MaxxForce® 7

Engine Operation and Maintenance Manual

Navistar, Inc.

2701 Navistar Drive, Lisle, IL 60532 USA

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MaxxForce® 7
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IMPORTANT

The information, specifications, and illustrations contained in this manual are based on data that was current at the time of publication. Navistar, Inc. reserves the right to make changes and/or improvements at any time without notification, liability, or without applying those changes or improvements to vehicles previously manufactured and/or sold.

NOTICE

Be advised that this motor vehicle may be equipped with computer / recording devices. Their function is to allow an authorized individual to download data or information relating to the operation or performance of this vehicle.

The stored data or information may be neither downloaded nor retrieved except by the vehicle's registered owner, or, in the alternative, by another individual or entity authorized by the registered owner, (e.g., International Dealer) who may need this data or information to properly service or diagnose this vehicle for repair or following an accident.

Any access to this information without the owner's consent may be in violation of law and may subject that person or entity to criminal penalties.

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.

Wash hands after handling.

Summary of Changes

Section	Description
Forward	Removed publications from Technical Service Literature
Warranty	Edited California Emission System Warranty
Section 4	Changed instruction for installing wheel chocks
Section 5	Placed U.S. units before metric units
Section 5	Changed instruction for installing wheel chocks
Section 5	Changed Oil Check Timing Interval to 15 minutes
Section 5	Edited Tool Number for the Navistar Coolant Management Tool Kit
Section 7	Changed instruction for installing wheel chocks

TABLE OF CONTENTS

FOREWORD.....1

SAFETY INFORMATION.....3

WARRANTY.....7

U.S. Federal Emission System Warranty.....7
- Warranty Period.....7
- Required Maintenance.....7
- Warranty Repairs and Service.....7
- Recommended Maintenance or Repair Parts.....8
- Emergency Repairs.....8
- What is not Covered by Warranty.....8
- Warranty Rights and Responsibilities.....9

California Emission System Warranty.....9
- Warranty Period.....9
- Required Maintenance.....10
- Warranty Repairs and Service.....10
- Recommended Maintenance or Repair Parts.....10
- Emergency Repairs.....10
- What is Covered by Warranty.....11
- What is not Covered by Warranty.....12
- Warranty Rights and Responsibilities.....13

SECTION 1 – ENGINE SYSTEMS

Engine Serial Number.....15
Engine Emission Label.....16
Engine Accessories.....16
Engine Specifications.....17
- Engine Description.....19

Engine Features....21
Engine Optional Features....24
Component Location – Top....27
Component Location – Front....28
Component Location – Left....29
Component Location – Right....30
Component Location – Rear....31

SECTION 2 – REQUIREMENTS FOR FUEL, ENGINE OIL, AND COOLANT

Fuel....33
Ultra Low Sulfur Diesel (ULSD)....33
Unacceptable Fuel and Blends....33
Acceptable Fuel Blends....34
Use of Higher Biodiesel Fuel Blends (B6 to B20)....34
Unsafe Practices....35
Engine Oil....35
Engine Oil Quality and Service Categories....35
API CJ-4 for High Performance Diesel Engines....35
Oil Viscosity....36
Coolant....37
Coolant Mixtures....37
Extended Life Coolant (ELC) - Red....37
Contamination of Coolant....38

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Instrument Panel Gauge Cluster....39
Warning Lamps....39
Wait to Start Lamp....39

Idle Shutdown Indicator....40
Maintenance Lamp....40
Amber Warning Lamp (AWL)....41
Red Stop Lamp (RSL)....41
High Exhaust System Temperature (HEST) Lamp....42
Diesel Particulate Filter (DPF) Indicator....42
Malfunction Indicator Lamp (MIL)....43
Typical Water Temperature Gauge....44
Oil Temperature Gauge....45
Oil Pressure Gauge....45
Engine Exhaust Brake On / Off Toggle Switch....46
Air Cleaner Restriction Indicator....47

SECTION 4 – ENGINE OPERATION

Preoperation Checklist....49
Priming the Fuel System....50
Priming the Fuel System After Servicing the Fuel Filters....50
Priming the Fuel System After Running Out of Fuel....51
Starting the Engine....51
Emergency Starting....53
Operation....54
Suggested Warm-up Time....54
Idle Speed....54
Extended Idling Periods....55
Aftertreatment System....55
Engine Idle Shutdown Timer (U.S. Federal-Optional [2010 and 2011 vehicles])....56
Engine Idle Shutdown Timer (California and all state - optional [2012 and newer vehicles])....57
Cold Weather Operation....58
Cold Ambient Protection (CAP)....58
Hot Weather Operation....59

Engine Shutdown....59
Engine Warning Protection System (EWPS)....59
HD-OBD Overview....61
Radiator Shuttle Enable (RSE)....61
Road Speed Limiting (RSL)....61
Road Operation....62
Downhill Operation....62

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Maintenance Schedule....63
Service Procedures....67
Oil Level....67
Coolant Level....68
Charge Air Cooler (CAC)....69
External Leakage....69
Air Cleaner Restriction....70
Fuel Water Separator....71
Engine Oil and Filter....72
Resetting Change Engine Oil Service Interval Message....76
Belt, Air Intake Piping and Clamps....76
Air Intake Piping and Clamps....78
Coolant Freeze Point....78
Primary Fuel Filter....79
Secondary Fuel Filter....83
Crankcase Breather....86
Resetting Change Service Breather Element Message (Serviceable Crankcase breather only)....88
Electrical System....88
Induction System....88
Extended Life Coolant (ELC) Extender....89

Cleaning Diesel Particulate Filter (DPF).....90
Service Cooling System.....90

SECTION 6 – LONG TERM STORAGE

General Information.....95

SECTION 7 – SERVICE RECORDS

Maintenance Service Record.....97
Daily Care and Report.....100

Foreword

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

NOTE: Photo illustrations identify specific parts or assemblies that support text and procedures; other areas in a photo illustration may not be exact.

This manual includes necessary information and specifications for operators to service Navistar® diesel engines. Contact your dealer for more information.

Technical Service Literature

MaxxForce® 7 *Engine Operation and Maintenance Manual*

MaxxForce® 7 *Engine Service Manual*

MaxxForce® 7 *Engine Diagnostic Manual*

Technical Service Literature is revised periodically. Use only up-to-date service information.

To order technical service literature, contact your dealer.

All marks are trademarks of their respective owners.

About the Manual

This manual contains information needed to correctly operate and maintain your engine as recommended by Navistar, Inc. Numerous illustrations, symbols and feature descriptions are used to aid in understanding the meaning of the text. The illustrations, symbols or feature descriptions will not be available for all applications; please reference your *Vehicle Operator Manual* for complete information. Both metric and U.S. customary values are listed in this manual. The U.S. customary value is listed first, followed by the metric value in brackets. For additional information refer to service literature noted in this manual. This manual does not cover vehicle or equipment maintenance procedures. Consult the original vehicle or equipment manufacturer for specific maintenance recommendations.

Safety Information

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual can lead to injury, death or damage to the engine or vehicle.

Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note.

Warning: A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

Caution: A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

Note: A note describes actions necessary for correct, efficient engine operation.

Safety Instructions

Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a First Aid Kit is available.

Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.
- Do not wear rings, watches or other jewelry.
- Restrain long hair.

Vehicle

- Make sure the vehicle is in park or neutral, the parking brake is set, and the wheels are blocked before servicing engine.
- Clear the area before starting the engine.

Engine

- The engine should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- If an engine is not safe to operate, tag the engine and ignition key.

Fire Prevention

- Make sure charged fire extinguishers are in the work area.

NOTE: Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.

1. Type A — Wood, paper, textiles, and rubbish
2. Type B — Flammable liquids
3. Type C — Electrical equipment

Batteries

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.
- Protect your eyes.
- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun. Limit blow gun air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at body or clothing.

Tools

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.
- Check for frayed power cords before using power tools.

Fluids Under Pressure

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

Fuel

- Do not overfill the fuel tank. Overfill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

Removal of Tools, Parts, and Equipment

- Reinstall all safety guards, shields, and covers after servicing the engine.
- Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.

Warranty

U.S. Federal Emission System Warranty

WARRANTY PERIOD

Navistar, Inc. warrants your heavy-duty diesel engine for the following warranty period (whichever comes first):

Light Heavy Diesel Engine

- 5 years
- 50,000 miles (80,000 km)
- Or if covered by any basic or extended warranty (if greater than above)

Medium Heavy Diesel Engine

- 5 years
- 100,000 miles (160,000 km)
- Or if covered by any basic or extended warranty (if greater than above)

Your heavy-duty diesel engine conforms to U.S. Environmental Protection Agency regulations for emission systems.

The engine model year, service class (light heavy or medium heavy), and required emission information is on the exhaust emission label located on top of the Exhaust Gas Recirculating (EGR) manifold mixer on the front of the engine. This warranty is based on the engine model year, not the model year of the vehicle. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser.

REQUIRED MAINTENANCE

As the vehicle owner, you are responsible for all required maintenance described in this manual. Navistar, Inc. recommends that you retain all maintenance receipts. Navistar will not deny an emission warranty claim solely because you have no record of maintenance. However, a claim may be denied if your failure to perform proper maintenance resulted in the failure of a warranted part and you cannot provide appropriate evidence of maintenance. Take your vehicle to an authorized service provider when a problem occurs.

WARRANTY REPAIRS AND SERVICE

All emission control system parts proven defective during normal use will be repaired or replaced during the warranty period. Warranty repairs and service will be done by an authorized service provider with no charge for parts, labor and diagnostics. Warranty repairs should be completed in a reasonable time, not to exceed 30 days. Navistar, Inc. may deny warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

U.S. Federal Emission System Warranty (cont.)

RECOMMENDED MAINTENANCE OR REPAIR PARTS

MaxxForce® service parts or MaxxForce® ReNEWed® parts are recommended for maintenance or repairs to maintain the original quality of your emission certified engine. If parts not recommended by Navistar. cause damage to the engine or vehicle, the warranty is invalid and maintenance and repair costs will not be covered.

EMERGENCY REPAIRS

Emergency repairs are recognized if parts are not available within 30 days or repairs are not completed within 30 days. If an authorized service provider is not reasonably available, the vehicle owner or any service establishment may install any replacement part.

Navistar, Inc. will reimburse you for emergency repairs (including diagnostics) for the following:

- Replacement parts that do not exceed manufacturer's suggested retail price
- Labor charges based on manufacturer's recommended time allowance and geographic hourly rate

Replaced parts and paid invoices must be given to your dealer for reimbursement of emergency repairs

WHAT IS NOT COVERED BY WARRANTY

Unauthorized parts or expendable parts:

- Parts other than MaxxForce® service parts or ReNEWed® parts
- Aftermarket parts or service kits
- Nondefective parts replaced by an unauthorized service provider
- Parts requiring replacement at inspection or adjustment maintenance intervals for reasons other than being defective
- Replacement of expendable items made in connection with scheduled maintenance

Vehicle, engine, and part malfunctions caused by the following:

- Use of incorrect fuel, engine oil, or coolant
- Failure to maintain correct maintenance schedule
- Incorrect adjustments, modifications, alterations, tampering or disconnection of vehicle components
- Abuse or misuse of engine
- Accidents, acts of nature or other events beyond control of Navistar, Inc.

U.S. Federal Emission System Warranty (cont.)

WHAT IS NOT COVERED BY WARRANTY (cont.)

Conditions Not Covered by Warranty:

- Loss of time, inconvenience, use of vehicle / engine or commercial loss
- Vehicles with an altered or disconnected odometer or hourmeter when mileage or hours cannot be determined

WARRANTY RIGHTS AND RESPONSIBILITIES

Navistar, Inc. ensures that the emission warranty is being properly administered. If you have not received satisfactory service or have questions regarding your warranty rights and responsibilities, contact the Navistar regional office for assistance. The address and phone number of each regional office is listed in your *Vehicle Operator Manual*. If additional assistance is required, contact the Manager of Customer Relations.

Manager, Customer Relations
Navistar, Inc.
2701 Navistar Drive
Lisle, Illinois 60532
(Telephone 1-800-448-7825)

California Emission System Warranty

WARRANTY PERIOD

The California Air Resources Board and Navistar, Inc. are pleased to explain the emission control system warranty on your 2014 heavy-duty diesel engine. In California, new motor vehicles must be desiged, built and equipped to meet the State's stringent anti-smog standards.

Navistar warrants your light or medium heavy-duty diesel engine for the following warranty period (whichever comes first):

- 5 years
- 100,000 miles (160,000 km) or 3000 hours
- Or if covered by any basic or extended warranty (if greater than above)

Your heavy-duty diesel engine conforms to applicable California Air Resources Board regulations. This vehicle is registered and certified for sale in California.

The engine model year, service class (light heavy or medium heavy), and required emission information are on the exhaust emission label located on top of the Exhaust Gas Recirculating (EGR) manifold mixer on the front of the engine. This warranty is based on the engine model year, not the model year of the

California Emission System Warranty (cont.)

WARRANTY PERIOD (cont.)

vehicle. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser.

REQUIRED MAINTENANCE

As the vehicle owner, you are responsible for all required maintenance described in this manual. Navistar, Inc. recommends that you retain all receipts covering maintenance on your truck, but Navistar will not deny warranty solely for the lack of receipts or your failure to ensure the performance of all scheduled maintenance. However, a claim may be denied if Navistar demonstrates that the (engine / vehicle) has been abused, neglected, or improperly maintained, and that such abuse, neglect, or improper maintenance was the cause of the need for the repair or replacement of the part. Take your vehicle to an authorized service provider when a problem occurs.

WARRANTY REPAIRS AND SERVICE

All emission control system parts proven defective, or fail to meet the requirements in the California Code of Regulations, Title 13, Sections 2700 to 2706, and 2710 during normal use, will be repaired or replaced during the warranty period. Warranty repairs and service will be done by an authorized service provider with no charge for parts, labor and diagnostics. Warranty repairs should be completed in a reasonable time, not to exceed 30 days. Navistar, Inc. may deny you warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

RECOMMENDED MAINTENANCE OR REPAIR PARTS

MaxxForce® service parts or MaxxForce® ReNEWed® parts are recommended for maintenance or repairs to maintain the original quality of your emission certified engine. If parts not recommended by Navistar, Inc. cause damage to the engine or vehicle, the warranty is invalid and maintenance and repair costs will not be covered.

EMERGENCY REPAIRS

Emergency repairs are recognized if parts are not available within 30 days or repairs are not completed within 30 days. If an authorized service provider is not reasonably available, the vehicle owner or any service establishment can install replacement parts.

Navistar, Inc. will reimburse you for emergency repairs (including diagnostics) for the following:

- Replacement parts that do not exceed manufacturer's suggested retail price

California Emission System Warranty (cont.)

EMERGENCY REPAIRS (cont.)

- Labor charges based on manufacturer's recommended time allowance and geographic hourly rate

Replaced parts and paid invoices must be given to your dealer for reimbursement of emergency repairs.

WHAT IS COVERED BY WARRANTY

Where a warrantable condition exists, Navistar, Inc. will repair your diesel engine at no cost to you including diagnosis, parts, and labor. If your (vehicle or truck) fails a Smog Check inspection, all necessary repairs and adjustments will be made by Navistar to ensure that your emission control system Performance Warranty.

If any emission-related part on your diesel engine is defective, the part will be repaired or replaced by Navistar. This is your short-term emission control system Defects Warranty. For diesel-powered heavy-duty vehicles (except medium-duty vehicles), and motor vehicle engines used in such vehicles, a period of use of five years, 100,000 miles, or 3000 hours of operation, whichever first occurs. However, in no case may this period be less than the basic mechanical warranty that the manufacturer provides (with or without additional charge) to the purchaser of the engine. Extended warranties on select parts do not extend the emissions warranty requirements for the entire engine but only for those parts. In cases where responsibility for an extended warranty is shared between the owner and the manufacturer, the emission warranty shall also be shared in the same manner as specified in the warranty agreement.

California Emission System Warranty (cont.)

WHAT IS COVERED BY WARRANTY (cont.)

