
MaxxForce® DT, 9, and 10 Diesel Engines

For
**2010 EPA Emission Compliant Model Year
Truck and Derivative Vehicle Applications**

Engine Operation and Maintenance Manual

© 2011 Navistar, Inc. All rights reserved.

TABLE OF CONTENTS

FOREWORD	1
SAFETY INFORMATION	3
WARRANTY	7
Federal Emission System Warranty	7
Warranty Period.....	7
Required Maintenance.....	7
Warranty Repairs and Service.....	7
Recommended Maintenance or Repair Parts.....	7
Emergency Repairs.....	8
What is not Covered by Warranty.....	8
Warranty Rights and Responsibilities.....	8
California Emission System Warranty	10
Warranty Period.....	10
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.....	11
Warranty Rights and Responsibilities.....	12
SECTION 1 – ENGINE SYSTEMS	
Engine Serial Number	13
Engine Emission Label	14
Engine Accessory Labels and Identification Plates	14
Engine Specifications	15

TABLE OF CONTENTS

Engine Description.....	17
Engine Features.....	19
Engine Optional Features.....	21
Engine Component Locations.....	24
Component Location - Top.....	24
Component Location - Front.....	25
Component Location - Intake Side.....	26
Component Location - Exhaust Side.....	27
Component Location - Rear.....	28

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

Fuel.....	29
Ultra Low Sulfur Diesel (ULSD)	29
Unacceptable Fuel and Blends.....	29
Acceptable Fuel Blends.....	30
Use of Higher Biodiesel Fuel Blends (B6 to B20).....	30
Unsafe Practices.....	31
Engine Oil.....	32
Engine Oil Quality and Service Categories.....	32
API CJ-4 for High Performance Diesel Engines.....	32
SAE Oil Viscosity Grades And Temperature Ranges.....	33
Coolant.....	34
Coolant Mixtures.....	34
Extended Life Coolant (ELC) – Red.....	34
Contamination of Coolant.....	35

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Instrument Panel Gauge Cluster.....	37
--	-----------

TABLE OF CONTENTS

Warning Lights	37
Wait to Start Lamp	37
Idle Shut Down Indicator	38
Maintenance Lamp	38
Warn Engine Lamp	39
Stop Engine Lamp	39
High Exhaust System Temperature (HEST) Lamp	40
Diesel Particulate Filter (DPF) Indicator	40
Malfunction Indicator Lamp	41
Typical Water Temperature Gauge	42
Oil Pressure Gauge	43
Oil Temperature Gauge	44
Switches	45
Engine Brake ON/OFF Switch.....	45
Engine Exhaust Brake ON/OFF Toggle Switch.....	45
Air Cleaner Restriction Indicator	46

SECTION 4 – ENGINE OPERATION

Preoperation Checklist	47
Priming the Fuel System	48
Starting the Engine	48
Emergency Starting	50
Operation	51
Suggested Warm up Time.....	51
Idle Speed.....	51
Extended Idling Periods.....	51
Aftertreatment System.....	52
Engine Idle Shutdown Timer (Federal-Optional).....	52
Engine Idle Shutdown Timer (California-Standard).....	53

TABLE OF CONTENTS

Cold Weather Operation.....	54
Cold Ambient Protection (CAP).....	55
Hot Weather Operation.....	56
Engine Shutdown.....	56
Engine Warning Protection System (EWPS).....	56
Radiator Shuttle Enable (RSE).....	57
Road Speed Limiting (RSL).....	58
Road Operation.....	58
Downhill Operation.....	58

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Maintenance Schedule	59
Service Procedures	62
Oil Level.....	62
Coolant Level.....	63
Water Separator	65
Charge Air Cooler (CAC).....	66
External Leakage.....	67
Air Cleaner Restriction	68
Engine Oil and Filter.....	69
Centrifuge Filter (If Equipped).....	73
Resetting Change Engine Oil Service Interval Message.....	76
Belt, Air Intake Piping and Clamps.....	77
Coolant Freeze Point.....	79
Fuel Filter.....	79
Fuel Strainer.....	83
Electrical System.....	86
Vibration Damper.....	87
Engine Valve Lash.....	87

TABLE OF CONTENTS

Engine Brake Lash.....	.87
Induction System.....	.87
Extended Life Coolant (ELC) Extender.....	.88
Crankcase Pressure.....	.89
Turbochargers.....	.89
Cleaning Diesel Particulate Filter.....	.89
Service Cooling System.....	.90

SECTION 6 – LONG TERM STORAGE

General Information.....	.93
---------------------------------	------------

SECTION 7 – SERVICE RECORDS

Maintenance Service Record.....	.95
Daily Care and Report.....	.98

FOREWORD

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 operate and maintain Navistar diesel engines. Contact your dealer for more information.

Technical Service Literature

1172040R1	MaxxForce® DT, 9, and 10 <i>Engine Operation and Maintenance Manual</i>
EGES-450	MaxxForce® DT, 9, and 10 <i>Engine Service Manual</i>
EGES-455	MaxxForce® DT, 9, and 10 <i>Engine Diagnostic Manual</i>
EGED-460	MaxxForce® DT, 9, and 10 Diagnostic Form
EGED-495	MaxxForce® DT, 9, and 10 Electronic Control System Diagnostics Form

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 operations manuals for complete information. Both metric and U.S. customary values are listed in this manual. The metric value is listed first, followed by the U.S. customary in brackets. For additional service literature 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.

FOREWORD

SAFETY INFORMATION

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.

Obey Safety Instructions, Warnings, Cautions, and Notes in this manual. Not following warnings, cautions, and notes 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

- Shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

SAFETY INFORMATION

- 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.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- 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 flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun rated at 207 kPa (30 psi).
- Limit shop air pressure to 207 kPa (30 psi).
- 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.

SAFETY INFORMATION

- 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 over fill the fuel tank. Over fill 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.

SAFETY INFORMATION

WARRANTY

Warranty

Federal Emission System Warranty

WARRANTY PERIOD

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

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

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

The engine model year, service class, and required emission information is on the emission label attached on top of the valve cover. 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 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 may deny warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

RECOMMENDED MAINTENANCE OR REPAIR PARTS

MaxxFace® service parts or MaxxFace® 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.

WARRANTY

Federal Emission System Warranty (cont.)

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 any replacement part.

Navistar 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 MaxxFace® service parts or ReNEWed® parts.
- Aftermarket parts or service kits
- Non-defective 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.

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 assures that the emission warranty is being properly administered. If you have not received satisfactory service

WARRANTY

Federal Emission System Warranty (cont.)

WARRANTY RIGHTS AND RESPONSIBILITIES (cont.)

or have questions regarding your warranty rights and responsibilities, contact the 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.
4201 Winfield Road
Warrenville, Illinois 60555
(Telephone 1-800-448-7825)

WARRANTY

California Emission System Warranty

WARRANTY PERIOD

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

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

Your medium-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, and required emission information is on the emission label attached on top of the valve cover. 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 recommends that you retain all receipts covering maintenance on your truck, but Navistar cannot 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 direct 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 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 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 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,

WARRANTY

California Emission System Warranty (cont.)

EMERGENCY REPAIRS (cont.)

the vehicle owner or any service establishment can install replacement part.

Navistar 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 a MaxxForce® dealer for reimbursement of emergency repairs.

WHAT IS COVERED BY WARRANTY

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 by Navistar:

- Fuel injection system
- Air induction system (includes turbocharger, exhaust manifold, and intake manifold)
- Diesel Particulate Filter (DPF)
- Hoses, clamps, fittings and tubing

- Pulleys, belts and idlers
- Vacuum, temperature and time sensitive valves and switches

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 other 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

WARRANTY

California Emission System Warranty (cont.)

WHAT IS NOT COVERED BY WARRANTY (cont.)

- 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.

Conditions not Covered by Warranty

- Vehicles registered and normally operated outside the United States.
- 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 assures 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 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.
4201 Winfield Road
Warrenville, Illinois 60555
(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

SECTION 1 – ENGINE SYSTEMS

Engine Serial Number

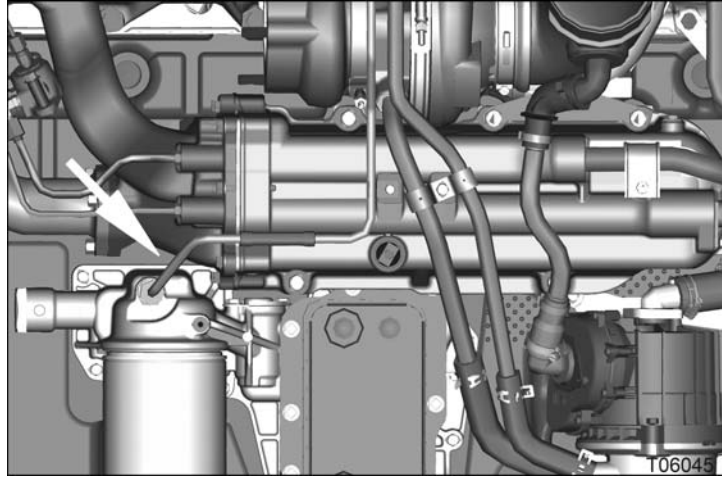


Figure 1 Engine serial number location

The engine serial number is in two locations:

- Stamped on the right side of the crankcase, just above the oil filter header.
- On the engine emission label on the valve cover.

