet tube (G) and clamps (H).

Theory of Operation:

Air enters the air cleaner inlet tube and into the air cleaner housing, and is directed into the side of a shield. This starts a high-speed centrifugal motion of air which continues around the element until it reaches the far end of the air cleaner housing, to an unloader valve.

Most of the dust is separated from the air by centrifugal force that causes heavy dust particles to enter the opening at the top of the unloader valve. The remaining air enters the primary air filter element. The primary filter element filters the larger dirt particles before the air enters the secondary air filter element. The finer dirt particles are filtered in the secondary air filter before the air enters the intake manifold.

The dirt that is deposited in the unloader valve is removed by the rubber diaphragm at the base of the air cleaner. When the engine is running, a pulsing action is created in the intake system by each intake stroke of the engine. This pulsing action causes the rubber diaphragm to open and close, thus emptying the unloader valve. The operator can squeeze the valve to let the large particles out.

ENGINE - DIESEL DIAGNOSTICS

Diagnostics

Engine Starting Problem

Park machine safely before performing diagnostic procedures. See "Parking Safely" in the Safety section.



Caution: Avoid Injury! Engine coolant is extremely hot during operation.



Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Important: Avoid Damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are pre-set by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by an EPA Authorized Diesel Service (ADS) Center.

Symptom: Engine Does Not Start

Problem	Cause - Solution
10. Water in fuel.	a. Check and repair.
11. Improper intake or exhaust valve clearance.	a. Adjust valve clearance.
12. Improper timing between injection pump, intake and exhaust valves.	a. Adjust valve clearance. Check valve timing.
13. Seized intake/exhaust valve.	a. Replace valve and check valve guide.
14. Broken or seized piston ring.	a. Replace rings and check cylinder.
15. Piston ring, piston or cylinder worn.	a. Bore or hone cylinder and replace piston.
16. Crankshaft pin or bearing seized.	a. Regrind crank and replace bearings.
17. Air entering fuel system.	a. Check and repair fuel supply system.

Symptom: Engine Does Not Start

Problem	Cause - Solution
1. Starting procedure being used is incorrect for conditions.	a. Use correct procedure for conditions See the Operator's Manual.
2. Battery voltage low.	a. Recharge battery. See "Battery Voltage and Specific Gravity Test" on page 163 in the Electrical section.
3. Starting motor defective.	a. Replace starting motor.
4. Alternator defective.	a. Repair or replace alternator.
5. Open circuit in wiring.	a. Repair wiring. See "Common Circuit Tests" on page 107 in the Electrical section.
6. Faulty fuel shutoff solenoid circuit or fuel shutoff solenoid.	a. Test electrical circuit, replace fuel shutoff solenoid.
7. Fuel filter clogged.	a. Replace fuel filter.
8. Clogged or cracked fuel lines.	a. Clean or replace fuel lines.
9. Fuel volume to injection pump low.	a. Check or replace fuel transfer pump. See "Fuel Transfer Pump" on page 93.

Symptom: Engine Starts But Does Not Continue Running - Exhaust Smoke Absent

Problem	Cause - Solution
1. Fuel filter clogged.	a. Replace fuel filter.
2. Clogged or cracked fuel lines.	a. Clean or replace fuel lines.
3. Water in fuel.	a. Check and repair.
4. Air entering fuel system.	a. Check and repair fuel supply system.
5. Fuel volume to injection pump low.	a. Check or replace fuel transfer pump. See "Fuel Transfer Pump" on page 93.
6. Improper engine oil viscosity/type.	a. Replace engine oil and filter.
7. Improper intake or exhaust valve clearance.	a. Adjust valve clearance.
8. Crankshaft pin or bearing seized.	a. Regrind crank and replace bearings.
9. Piston ring end gaps not correct.	a. Stagger piston ring gaps.
10. Governor not functioning properly.	a. Repair or replace governor.