New vehicles and engines, registered and certified for sale in California, have the following items covered by the emission warranty when first installed on the engine as original equipment:

- Fuel injection system
- Air induction system (includes turbocharger, exhaust manifold, Exhaust Gas Recirculation [EGR] system, EGR rate and feedback control system, and intake manifold)
- Positive crankcase ventilation system (includes Crankcase Ventilation Valve [CCV] and oil fill cap)
- Diesel Particulate Control System (includes catalytic converter, traps, fuel additive devices, and other devices used to regenerate or aid in the regeneration of the particulate control device)
- Miscellaneous items used in above systems
    A. Hoses, clamps, fittings and tubing
    B. Pulleys, belts and idlers
    C. Vacuum, temperature and time sensitive valves and switches
    D. Electronic controls

WHAT IS NOT COVERED BY WARRANTY

Unauthorized parts or expendable parts:

- Parts other than MaxxForce® service parts or ReNEWed® parts
- Aftermarket parts or service kits
- Nondefective parts replaced by an unauthorized service provider
- Parts requiring replacement at inspection or adjustment maintenance intervals for reasons other than being defective
- Replacement of expendable items made in connection with scheduled maintenance

Vehicle, engine, and part malfunctions caused by the following:

- Use of incorrect fuel, engine oil, or coolant
- Failure to maintain correct maintenance schedule
- Incorrect adjustments, modifications, alterations, tampering or disconnection of vehicle components
- Abuse or misuse of engine
- Accidents, acts of nature or other events beyond the control of Navistar, Inc

California Emission System Warranty (cont.)

WHAT IS NOT COVERED BY WARRANTY (cont.)

Conditions Not Covered by Warranty:

- Loss of time, inconvenience, use of vehicle / engine or commercial loss
- Vehicles with an altered or disconnected odometer or hourmeter when mileage or hours cannot be determined

WARRANTY RIGHTS AND RESPONSIBILITIES

If you have not received satisfactory service or have questions regarding your warranty rights and responsibilities, contact the Navistar, Inc. regional office for assistance. The address and phone number of each regional office is listed in your *Vehicle Operator Manual*. If additional assistance is required, contact the Manager of Customer Relations.

Manager, Customer Relations
Navistar, Inc.
2701 Navistar Drive
Lisle, Illinois 60532
(Telephone 1-800-448-7825)

If further questions of warranty rights and responsibilities remain, contact:

The Air Resources Board
9528 Telstar Avenue
El Monte, California 91731

Engine Serial Number

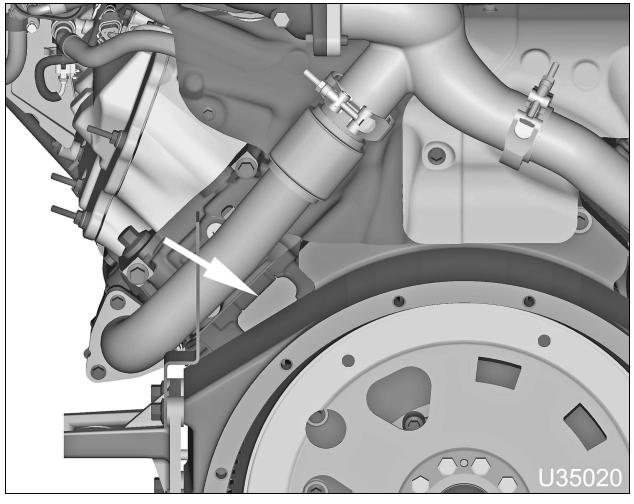

Figure 1 Engine Serial Number

The engine serial number is stamped on the crankcase pad, on the rear left side below the cylinder head.

Engine Serial Number Example

6.5HM2YXXXXXXX

6.5 – Engine family code
H – Diesel, turbocharged, Charge Air Cooler (CAC), and electronically controlled
M2 – Motor truck or **U2** power unit and OEM (sold to original equipment manufacturer)
Y – United States, Huntsville Alabama
7-digit suffix – Engine serial number sequence

Engine Emission Label

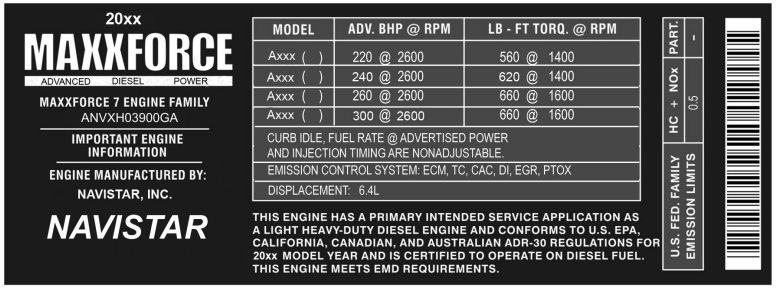

Figure 2 The U.S. Environmental Protection Agency (EPA) Exhaust Emission Label (Example)

The U.S. Environmental Protection Agency (EPA) exhaust emission label is located on top of the Exhaust Gas Recirculation (EGR) manifold mixer, on the front of the engine. The label includes the following:

- Advertised brake horsepower ratings
- Engine model code
- Service applications (light heavy or medium heavy)
- Emission family and control systems
- Year the engine was certified to meet EPA emission standards

Engine Accessories

The following engine parts may have manufacturers' labels or identification plates:

- Air compressor
- Air conditioning compressor (single and dual)
- Alternator
- Cooling fan clutch
- Power steering pump
- Starter motor
- Engine Control Module (ECM)

Labels or identification plates include information and specifications helpful to vehicle operators and technicians.

Engine Specifications

MaxxForce® 7 Features and Specifications	
Engine Configuration	4 stroke, V8 diesel
Rated power @ rpm	See EPA exhaust emission label.
Peak torque @ rpm	See EPA exhaust emission label.
Displacement	6.4 L (389 in^3)
Compression ratio	16.5 : 1
Stroke	4.134 in (105 mm)
Bore (sleeve diameter)	3.87 in (98.2 mm)
Firing order	1-2-7-3-4-5-6-8
Aspiration	Dual Turbocharger and Charge Air Cooled (CAC)
Combustion system	Direct injection, turbocharged
Fuel system	Direct injection common rail
Lube system capacity (including filter)	18.9 L (20 qts US) [1] **NOTE:** For TerraStar® 4x2 applications only, the lube system capacity (including filter) is 20.8 L (22 qts).
Lube system capacity (overhaul only, with filter)	19.9 L (21 qts US) [2] **NOTE:** For TerraStar® 4x2 applications only, the lube system capacity (overhaul only, with filter) is 21.7 L (23 qts).

Engine Specifications (cont.)

Engine lubrication oil pressure at operating temperature	
Low idle	12 psi (83 kPa) minimum
High idle	45 psi (310 kPa) minimum
Idle speed (no load)	700 rpm ± 50 (nonadjustable)
Thermostat operating temperature	
With bypass	198°F - 205°F (92°C - 96°C)
Without bypass	188°F - 196°F (87°C - 91°C)

1 Verify engine lubrication capacities if additional equipment added to system.

2 Verify engine lubrication capacities if additional equipment added to system.

Engine Specifications (cont.)

Engine Description

The MaxxForce® 7 is a V8 engine with a displacement of 6.4 liters (389 cubic inches). The engine has been designed for increased durability, reliability, and ease of maintenance.

Air Management System

A two-stage turbocharger provides boost air pressure to the engine for various speed and load conditions. An electronically controlled solenoid modulates boost air to a wastegate actuator that controls the turbocharger discharge pressures.

A chassis-mounted Charge Air Cooler (CAC) is piped into the air management system between the turbocharger and intake throttle. The CAC is an air-to-air heat exchanger that cools and increases the density of the air charge after the turbocharger.

The Exhaust Gas Recirculating (EGR) system includes an EGR valve and an intake throttle valve. The EGR valve is mounted in an EGR mixer duct that is part of the EGR valve elbow housing. The intake throttle valve is mounted on the other side of the EGR valve elbow housing in the air stream from the CAC.

The EGR system circulates cooled exhaust into the intake air stream in the intake manifold. This cools the combustion process and reduces the formation of NO_X engine emissions.

Cold Start Assist

A relay controlled grid (duct) heater is used in the intake air stream to aid cold ambient starting.

Crankcase Assembly

The crankcase is comprised of two major matching components. The upper crankcase half houses the cylinders and main bearing saddles, with oil and coolant passages either cast or machined. The lower crankcase consists of a structural plate with the main bearing caps machined into it for improved load retention and alignment.

The upper crankcase utilizes Compact Graphite Iron (CGI) material technology for a lighter and stronger crankcase.

One-piece aluminum-alloy pistons are fitted with one keystone ring, one rectangular intermediate compression ring, and a two-piece oil control ring. The combustion bowl is located in the piston crown to reduce emissions. All pistons are mated to fractured cap joint connecting rods.

A gerotor lube oil pump, mounted on the front crankcase bulkhead, is driven by the crankshaft to supply pressurized oil to engine components. All MaxxForce® 7 engines use an engine oil cooler and spin on oil filter. The oil filter is located at the lower driver-side corner of the engine where there is a filter header integrated to the cast aluminum oil pan.

The camshaft is supported by five bushings pressed into the crankcase. The camshaft is crankshaft driven, and thrust is controlled by a plate mounted behind the rear bulkhead.

An open crankcase breather system draws crankcase vapors through a breather element. The breather element separates oil from oil vapors, then routes breather air through an open breather outlet tube assembly and returns the oil to the crankcase through a passage in the right valve cover.

Engine Description (cont.)

Crankshaft

The crankshaft is supported by five main bearings with fore and aft thrust controlled at the upper half of the fourth main bearing. Two connecting rods are attached to each crankshaft rod journal and are offset to minimize vibration. Piston pins are free floating, allowing the pins free lateral movement within the connecting rod as well as the piston. Piston pins are held in place with retaining rings.

Cylinder Heads

The cylinder heads have four valves per cylinder. Each fuel injector is centrally located between the four valves and directs fuel over the piston bowl for improved performance and reduced emissions.

The overhead valve train includes hydraulic roller cam followers, push rods, rocker arms, and valve bridges to open the dual intake and exhaust valves.

Electronic Control System

An Engine Control Module (ECM) monitors and controls engine performance to ensure maximum performance and compliance with EPA emissions requirements.

Heavy-Duty On-Board Diagnostics (HD-OBD) is a U.S. Government mandated standard for all 2013 and later Class 4 and above vehicles with a Gross Vehicle Weight Rating (GVWR) of 14,001 pounds or more. The HD-OBD system monitors the engine and aftertreatment systems to verify they are operating within emissions limits. If an emissions fault is logged, the Malfunction Indicator Lamp (MIL) will illuminate and one or more fault codes will be set.

The HD-OBD system operates similarly to previous power train control systems by storing fault codes and turning on the MIL. If the problem that caused the fault goes away, the code will clear and the MIL will go out after certain operating conditions have been met. This may take several times operating the vehicle.

The Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor are used by the ECM to calculate rpm, fuel timing, fuel quantity, and duration of fuel injection.

Fuel System

The high-pressure fuel system includes a High-Pressure Fuel Pump (HPFP), high-pressure common rails, and fuel injectors. The ECM electronically controls the injectors, allowing multiple injections and more precise fuel delivery to improve combustion, emissions, and cold start performance.

The low-pressure fuel system uses an integrated low-pressure fuel module with primary filter, secondary filter, fuel cooler, and electric self-priming fuel pump to draw fuel from the tank(s) to the engine. This integrated low-pressure module significantly reduces the number of fuel lines and connection points, and is mounted over the left valve cover. The primary fuel filter assembly includes a Water In Fuel (WIF) sensor and an optional

Engine Description (cont.)

fuel heater. Water and solids are separated from the fuel and the water is connected in the water separator bowl. The instrument panel WIF lamp illuminates when water needs to be drained. A drain valve in the water separator bowl drains water out. Fuel is discharged to the secondary fuel filter. The secondary fuel filter assembly is pressure regulated and incorporates an air bleed orifice to automatically purge air introduced into the system.

Optional Air Compressor

An air compressor is available for applications that require air brakes or air suspension.

Optional Fuel Heater

A fuel heater is available and installed in the primary fuel filter assembly. The heater warms the supply fuel to prevent waxing during cold conditions.

Optional Coolant Heater

A coolant heater is available to raise the temperature of the coolant surrounding the cylinders for improved performance during cold weather startups.

Engine Features

Aftertreatment System

The engine and vehicle exhaust piping includes an Aftertreatment System to capture soot and other particulates before they exit the exhaust pipe. The soot is captured by the Diesel Particulate Filter (DPF) and is periodically converted to carbon dioxide (CO_2) by a Regeneration (Regen) process. For further information see Aftertreatment System (page 55).

Engine Features (cont.)

Cold Ambient Protection (CAP)

CAP keeps the engine warm during cold temperatures and may provide better fuel economy, increased operator comfort, and improved engine performance. This feature should only be disabled for specialized applications. Engine damage may occur if CAP is disabled.

CAP maintains engine coolant temperature by increasing engine rpm to a programmed value when ambient air temperature is below 32°F (0°C), coolant temperature is below 167°F (75°C), and engine has been idling at no load (or driver input) for over five minutes.

For further information see Cold Ambient Protection (CAP) (page 58).

Electronic Governor Control

The governor controls engine rpm within a safe and stable operating range.

The low idle governor prevents engine rpm from dropping below a stable speed to prevent stalling when various loads are demanded on the engine.

The high idle governor prevents engine rpm from going above a safe speed that would cause engine damage.

Electronic Service Tool (EST) Interface

Vehicles are equipped with the EST interface for communication between the Engine Control Module (ECM) and the EST.

CAN is a J1939 serial bus system, also know as the Drivetrain Datalink. The public Controller Area Network (CAN) provides a communication link between all connecting modules by sending and receiving messages.

The EST with ServiceMaxx®software communicates with the ECM through the EST interface. The EST, through the public CAN, is able to retrieve Diagnostic Trouble Codes (DTCs), run diagnostic tests, and view Parameter Identifiers (PIDs) from all inputs and outputs of the ECM.

CAN public supports the following functions:

- Transmission of engine parameter data
- Transmission and clearing of DTCs
- Diagnostics and troubleshooting
- Programming performance parameter values
- Programming engine and vehicle features
- Programming calibrations and strategies in the ECM

Electronic Speedometer and Tachometer

The engine control system calibrates vehicle speed. Any new speed calibration information must be programmed with an EST.

Engine Features (cont.)

The tachometer signal is generated by the ECM by computing signals for the Camshaft position (CMP) sensor and Crankshaft Position (CKP) sensor.

Engine Crank Inhibit (ECI)

ECI prevents starter engagement when the engine is running or when the transmission is in gear.

Engine Warning Protection System (EWPS)

EWPS is designed to protect the engine from damage by monitoring critical engine data such as engine speed, temperature, oil pressure and coolant levels. This feature will alert the operator by using a combination of visual and audible warnings when critical engine parameters have been exceeded. For further information see Engine Warning Protection System EWPS (page 59).

Event Logging System

The event logging system, known as Trip Reporting, records engine operation above maximum rpm (over speed), high coolant temperature, or low oil pressure. The readings for the odometer and hourmeter are stored in the ECM memory at the time of an event and can be retrieved using the EST.

Fast Idle Advance

Fast idle advance increases engine idle speed for faster warm-up to operating temperature. This occurs when the ECM monitors Engine Coolant Temperature (ECT) sensor input and adjusts fuel injector operation accordingly.

Engine Features (cont.)

Low idle speed is increased proportionally when the ECT is below 104°F (40°C) at 700 rpm to below 32°F (0°C) at 900 rpm maximum.

Service Diagnostics

The Electronic Service Tool (EST) communicates with the control system through the public Controller Area Network (CAN). The EST allows the user to retrieve and clear fault codes, run special diagnostics tests, monitor control system sensors and actuators, update control system software, and adjust special features.

Service Interval

The service interval feature is designed to provide a visual reminder to the operator that the engine oil change interval has expired and routine maintenance procedures should be performed.

The term “interval” in this case is used to describe the distance, time, or fuel used between the last maintenance performed on the vehicle and the next maintenance that is due.

It is essential that operators are trained to know the maintenance schedules and instructions regarding the operation and reset functionality of the service interval for the feature to be effective. For further information see Resetting Change Engine Oil Service Interval Message (page 76).

Engine Optional Features

Cruise Control with Hardwire Cruise Switches

The Engine Control Module (ECM) controls the cruise control feature. The cruise control system functions similarly for all electronic engines. Maximum and minimum allowable cruise control speeds will vary based on application. To operate cruise control, see appropriate *Vehicle Operator Manual*.

Engine Fan Control

The engine fan control commands higher air flow through the radiator when the Air Conditioner (A/C) is on or when the coolant or inlet air temperature goes above a set temperature.

Engine Assisted Windshield Defrost (EAWD)

EAWD is an automated feature that assists windshield defrosting during cold ambient temperatures by increasing engine rpm to heat up the engine faster.

Engine Exhaust Brake

An exhaust brake is available to provide additional brake torque to reduce stress on the vehicle brakes. The exhaust brake has three operation modes: OFF, LATCH, and COAST.