Engine Serial Number Examples

MaxxFace® DT: 466HM2U3300001

MaxxFace® 9 and 10: 570HM2U3300001

Engine Serial Number Codes

466 – Engine displacement

570 – Engine displacement

H – Diesel, turbocharged, Charge Air Cooler (CAC) and electronically controlled

M2 – Motor truck

U – United States

7 digit suffix – Engine serial number sequence beginning with 3300001

SECTION 1 – ENGINE SYSTEMS

Engine Emission Label



Figure 2 U.S. Environmental Protection Agency (EPA) exhaust emission label (example)

The U.S. Environmental Protection Agency (EPA) exhaust emission label is attached on top of the valve cover. The EPA label typically includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission family and control systems
- Valve lash specifications
- Engine serial number
- EPA, EURO, and reserved fields for specific applications

Engine Accessory Labels and Identification Plates

The following engine accessories may have manufacturer's labels or identification plates:

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

SECTION 1 – ENGINE SYSTEMS

Engine Specifications

MaxxForce® DT, 9, and 10 Diesel Engines

Engine Configuration	4 stroke, inline six cylinder diesel
Advertised brake horsepower @ rpm	See engine emission label
Peak torque @ rpm	See engine emission label
Displacement	
• MaxxForce® DT	7.6 L (466 in ³)
• MaxxForce® 9 and 10	9.3 L (570 in ³)
Compression ratio	
• MaxxForce® DT	16.9: 1
• MaxxForce® 9 and 10	16.5 : 1
Stroke	
• MaxxForce® DT	119 mm (4.68 in)
• MaxxForce® 9 and 10	146 mm (5.75 in)
Bore (sleeve diameter)	116.6 mm (4.59 in)
Firing order	1-5-3-6-2-4
Aspiration	Dual turbocharged and charge air cooled
Combustion system	Direct injection turbocharged
Fuel system	Electro-hydraulic injection

SECTION 1 – ENGINE SYSTEMS

Engine Specifications (cont.)

MaxxForce® DT, 9, and 10 Diesel Engines

Lube system capacity (including filter)	28 L (30 qts US) ¹
Lube system capacity (overhaul only, with filter)	32 L (34 qts US) ²
Engine lubrication oil pressure at operating temperature with SAE 10W-30 oil	
• Low idle	214 kPa (31 psi) minimum
• High idle	276 kPa (40 psi) minimum
Idle speed (no load)	700 rpm ± 50 (nonadjustable)
Thermostat operating temperature	96 °C (205 °F)

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

SECTION 1 – ENGINE SYSTEMS

Engine Specifications (cont.)

Engine Description

MaxxForce® DT, 9, and 10 are inline six cylinder diesel engines which have been designed for increased durability, reliability, and ease of maintenance.

Air Management System

The MaxxForce® DT, 9, and 10 engines use an electronically controlled two stage turbocharging system consisting of a high-pressure and low-pressure turbocharger. The high and low-pressure turbochargers are installed as an assembly on the exhaust manifold.

A Charge Air Cooler (CAC) is an air-to-air heat exchanger which cools and increases the density of the air charge. In addition to the CAC, the MaxxForce® 9 and 10 diesel engines have an engine mounted interstage cooler. The cooler has a low temperature radiator and a low temperature thermostat.

The Exhaust Gas Recirculation (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

The Inlet Air Heater (IAH) system warms the incoming air supply to aid cold engine starting and reduce white smoke during warm-up. The IAH system will initially illuminate the WAIT TO

START lamp. When the lamp turns off, the engine can be started.

Crankcase Assembly

The camshaft is supported by four insert bushings pressed into the crankcase. The camshaft gear is driven from the front of the engine. A thrust flange is located between the camshaft and the drive gear. The overhead valve train includes mechanical roller lifters, push rods, rocker arms, and dual valves that open using a valve bridge.

A gerotor lube oil pump is mounted on the front cover and is driven by the crankshaft. Pressurized oil is supplied to engine components and the high-pressure injection system. All MaxxForce® DT, 9, and 10 engines use an engine oil cooler and spin-on engine oil filter.

The MaxxForce® DT engine uses a one piece aluminum alloy piston. The MaxxForce® 9 and 10 engines use a one piece steel piston. The pistons have a 0.0 offset and are fully symmetric.

The one piece crankcase uses replaceable wet cylinder sleeves that are sealed by a single crevice seal. Some applications include a crankcase ladder which is designed to absorb heavier loads and reduce engine noise.

A closed crankcase breather system uses an engine mounted oil separator to return oil to the crankcase and vent crankcase pressure into the intake system.

SECTION 1 – ENGINE SYSTEMS

Engine Description (cont.)

Crankshaft

The crankshaft has seven main bearings with fore and aft thrust controlled at the rear bearing. One fractured cap connecting rod is attached at each crankshaft journal. The piston pin moves freely inside the connecting rod and piston. Piston pin retaining rings secure the piston pin in the piston. The rear oil seal carrier is part of the flywheel housing.

Cylinder Head

The cylinder head has four valves per cylinder with centrally located fuel injectors directing fuel over the pistons. This configuration provides improved performance and reduces emissions.

The fuel injection system is electro-hydraulic. The system includes an under-valve-cover high-pressure oil manifold, fuel injectors, and a high-pressure oil pump. The injectors are installed in the cylinder head, under the valve cover and under the high-pressure oil manifold.

The water supply housing serves as the mounting bracket for the refrigerant compressor. Mounting capabilities for a dual refrigerant compressor are available as an option. The pad mounting design of the alternator and refrigerant compressor brackets provide easy removal and improved durability.

Electronic Control System

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

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 low-pressure electric fuel pump draws fuel from the fuel tank through the fuel filter housing. The housing includes an electric fuel pump, strainer, filter, drain valve, Water in Fuel (WIF) sensor, and Engine Fuel Pressure (EFP) sensor. If equipped, an optional fuel heater element is located in the fuel filter housing. Conditioned fuel is pumped through the intake manifold and cylinder head to the fuel injectors.

The WIF sensor detects water in the fuel system. When a programmed value of water is collected in the fuel filter housing, the FUEL FILTER lamp will illuminate. The collected water must be removed immediately. The water is drained by using the drain valve located on the fuel filter housing.

SECTION 1 – ENGINE SYSTEMS

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 (CO₂) by a Regeneration (Regen) process. For further information see Aftertreatment System (page 52).

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 0 °C (32 °F), coolant temperature is below 65 °C (149 °F), and engine has been idling at no load for over five minutes.

For further information see Cold Ambient Protection (CAP) (page 55).

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

Engines 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 known 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

SECTION 1 – ENGINE SYSTEMS

Engine Features (cont.)

Electronic Speedometer and Tachometer

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

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.

Event Logging System

The event logging system records engine operation above maximum rpm (over speed), low coolant level, 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.

Low idle speed is increased proportionally when the ECT is below 70 °C (158 °F) at 700 rpm to below -10 °C (14 °F) at 875 rpm maximum.

Service Diagnostics

The Electronic Service Tool (EST) communicates with the control system through the public CAN network. 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.

SECTION 1 – ENGINE SYSTEMS

Engine Optional Features

Air Compressor

An air compressor is available for applications that require air brakes or air suspension. A hydraulic power steering pump can be used with or without the air compressor.

Coolant Heater

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

Cruise Control

The 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's Manual*.

Engine Brake

An optional exhaust or engine brake is available to aid in the deceleration rate of vehicles. The exhaust and engine brake provides improved braking performance. These options are mutually exclusive and are available for all ratings.

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 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 56).

Fuel Heater

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

Idle Shutdown Timer (IST) Federal - Optional or California - Standard

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

Beginning with the 2008 Model Year engine, all MaxxForce® engines certified for sale in the state of California will conform to mandatory California Air Resources Board (CARB) Engine Shutdown System (ESS) regulations.

All (non-California) Federal MaxxForce® engines can have idle time that can be programmed from 2 to 120 minutes.

For further information, see Engine Shutdown (page 52).

SECTION 1 – ENGINE SYSTEMS

Engine Optional Features (cont.)

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 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 with out disengaging the PTO is an example.

Oil Pan Heater

The oil pan heater warms engine oil in the pan to ensure optimum oil flow.

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.

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.

SECTION 1 – ENGINE SYSTEMS

Engine Optional Features (cont.)

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.

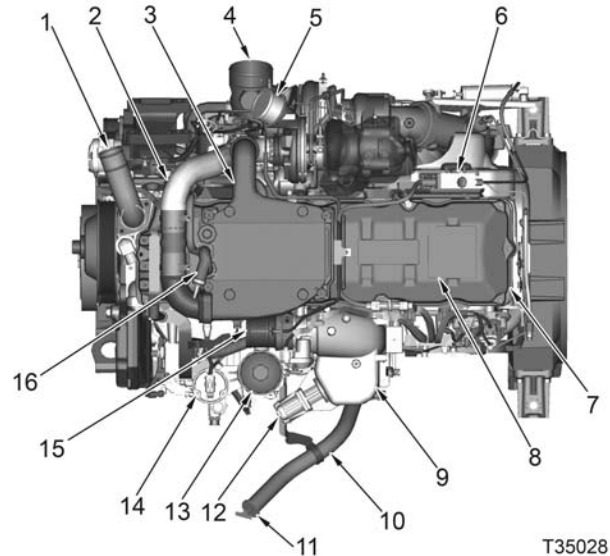
The term “interval” in this case is used to describe the distance, time, or fuel used between the last maintenance performed on the vehicle and the next maintenance which is due.

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. See Resetting Change Engine Oil Service Interval Message (page 76).