Engine Optional Features (cont.)

Idle Shutdown Timer (IST)

IST allows the ECM to shut down the engine during extended engine idle times.

Figure 3 Certified Clean Idle label

Vehicles that comply with the clean idle regulations will have a Certified Clean Idle label applied to the hood or door of the vehicle.

2010 and 2011 model year vehicles with (non-California) U.S. Federal MaxxForce® 7 engines have idle time that can be programmed from 2 to 120 minutes.

2012 and newer model year vehicles with U.S. Federal MaxxForce® 7 engines have idle time that can be programmed from 2 to 120 minutes.

For further information see Engine Shutdown (page 56).

In-Cab Power Take-off (PTO) Control

The in-cab engine speed control feature, commonly referred to as Power Take-off (PTO), allows the operator to set and maintain a constant engine speed without using the accelerator pedal. It is commonly used for powering auxiliary devices.

Customer programmable parameters within the Engine Control Module (ECM) provide in-cab engine speed control related options that can be adjusted to suit the customer's needs. Choosing whether the operator is allowed to increase the engine speed using the accelerator pedal without disengaging the PTO is an example.

Engine Optional Features (cont.)

Radiator Shutter Enable (RSE)

RSE provides a signal to open or close the radiator shutters. Closing the shutters will keep the engine warm during cold weather operation. This provides faster warm-up of the passenger cab and enables faster windshield defrosting.

Remote Engine Speed Control (RESC)

RESC, commonly referred to as remote PTO, provides a method for an operator to set and maintain engine speed without using the accelerator pedal. It is commonly used for powering auxiliary devices.

When control over engine speed is required from outside the vehicle's cab, remote mounted switches must be used to turn on PTO engine speed control and select the desired engine speed.

Engine speed can be ramped up and down with RESC similar to the way the in-cab PTO feature works; however, the RESC feature includes two additional switches (remote preset and remote variable), which allow the operator to choose the mode of engine speed control operation.

Customer programmable parameters within the ECM provide RESC related options that can be adjusted to suit the customer's needs. Choosing whether a remote throttle pedal is used for PTO operation is an example.

Road Speed Limiting (RSL)

RSL is designed to regulate the maximum vehicle speed as controlled by the accelerator pedal.

Customer programmable parameters within the ECM provide vehicle speed governor related options that can be adjusted to suit the customer's needs. A parameter is used to set the maximum accelerator controlled vehicle speed.

Additional programming flexibility is included to allow a trade-off to be made between performance and fuel economy.

Component Location – Top

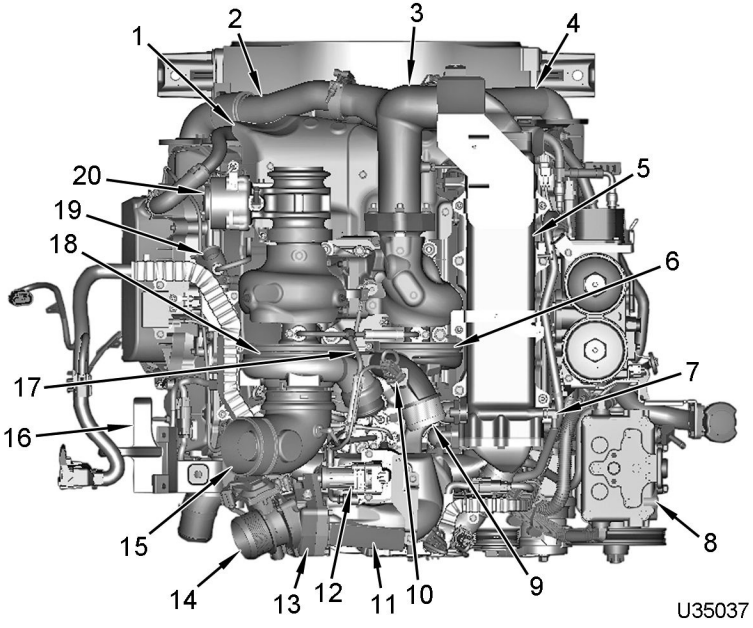

Figure 4 Top

1. Pump cover heat shield (right)
2. Right exhaust tube assembly
3. Exhaust turbocharger inlet manifold
4. Left exhaust tube assembly
5. Exhaust Gas Recirculation (EGR) cooler
6. High-pressure turbocharger assembly
7. Engine coolant vent
8. Air compressor assembly
9. Turbocharger outlet
10. Turbocharger Outlet Temperature (TCOT) sensor
11. Manifold mixer (exhaust emission label location)
12. EGR valve
13. Inlet Air Heater (IAH)
14. Engine Throttle Valve (ETV)
15. Turbocharger inlet duct assembly
16. Primary Freon compressor mount
17. Turbocharger oil supply tube
18. Low-pressure turbocharger assembly
19. Heater supply
20. Thermal Management Valve (TMV)

Component Location – Front

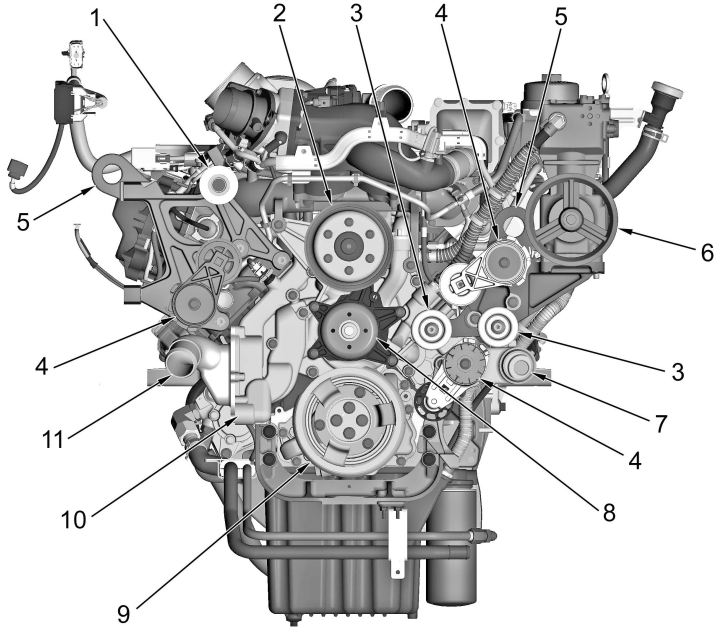

Figure 5 Front

1. Grooved idler pulley
2. Fan pulley
3. Flat idler pulley (2)
4. Belt tensioner (3)
5. Lifting eye (2)
6. Air compressor pulley
7. Coolant inlet
8. Water pump pulley
9. Vibration damper and pulleys
10. Heater return
11. Thermostat housing (coolant outlet)

Component Location – Left

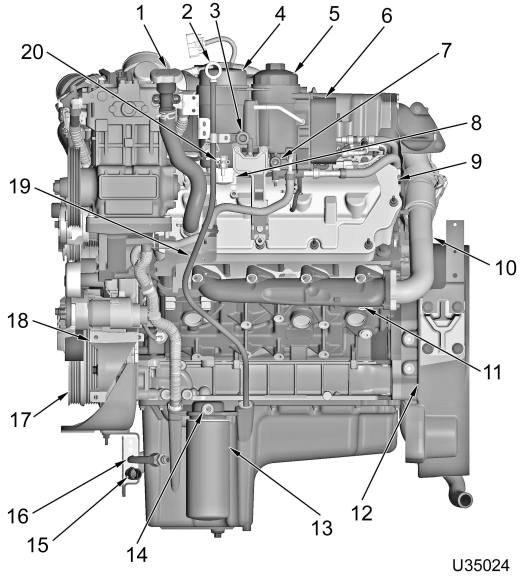

Figure 6 Left

1. Oil fill tube cap
2. Oil level gauge (dipstick)
3. Fuel supply port (from tank)
4. Primary fuel filter housing
5. Secondary fuel filter housing
6. Fuel cooler
7. Fuel return port (to tank)
8. Fuel pump
9. Left valve cover
10. Left exhaust tube assembly
11. Left exhaust manifold
12. Starter motor mounting location
13. Oil filter
14. Diagnostic test port (oil pressure port)
15. Power steering return tube
16. Power steering supply tube
17. Power Take Off (PTO) air compressor front pulley
18. Auxiliary Freon compressor mounting bracket
19. Oil level gauge tube
20. Water drain valve

Component Location – Right

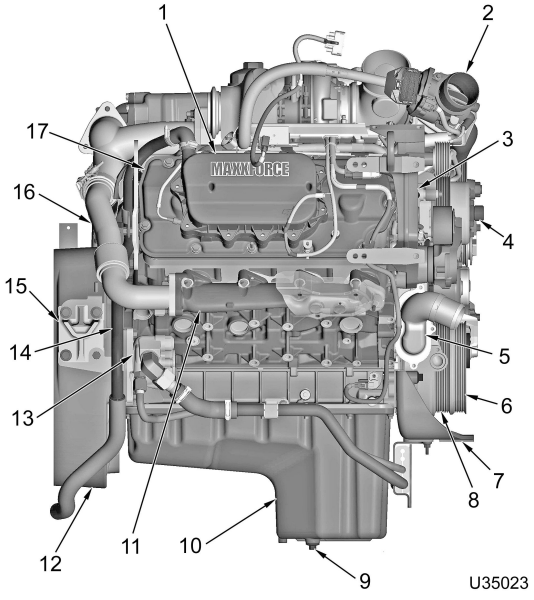

Figure 7 Right

1. Breather filter cover
2. Engine Throttle Valve (ETV)
3. Primary Freon compressor mounting
4. Fan clutch mounting
5. Thermostat housing
6. Power Take Off (PTO) air compressor front pulley
7. Front engine mounting support
8. Inner front pulley (alternator and primary Freon compressor)
9. Oil pan drain plug
10. Oil pan
11. Right exhaust manifold
12. Rear crankcase cover assembly (flywheel housing)
13. Power steering pump
14. Draft tube assembly
15. Rear engine mounting bracket (2)
16. Right exhaust tube assembly
17. Right valve cover

Component Location – Rear

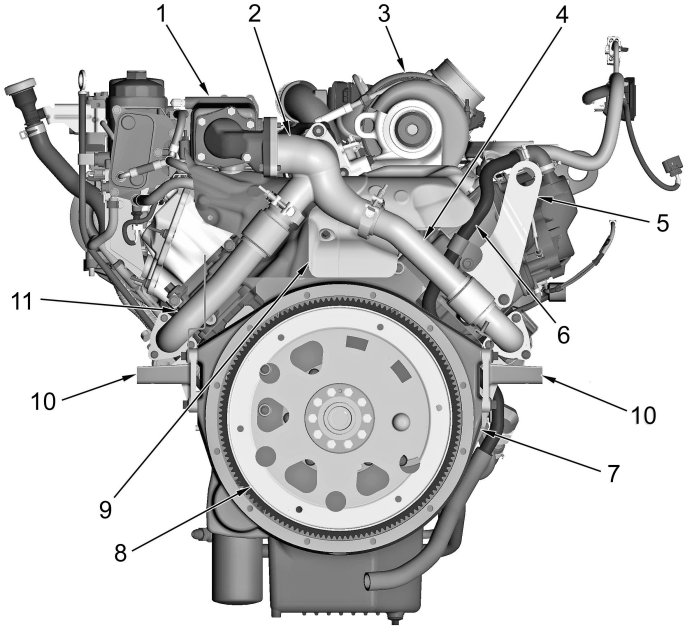

Figure 8 Rear

1. Exhaust Gas Recirculation (EGR) cooler
2. Exhaust turbocharger inlet manifold
3. Low-pressure turbocharger assembly
4. Right exhaust tube assembly
5. Lifting eye
6. Draft tube assembly
7. Rear crankcase cover assembly (flywheel housing)
8. Flexplate
9. High-pressure pump cover heat shield (right)
10. Rear engine mounting bracket (2)
11. Left exhaust tube assembly

Fuel

ULTRA LOW SULFUR DIESEL (ULSD)

Figure 9 American Petroleum Institute (API) Diesel Pump Label

The API Diesel Pump Label is compliant with Environmental Protection Agency (EPA) CFR 80.570.

GOVERNMENT REGULATION: Diesel fuel sold for use in 2007 and later highway vehicles must be limited to a sulfur content of 15 parts per million (ppm).

Ultra Low Sulfur Diesel (ULSD) fuel is required for MaxxForce® 7 Diesel Engines used with advanced aftertreatment systems. The fuel should meet all the specifications of ASTM D975 standard (current year revision), including the EPA specification for sulfur content (0.0015 % mass or 15 ppm maximum). These specifications are included in the standard under the designation No. 2-D S15 fuel and No. 1-D S15 fuel. Grade No. 1-D fuel is a lighter fuel with higher volatility than grade No. 2-D; it may be blended with grade No. 2-D in wintertime to provide engine operability under low ambient temperature.

UNACCEPTABLE FUEL AND BLENDS

- Low Sulfur Diesel (LSD) fuel 0.05% (500 ppm)
- Commercial Jet A or JP8 aviation fuel
- Heating or furnace oil
- Biodiesel B100 (neat biodiesel)
- Biodiesel blends higher than 20%
- Any fuel mixed with used motor oil

Fuel (cont.)

UNACCEPTABLE FUEL AND BLENDS (cont.)

Biodiesel fuels are methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oils, animal fats, and waste cooking oils. These oxygenated organic compounds have key properties that are comparable to those in diesel fuel.

ACCEPTABLE FUEL BLENDS

- Ultra low sulfur kerosene (No. 1-D S15 diesel fuel) blended with No. 2-D S15 fuel to improve cold weather performance. Blend rate would depend upon regional low temperatures.
- Lower biodiesel blends up to B5 (a blend of 5% neat biodiesel with 95% diesel fuel).

  Such blends have characteristics indistinguishable from diesel fuel, if the two components meet the requirements of their respective standards: ASTM D6751 current revision, for neat biodiesel and ASTM D975 current revision, for ultra low sulfur diesel fuel.

  As of 1 October 2008, blends of up to 5% biodiesel are included in the diesel fuel Standard ASTM D975-08a (D975-08a designates the 2008 revision of the standard).

Navistar, Inc. approves of blends up to B5, provided that the two components satisfy current standard specifications. Quality biodiesel blends up to B5 should not cause engine or fuel system problems.

USE OF HIGHER BIODIESEL FUEL BLENDS (B6 TO B20)

Standard ASTM D7467 (current revision) covers the specifications for blends between 6% and 20% (B6 to B20). These blends may be used in vehicles that operate in populated areas or in fleets that require use of alternative fuels to reduce urban pollution.

Use of B6 to B20 blends is at the discretion of the customer / operator and will not automatically void an engine warranty. However, if engine component failure can be directly attributable to use of a B6 to B20 blend not provided by a BQ9000 certified fuel supplier or not meeting the ASTM D7467 (current revision) Standard, Navistar may deny warranty on the affected engine or engine component.

Navistar, Inc. recommends that users of B20 select a BQ9000 certified fuel supplier and request proof from the supplier the fuel meets ASTM D7467 (current revision) Standard. Fuels not meeting the specification may cause fuel system deposits, plugged filters, contaminated engine oil, and fuel degradation.

If providers and customers follow correct storage and maintenance procedures for fuel and equipment, blends of B6 to B20 that meet ASTM D7467 (current revision) Standard should perform satisfactorily in diesel engines. Contact your dealer for recommendations for correct storage and maintenance procedures.

Fuel (cont.)

USE OF HIGHER BIODIESEL FUEL BLENDS (B6 TO B20) (cont.)

Navistar, Inc. follows the official position of the Truck and Engine Manufacturers Association (EMA) on biodiesel fuel. See www.truckandenginemanufacturers.org for more information.

UNSAFE PRACTICES

WARNING: To prevent personal injury or death, do not mix gasoline, gasohol, or alcohol with diesel fuel. An open heat source, spark, cell phone or electronic device can ignite these fuel mixtures. This creates a fire hazard and possible explosion.

CAUTION: To prevent engine damage, do not mix propane with diesel fuel. Navistar, Inc. will not honor warranty claims against engines that have used propane.

Engine Oil

ENGINE OIL QUALITY AND SERVICE CATEGORIES

The American Petroleum Institute (API) defines engine oil quality by service categories that define oil performance measured in standardized engine tests.