SECTION 1 – ENGINE SYSTEMS

Engine Component Locations

COMPONENT LOCATION - TOP



T35028

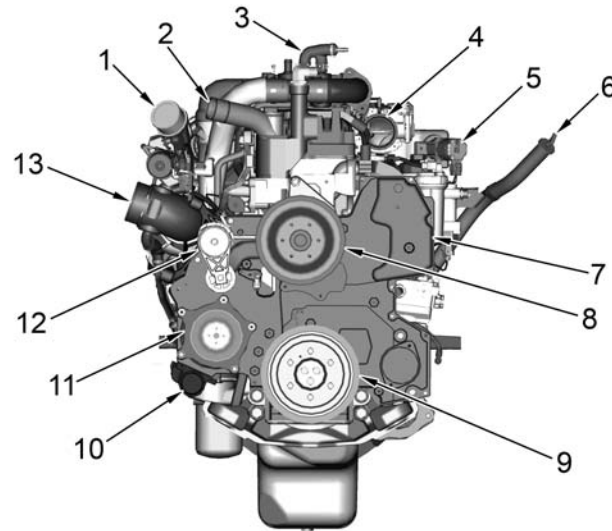
Figure 3 Top

- | | | |
|--|---|---|
| 1. Water outlet tube assembly | 7. Valve cover | 13. Fuel filter assembly |
| 2. Interstage cooler inlet duct (245 HP and above) | 8. Exhaust emission label (location) | 14. Electronic fuel pump (fuel strainer location) |
| 3. Interstage cooler (245 HP and above) | 9. Air and Exhaust Gas Recirculation (EGR) mixer duct | 15. Throttle coupling |
| 4. Turbocharger air inlet duct | 10. Oil filler tube | 16. Deaeration hose elbow |
| 5. High-pressure turbocharger outlet | 11. Oil level gauge | |
| 6. Exhaust brake valve assembly | 12. EGR valve | |

SECTION 1 – ENGINE SYSTEMS

Engine Component Locations (cont.)

COMPONENT LOCATION - FRONT



T35029

Figure 4 Front

- | | | |
|---|------------------------------|---------------------------------|
| 1. High-pressure turbo outlet | 5. EGR valve | 10. Water inlet elbow |
| 2. Water outlet tube assembly | 6. Oil level gauge | 11. Water pump pulley |
| 3. Deaeration hose elbow | 7. Front cover | 12. Auto belt tensioner |
| 4. Air and Exhaust Gas Recirculation (EGR) mixer duct | 8. Fan drive pulley | 13. Turbocharger air inlet duct |
| | 9. Vibration damper assembly | |

SECTION 1 – ENGINE SYSTEMS

Engine Component Locations (cont.)

COMPONENT LOCATION - INTAKE SIDE

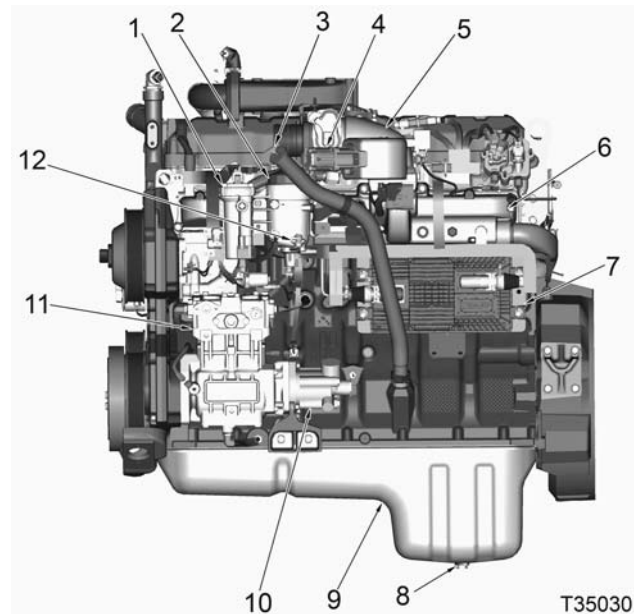


Figure 5 Intake side

- | | | |
|--|--------------------------------|-----------------------------|
| 1. Electric fuel pump (fuel strainer location) | 5. Air and EGR mixer duct | 9. Oil Pan |
| 2. Fuel filter assembly | 6. Intake manifold | 10. Power steering pump |
| 3. Oil level gauge | 7. Engine Control Module (ECM) | 11. Air compressor assembly |
| 4. Exhaust Gas Recirculation (EGR) valve | 8. Oil pan drain plug | 12. Water drain valve |

SECTION 1 – ENGINE SYSTEMS

Engine Component Locations (cont.)

COMPONENT LOCATION - EXHAUST SIDE

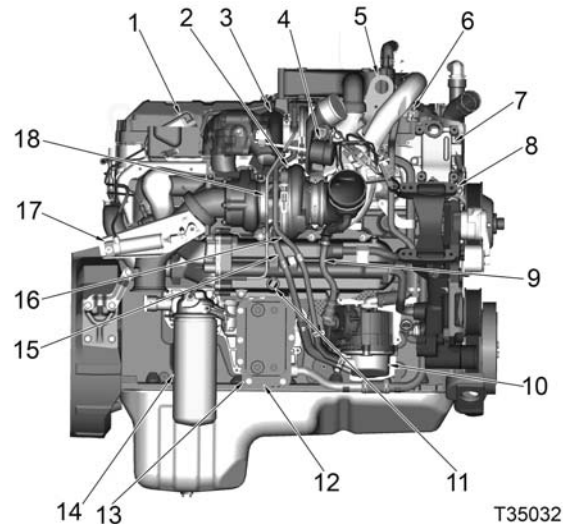


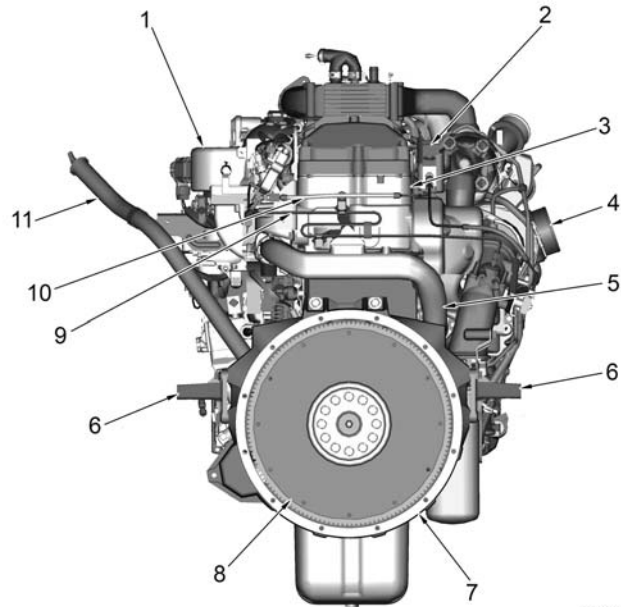
Figure 6 Exhaust side

- | | | |
|--|--|--|
| 1. Exhaust brake valve assembly | 8. Alternator bracket | 14. Oil filter |
| 2. Low-pressure turbocharger | 9. Crankcase breather outlet tube | 15. Low-pressure turbo oil drain tube |
| 3. High-pressure turbocharger | 10. Crankcase breather assembly with turbine | 16. High-pressure turbo oil drain tube |
| 4. Turbocharger wastegate actuator | 11. Exhaust Gas Recirculation (EGR) coolant drain plug | 17. Exhaust brake assembly |
| 5. Lifting eye | 12. Coolant drain plug | 18. Turbocharger oil supply tube |
| 6. Vehicle heater port | 13. Oil cooler module | |
| 7. Water supply housing refrigerant compressor mount | | |

SECTION 1 – ENGINE SYSTEMS

Engine Component Locations (cont.)

COMPONENT LOCATION - REAR



T35015

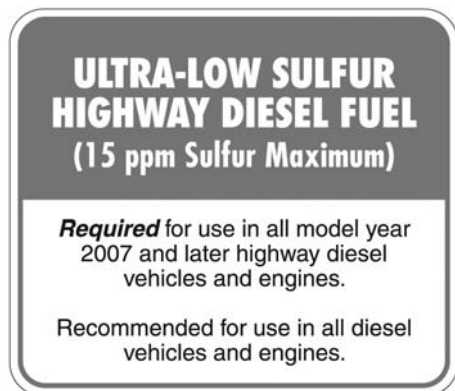
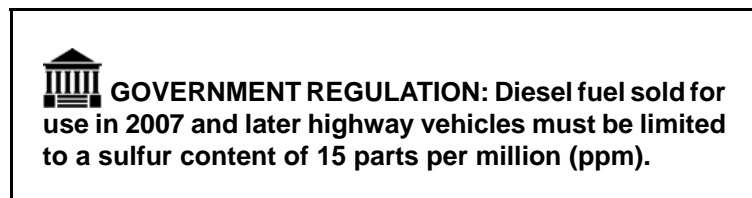
Figure 7 Rear

- | | | |
|--|-------------------------------------|-------------------------------------|
| 1. Air and Exhaust Gas Recirculation (EGR) mixer | 4. Turbo air inlet duct | 8. Flywheel |
| 2. Exhaust brake valve | 5. EGR crossover tube assembly | 9. Injector feed tube assembly |
| 3. Cylinder head | 6. Rear engine mounting bracket (2) | 10. Exhaust brake valve supply hose |
| | 7. Flywheel housing | 11. Oil fill tube |

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

Fuel

ULTRA LOW SULFUR DIESEL (ULSD)



K35145

Figure 8 American Petroleum Institute (API) Diesel Pump Label

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

Ultra Low Sulfur Diesel (ULSD) fuel is required for MaxxForce® DT, 9, and 10 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

- Off road diesel fuel
- 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.

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.

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

Fuel (cont.)

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 October 1, 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 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 D7467-08 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 which are required to use 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 D7467-08 Standard, Navistar may, at its option, deny warranty on the affected engine or engine component.

Navistar recommends users of B20 select a BQ9000 certified fuel supplier and request proof from the supplier the fuel meets ASTM D7467-08 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 D7467-08 Standard should perform satisfactorily in diesel engines. Contact your dealer for recommendations for correct storage and maintenance procedures.

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

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

Fuel (cont.)

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 will not honor warranty claims against engines that have used propane.

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

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 9 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.

NOTE: Mineral and synthetic oils are acceptable for use provided they meet the API category recommendations and ambient temperature guidelines.

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

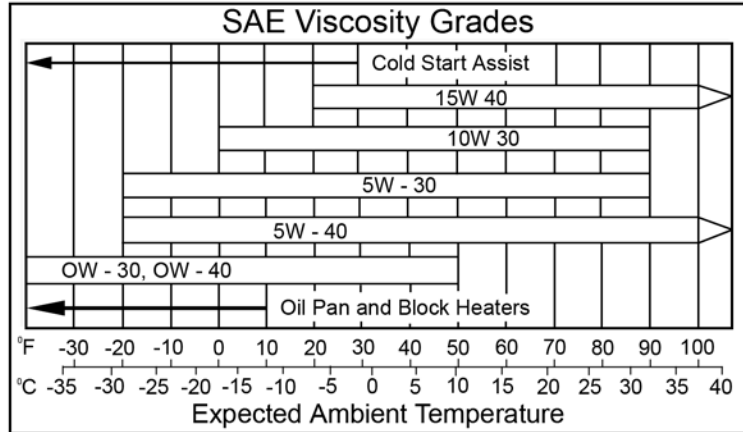
API CJ-4 oil, in combination with Ultra Low Sulfur Diesel (ULSD) fuel [0.0015% (15 ppm) maximum sulfur content], is recommended to maintain performance and durability of aftertreatment systems meeting 2007 and beyond diesel emission regulations.

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.

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

Engine Oil (cont.)

SAE OIL VISCOSITY GRADES AND TEMPERATURE RANGES



U13033

Figure 10 SAE oil viscosity grades and temperature ranges

The Society of Automotive Engineers (SAE) defines oil viscosity (thickness) by grade. Colder temperatures require lower grade oils for correct flow during starting. Higher temperatures require higher grade oils for satisfactory lubrication.

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

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

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 (page 59) for service intervals.

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 88).

Freeze Point Protection Levels Concentrate (ethylene glycol) and Water Mixtures

Concentrate and Water Mixtures	Freeze Point Protection
40% Concentrate and 60% water	-24.4 °C (-12 °F)
50% Concentrate and 50% water	-36.7 °C (-34 °F)
60% Concentrate and 40% water	-52.0 °C (-62 °F)
67% Concentrate and 33% water	-70.6 °C (-95 °F)

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

For cooling system service, see (page 90).

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

Coolant (cont.)

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.

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

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

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.

This manual does not describe indicator lamps for the drivetrain, chassis components, or cab interior. See the *Vehicle Operator Manual*.

Warning Lights

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



R01014

Figure 11 Wait to Start Lamp

The WAIT TO START lamp will illuminate when inlet air heater is required. Wait until the lamp goes off before starting engine. See Starting the Engine (page 48) for further information.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Idle Shut Down Indicator



Figure 12 Idle shutdown indicator

The IDLE SHUTDOWN indicator will illuminate when the vehicle shutdown timer will turn the engine off in 30 seconds. See Engine Idle Shutdown Timer (page 52) for further information.

Maintenance Lamp

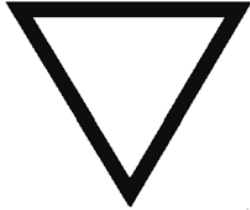


Figure 13 Maintenance lamp

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.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Warn Engine Lamp



T35038

Figure 14 Warn engine lamp

The warn engine lamp will illuminate 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.

Stop Engine Lamp



T35040

Figure 15 Stop engine lamp

CAUTION: To prevent engine damage, shutdown engine immediately , if the Stop Engine lamp flashes.

The Stop Engine 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 red STOP alert. See Engine Warning Protection System (EWPS) (page 56) for further information. Consult an authorized service provider immediately to correct the problem.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

High Exhaust System Temperature (HEST) Lamp



Figure 16 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.

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

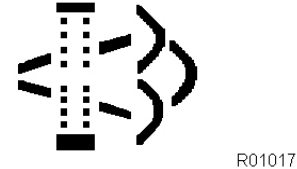


Figure 17 DPF indicator

The DPF indicator operates at three different levels.

Level One

- The 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.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Diesel Particulate Filter (DPF) Indicator (cont.)

Level Two

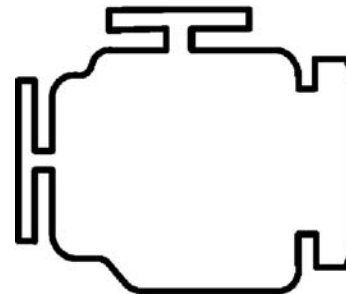
The DPF indicator will be flashing indicating the exhaust filter is full. The vehicle should be safely pulled off the roadway and parked. Start the Parked Regeneration process to prevent loss of engine power. The lamp will stop flashing when the regeneration process is complete. For additional information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



N35020

Figure 18 MIL

The MALFUNCTION INDICATOR LAMP (MIL) illuminates to notify the vehicle operator that the emissions system has a malfunction. Or illuminates to notify the vehicle operator that the ECM system has confirmed that a malfunction exists. It will also stay on for a set number of trips if the fault is no longer active. It is safe to drive the vehicle, however contact your authorized service provider immediately to have the problem corrected.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Typical Water Temperature Gauge



CAUTION: To prevent engine damage – do not operate engine above 112 °C (234 °F); this may cause internal damage.

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

Figure 19 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 96 °C (205 °F).

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Oil Pressure Gauge

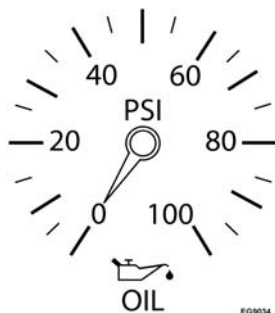


Figure 20 Oil pressure gauge

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. Shutdown the engine immediately if the lamp and alarm are activated. Contact an authorized service provider immediately to have the problem corrected.

Lubrication Oil Pressure

Lube Oil Pressure

At normal operating temperature

Low idle	214 kPa (31 psi) min.
High idle	276 kPa (40 psi)

CAUTION: To prevent engine damage, shut down engine immediately if the gauge fluctuates or drops below 276 kPa (40 psi) under load. Correct the problem.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Oil Temperature Gauge

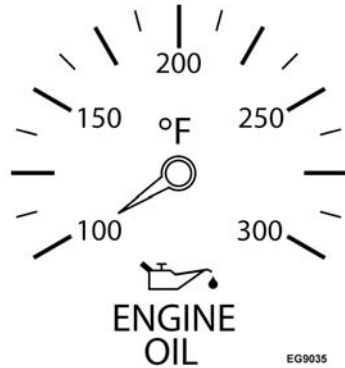


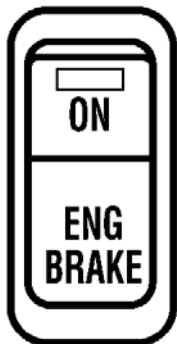
Figure 21 Oil temperature gauge

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

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Switches

ENGINE BRAKE ON/OFF SWITCH

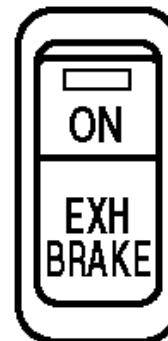


T35044

Figure 22 Engine brake ON / OFF switch

Turns engine compression brake ON or OFF.

ENGINE EXHAUST BRAKE ON/OFF TOGGLE SWITCH



T35042

Figure 23 Exhaust brake toggle switch

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

NOTE: The Exhaust Brake and Engine Exhaust Brake can not be used together.

SECTION 3 – INSTRUMENTS, INDICATORS, AND SWITCHES

Air Cleaner Restriction Indicator

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



U18001

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 element should be installed.

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 element should be installed at the earliest convenience.

Air Restriction Indicator Reset

- Once the filter has been changed reset the air restriction indicator as follows:
 - Push the button on the indicator to reset.

SECTION 4 – ENGINE OPERATION

Preoperation Checklist



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, 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 MaxxFoer 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.



Figure 25 Oil level gauge (typical)

2. Check for correct oil level.

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

3. If oil level is below operating range, fill with recommended oil for operating climate. The ADD mark indicates 2.8 liters (3 quarts US) of oil should be added. See Engine Oil Quality and Service Categories (page 32).
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. See Acceptable Fuel Blends (page 30).
9. Inspect exhaust system for obstruction or damage.
10. Drain water from fuel system.

SECTION 4 – ENGINE OPERATION

Priming the Fuel System

⚠ 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. Turn ignition switch to ON for approximately 60 seconds allowing electric fuel pump to prime the fuel system.

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 a cold starting device or other cold climate starting aid.