API CJ-4 FOR HIGH PERFORMANCE DIESEL ENGINES

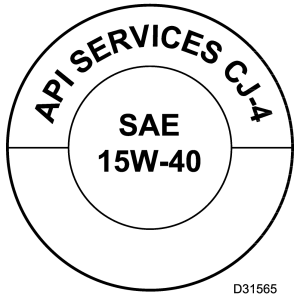

Figure 10 API Identification Symbol

API CJ-4 oils are recommended for high speed diesel engines with advanced exhaust aftertreatment systems that meet 2007 and beyond on-highway exhaust emission standards.

Engine Oil (cont.)

API CJ-4 FOR HIGH PERFORMANCE DIESEL ENGINES (cont.)

NOTE: Mineral and synthetic oils are acceptable for use provided they meet the API category recommendations and ambient temperature guidelines. Always follow recommended oil change guidelines no matter what oil is used.

API CJ-4 oils provide protection against the following:

- Catalyst poisoning and particulate blockage
- Engine wear
- Piston deposits
- Soot related viscosity increase, deposits, and wear
- Viscosity loss due to shear
- Oxidative thickening
- Oil foaming and aeration

API CJ-4 oil, in combination with Ultra Low Sulfur Diesel (ULSD) fuel (0.0015% [15 ppm] maximum sulfur content), is required to maintain performance and durability of aftertreatment systems meeting 2007 and beyond diesel emission regulations.

API CI-4 oils are allowed in diesel engines that meet these regulations. Use of the CI-4 engine oil shortens Diesel Particulate Filter (DPF) cleaning service intervals.

OIL VISCOSITY

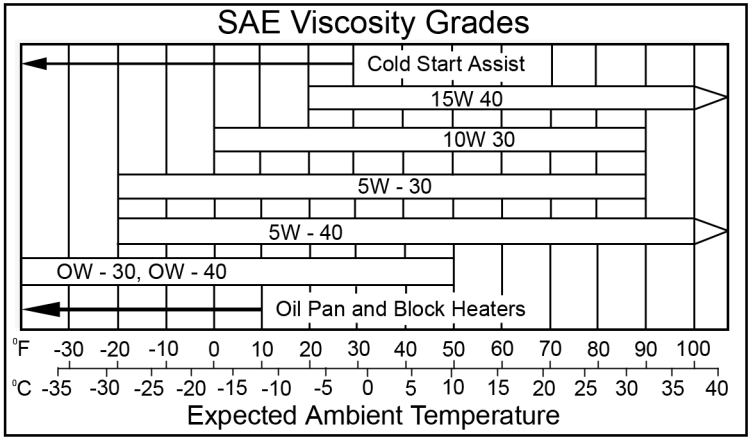

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Figure 11 SAE Viscosity Grades And Temperature Ranges

The Society of Automotive Engineers (SAE) defines oil viscosity (thickness) by grade. Colder temperatures require lower grade

Engine Oil (cont.)

OIL VISCOSITY (cont.)

oils for correct flow during starting. Higher temperatures require higher grade oils for satisfactory lubrication.

- A block coolant heater is required, if temperatures are below 10°F (-12°C).
- A block coolant heater and oil pan heater are required, if temperatures are below -10°F (-23°C).
- For heavy duty driving or trailer towing, higher oil grades 15W-40 and 5W-40 oils are required, if temperatures are over 50°F (10°C).

Coolant

COOLANT MIXTURES

Engine coolant mixtures include water, glycol (ethylene or propylene), and inhibitors. Conventional and fully formulated coolants require regular testing of inhibitor levels to maintain safe levels of protection. Testing of conventional coolant determines levels of nitrite, nitrite / molybdate, and freeze point protection. If necessary, Supplemental Coolant Additives (SCAs) are added to replenish inhibitors.

Extended life coolant mixtures (water and ethylene glycol) do not require regular testing of inhibitor levels or addition of SCAs. See service intervals (page 63).

EXTENDED LIFE COOLANT (ELC) - RED

Heavy Duty Extended Life Coolant (ELC) 50 / 50 Premix meeting CEMS B-1 Type III is the standard factory fill for the cooling system. The coolant should minimally meet ASTM D6210, Standard Specification for fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines.

ELC 50 / 50 Extender is added at the designated service interval. For further information see Extended Life Coolant (ELC) Extender (page 89).

Freeze Point Protection Levels Concentrate (Ethylene Glycol) and Water Mixtures

Concentrate and Water Mixtures	Freeze Point Protection
40% Concentrate and 60% water	-12°F (-24°C)
50% Concentrate and 50% water	–34°F (37°C)
60% Concentrate and 40% water	–62°F (52°C)
67% Concentrate and 33% water	-95°F (-71°C)

Coolant (cont.)

EXTENDED LIFE COOLANT (ELC) - RED (cont.)

For vehicles operating in extremely cold climates, coolant mixtures of 60% Concentrate and 40% water or 67% Concentrate and 33% water provide additional freeze protection as shown in table above. Mixtures having more than 67% Concentrate are not recommended.

For further information see Coolant Freeze Point (page 78).

CONTAMINATION OF COOLANT

The coolant color should indicate the condition of the coolant.

- Coolant color should be a reddish orange (clear – not cloudy).
- Coolant must not have floating debris or visible oil.

Contamination of ELC with other coolant products will not be obvious.

To verify coolant quality, contact an authorized service provider, or use a refractometer to verify coolant strength. For further information see Freeze Point Protection Levels Concentrate and Water Mixtures(page 37).

Instrument Panel Gauge Cluster

During engine starts and engine operation, gauges and indicator lamps should be checked periodically.

Gauges may vary with vehicle applications. Warning and indicator lamps show conditions not indicated by the gauges.

See the *Vehicle Operator Manual* for description of indicator lamps for the drivetrain, chassis components, and cabin.

Warning Lamps

Warning lights signal when a reading is outside preset limits.

- Warning lamps indicate situations that must be inspected before operating the vehicle.

Wait to Start Lamp

Figure 12 Wait To Start Lamp

The Wait To Start lamp will illuminate Yellow when inlet air heater is required. Wait until the lamp goes off before cranking engine. For further information see Starting the Engine (page 51).

Idle Shutdown Indicator

Figure 13 Idle Shutdown Indicator

The Idle Shutdown indicator will illuminate Yellow when the vehicle shutdown timer will turn the engine off in 30 seconds. For further information see Engine Idle Shutdown Timer (page 56).

Maintenance Lamp

Figure 14 Maintenance Lamp

The Maintenance lamp will illuminate in conjunction with other warning lights or general text and warning messages. It may be accompanied by an audible alarm to indicate an alert condition to the operator.

Amber Warning Lamp (AWL)

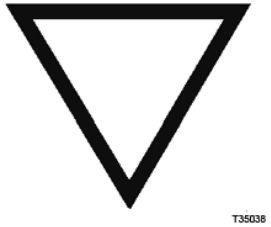


Figure 15 AWL

The Amber Warning Lamp (AWL) will illuminate YELLOW by itself, or in conjunction with other warning lights or general text and warning messages, to indicate an alert condition to the operator. This lamp indicates the Engine Control Module (ECM) is taking action to protect the engine. It is normal for this lamp to illuminate under certain high load and / or high ambient temperature conditions. It is safe to drive the vehicle. However, if the lamp continues to light or remains on, contact an authorized service provider immediately to have the problem corrected.

Red Stop Lamp (RSL)

Figure 16 RSL

CAUTION: To prevent engine damage, shut down engine immediately , if the Red Stop Lamp flashes.

The Red Stop Lamp will flash and an alarm will sound when a serious problem arises. The lamp is used in conjunction with other warning lights or general text and warning messages to indicate a STOP alert. For further information see Engine Warning Protection System (EWPS) (page 59). Consult an authorized service provider immediately to correct the problem.

High Exhaust System Temperature (HEST) Lamp

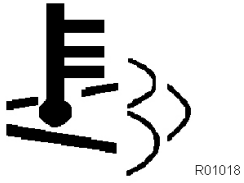


Figure 17 HEST Lamp

WARNING: Exhaust components are operating under normal conditions and exhaust gases are at extremely high temperatures. When stationary, keep away from people and flammable materials, vapors, or structures, or stop the engine.

The HEST lamp will illuminate when the exhaust system is hot and regeneration is in progress. For additional information see the applicable *Vehicle Operator Manual*.

Diesel Particulate Filter (DPF) Indicator

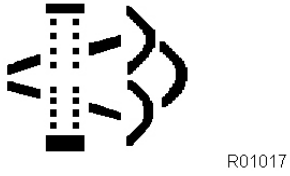


Figure 18 Diesel Particulate Filter Indicator

The diesel particulate filter indicator operates at three different levels.

Level One

- DPF indicator will illuminate solid and remain on when the levels of soot exceed acceptable levels. The regeneration process should begin by using either of the following two methods. The lamp will turn off when the regeneration process is complete.
  - The vehicle can be safely driven on the highway at highway speeds while the regeneration process is in operation.
  - The vehicle should be parked in a safe location and start the Parked Regeneration process to prevent loss of power.

Diesel Particulate Filter (DPF) Indicator (cont.)

Level Two

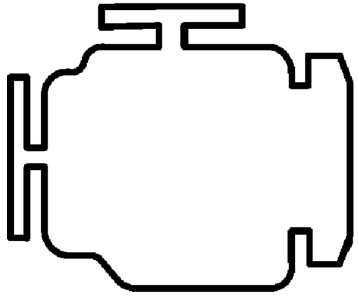
The DPF indicator will be flashing indicating the exhaust filter is full. The vehicle should be safely pulled off the roadway and parked. Start the Parked Regeneration process to prevent loss of engine power. The lamp will stop flashing when the regeneration process is complete. For additional information see the applicable *Vehicle Operator Manual*.

Level Three

WARNING: Pull vehicle safely off roadway and start Parked Regeneration to prevent engine stopping.

The DPF indicator will be flashing and an alarm will beep continuously while the ignition is on. This indicates the exhaust filter is full and engine performance is limited. Pull the vehicle safely off the roadway and start Parked Regeneration process to prevent the engine from stopping. For additional information see the applicable *Vehicle Operator Manual*.

Malfunction Indicator Lamp (MIL)



N35020

Figure 19 MIL

The Malfunction Indicator Lamp (MIL) illuminates when the Heavy-Duty On-Board Diagnostics (HD-OBD) system detects a malfunction related to the emissions control system. The illuminated MIL indicates the vehicle needs to be serviced at the first convenient opportunity. Lamp may remain active after repair until system operation confirms repair.

Typical Water Temperature Gauge

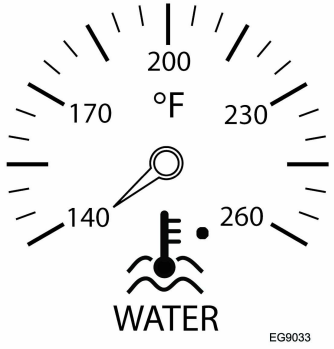


Figure 20 Water Temperature Gauge

The water temperature gauge indicates the temperature of coolant in the cooling system. The gauge operates only when the ignition switch is turned to ON. Normal engine operating temperature is 190°F – 228°F (88°C – 109°C).

CAUTION: To prevent engine damage do not operate engine above 228°F (109°C); this may cause internal damage.

The indicator lamp will be activated at engine coolant temperatures above 228°F (109°C). If engine temperature suddenly rises, shut down engine and determine the cause of overheating. If necessary, contact an authorized service provider.

Oil Temperature Gauge

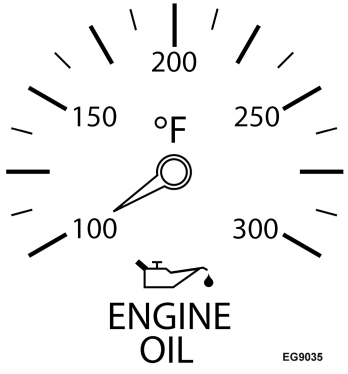


Figure 21 Oil Temperature Gauge

The engine oil temperature gauge indicates the oil temperature of the engine.

Oil Pressure Gauge

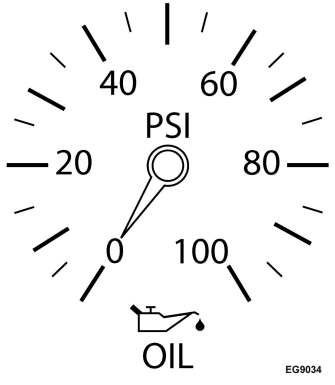


Figure 22 Oil Pressure Gauge

The engine oil pressure gauge indicates operating oil pressure. The engine oil pressure indicator lamp and alarm will be activated when oil pressure falls below acceptable levels. Shut down the engine immediately if the lamp and alarm are activated. Contact an authorized service provider immediately to have the problem corrected.

Oil Pressure Gauge (cont.)

Lubrication Oil Pressure

Lube Oil Pressure At normal operating temperature	
Low idle	12 psi (83 kPa) min.
High idle	45 psi (310 kPa)

CAUTION: To prevent engine damage, shut down engine immediately if the oil pressure indicator lamp and alarm are active.

Engine Exhaust Brake On / Off Toggle Switch

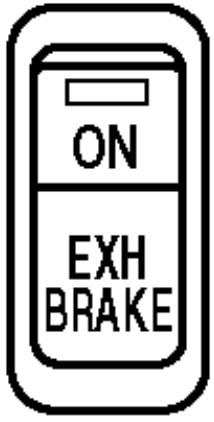


Figure 23 Exhaust Brake Toggle Switch

The exhaust brake toggle switch turns the engine exhaust brake ON or OFF.

Air Cleaner Restriction Indicator

Air restriction is resistance of airflow through the air cleaner. Accurate air restriction is measured at maximum airflow.

Figure 24 Air Cleaner Restriction Indicator

Air cleaner restriction is measured by an air restriction indicator. The restriction indicator may be located anywhere within the air induction system or instrument panel depending on your specific application.

Air Restriction Indicator Calibration

- The indicator is calibrated in inches of water.
- The indicator should be tested periodically (using a master vacuum gauge) to ensure a correct calibration.

Air Restriction Indicator Operation

- The yellow position indicator progressively fills the window as air filter restriction increases, locking at the highest restriction at full load.
- When the yellow position indicator reaches and locks in the red zone, a new air filter should be installed at the earliest convenience.

NOTE: If the yellow indicator locks in the red zone, it is not necessary to shut down the engine immediately, but a new air filter should be installed at the earliest convenience.

Air Restriction Indicator Reset

- Once the filter has been changed, reset the air restriction indicator as follows:
  - If the air restriction indicator is mounted on the air cleaner, push the button on the indicator to reset.

Preoperation Checklist

WARNING: To prevent personal injury or death, provide ventilation when operating an engine in a closed area. Inhalation of exhaust gas can be fatal.

This engine has been given predelivery and delivery service by your dealer and is ready for operation. The operator should fully understand the use and function of all controls and instruments.

1. Check cooling system level.

CAUTION: To prevent engine damage, do not overfill with oil.

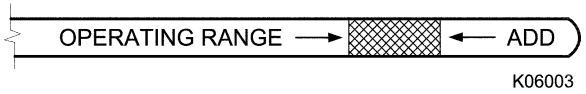


Figure 25 Oil Level Gauge (Typical)

2. Check for correct oil level.
3. If oil level is below operating range, fill with recommended oil for operating climate. The ADD mark indicates 2 quarts (1.9 liters) of oil should be added. For further information see Engine Oil Quality and Service Categories (page 35).
4. Inspect for coolant, fuel or oil leaks.
5. Inspect air cleaner and piping for tightness and correct installation of filter element.
6. Check for loose or hanging electrical connections.
7. Check belt condition and alignment.
8. Fill the tank with recommended fuel. For further information see Acceptable Fuel Blends (page 34).
9. Inspect exhaust system for obstruction or damage.
10. Drain water from fuel system.

Priming the Fuel System

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent property damage, personal injury and / or death, shift transmission to park or neutral, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from open flames and sparks.

CAUTION: To prevent engine damage, do not add fuel to the fuel filter header. This can contaminate the fuel.

1. Set parking brake and shift transmission to park or neutral.
2. Verify water drain valve on primary fuel filter housing is closed and fuel filter caps are on tight.
3. There are two ways to prime the fuel system; use only one of the following two ways.

PRIMING THE FUEL SYSTEM AFTER SERVICING THE FUEL FILTERS

1. Prime the engine after the primary and secondary fuel filters have been serviced as follows:
   a. Key - On for 10 seconds
   b. Key - Off for 15 seconds
   c. Key - On for 10 seconds
   d. Key - Off for 15 seconds
   e. Key - On for 10 seconds
2. Check for fuel leaks prior to starting engine. If leaks are found, correct the problem.
3. Start the engine and check for leaks. For further information see Starting the Engine (page 51).
4. If leaks are found, shut down the engine and correct the problem.
5. If engine does not start, see the *Engine Diagnostic Manual*.