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

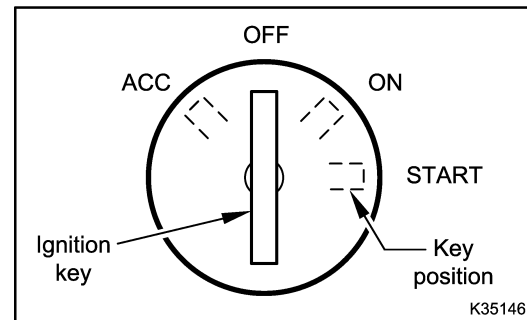


Figure 26 Ignition switch positions

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

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 inlet air heater element. The WAIT TO START lamp will illuminate when the inlet air heater is required.

NOTE: The ECM normally does not energize the inlet air heater element during hot starts. However, the ECM senses reduced atmospheric pressure at high altitude and could energize the air heater element during hot starts.

4. Wait for the WAIT TO START lamp to stop illuminating. Do not crank engine until the lamp is off. When the WAIT TO START lamp goes off, turn ignition switch to START. If

SECTION 4 – ENGINE OPERATION

Starting the Engine (cont.)

the engine has push button starting, press and hold starter button.

5. 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.
6. With the transmission in neutral, release clutch pedal if equipped.

CAUTION: To prevent damage to the engine , if the engine fails to start within 30 seconds, do the following:

- Turn ignition switch to OFF and wait 2-3 minutes.
 - Repeat steps 1 through 5.
 - If after three attempts the engine does not start, determine the cause.
 - If starting attempts are continued, the starter motor can be damaged.
7. Low idle speed is 700 rpm (nonadjustable). Extended idling periods should be avoided. See Extended Idling Periods in this section. Check all gauges during warm-up.


CAUTION: To prevent engine damage – do not increase engine speed until oil pressure gauge indicates above 214 kPa (31 psi). If oil pressure does not reach the minimum limit within 20 seconds, shutdown the engine.


8. Within 20 seconds after engine start, engine oil pressure should exceed 214 kPa (31 psi).
9. After the engine has reached operating temperature, the oil pressure, at a high idle, should be 276 kPa (40 psi) minimum. If oil pressure does not meet the minimum limit, stop the engine and correct the problem.

NOTE: If engine starts and then stops, repeat engine starting procedure. If more than three attempts are required, correct cause of no-start.

SECTION 4 – ENGINE OPERATION

Emergency Starting


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

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


- Wear eye protection.
- Do not smoke
- Keep flames or 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 (-) dead battery terminal. This can cause sparks and an explosion.

5. Connect one end of the second jumper cable to the negative (-) terminal of the booster 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.

SECTION 4 – ENGINE OPERATION


Operation

SUGGESTED WARM UP TIME

NOTE: Before applying a load or increasing speed above 1000 rpm, warm up engine for a minimum of 5 minutes at or below 1000 rpm. The warm up period allows lubricating oil to establish a film between moving parts.

After allowing the engine to warm up for 5 minutes, begin operating the vehicle at reduced engine speeds and load until it reaches operating temperature. Once operating temperature is reached, begin normal operation. The Cold Ambient Protection (CAP) system aids in engine warm up and maintains engine heat during extended idling periods. See Cold Ambient Protection (CAP) (page 55).

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® DT, 9, and 10 Diesel Engines is 700 rpm (nonadjustable). If the engine coolant temperature is below 70 °C (158 °F), the Engine Control Module (ECM) will adjust the low idle speed from 700 rpm to a maximum of 875 rpm. High idle speed is a nonadjustable factory setting.

High idle speed is a nonadjustable factory setting. The high idle setting depends on the application of the engine and has the following ranges:

MaxxForce® DT: 2600 rpm through 2770 rpm

MaxxForce® 9 and 10: 2325 rpm through 2425 rpm

EXTENDED IDLING PERIODS

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

Idling periods over 15 minutes 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 washes lubricating oil from cylinder sleeves. Unburned fuel will be carried into the lubricating oil, dilute the oil, and change oil viscosity.
- Carbon forms on internal components of turbochargers and Exhaust Gas Recirculation (EGR), reducing engine efficiency.
- Carbon clogs and damages the Diesel Particulate Filter (DPF).

SECTION 4 – ENGINE OPERATION

Operation (cont.)

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 (CO₂) 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 insufficient 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 Passive Regeneration cannot be completed during driving.
- In this case, a lamp will be lit to alert the operator to perform a Parked Regeneration.
- The operator 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.

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

A Preliminary Diesel Oxidation Catalyst (PDOC) and a DOC operates together to oxidize the injected fuel to increase the exhaust gas temperature as needed for DPF Regen.

ENGINE IDLE SHUTDOWN TIMER (FEDERAL-OPTIONAL)



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 shutdown the engine during extended idle. Idle time can be programmed from 5 to 120 minutes. The ECM can be programmed to deactivate the IST when the Power Takeoff (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).

SECTION 4 – ENGINE OPERATION

Operation (cont.)

ENGINE IDLE SHUTDOWN TIMER (FEDERAL-OPTIONAL) (cont.)

- 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 °C (140 °F).
- Ambient temperature below 16 °C (60 °F) or above 44 °C (110 °F).
- 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.

ENGINE IDLE SHUTDOWN TIMER (CALIFORNIA-STANDARD)



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 shutdown 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.

SECTION 4 – ENGINE OPERATION

Operation (cont.)


ENGINE IDLE SHUTDOWN TIMER (CALIFORNIA-STANDARD) (cont.)

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 Pedal Sensor (APS) fault is detected.
- Engine coolant operating temperature is below 16 °C (60 °F).
- 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.

COLD WEATHER OPERATION

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

NOTE: If operating in temperatures below -12 °C (10 °F), contact an authorized service provider for information about special cold weather equipment and precautions.

At temperatures below -12 °C (10 °F) a block coolant heater and oil pan heater is required for cold starting.

1. Before operating the engine at 0 °C (32 °F) 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 leaks

SECTION 4 – ENGINE OPERATION

Operation (cont.)

COLD WEATHER OPERATION (cont.)

- 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 build up.
 - Clean outside and in between radiators to prevent dirt or build up.

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 0 °C (32 °F), coolant temperature is below 65 °C (149 °F), and engine has been idling at no load for over five minutes.

Engine speed will ramp up to 1400 rpm and will maintain at 1400 rpm until coolant temperature has reached 75 °C (167 °F).

SECTION 4 – ENGINE OPERATION

Operation (cont.)

HOT WEATHER OPERATION

1. Before operating the engine above 21 °C (70 °F), check or service the following:
 - Full battery charge
 - Condition of other electrical equipment
 - Check belts for severe cracks, excessive wear, or missing material
 - Cooling system 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 radiator to prevent dirt build up.

ENGINE SHUTDOWN

Before shutting down an engine that has reached operating temperature, idle the engine for 2 to 3 minutes, 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.

The Standard Warning System is the base system in which all engines are equipped. If one of these faults are detected, the ECM will illuminate the STOP ENGINE lamp and set a corresponding Diagnostic Trouble Code (DTC).

Standard Warning

- The engine will not shut down.
- RPM - Engine over-speed warning
- Engine Coolant Temperature (ECT) - Engine overheat warning

SECTION 4 – ENGINE OPERATION

Operation (cont.)

ENGINE WARNING PROTECTION SYSTEM (EWPS) (cont.)

The following optional features to this base system provide added warning or protection.

2 - Way Warning (optional)

- The warning mode is an optional calibration that can be added to the EWPS by an authorized service provider.
- The engine will not shut down.
- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning

3 - Way Warning (optional)

- The warning mode is an optional calibration that can be added to the EWPS by an authorized service provider.
- The engine will not shut down.
- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning
- ECL - Low engine coolant level warning

3 - Way Protection (optional)

- The protection mode is an optional calibration that can be added to the EWPS by an authorized service provider.
- Engine shut down is available if critical condition is detected.

- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning
- ECL - Low engine coolant level warning

Warning - Temperature above specific threshold will illuminate the STOP ENGINE lamp and set a DTC.

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

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.

SECTION 4 – ENGINE OPERATION

Operation (cont.)

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 204 kph (127 mph).

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

ROAD OPERATION

Correct road operation of your vehicle will provide 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 more 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 allow engine speed to drop below 1,200 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 the 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 closest to high idle for maximum retarder system operation.
- See *Vehicle Operator Manual* for engine retarder system operation procedures.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

NOTE: No maintenance is required on the Doser Injector, it is not a serviceable component. Failed parts should be replaced, not serviced. The Doser is warranted under base mechanical and or emission warranty.

Maintenance Schedule

MaxxForce® DT, 9, and 10 Diesel Engines

Service operation interval - which ever comes first: kilometers/miles, months, years, hours, or liters/gallons of fuel

Service Interval	Service Operation
Before Engine Operation	See service procedures in this section for more information. Check engine oil level. Check coolant level. Drain water separator. ¹ Inspect Charge Air Cooler (CAC). Check for external leaks. Check air restriction indicator.
Engine oil drain, engine oil filter and centrifuge filter change intervals based on engine family and fuel consumption. See Engine Oil and Filter (page 69) .	Change engine oil and filter Change centrifuge filter. See Centrifuge Filter (page 73)

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Maintenance Schedule (cont.)

MaxxForce® DT, 9, and 10 Diesel Engines (cont.)

Service operation interval - which ever 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.
24,140 km (15,000 miles) 6 months, 550 hours 7949 liters (2,100 gallons) of fuel	Inspect belt, air intake piping, and clamps. Check coolant freeze point.
48,300 km (30,000 miles) 12 months, 1,100 hours 15,898 liters (4,200 gallons) of fuel	Change fuel filter. Clean or change fuel strainer.
Annually	Inspect electrical system.
193,000 km (120,000 miles) 5,000 hours	Inspect vibration damper. Adjust engine valve lash. Adjust engine brake lash (if equipped).
24 months	Pressurize air induction system.
240,000 km (150,000 miles) 30 months, 6,000 hours	Add Extended Life Coolant (ECL) Extender to ELC maintained systems.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Maintenance Schedule (cont.)

MaxxForce® DT, 9, and 10 Diesel Engines (cont.)

Service operation interval - which ever 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.
290,000 - 322,000 km (180,000 - 200,000 miles) 6,700 - 7,500 hours	Measure crankcase pressure. Inspect sequential turbochargers.
322,000 km (200,000 miles) 30 months, 6,000 hours	Cleaning Diesel Particulate Filter (DPF) ²
500,000 km (300,000 miles) 5 years, 12,000 hours	Service cooling system ³ .

- 1 Drain water separator Daily.
- 2 Reduced service interval required if allowed CI-4 engine lubrication oil is used. If using CI-4 oil, reduce DPF cleaning interval to 240,000 km (150,000 miles) 22 months, or 4,500 hours.
- 3 For Extended Life Coolants (ELC). Coolant service intervals are more frequent with conventional coolants.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

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 or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

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 5 minutes.
3. Remove oil level gauge from fill tube.



Figure 27 Oil level gauge (typical)

CAUTION: To prevent engine damage do the following:

- Assure 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.
4. If oil level is below operating range, fill with recommended oil for operating climate. The ADD mark indicates 2.8 liters (3 quarts US) of oil should be added. See Engine Oil Quality and Service Categories (page 32).

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

COOLANT LEVEL



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 block wheels before doing diagnostic or service procedures.

Service Interval: Before Engine Operation

Extended Life Coolant (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.

NOTE: Never add ELC to the expansion tank. Only add ELC to the coolant tank.




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 opaque plastic 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. Add ELC 50/50 Premix to the correct coolant level (midpoint of ADD and MAX).
 3. Install and tighten coolant tank cap until the plastic cap clicks or the metal caps runs up against the detent.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

COOLANT LEVEL (cont.)

 **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.
4. Check coolant level in the coolant tank.
 - For cold engine check, coolant level should be between COLD MIN and COLD MAX marks.
 - For hot engine check, make sure the vehicle is on level ground, coolant level should be between the midpoint of the COLD MIN and COLD MAX marks or up to the COLD MAX mark.
 - If coolant level is below the COLD MIN mark, continue with step 5 and 6.
 5. Add ELC 50/50 Premix to the correct coolant level (between COLD MIN and COLD MAX marks).
 6. Install and tighten coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

WATER SEPARATOR

Service Interval: Before Engine Operation



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.

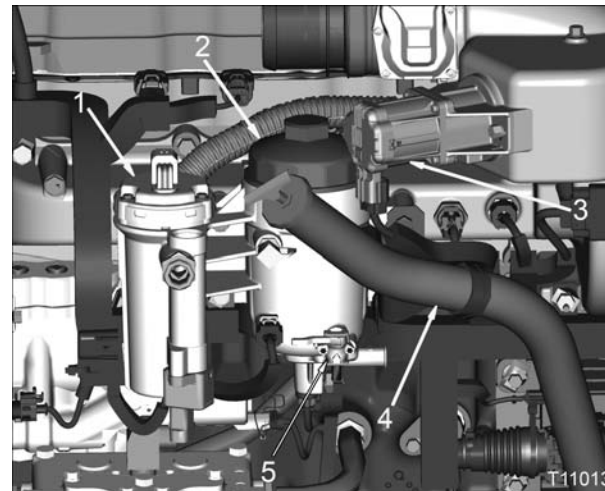


Figure 28 Fuel filter header assembly

1. Electric fuel pump
2. Fuel filter cover
3. Exhaust Gas Recirculation (EGR) valve
4. Oil fill tube
5. Water drain valve

1. If necessary, connect a hose to the end of the water drain valve.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

WATER SEPARATOR (cont.)

2. Put a suitable container under water drain valve or drain hose.
3. Turn ignition switch to ON. This will start the electric fuel pump. Do not start engine.

NOTE: The water/fuel mixture will drain slowly and may take up to a minute to attain pure fuel flow.


4. Turn water drain valve to open and allow water/fuel mixture to drain. Continue draining until only fuel is draining.

NOTE: Fuel will only drain from the water drain valve as long as the electric fuel pump is running. The electric fuel pump can run any where from 10 to 20 seconds. Do not turn the ignition switch to OFF then ON again without waiting the 10 seconds. If the 10 seconds waiting period is not observed, the electric fuel pump will not restart.

5. Fuel will only flow as long as the fuel pump is running. If additional fuel pump run time is desired, turn the ignition switch to OFF, wait 10 seconds then turn the ignition switch to ON to continue draining water.
6. Once fuel-water draining is complete, close water drain valve and turn the ignition switch to OFF.
7. Recycle or dispose of drained fluids properly according to applicable regulations.

CHARGE AIR COOLER (CAC)

Service Interval: Before Engine Operation

 **WARNING:** To prevent personal injury or death, shut down engine, set parking brake, and block wheels before inspecting the Charge Air Cooler.


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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

EXTERNAL LEAKAGE

Service Interval: Before Engine Operation

 **WARNING:** To prevent personal injury or death, shut down engine, set parking brake, and block wheels before inspecting for external leakage.

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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

AIR CLEANER RESTRICTION

Service Interval: Before Engine Operation



U18001

Figure 29 Air cleaner restriction indicator

Push reset button to check air restriction indicator. 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.

If the yellow position indicator has locked in the red zone, a new air filter should be installed to prevent low engine power or engine damage.

1. Remove restricted 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. Install a new air filter element.
5. Push reset button on air restriction indicator. The yellow indicator will return to zero.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

ENGINE OIL AND FILTER

⚠ WARNING: To prevent personal injury or death, wear safety glasses and avoid moving components such as fans, pulleys, and belts when taking an engine oil sample.

Engine oil sampling can be utilized for the following:

Engine Oil Sampling - Optional

1. Determine oil change interval based upon fuel consumption and specific engine application.
2. Catch contaminants which, if left unattended, may result in engine failure.

Service Interval (based upon fuel consumption and specific engine application) :

If > 8.5 miles per gallon of fuel:

See charts for specific engine family and service interval.

If 4.5 to 8.5 miles per gallon of fuel:

See charts for specific engine family and service interval.

If < 4.5 miles per gallon of fuel:

See charts for specific engine family and service interval.

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

MaxxForce® DT Diesel Engine With Less Than or Equal to 230 Horsepower (Without Centrifuge Filter)

		Average Vehicle Speed	
		≤48 kmpl (≤ 30 mph)	> 48 kmpl (> 30 mph)
Fuel Economy (mpg)	>8.5	825 hours	40234 km (25,000 miles)
	4.5 to 8.5	700 hours	See Figure 30
	<4.5	600 hours	16093 km (10,000 miles)

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

MaxxForce® DT Diesel Engine With Less Than or Equal to 230 Horsepower (With Centrifuge Filter)

		Average Vehicle Speed	
		≤48 kmpl (≤ 30 mph)	> 48 kmpl (> 30 mph)
Fuel Economy (mpg)	>8.5	1,000 hours	48300 km (30,000 miles)
	4.5 to 8.5	800 hours	See Figure 30
	<4.5	600 hours	20117 km (12,500 miles)

MaxxForce® DT, 9, and 10 Diesel Engine With Greater Than 230 Horsepower (With Centrifuge Filter)

		Average Vehicle Speed	
		≤48 kmpl (≤ 30 mph)	> 48 kmpl (> 30 mph)
Fuel Economy (mpg)	>8.5	825 hours	40234 km (25,000 miles)
	4.5 to 8.5	650 hours	See Figure 30
	<4.5	500 hours	12070 km (7,500 miles)

MaxxForce® DT, 9, and 10 Diesel Engines With Greater Than 230 Horsepower (Without Centrifuge Filter)

		Average Vehicle Speed	
		≤48 kmpl (≤ 30 mph)	> 48 kmpl (> 30 mph)
Fuel Economy (mpg)	>8.5	650 hours	32187 km (20,000 miles)
	4.5 to 8.5	575 hours	See Figure 30
	<4.5	500 hours	9656 km (6,000 miles)

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

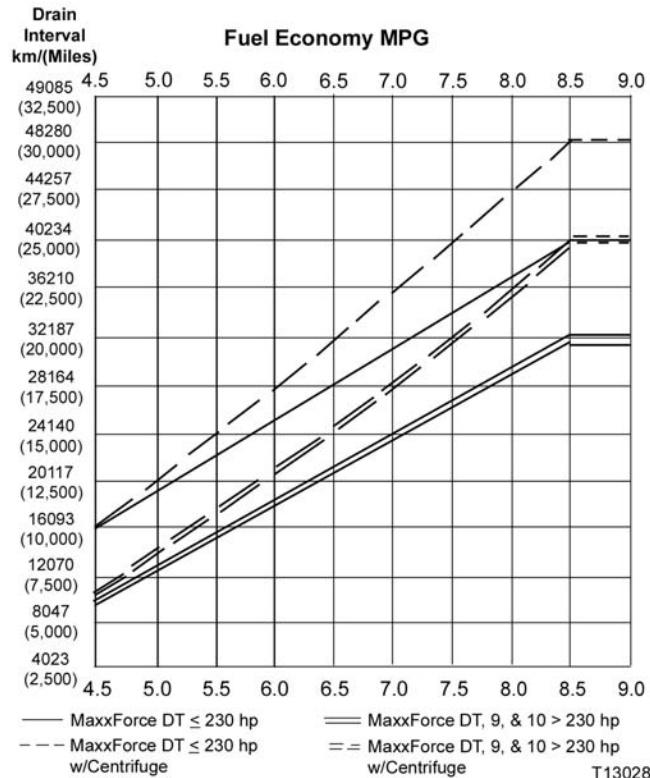





Figure 30 Drain intervals for standard applications

1. Park vehicle on level ground. Set parking brake and shift transmission to park or neutral.
2. Run engine until operating temperature is reached, then shut down 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.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

3. Place a drain pan under the oil pan drain plug, remove oil pan drain plug, and drain oil.
4. Discard oil pan drain plug O-ring. Inspect the oil pan drain plug. If it is free of defects, it can be reused. Replace if necessary.
5. Using clean engine oil, lubricate a new oil pan drain plug O-ring. Put O-ring onto the oil pan drain plug.
6. Install oil pan drain plug and tighten to 68 N·m (50 lbf·ft).
7. Recycle or dispose of oil according to applicable regulations.