Priming the Fuel System (cont.)

PRIMING THE FUEL SYSTEM AFTER RUNNING OUT OF FUEL

1. If the vehicle has run out of fuel, turn ignition switch to OFF and fill the fuel tank(s). Prime the engine fuel system with seven Key ON / Key OFF sequences as follows:
    a. Key - Off for 20 seconds
    b. Key - On for 15 seconds
2. Check for fuel leaks prior to starting engine. If leaks are found, correct the problem.
3. Start the engine and check for leaks. For further information see Starting the Engine (page 51).
4. If leaks are found, shut down the engine and correct the problem.
5. If engine does not start, see the *Engine Diagnostic Manual*.

Starting the Engine

WARNING: To prevent personal injury or death, do not use ether, propane, gasoline or gasohol as starting aids.

WARNING: To prevent personal injury or death, do not install ether start equipment, if an engine has an intake air heater or other cold climate starting aid.

WARNING: To prevent personal injury or death, do not use ether starting fluid to start engine.

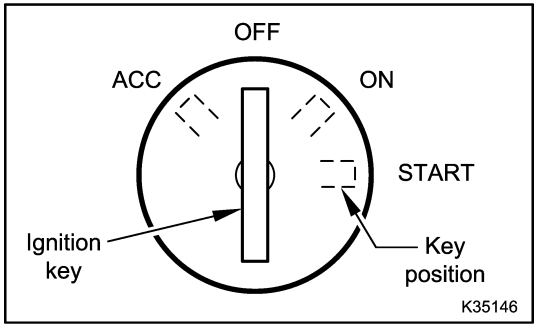


Figure 26 Ignition Switch Positions

1. Set parking brake and shift transmission to park or neutral.

Starting the Engine (cont.)

CAUTION: To prevent damage to the engine, do not depress the accelerator pedal.

2. Depress clutch pedal if equipped.
3. Turn ignition switch to ON to preheat the grid (duct) heater.

NOTE: The Engine Control Module (ECM) normally does not energize the grid (duct) heater during hot starts. However, the ECM senses reduced atmospheric pressure at high altitude and could energize the grid (duct) heater during hot starts.

4. Watch for the WAIT TO START lamp to go off. Do not crank engine until the lamp is off.

NOTE: Observe battery voltage gauge while cranking the engine. If voltage drops below 10V recharge batteries, or replace batteries if needed.

5. When the WAIT TO START lamp goes off, turn ignition switch to START. If the engine has push button starting, press and hold starter button.
6. When the engine starts, release the ignition switch or starter button. The ignition switch will return to ON and the engine will continue to run.
7. With the transmission in neutral, release clutch pedal, if equipped.

CAUTION: To prevent damage to the engine, if the engine fails to start within 20 seconds, do the following:

- Turn ignition switch to OFF and wait 2 to 3 minutes.
- Repeat Steps 1 – 6.
- If after three attempts the engine does not start, determine the cause.
- If starting attempts are continued, the starter motor can be damaged.

8. Warm engine low idle speed is 700 rpm (nonadjustable). Extended idling periods should be avoided. For further information, seeExtended Idling Periods. Check all gauges during warm-up.
9. Within 20 – 30 seconds after engine start, engine oil pressure should exceed 12 psi (83 kPa).

CAUTION: To prevent engine damage – do not increase engine speed until oil pressure gauge indicates normal. If oil pressure does not reach the minimum limit within 20 – 30 seconds, shut down engine.

10. If oil pressure, at low idle, does not meet the minimum limit 12 psi (83 kPa), stop the engine and correct the problem.

Emergency Starting

WARNING: To prevent personal injury or death, do not use ether starting fluid to start the engine.

WARNING: To prevent personal injury or death, do the following when jump starting an engine:

- Wear eye protection.
- Do not smoke.
- Keep flames and sparks away from battery.
- Protect against inhaling hydrogen gas fumes from battery.
- Use a 12-volt system with a negative ground.
- Do not exceed 16.0 volts, if the ignition switch is turned to OFF, ACC or ON during engine cranking.

CAUTION: To prevent engine damage, do not allow metal tools to contact positive terminal of battery.

1. Set parking brake and shift transmission to Park or Neutral.
2. Shut off lights, heater, air conditioner, and other electrical loads in both vehicles.
3. Make sure vehicles are not touching.

WARNING: To prevent personal injury or death, always connect jumper cable for positive battery terminals first.

4. Connect one end of the first jumper cable to the positive (+) terminal of the dead battery or to the positive (+) terminal of the jump start stud. Connect the other end to the positive (+) terminal of the booster battery.

WARNING: To prevent personal injury or death, do not attach jumper cable to the negative (-) terminal of the dead battery and the negative (-) terminal of the booster battery. This can cause sparks and an explosion.

5. Connect one end of the second jumper cable to the negative (-) terminal of the charged battery and the other end to chassis frame of the vehicle with the dead battery.
6. Start engine in vehicle that has the charged battery.
7. Start engine in vehicle that has the dead battery.

WARNING: To prevent personal injury or death, always disconnect jumper cable from negative contacts first.

8. Disconnect jumper cable from negative terminal and chassis frame.
9. Disconnect jumper cable from positive battery terminals or one terminal and jump start stud.

Operation

SUGGESTED WARM-UP TIME

NOTE: The warm–up period allows lubricating oil to establish a film between moving parts. Keep the engine lower than 1800 rpms and below half throttle for the first 5 minutes.

Cold ambient engine warm-up time can be reduced by operating the engine under load at reduced engine speed. Begin normal operation when engine systems reach operating temperature. The Cold Ambient Protection (CAP) system aids in engine warm-up and maintains engine heat during extended idling periods. For further information seeExtended Idling Periods.

IDLE SPEED

WARNING: To prevent personal injury or death, provide ventilation when operating an engine in a closed area. Inhalation of exhaust gas can be fatal.

Low idle speed for the MaxxForce® 7 Diesel Engines is 700 rpm (nonadjustable). If the engine coolant temperature is below 167°F (75°C) and CAP is enabled, the Engine Control Module (ECM) adjusts the low idle speed from 700 rpm to a maximum of 1400 rpm. High idle speed (2950 rpm) is a nonadjustable factory setting.

Operation (cont.)

EXTENDED IDLING PERIODS

CAUTION: To prevent engine damage, do not extend low idle periods.

Extended idling periods should be avoided. Diesel engine efficiency is improved when the cylinder temperature remains high. Low temperature in cylinders may cause the following:

- Unburned fuel may seep from exhaust manifold gaskets and vehicle exhaust system connections. This seepage has the dark colored appearance of lubricating oil.
- Incomplete combustion and unburned fuel will wash lubricating oil from cylinder sleeves. Unburned fuel will be carried into the lubricating oil, dilute the oil, and change oil viscosity.
- Carbon will form on internal components of turbocharger and Exhaust Gas Recirculation (EGR), reducing engine efficiency.
- Carbon will clog and damage the Diesel Particulate Filter (DPF).

AFTERTREATMENT SYSTEM

The engine and vehicle exhaust piping includes an Aftertreatment System to capture soot and other particulates before they exit the exhaust pipe. The soot is captured by the Diesel Particulate Filter (DPF) and is periodically converted to carbon dioxide (CO_2) by a Regeneration (Regen) process.

The Regen process may take place during vehicle operation (Active Regen). The Active Regen process will be triggered by either a time-based soot or a soot mass buildup-based strategy.

A Parked Regen process is required when sufficient thermal energy has not been present to initiate the process for Diesel Oxidation Catalyst (DOC) light off. The vehicle is required to be parked (stationary).

- A Parked Regeneration will be requested if the Regeneration cannot be completed during driving.
- In this case, a dash-mounted lamp will be lit to alert the driver to perform a Parked Regeneration.
- The driver must park the vehicle and then perform the Regen as required.
- Follow the Parked Regeneration process listed in the *Vehicle Operator Manual*.
- If the Parked Regeneration process is ignored, the engine may stop running.

Operation (cont.)

AFTERTREATMENT SYSTEM (cont.)

- See “Safety Information” (page 3) for safety precautions.

A DOC operates to oxidize the injected fuel to increase the exhaust gas temperature as needed for DPF Regen.

ENGINE IDLE SHUTDOWN TIMER (U.S. FEDERAL-OPTIONAL [2010 AND 2011 VEHICLES])

GOVERNMENT REGULATION: State and local regulations may limit engine idle time. The vehicle owner or operator is responsible for compliance with these regulations.

The optional Idle Shutdown Timer (IST) allows the Engine Control Module (ECM) to shut down the engine during extended idle. Idle time can be programmed from 2 – 120 minutes. The ECM can be programmed to deactivate the IST when the PTO is active.

Thirty seconds before engine shutdown, the IDLE SHUTDOWN indicator illuminates. This continues until the engine shuts down or the low idle shutdown timer is reset. The engine must be out of gear for the IST to work. Engine shutdown timer will deactivate for one or more of the following conditions:

- Engine speed is not at idle speed (700 rpm).
- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- Manual DPF Regeneration is enabled (Parked Regen).
- Accelerator pedal movement or an Accelerator Position Sensor (APS) fault is detected.
- Engine coolant operating temperature is below 140°F (60°C).
- Ambient temperature is below 60°F (16°C) or above 110°F (44°C).
- Brake pedal movement is detected or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the Cold Ambient Protection (CAP) will not function.

Operation (cont.)

ENGINE IDLE SHUTDOWN TIMER (CALIFORNIA AND ALL STATE - OPTIONAL [2012 AND NEWER VEHICLES])

GOVERNMENT REGULATION: State and local regulations may limit engine idle time. The vehicle owner or operator is responsible for compliance with these regulations.

Your heavy duty diesel engine conforms to applicable California Air Resources Board (CARB) Engine Shutdown System (ESS) regulations. This vehicle is registered and certified for sale in California.

The CARB Idle Shutdown Timer (IST) allows the Engine Control Module (ECM) to shut down the engine during extended idle. When parking brake is set, the idle time can be programmed up to 5 minutes. When parking brake is released, the idle time can be programmed up to 15 minutes. No parking brake, the idle time can be programmed up to 15 minutes. During service, the idle time can be programmed up to 60 minutes. The ECM will deactivate the IST when the PTO is active.

Thirty seconds before engine shutdown, the IDLE SHUTDOWN indicator in the instrument panel gauge cluster illuminates. This continues until the engine shuts down or the low idle shutdown timer is reset. The engine must be out of gear for the IST to work. Engine shutdown timer will deactivate for one or more of the following conditions:

- Engine speed is not at idle speed (700 rpm).
- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- Manual DPF regeneration is enabled (Parked Regen).
- Accelerator pedal movement or an Accelerator Pedal Sensor (APS) fault is detected.
- Engine coolant operating temperature is below 60°F (16°C).
- Brake pedal movement or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the Cold Ambient Protection (CAP) will not function.

Operation (cont.)

COLD WEATHER OPERATION

NOTE: If operating in temperatures below -20°F (-29°C), contact an authorized service provider for information about special cold weather equipment and precautions.

NOTE: At temperatures below 10°F (-12°C), a crankcase mounted cup plug coolant heater is recommended to improve cold starting.

1. Before operating the engine at 32°F (0°C) or lower, check or service the following:
   - Correct battery size
   - Correct amount of electrolyte, if not a maintenance free battery
   - Full battery charge
   - Condition of other electrical equipment
   - Cooling system hoses for leaks
   - Correct coolant and cooling system level
   - Recommended oil grade
2. At the end of each daily operation do the following:
   - Fill the fuel tank with correct fuel.
   - Drain water from the fuel filter housing.
   - Check oil level.
   - Clean external surfaces of the engine and accessories to prevent dirt or snow buildup.
   - Clean outside and in between radiators to prevent dirt or snow buildup.

COLD AMBIENT PROTECTION (CAP)

CAP safeguards the engine from damage caused by prolonged idle at no load during cold weather. This feature should only be disabled for specialized applications. Engine damage may occur if CAP is disabled.

CAP maintains engine coolant temperature by increasing engine rpm to a programmed value when ambient air temperature is below 32°F (0°C), coolant temperature is below 167°F (75°C), and engine has been idling at no load for over 5 minutes.

The engine speed continues to increase or decrease to maintain a coolant temperature of 194°F (90°C) until the following occurs:

- Engine load is greater than 45%.
- Brake pedal is applied or brake switch fault is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).

Operation (cont.)

COLD AMBIENT PROTECTION (CAP) (cont.)

- Shift selector is moved from neutral (automatic transmissions). Shift selector must be in neutral for CAP to work.
- Power Takeoff (PTO) switch, also used for electronic hand throttle, is turned on and actively controls engine speed.
- Accelerator pedal is pressed or Accelerator Pedal Position (APP) fault is detected.
- IST is enabled (2010 and 2011 vehicles only).
- Engine Coolant Temperature (ECT) sensor fault is detected.
- Intake Air Temperature (IAT) ambient temperature sensor fault is detected.

HOT WEATHER OPERATION

1. Before operating the engine above 32°F (0°C), check or service the following:
   - Full battery charge
   - Condition of other electrical equipment
   - Cooling system hoses for leaks
   - Correct coolant and cooling system level
2. At the end of each daily operation do the following:
   - Fill the fuel tank with correct fuel.
   - Drain water from the fuel filter housing.
   - Check oil level.
   - Clean external surfaces of the engine and accessories to prevent dirt build up.
   - Clean outside and in between radiators to prevent dirt build–up.

ENGINE SHUTDOWN

Before shutting down an engine that has reached operating temperature, idle the engine for 30 seconds, allowing the hottest engine components to dissipate some of their internal heat.

- Idling is recommended, if an engine has been running at maximum horsepower.

ENGINE WARNING PROTECTION SYSTEM (EWPS)

The Engine Warning Protection System (EWPS) warns the operator of engine conditions that can damage the engine. Optional engine shutdown is available and is activated if one or more critical conditions are detected.

Operation (cont.)

ENGINE WARNING PROTECTION SYSTEM (EWPS) (cont.)

The Standard Warning System is the base system in which all engines are equipped. If one of these faults is detected, the ECM will illuminate the Amber Warning Lamp (AWL), set a corresponding Diagnostic Trouble Code (DTC), and de-rate the engine.

Standard Warning

- The engine will not shut down and will warn of an engine fault.
- RPM - Engine over-speed warning.
- Engine Coolant Temperature (ECT) - Engine overheat warning.
- EOT - Engine Oil Temperature overheat warning
- EOP - Low Engine Oil Pressure warning
- EFT - Engine Fuel Temperature overheat warning
- ECL - Low Engine Coolant Level warning

NOTE: The protection mode is not offered for school buses or emergency vehicles.

Protection Mode (optional)

- The protection mode is an optional calibration that can be added to the EWPS by an authorized service provider.

Engine shutdown is available if critical condition is detected:

- ECT - Engine Coolant Temperature overheat protection
- EOT - Engine Oil Temperature overheat protection
- EOP - Low Engine Oil Pressure protection

Operation (cont.)

ENGINE WARNING PROTECTION SYSTEM (EWPS) (cont.)

- EFT - Engine Fuel Temperature overheat protection
- ECL - Low Engine Coolant Level protection

Warning - Temperature above specific threshold will sound a buzzer, illuminate the Amber Warning Lamp, set a DTC, and de-rate the engine.

Critical - Temperature above specific threshold will shut down the engine and set a DTC. The operator has 30 seconds to safely pull vehicle off the road before the engine shuts off. A Red Stop Lamp will illuminate before engine shutdown is approaching. The ECM allows the engine to be restarted and run for 30-second periods.

Event Log - This feature logs occurrences of the event according to engine hours and odometer readings, for both Standard warning and optional Protection modes.

HD-OBD OVERVIEW

The HD-OBD system uses many individual pre-programmed “monitors” to ensure the vehicle is meeting emissions standards. An HD-OBD monitor is a strategy to evaluate the performance of an emissions related system or component. All monitors are designed for execution in a prescribed frequency; some monitors run continuously, while some run a specific ratio against the number of drive cycles.

The operator will be alerted to emissions or other system problems when the Malfunction Indicator Lamp (MIL) illuminates. When the MIL illuminates, bring the vehicle in for service at the next available opportunity. The HD-OBD system does not change the way the vehicle should be driven, the recommended driving style, or the way you use the vehicle.

RADIATOR SHUTTLE ENABLE (RSE)

RSE is an optional feature that provides a signal to open or close the radiator shutters. Closing the shutters will keep the engine warm during cold weather operation.