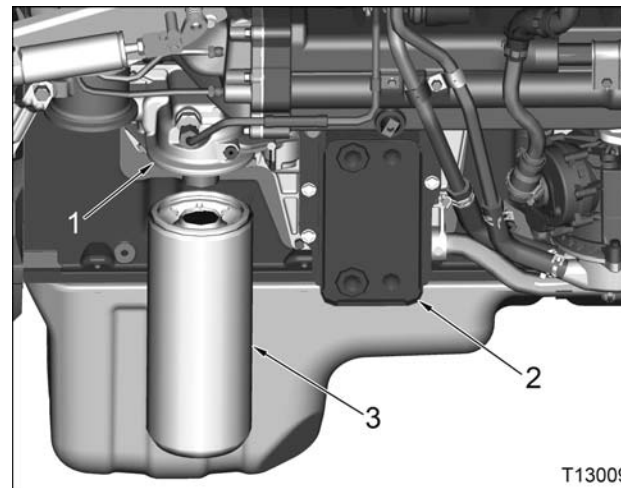


Figure 31 Oil cooler module assembly

1. Oil cooler housing
2. Oil cooler
3. Oil filter

8. Put drain pan under oil filter.
9. Remove old oil filter and recycle or dispose of according to applicable regulations.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

ENGINE OIL AND FILTER (cont.)

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.

- Standard oil filter (long)
- Front drive/steering axle oil filter (shorter)

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

12. Hand tighten filter 2/3 to 1 full turn after gasket first contacts oil filter header.

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

13. Add engine oil with the correct oil viscosity and formulation. API CJ-4 oil is recommended but CI-4 is allowable. Use of CI-4 oils will reduce DPF cleaning interval, see Maintenance Schedule (page 59). 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.

15. Start engine and run at low idle.

16. Check reading on oil pressure gauge.

- Minimum lube oil pressure is 214 kPa (31 psi) minimum @ 700 rpm.
- If there is no gauge reading, shut engine down immediately. Check for oil filter 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.

CENTRIFUGE FILTER (IF EQUIPPED)

Service Interval (based upon fuel consumption and specific engine application):

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

CENTRIFUGE FILTER (IF EQUIPPED) (cont.)

The centrifuge filter (if equipped) is located in one of the following positions:

- On the right side of the engine compartment. It is recommended to change the centrifuge filter every time the engine oil filter is changed. For safety information, refer to the your *Engine Operation and Maintenance Manual* and *Vehicle Operator Manual*.
- In the engine compartment. It is recommended to change the centrifuge filter every time the engine oil and filter is changed. See Engine Oil and Filter (page 69) for specific service intervals. For safety information, refer to the your *Engine Operation and Maintenance Manual* and *Vehicle Operator Manual*.



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.

1. Park the vehicle on level ground. Set the parking brake and shift the transmission to park or neutral.
2. Before attempting to open the centrifuge oil filter, wait two minutes to assure the rotor has stopped spinning.

NOTE: When separating the cover assembly from the body assembly, it may be necessary to insert a coin or flat blade screwdriver in to the gap to start the separation.

3. Turn the band clamp handle counter clockwise until the tee bolt head can be disengaged. Remove band clamp.
4. Remove the cover and rotor assembly from the body assembly.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

CENTRIFUGE FILTER (IF EQUIPPED) (cont.)

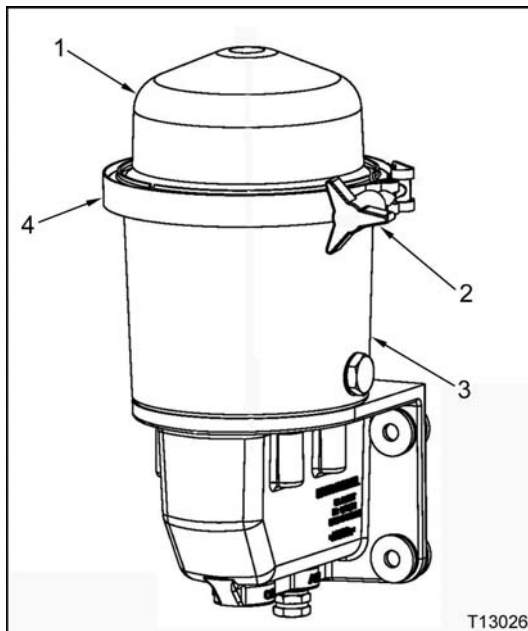


Figure 33 Centrifuge filter assembly

1. Cover assembly
2. Band clamp handle
3. Body assembly
4. Band clamp

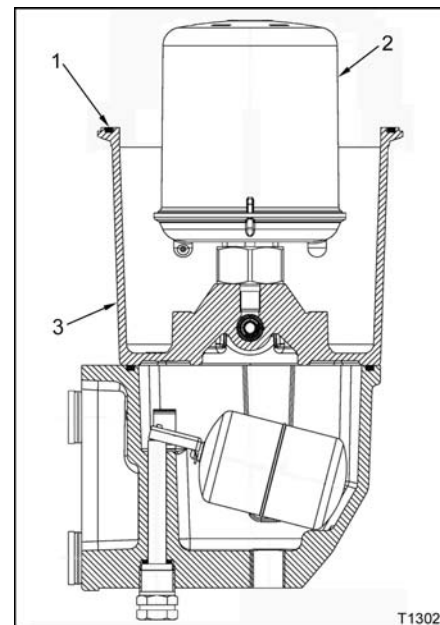


Figure 34 Centrifuge rotor

1. O-ring
2. Rotor
3. Body assembly

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

CENTRIFUGE FILTER (IF EQUIPPED) (cont.)

5. Remove and discard O-ring.
6. Remove the rotor and allow the oil to drain out of it before discarding. Dispose of the rotor according to applicable regulations.
7. Clean and inspect the cover assembly. Clean the O-ring groove in the cover assembly and mating surface.
8. Inspect the bearings in the cover and body assemblies. Make sure both assemblies are free of debris.
9. Lubricate a new O-ring with clean engine oil and insert in to the groove of the cover assembly.
10. Insert a new rotor assembly into the cover assembly and firmly press until it seats.
11. Insert the rotor inlet with the bearing in the body assembly. Press the cover and body assemblies together.
12. Position the band clamp over the cover and body flanges. Engage the tee bolt and turn the band clamp handle and tighten securely.
13. Start the engine and check all connections for leaks.
 - If no leaks are observed, shutdown engine.
 - If leaks are observed, shutdown engine and correct leaks. Start engine again and observe for leaks. If no leaks are observed, shutdown engine.

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 four seconds.
7. The Change Oil message should clear.
8. 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 six seconds. If you fail to reset the message, repeat the process.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

BELT, AIR INTAKE PIPING AND CLAMPS

Service Interval: 24,000 km (15,000 miles), 6 months, or 550 hours

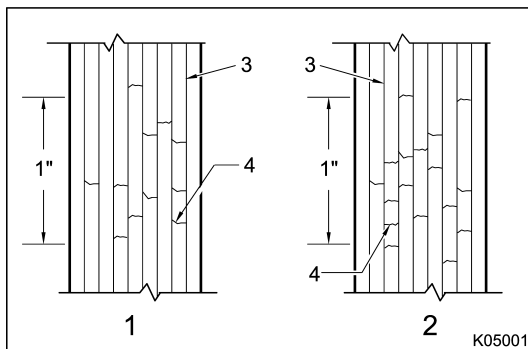


Figure 35 Cracks in belt ribs

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

Inspect condition of all drive belts. For any of the following conditions install a new belt:

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

Belt Removal

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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

BELT, AIR INTAKE PIPING AND CLAMPS (cont.)