ROAD SPEED LIMITING (RSL)

RSL is an optional feature that limits the top vehicle speed the ECM allows. RSL is set to one of the following two positions:

- OFF
- Vehicle speed to be determined by customer, up to a maximum of 127 mph (204 km/h)

To have the RSL set, changed, or turned off, see an authorized service provider.

Operation (cont.)

ROAD OPERATION

Correct road operation of your vehicle provides the following:

- Satisfactory engine performance
- Maximum fuel economy
- Long service life

General guidelines for correct road operation:

1. Use the lowest gear to get the vehicle moving. This allows the engine to easily move the load.
2. Accelerate smoothly and evenly to engine's rated speed. Rapid acceleration causes high fuel consumption.
3. To prevent lugging, do not let engine speed to drop below peak torque rpm during full throttle.
4. When approaching a hill, press accelerator smoothly to start the upgrade at full power. Downshift to maintain maximum vehicle speed.

DOWNHILL OPERATION

CAUTION: To prevent engine damage when driving downhill, do not operate engine above high idle.

Protect your engine when driving downhill as follows:

- Prevent overspeeding of engine when going down long and steep grades.
- Operate the engine in a gear that allows a lower rpm.
- Operate the engine closest to high idle for maximum engine exhaust brake effectiveness.

Maintenance Schedule

MaxxForce® 7 Diesel Engines

Service operation interval - whichever comes first: kilometers / miles, months, years, hours or liters / gallons of fuel	
Service Interval	**Service Operation** **See service procedures in this section for more information.**
Before Engine Operation	Check engine oil level. Check coolant level. Check charge air cooler. Check for external leaks. Check air restriction indicator.
With Oil Change or When Water In Fuel Sensor Light Illuminates	Drain water from fuel water separator.
Average > 11 mpg (4.7 Kmpl) of fuel consumption: • **500 hours or 6 months** - if average speed < 15 mph (24 Kmph) • **15,000 miles (24,000 km) or 6 months** - if average speed is ≥15 mph (24 Kmph)	Change engine oil and oil filter.[1] **NOTE:** For RV and motor home applications only, oil change interval duration is every 12 months instead of 6 months. Maximum hours and distance between oil change intervals remain the same.

Maintenance Schedule (cont.)

MaxxForce® 7 Diesel Engines (cont.)

Service operation interval - whichever comes first: kilometers / miles, months, years, hours or liters / gallons of fuel	
Service Interval	**Service Operation** **See service procedures in this section for more information.**
Average of 7 - 11 mpg (3.0 - 4.7 Kmpl) of fuel consumption: • **500 hours or 6 months** - if average speed < 15 mph (24 Kmph) • **See Oil change interval graph (Figure 30), or 6 months** - if average speed of > 15 mph (24 Kmph)	Change engine oil and oil filter [1] **NOTE:** For RV and motor home applications only, oil change interval duration is every 12 months instead of 6 months. Maximum hours and distance between oil change intervals remain the same.
Average of < 7 mpg (3.0 Kmpl) of fuel consumption: • **500 hours or 6 months** - if an average of < 15 mph (24 Kmph) • **7,000 miles (11,265 km) or 6 months**- if average speed of > 15 mph (24 Kmph)	Change engine oil and oil filter. [1] **NOTE:** For RV and motor home applications only, oil change interval duration is every 12 months instead of 6 months. Maximum hours and distance between oil change intervals remain the same.
Every Three Oil Changes	Service crankcase breather filter (for 2010 & 2011 model year engines only). For engines built in July 2012 and later, no service is required for non-serviceable crankcase breather.

Maintenance Schedule (cont.)

MaxxForce® 7 Diesel Engines (cont.)

Service operation interval - whichever comes first: kilometers / miles, months, years, hours or liters / gallons of fuel	
Service Interval	**Service Operation** **See service procedures in this section for more information.**
15,000 miles (24,000 km) **6 months, 500 hours** **2000 gallons (7570 liters) of fuel**	Inspect belt, air intake piping, and clamps. Check coolant freeze point.
30,000 miles (48,280 km) **12 months, 1050 hours** **3000 gallons (11,360 liters) of fuel**	Change primary and secondary fuel filter elements.
Annually	Inspect electrical system. Pressurize air induction system.
150,000 miles (240,000 km) **30 months, 6,000 hours**	Add Extended Life Coolant (ECL) Extender.

Maintenance Schedule (cont.)

MaxxForce® 7 Diesel Engines (cont.)

Service operation interval - whichever comes first: kilometers / miles, months, years, hours or liters / gallons of fuel	
Service Interval	**Service Operation** **See service procedures in this section for more information.**
200,000 miles (322,000 km) 30 months, 6,000 hours	Cleaning Diesel Particulate Filter (DPF) [2]
300,000 miles (483,000 km) 12,000 hours 60 months, 5 years	Service cooling system.

1 Engine Control Module (ECM) will notify operator when appropriate interval is reached based on the mileage, hours, and fuel consumption calculation. For further information see Resetting Change Engine Oil Service Interval Message (page 76). Alternatively, use the Daily Care and Report table (page 101) to record mileage, engine hours, and fuel consumption. Calculate average miles per hour and average miles per gallon since last oil change and use with specified intervals to determine change interval.

2 Reduced service interval required if allowed CI-4 engine lubrication oil is used. If using CI-4 oil, reduce DPF cleaning interval to 150,000 miles (241,000 km), 22 months, or 4,500 hours.

Service Procedures

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, shift transmission to park neutral, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

OIL LEVEL

Service Interval: Before Engine Operation

1. Park vehicle on level ground.

NOTE: Do not check oil level if engine is running or immediately after engine shutdown.

2. Shut down engine and wait 15 minutes.
3. Remove oil level gauge from oil level gauge tube.

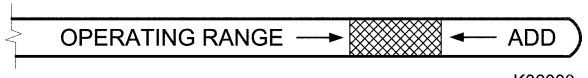


Figure 27 Oil Level Gauge (Typical)

CAUTION: To prevent engine damage do the following:

- Verify oil level readings are within the crosshatched operating range on the oil level gauge.
- Do not overfill the engine with oil.
- Do not operate engine if oil level is above or below the operating range.

Service Procedures (cont.)

OIL LEVEL (cont.)

4. If oil level is below operating range, fill with recommended oil for operating climate. The ADD mark indicates 2 quarts (1.9 liters) of oil should be added. For further information see Engine Oil Quality and Service Categories (page 35).

COOLANT LEVEL

Service Interval: Before Engine Operation

Extended Life Coolant (ELC) Premix 50 / 50 is the standard factory fill for the cooling system. If a customer wishes to use a different coolant, it should minimally meet ASTM D6210, Standard Specification for fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines. ELC Premix 50 / 50 is used to replenish coolant loss and ensure that glycol / water concentrations stay in balance.

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or coolant tank cap:

- Allow the engine to cool for 15 minutes or more.
- Wrap a thick cloth around the radiator cap or coolant tank cap.
- Loosen cap slowly a quarter to half turn to vent pressure.
- Pause for a moment until all pressure has escaped to avoid being scalded by steam.
- Continue to turn cap counterclockwise to remove.

1. Check coolant level in the coolant tank.
   - Coolant level should be at midpoint of ADD and MAX.
   - If coolant level is below the ADD mark, continue with Step 2.
2. Remove coolant tank cap and add ELC Premix 50 / 50 until the fluid level reaches the midpoint between ADD and MAX.
3. Install and tighten the coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.

Service Procedures (cont.)

CHARGE AIR COOLER (CAC)

Service Interval: Before Engine Operation

WARNING: To prevent personal injury or death, shut down engine, set parking brake, and install wheel chocks before inspecting the Charge Air Cooler.

1. Inspect Charge Air Cooler (CAC) core for debris and clogged external fins.
2. Before starting engine, remove debris blocking the core.

EXTERNAL LEAKAGE

Service Interval: Before Engine Operation

WARNING: To prevent personal injury or death, shut down engine, set parking brake, and install wheel chocks before inspecting for external leakage.

1. Check for the following conditions:
   - Cracked hoses
   - Loose clamps
   - Coolant stains
   - Oil stains
   - Fuel stains
   - Leakage at water pump (wetness from the weep hole is normal)
2. Correct problems.

Service Procedures (cont.)

AIR CLEANER RESTRICTION

Service Interval: Before Engine Operation

Figure 28 Air Cleaner Restriction Indicator

Observe the restriction reading on the air filter restriction gauge.

If the yellow restriction indicator is at or near the red zone, the restriction is high and a new air filter should be installed to prevent reduced fuel economy, low engine power, or engine damage.

Push reset button and observe the movement of the air restriction indicator to make sure it is not locked up. If the air filter was not changed, the yellow indicator will return to the same reading when the vehicle is driven under normal driving conditions.

1. Remove plugged air filter element and discard.

CAUTION: To prevent engine damage, do not use compressed air to clean filter housing.

2. Use a clean water-dampened cloth to clean inside of air filter housing.
3. Inspect air filter housing for damage or distortion. Install new housing, if necessary.
4. Verify nothing has fallen into the filter housing prior to installing a new filter element.
5. Install a new air filter element.
6. Push reset button on air restriction indicator. The yellow indicator will return to zero.

Service Procedures (cont.)

FUEL WATER SEPARATOR

Service Interval: With Oil Change or When Water In Fuel Sensor Light Illuminates

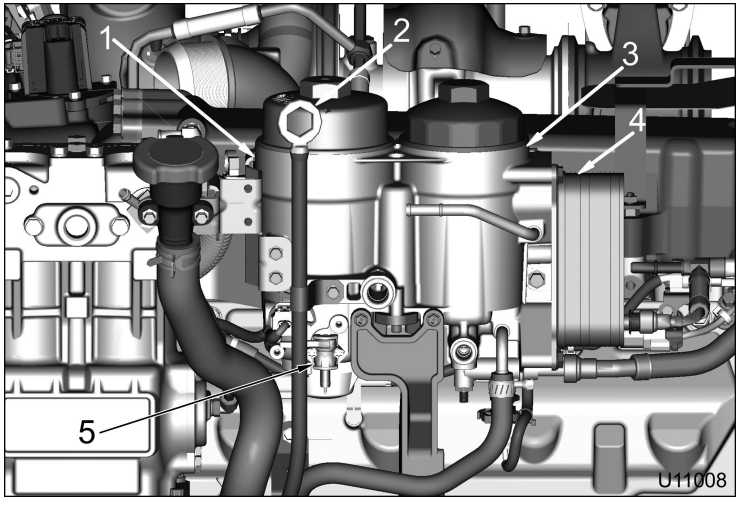


Figure 29 Water Drain Valve

1. Primary fuel filter
2. Oil level gauge
3. Secondary fuel filter
4. Fuel cooler
5. Water drain valve

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

WARNING: To prevent personal injury or death, store diesel fuel properly in an approved container designed for and clearly marked DIESEL FUEL.

1. If the desired collection container will not fit under the water drain valve, connect a hose to the end of the water drain valve.
2. Put a suitable container under water drain valve (or drain hose).

Service Procedures (cont.)

FUEL WATER SEPARATOR (cont.)

NOTE: Drain until no water or other contaminants are observed exiting from the drain valve. Upon opening the drain valve, a hissing sound will be heard as air fills the fuel line between the engine and the fuel tank. After the sound stops, liquid will exit the drain valve.

3. Turn the water drain valve to open and allow the water / fuel mixture to drain out.
4. Close water drain valve and remove drain hose.
5. Recycle or dispose of fuel according to applicable regulations.
6. Prime the engine. For further information see Priming the Fuel System (page 50).

ENGINE OIL AND FILTER

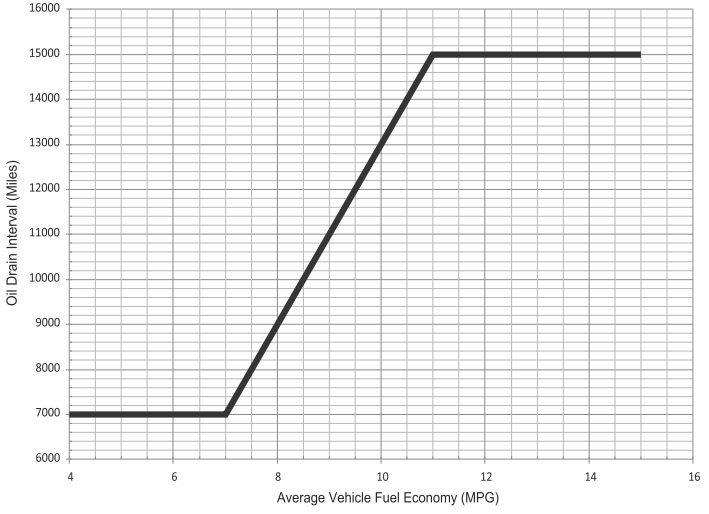


Figure 30 Figure 30 Oil Change Interval Graph

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

Service Interval, whichever comes first: 6 months or calculation from one of the following tables.

Average fuel consumption rate in Kilometers per liter (Kmpl) vs. average speed in Kilometers per hour (Kmph).

	< 24 Kmph	> 24 Kmph
> 4.7 Kmpl	500 hrs	24,000 km
3.0 - 4.7 Kmpl	500 hrs	See Oil Change Interval graph (Figure 30).
< 3.0 Kmpl	500 hrs	11,265 km

Average fuel consumption Miles Per Gallon (MPG) vs. average speed Miles Per Hour (MPH).

	<= 15 MPH	> 15 MPH
> 11 MPG	500 hrs	15,000 miles
7- 11 MPG	500 hrs	See Oil Change Interval graph (Figure 30)
< 7 MPG	500 hrs	7,000 miles

CAUTION: To prevent engine damage, do not extend recommended oil change intervals.

The Engine Control Module (ECM) will notify you when the appropriate interval is reached based on the mileage, hours, and fuel consumption calculation. For further information see Resetting Change Engine Oil Service Interval Message (page 76).

Alternatively, use the Daily Care and Report table (page 101) to record mileage, engine hours, and fuel consumption. Calculate the average miles per hour and the average miles per gallon since the last oil change and use with the specified intervals to determine the appropriate change interval.

Engine oil sampling can be utilized for the following:

Engine Oil Sampling - Optional

1. Determine if specified engine oil change intervals should be shortened, based upon specific engine application.
2. Catch contaminants which, if left unattended, may result in engine failure.

Change engine oil and oil filter procedure:

1. Park vehicle on level ground. Set parking brake and shift transmission to park or neutral.

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

2. Run engine until operating temperature is reached, then shut down the engine.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, wear protective clothing when draining hot oil.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

3. Place a drain pan under the oil pan drain plug, remove oil pan drain plug and drain oil.
4. Inspect the oil pan drain plug and seal, if they are free of defects, they can be reused. Replace if necessary.
5. Using clean engine oil, liberally lubricate the oil pan drain plug seal.
6. Install oil pan drain plug and tighten to 18 lb·ft (25 N·m).
7. Recycle or dispose of oil according to applicable regulations.
8. Put drain pan under oil filter.
9. Remove oil filter and recycle or dispose of according to applicable regulations.
10. Lubricate new oil filter gasket with clean engine oil.

CAUTION: To prevent engine damage, install the correct oil filter for the engine application.

11. Install new oil filter.

CAUTION: To prevent engine damage, do not overtighten oil filter.

12. Hand tighten oil filter 3/4 to 1 full turn after gasket first contacts oil filter header.

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

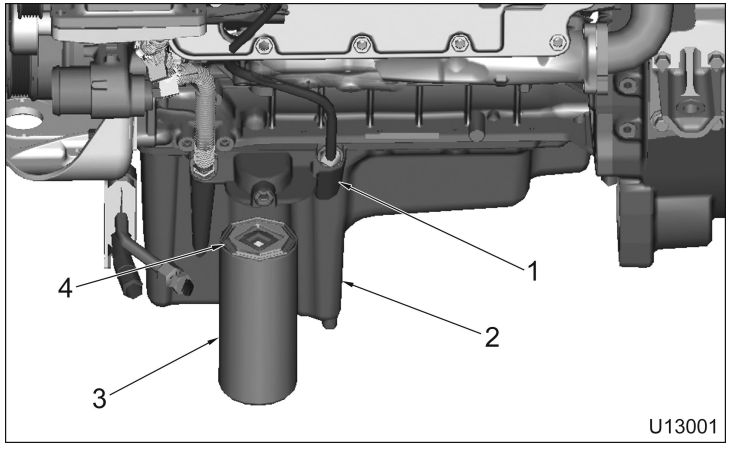


Figure 31 Oil Filter Removal And Installation

1. Oil filter header
2. Oil pan
3. Spin-on oil filter
4. Oil filter O-ring

CAUTION: To prevent engine damage, do not overfill with oil.

13. Add correct oil viscosity. API CJ-4 oil is recommended but CI-4 is allowable. Use of CI-4 engine oil will reduce DPF cleaning interval. For further information see Maintenance Schedule and Service Procedures chart (page 63). Add oil through the engine oil fill tube.

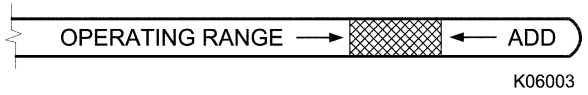


Figure 32 Oil Level Gauge (Typical)

14. Check oil level gauge. Oil level must be within the crosshatched operating range on the gauge.
15. Start engine and run at low idle.
16. Check reading on oil pressure gauge.
    - Minimum lube oil pressure is 12 psi (83 kPa) @ 700 rpm.
    - If there is no gauge reading, shut engine down immediately. Check for oil filter and drain plug leaks.
    - Let engine run until operating temperature is reached. Check for leaks.
17. Shut down engine for 15 minutes.

CAUTION: To prevent engine damage, do not overfill with oil.

18. Recheck oil level and add oil to bring oil level within the upper half of the crosshatched operating range on oil level gauge.

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

19. Reset the change engine oil service interval message. See Resetting Change Engine Oil Service Interval Message (page 76).

RESETTING CHANGE ENGINE OIL SERVICE INTERVAL MESSAGE

Reset the Service Interval Message (change engine oil) per the following procedure:

1. If not already done, set the parking brake.
2. Turn ignition switch to ON.
3. Turn CRUISE ON.
4. Turn CRUISE OFF.
5. Turn CRUISE ON.
6. Very rapidly push the resume switch four times and then hold down on the fifth time for 4 seconds.
7. The operation from the time the CRUISE is turned ON for the second time to the fifth activation of the resume switch must take place within 6 seconds. If you fail to reset the message, repeat the process.
8. The Change Engine Oil Service Interval message should clear and reset for the next service interval.

BELT, AIR INTAKE PIPING AND CLAMPS

Service Interval: 10,000 miles (16,000 km), 6 months, 350 hours or 1000 gallons (3785 liters of fuel)

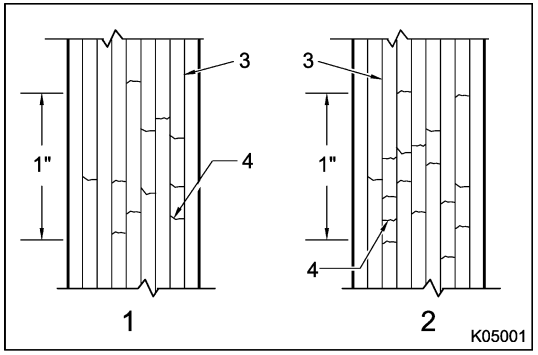


Figure 33 Cracks In Belt Ribs

1. Belt in good condition
2. Belt ready for replacement
3. Belt ribs
4. Cracks in belt

Service Procedures (cont.)

BELT, AIR INTAKE PIPING AND CLAMPS (cont.)

Install a new belt if any of the following conditions exist:

- Excessive wear
- Missing material
- Grease or oil contamination
- Over three cracks per inch in a belt rib

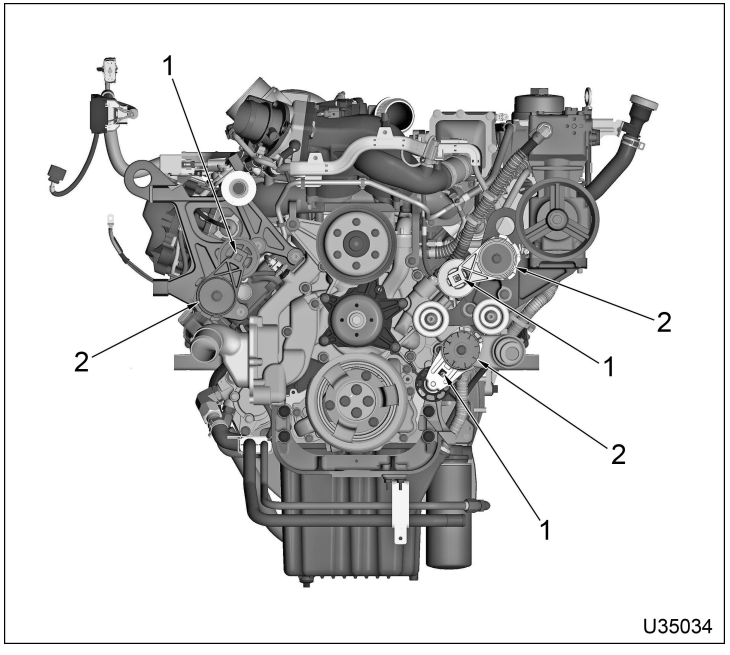


Figure 34 Square Hole In Auto Tensioner (Typical)

1. Square hole location in auto tensioner
2. Auto tensioner

Service Procedures (cont.)

BELT, AIR INTAKE PIPING AND CLAMPS (cont.)

Removing the Belt

1. Attach a 1/2–inch drive breaker bar to square hole in auto tensioner.
2. Pull breaker bar clockwise and remove belt from auto tensioner pulley and other pulleys.
3. Slowly release breaker bar; auto tensioner automatically adjusts.
4. Remove breaker bar.

Installing the Belt

1. Attach a 1/2–inch drive breaker bar to square hole in auto tensioner.
2. Pull breaker bar clockwise and install belt over auto tensioner pulley and other pulleys.
3. Slowly release breaker bar; auto tensioner automatically adjusts.
4. Remove breaker bar.

AIR INTAKE PIPING AND CLAMPS

For any of the following conditions, install new parts:

- Loose hoses or clamps, tighten or replace as required
- Ruptured hoses
- Cracked air cleaner housing
- Damaged Charge Air Cooler (CAC)

COOLANT FREEZE POINT

Service Interval: 15,000 miles (24,000 km), 6 months, 500 hours, or 2000 gallons (7570 liters) of fuel

CAUTION: To prevent engine damage, do not use Dex-cool® in MaxxForce® 7 engines.

ELC 50 / 50 Premix provides freeze protection to -34°F (-36°C) and maximum corrosion protection. If a customer wishes to use a conventional (non-OAT ELC) coolant, it should minimally meet ASTM D6210, Standard Specification for fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines. ELC 50 / 50 Premix is used to replenish coolant loss and ensure that glycol / water concentrations stay in balance.

ELC 50 / 50 Extender is added at the designated service interval.

Service Procedures (cont.)

COOLANT FREEZE POINT (cont.)

Freeze Point Protection Levels Concentrate (Ethylene Glycol) and Water Mixtures

Concentrate and Water Mixtures	Freeze Point Protection
40% Concentrate and 60% water	-12°F (-24°C)
50% Concentrate and 50% water	-34°F (37°C)
60% Concentrate and 40% water	-62°F (-52°C)
67% Concentrate and 33% water	-95°F (-71°C)

CAUTION: To prevent engine damage, do not use a concentrate and water mixture of less than 40% concentrate.

For vehicles operating in extremely cold climates, coolant mixtures of 60% Concentrate and 40% water or 67% Concentrate and 33% water provide additional freeze protection as shown in the table above. Mixtures having more than 67% Concentrate are not recommended.

Check freeze point with a refractometer.

1. Put drop of coolant on refractometer window.
2. Look through eyepiece and focus.
3. Record freeze point.
4. Adjust coolant concentration as necessary to achieve desired freeze point protection.

PRIMARY FUEL FILTER

Service Interval: 30,000 miles (48,280 km), 12 months, 1050 hours, or 3,000 gallons (11,360 liters) of fuel

NOTE: Drain fuel filters if optional Water In Fuel (WIF) lamp is illuminated.

NOTE: If fuel used has more than average impurities, shorter service intervals may be required.

Service Procedures (cont.)

PRIMARY FUEL FILTER (cont.)

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

WARNING: To prevent personal injury or death, store diesel fuel properly in an approved container designed for and clearly marked DIESEL FUEL.

WARNING: To prevent personal injury or death, do not mix gasoline, gasohol, or alcohol with diesel fuel. A heat source, spark, or electronic device can ignite these fuel mixtures. This creates a fire hazard and possible explosion.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

Service Procedures (cont.)

PRIMARY FUEL FILTER (cont.)

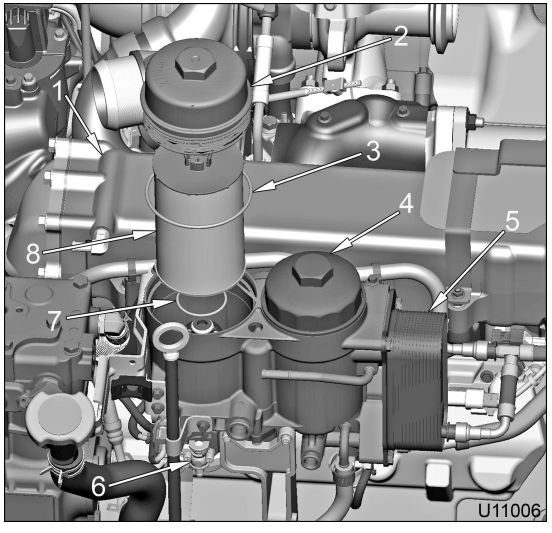


Figure 35 Primary Fuel Filter Assembly

1. Exhaust Gas Recirculation (EGR) cooler
2. Primary fuel filter cap
3. Primary fuel filter cap O-ring
4. Secondary fuel filter
5. Fuel cooler
6. Water drain valve
7. Primary fuel element O-ring
8. Primary fuel filter element

1. Set parking brake and shift transmission to park or neutral.

NOTE: Both the primary and secondary fuel filter elements should be replaced during this service interval.

⚠ WARNING: To prevent personal injury or death, make sure that the engine has cooled before removing components.

2. Turn ignition switch to OFF and allow engine to cool before removing components.

⚠ WARNING: To prevent personal injury or death, wear safety glasses with side shields. Limit compressed air pressure to 30 psi (207 kPa).

CAUTION: Clean area around and above fuel filter housing before removing fuel filter cover. This protects the open fuel filter housing from contaminants falling into the housing. If contaminants do fall in, remove them and blow out fuel filter housing with compressed air before installing a new filter element. Contaminants reaching high-pressure fuel system components may cause component failure.

Service Procedures (cont.)

PRIMARY FUEL FILTER (cont.)

3. Clean engine compartment components in the area of the fuel filter housing using compressed air. Before removing the fuel filter cap, wipe the fuel filter cap and top portion of fuel filter housing clean. This prevents contaminants from entering the fuel system, which could cause engine failure.
4. Loosen the primary fuel filter cap counterclockwise 3 and 1/2 turns to allow the primary fuel filter housing to vent.
5. If the desired collection container will not fit under the water drain valve, attach a hose to the end of the water drain valve.
6. Put a suitable container under the water drain valve.
7. Open water drain valve and drain the fuel filter assembly.
8. Recycle or dispose of fuel according to applicable regulations.
9. Remove primary fuel filter cap and fuel filter element from the fuel filter housing.
10. Remove O-ring from primary fuel filter cap and discard O-ring.
11. Remove fuel filter element from fuel filter cap and discard according to applicable regulations.
12. Remove the O-ring from the primary fuel filter element.
13. Clean mating surfaces.
14. Coat the new primary fuel filter element O-ring with clean diesel fuel and install it into the groove inside the fuel filter module.

CAUTION: To prevent engine damage, do not add fuel to the fuel filter housing; this can add contaminants to the fuel.

15. Coat a new O-ring for the primary fuel filter cap with clean diesel fuel and install onto the primary fuel filter cap.

CAUTION: To prevent engine damage, the fuel filter cap must be tightened on the fuel filter housing.

16. Attach primary fuel filter cap to the primary fuel filter. Push the cap onto the element until it snaps to secure it.
17. Coat the threads of the primary fuel filter cap with clean diesel fuel.
18. Verify a small O-ring is installed at the bottom of the primary fuel filter. If the O-ring is loose (not installed) in the bottom of the filter, install the O-ring in the groove located at the bottom of the primary fuel filter. Coat the O-ring with clean diesel fuel.
19. Install the primary fuel filter element with cap into the primary fuel filter housing. Slowly lower the element into the housing until primary fuel filter cap is ready to be secured to the primary fuel filter housing.

Service Procedures (cont.)

PRIMARY FUEL FILTER (cont.)

20. Secure the fuel filter cap and element to the fuel filter housing by turning the fuel filter cap clockwise until finger-tight.
21. Tighten fuel filter cap to 37 lb·ft (50 N·m).
22. Close water drain valve on fuel filter housing assembly and remove water drain hose.
23. Continue with secondary fuel filter replacement.

SECONDARY FUEL FILTER

Service Interval: 30,000 miles (42,280 km), 12 months, 1050 hours or 3,000 gallons (11,360 liters) of fuel.

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

WARNING: To prevent personal injury or death, store diesel fuel properly in an approved container designed for and clearly marked DIESEL FUEL.

WARNING: To prevent personal injury or death, do not mix gasoline, gasohol, or alcohol with diesel fuel. A heat source, spark, or electronic device can ignite these fuel mixtures. This creates a fire hazard and possible explosion.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

Service Procedures (cont.)

SECONDARY FUEL FILTER (cont.)

NOTE: If fuel used has more than average impurities, shorter service intervals may be required.

1. If not already done, replace the primary fuel filter element. For further information see Primary Fuel Filter (page 79).

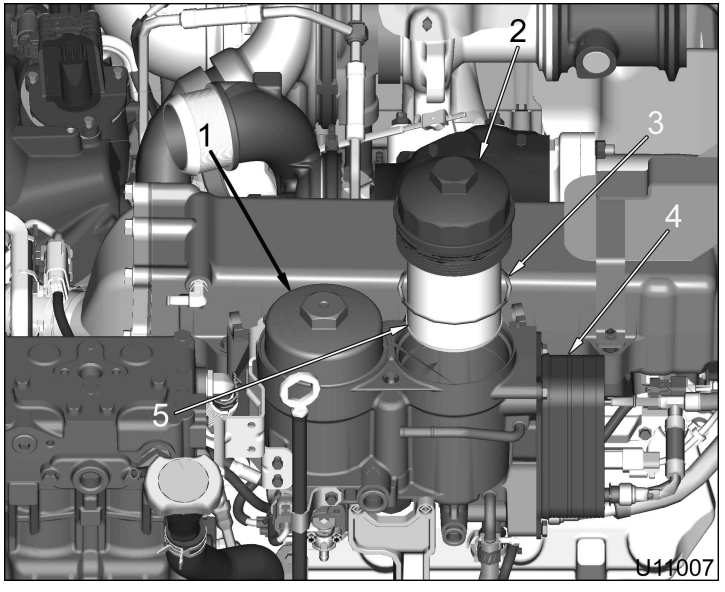


Figure 36 Secondary Fuel Filter Assembly

1. Primary fuel filter cap
2. Secondary fuel filter cap
3. Secondary fuel filter cap O-ring
4. Fuel cooler
5. Fuel filter element

Service Procedures (cont.)

SECONDARY FUEL FILTER (cont.)

2. Loosen the secondary fuel filter cover counterclockwise 3 and 1/2 turns to allow the secondary fuel filter housing to vent.
3. Remove fuel filter cap and fuel filter element from the secondary fuel filter housing.
4. Remove O-ring from fuel filter cap and discard O-ring.
5. Remove fuel filter element from fuel filter cap and discard according to applicable regulations.
6. Clean mating surfaces.

CAUTION: To prevent engine damage, do not add fuel to the fuel filter housing; this can add contaminants to the fuel.

7. Coat a new O-ring for the fuel filter cap with clean diesel fuel and install onto the fuel filter cap.

CAUTION: To prevent engine damage, the fuel filter cap must be tightened on the fuel filter housing.

8. Attach fuel filter cap to the fuel filter element. Push the cap onto the element until it snaps to secure it.
9. Coat the threads of the fuel filter cap with clean diesel fuel.

Service Procedures (cont.)

SECONDARY FUEL FILTER (cont.)

10. Install the fuel filter element with cap into the secondary fuel filter housing. Slowly lower the fuel filter element into the housing until fuel filter cap is ready to be secured to the secondary fuel filter housing.
11. Secure the fuel filter cap and element to the fuel filter housing by turning the fuel filter cap clockwise until finger-tight.
12. Tighten fuel filter cap to 29 lb·ft (40 N·m).
13. Prime the engine as follows:
    - Key - On for 10 seconds
    - Key - Off for 15 seconds
    - Key - On for 10 seconds
    - Key - Off for 15 seconds
    - Key - On for 10 seconds
14. Check for fuel leaks prior to starting engine. If leaks are found, correct the problem.
15. Start the engine and check for leaks. For further information see Starting the Engine (page 51).
16. If leaks are found, shut down the engine and correct the problem.
17. If engine does not start, see the *Engine Diagnostic Manual*.

CRANKCASE BREATHER

NOTE: Engines built in July 2012 and later have a non-servicable crankcase breather.

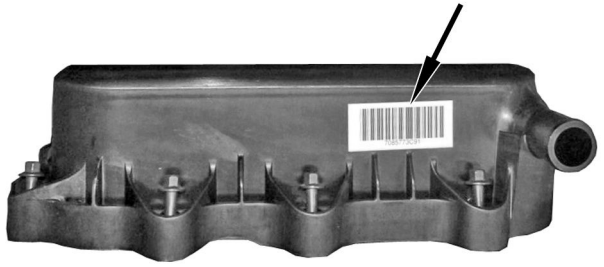


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Figure 37 Non-Serviceable Crankcase Breather Identifier

The non-serviceable crankcase breather can be identified by a bar code label on the side. Serviceable crankcase breathers will not have a barcode on the side.

Service Procedures (cont.)

CRANKCASE BREATHER (cont.)

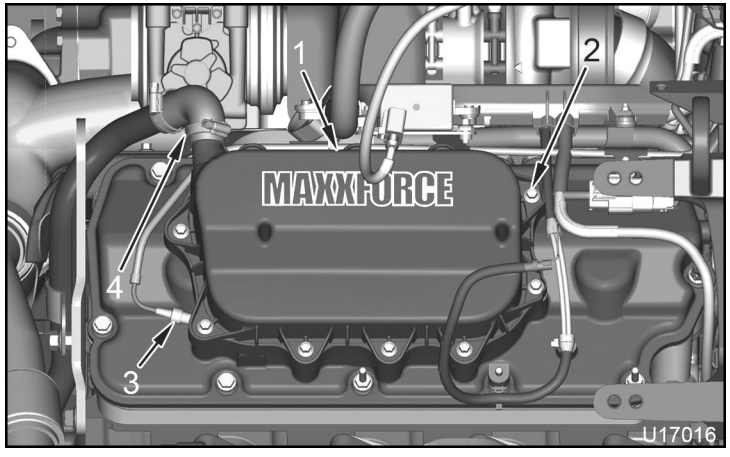

Figure 38 Crankcase Breather Assembly

1. Breather assembly
2. M6 captive bolt (10)
3. Jet pump boost tube connector
4. Draft tube clamp

Service Interval: Every three oil changes (for engines with a serviceable crankcase breather built before July 2012 only). The serviceable crankcase breather assembly can be replaced with a new non-serviceable crankcase breather at the next service interval.

1. For serviceable crankcase breather only: Install a new filter element per instructions in the *Engine Service Manual*.
2. Reset the service breather element message. See Resetting Change Service Breather Element Message (page 88).

NOTE: Replace the crankcase breather if the engine oil is contaminated with fuel or coolant.

Service Procedures (cont.)

RESETTING CHANGE SERVICE BREATHER ELEMENT MESSAGE (SERVICEABLE CRANKCASE BREATHER ONLY)

Reset the Service Breather Element Message (change breather element) per the following procedure:

1. If not already done, set the parking brake. (Required for the correct Electronic System Controller [ESC] signal)
2. Turn ignition switch to ON.
3. Turn CRUISE ON.
4. Turn CRUISE OFF.
5. Turn CRUISE ON.
6. Very rapidly push the SET / CRUISE switch four times and then hold down on the fifth time for 4 seconds.
7. The operation from the time the cruise is turned ON for the second time to the fifth activation of the SET / CRUISE switch must take place within 6 seconds. If you fail to reset the message, repeat the process.
8. The Change Breather Element message should clear and reset for the next service interval.

ELECTRICAL SYSTEM

Service Interval: Annually

1. Check wiring harness for cracks, rubbing, and loose connections.
2. Check sensors for loose connections, corrosion, or cracks.
3. Check battery cables for the following conditions:
   - Broken insulation
   - Rubbing or chafing
   - Corroded or loose connections

Electronics

Check for fault codes and repair as required. After repairs are made, clear fault codes and verify they do not reappear. For correct procedures, see MaxxForce® 7 *Engine Diagnostic Manual* or contact an authorized service provider.

INDUCTION SYSTEM

Service Interval: Annually

Have an authorized service provider pressure test the air induction system.

Service Procedures (cont.)

EXTENDED LIFE COOLANT (ELC) EXTENDER

Service Interval: 150,000 miles (240,000 km), 30 months, or 6,000 hours

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or coolant tank cap:

- Allow the engine to cool for 15 minutes or more.
- Wrap a thick cloth around the radiator cap or coolant tank cap.
- Loosen cap slowly a quarter to half turn to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn cap counterclockwise to remove.

1. Remove coolant tank cap.
2. Confirm coolant system capacity.
3. According to cooling system capacity in the ELC Extender table, drain the correct volume of coolant from the cooling system.

ELC Extender

Cooling System Capacity	Drain ELC Coolant	Add ELC Extender
6-8 gallons (22-30 liters)	0.5 quart (0.2 liter)	0.5 quart (0.2 liter)
8-13 gallons (30-49 liters)	1.0 quart (0.5 liter)	1.0 quart (0.5 liter)
13-22 gallons (49-83 liters)	1.5 quart (0.7 liter)	1.5 quart (0.7 liter)

NOTE: ELC 50 / 50 Premix is the standard factory fill for the cooling system. ELC 50 / 50 Premix is used to replenish coolant loss and ensure that glycol / water concentrations stay in balance. If a customer wishes to use a conventional (non-OAT ELC) coolant, it should minimally meet ASTM D6210, Standard Specification for fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines.

4. Add the same volume of ELC Extender to the cooling system.
5. Check coolant level. If necessary, add ELC 50 / 50 Premix to bring coolant level between ADD and MAX of deaeration tank.
6. Install and tighten the coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.

Service Procedures (cont.)

CLEANING DIESEL PARTICULATE FILTER (DPF)

CJ-4 Engine Oil

Service Interval: 200,000 miles (322,000 km), 30 months or 6,000 hours

Clean DPF at designated service interval. The ECM will illuminate the Maintenance Lamp and generate an ASH Servicing Required message on the integral digital display. Take vehicle to an authorized service provider for cleaning.

CI-4 Engine Oil

Service Interval: 150,000 miles (241,000 km), 22 months or 4,500 hours

Clean DPF at designated service interval. Take vehicle to an authorized service provider for cleaning.

SERVICE COOLING SYSTEM

Service Interval: 300,000 miles (483,000 km), 12,000 hours, 60 months, or 5 years

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or coolant tank cap:

- Allow the engine to cool for 15 minutes or more.
- Wrap a thick cloth around the radiator cap or coolant tank cap.
- Loosen cap slowly a quarter to half turn to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn cap counterclockwise to remove.

It is recommended that the coolant be replaced using a coolant extraction tool. The advantage to using this tool is that the coolant system will evacuate and fill more completely, in less time, and in a sanitary fashion. Extraction and filling is done through quick disconnect fittings installed in the radiator end tanks from the factory.

Service Procedures (cont.)

SERVICE COOLING SYSTEM (cont.)

1. Park vehicle so the engine is level and shut engine off.
2. Set parking brake and shift transmission to Park or Neutral.
3. Drain the coolant using one of the following two methods.

NOTE: If using the coolant extraction service tool method, order KL5007NAV - Navistar Coolant Management Tool Kit. If the vehicle is not equipped with a male quick-connect fitting at the coolant drain location, see your authorized service provider for part and installation.

Coolant Replacement Using Extraction Service Tool

1. See instructions included with the extraction tool for proper operation.
2. Both the high temperature and low temperature radiator must be drained.

Coolant Replacement Using Gravity Method

1. Put a drain pan under the radiator.
2. Remove coolant tank pressure cap.
3. Open radiator drain cock (if present) or install a female quick-connect fitting and hose to the quick disconnect fitting installed in the radiator end tank(s) from the factory.
4. After one radiator has drained, close the drain valve, remove female quick connect, and repeat Steps 3 – 5 for the other radiator.
5. Begin draining the engine block by moving the drain pan under the right side of the engine.

Service Procedures (cont.)

SERVICE COOLING SYSTEM (cont.)

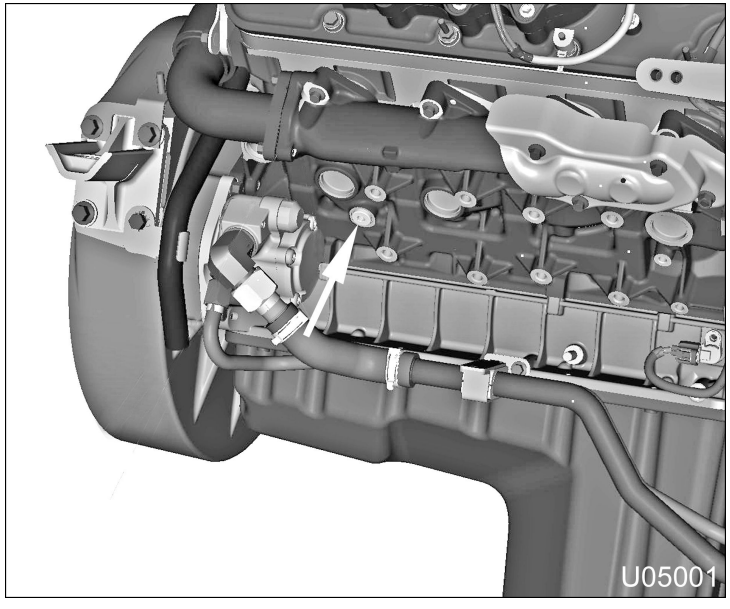

Figure 39 Right Side Coolant Drain Plug

6. Remove right side coolant drain plug.
7. After coolant has drained, put a new O-ring on drain plug and install plug into crankcase. Tighten plug to 15 lb·ft (20 N·m).

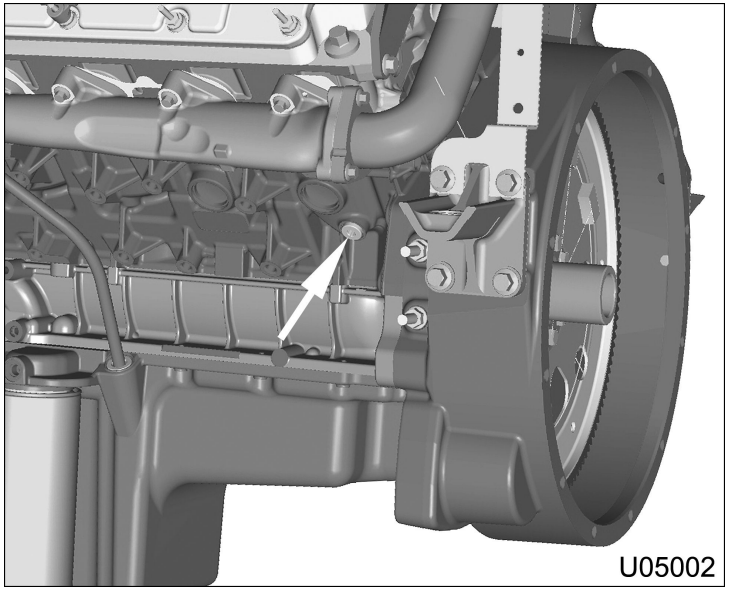

Figure 40 Left Side Coolant Drain Plug

8. Move the drain pan under left side coolant drain plug.
9. Remove left side coolant drain plug.

Service Procedures (cont.)

SERVICE COOLING SYSTEM (cont.)

10. After coolant has drained, put a new O-ring on drain plug and install plug into crankcase. Tighten plug to 15 lb·ft (20 N·m).
11. Recycle or dispose of coolant, according to applicable regulations.

NOTE: ELC 50 / 50 Premix is the standard factory fill for the cooling system. ELC 50 / 50 Premix is used to replenish coolant loss and ensure that glycol / water concentrations stay in balance. If a customer wishes to use a conventional (non-OAT ELC) coolant, it should minimally meet ASTM D6210, Standard Specification for fully Formulated Glycol Base Engine Coolant for Heavy Duty Engines.

12. Slowly fill cooling system with new ELC 50 / 50 Premix or Concentrate and water mixture until coolant is at the FULL level in the coolant tank.
13. Install and tighten the coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.
14. Disconnect the Exhaust Gas Recirculation (EGR) valve electrical connector.
15. Start the engine.
16. Allow the engine to operate at a fast idle until the engine reaches normal operating temperature.
17. As the engine warms up, make sure coolant is flowing through coolant line – coolant will feel warm to the touch.
18. After engine reaches normal operating temperature and the thermostat has opened, shut engine off.

NOTE: Use of a Coolant Extraction / Fill Service Tool will provide faster and more complete filling. Gravity filling will likely cause a need for topping off the coolant level again after the first heat and cool-down cycle.

19. If necessary, after the engine has cooled fully, add coolant to the coolant tank to bring the level up to the MAX mark.

General Information

Engines in storage 30 days or longer require the following procedures:

- Maintain a “Full” fuel tank with the addition of diesel fuel stabilizer to minimize microbial growth within the fuel system. Run engine long enough to allow the fuel stabilizer to enter the entire fuel system. If the engine is utilized in a mobile application, drive vehicle to mix the stabilizer in the fuel tank.
- Before storage replace engine fuel filter(s) and drain all water separators of any water.
- Every 30 days or less, run engine until full operating temperature has been maintained. For an engine with less than 750 miles, run the engine to operating temperature every time the engine is started. Run engine smoothly through entire operating rpm range. If the High Exhaust System Temperature (HEST) light is on, wait until it turns off. If the Diesel Particulate Filter (DPF) light is on, do a parked regeneration.
- Before storage, change the engine oil and filter with the appropriate engine oil for conditions the engine will experience during storage.
- Check and replace the air filter element and cover air intake ducts to prevent moisture and debris intrusion during storage.
- Cover vertical exhaust stack.
- Check state -of- charge eye in batteries. If any of the batteries has a dark state -of- charge indication, charge all batteries. If the battery eye charge indicators of all batteries are green, batteries are charged. If batteries do not have an indicator eye, recharge if below 12.6 volts. Check the battery charge and recharge if needed. Remove batteries and store in an area to protect from freezing if applicable. If battery removal is not required (warm climate), maintain the battery charge every 30 days.
- Test the cooling system, additive levels, and coolant freeze protection. Coolant freeze protection must be set below the coldest anticipated temperature during storage.

Maintenance Service Record

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, put transmission in neutral or park, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

Save scheduled maintenance work orders and receipts for proof of correct maintenance. Failure to maintain work orders and receipts may affect your warranty coverage.

Maintenance Service Record (cont.)

Maintenance Service Record

Date	Service Month	Service Hours	Miles (Km)	Item Serviced

Maintenance Service Record (cont.)

Table 1 Maintenance Service Record

Date	Service Month	Service Hours	Miles (Km)	Item Serviced

Daily Care and Report

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, put transmission in neutral or park, set parking brake, and install wheel chocks before doing diagnostic or service procedures.

Check the following daily to prevent engine failure. Report all problems for immediate service.

- Oil level
- Oil, air, fuel or coolant leaks
- Cooling system hoses for leaks
- Correct coolant and coolant system level
- Excessive use of crankcase lubricating oil, coolant, battery fluid, or fuel
- Unusual engine noise
- Correct amount of electrolyte, if not a maintenance-free battery
- Condition of electrical equipment

Do the following daily to prevent engine failure:

- Add coolant if necessary. Make sure filler cap seal is in good condition and the cap is installed tightly.
- Check air cleaner indicator with engine running. When the yellow position indicator reaches and locks in the red zone, a new air filter should be installed.
- Fill the fuel tank with correct fuel.
- Drain water from the fuel filter housing.
- Clean external surfaces of the engine, radiator, and accessories to prevent dirt or snow buildup.

Daily Care and Report (cont.)

Daily Care and Report

Model										
Serial No.										
Date	Miles	Hours	Fuel		Lube Oil	Parts		Labor		Service Performed
			Qty	Cost		Parts	Cost	Time	Cost	

Daily Care and Report (cont.)

Daily Care and Report

Model										
Serial No.										
Date	Miles	Hours	Fuel		Lube Oil	Parts		Labor		Service Performed
			Qty	Cost		Parts	Cost	Time	Cost	