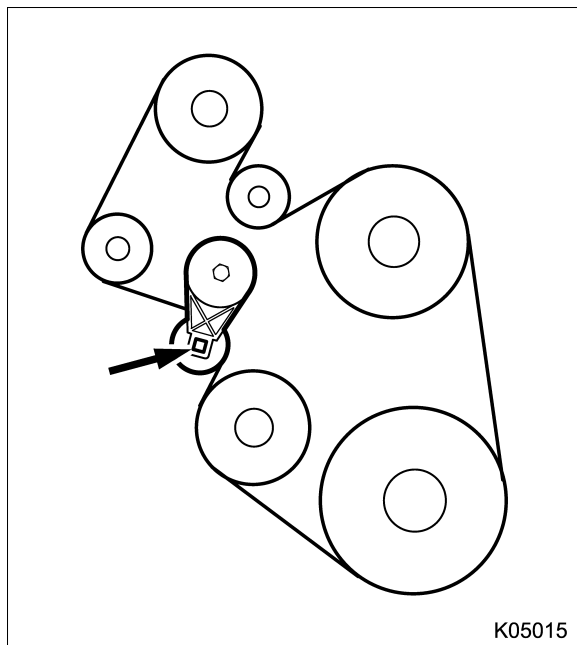


Figure 36 Square hole in auto tensioner

Belt Installation

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

Air Intake Piping and Clamps

Inspect hoses, pipes, 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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

COOLANT FREEZE POINT

Service Interval: 24,000 km (15,000 miles), 6 months, or 550 hours

ELC 50/50 Premix provides freeze protection to -36 °C (-34 °F) 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.

Freeze Point Protection Levels Concentrate (ethylene glycol) and Water Mixtures

Concentrate and Water Mixtures	Freeze Point Protection
40% Concentrate and 60% water	-24.4 °C (-12 °F)
50% Concentrate and 50% water	-36.7 °C (-34 °F)
60% Concentrate and 40% water	-52.0 °C (-62 °F)
67% Concentrate and 33% water	-70.6 °C (-95 °F)

For vehicles operating in extremely cold climates, a coolant mixture 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 due to the risk of additive fallout.

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.

FUEL FILTER

Service Interval: 43,300 km (30,000 miles), 12 months, 1,100 hours or 15898 liters (4200 gallons) of fuel

NOTE: Change fuel filter, if optional fuel filter lamp is illuminated.

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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

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, store diesel fuel properly in an approved container designed for and clearly marked **DIESEL FUEL**.

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

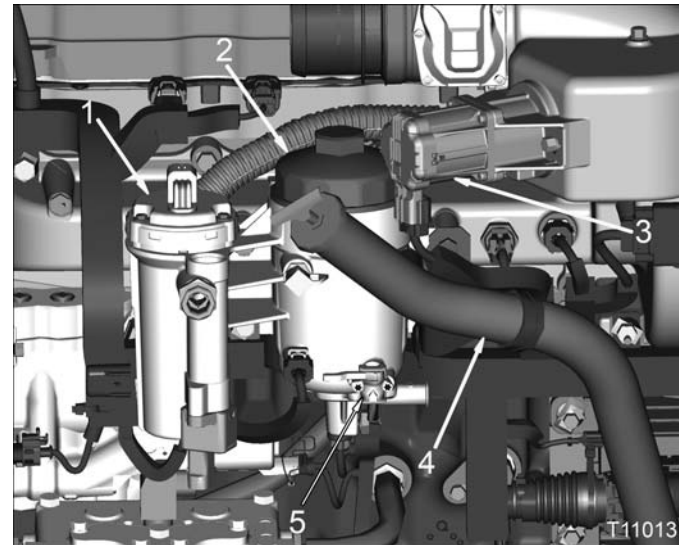


Figure 37 Fuel filter header assembly


1. Electric fuel pump
2. Fuel filter cover
3. Exhaust Gas Recirculation (EGR) valve
4. Oil fill tube
5. Water drain valve

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES


Service Procedures (cont.)

FUEL FILTER (cont.)

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

 **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 207 kPa (30 psi).

CAUTION: To prevent engine damage, clean area around fuel filter housing before removing fuel filter cover. This will protect 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.

3. Clean engine compartment components in the area of the fuel filter housing using compressed air, before removing the fuel filter cover. Also, wipe the fuel filter cover clean to prevent contaminants from entering the fuel system. Contaminants may cause engine failure.

4. Using a 23 mm wrench, loosen the fuel filter cover counterclockwise three and one-half turns to expose the vent hole below O-ring.
5. If necessary, 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. Close water drain valve.
9. Recycle or dispose of fuel according to applicable regulations.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

FUEL FILTER (cont.)

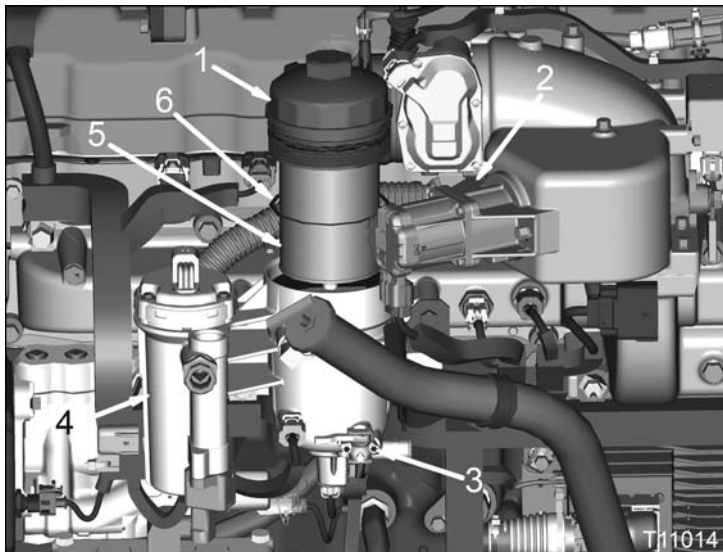


Figure 38 Fuel filter removal and installation

1. Fuel filter cover
2. Exhaust Gas Recirculation (EGR) valve
3. Water drain valve
4. Fuel pump (fuel strainer location)
5. Fuel filter element
6. Fuel filter cover O-ring

10. Continue turning the fuel filter cover until loose. Remove the fuel filter cover and element from the fuel filter housing.
11. Remove the fuel filter cover from the fuel filter element by holding the element vertically and pushing up on the cover. The cover will snap off the fuel filter element. Dispose of the fuel filter element according to applicable regulations.
12. Remove O-ring from the fuel filter cover. Discard O-ring.
13. Coat a new fuel filter O-ring for the fuel filter cover with clean diesel fuel and install onto the fuel filter cover.
14. Attach fuel filter cover to the fuel filter element. Secure the fuel filter cover to the fuel filter element by pushing the fuel filter cover onto the fuel filter element. The fuel filter cover will snap onto the fuel filter element.
15. Coat threads of fuel filter cover with clean diesel fuel.
16. Install a fuel filter element with cover into the fuel filter housing. Slowly lower the fuel filter element into the fuel filter housing, until fuel filter cover is ready to be secured to the fuel filter housing.
17. Secure the fuel filter cover and element to the fuel filter housing by turning the fuel filter cover clockwise until finger-tight.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

FUEL FILTER (cont.)

CAUTION: To prevent engine damage, tighten fuel cover on fuel filter assembly.


18. Using a 23 mm wrench tighten fuel filter cover to 30 N·m (22 lbf·ft).
19. Depress clutch pedal if equipped.
20. Turn the ignition switch to ON for approximately 60 seconds, allowing the fuel pump to prime the fuel system. See Priming the Fuel System (page 48).
21. Wait for the WAIT TO START lamp to stop illuminating. Do not crank engine until the lamp is off. When the WAIT TO START lamp goes off, turn ignition switch to START. If the vehicle has push button starting, press and hold starter button.
22. 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. Check for leaks. Turn the ignition switch to OFF.

FUEL STRAINER

Service Interval: 43,300 km (30,000 miles), 12 months, 1,100 hours or 15898 liters (4200 gallons) of fuel

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

NOTE: The fuel strainer is located under the electric fuel pump. The pump must be disconnected from the engine wiring harness and removed from the fuel filter housing for the fuel strainer to be cleaned or replaced. See following procedure.

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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

FUEL STRAINER (cont.)

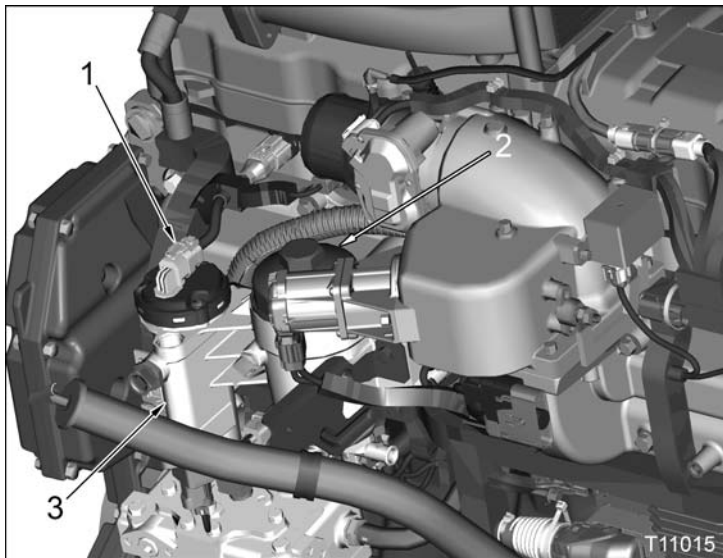


Figure 39 Electric fuel pump and fuel strainer location

1. Electrical fuel pump wiring harness connector
2. Fuel filter cap
3. Fuel filter housing

1. Set parking brake and shift transmission to park or neutral.
2. Disconnect the wiring harness to the electric fuel pump by pushing down on the tab of the wiring harness connector and pulling away from the electric fuel pump.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

FUEL STRAINER (cont.)

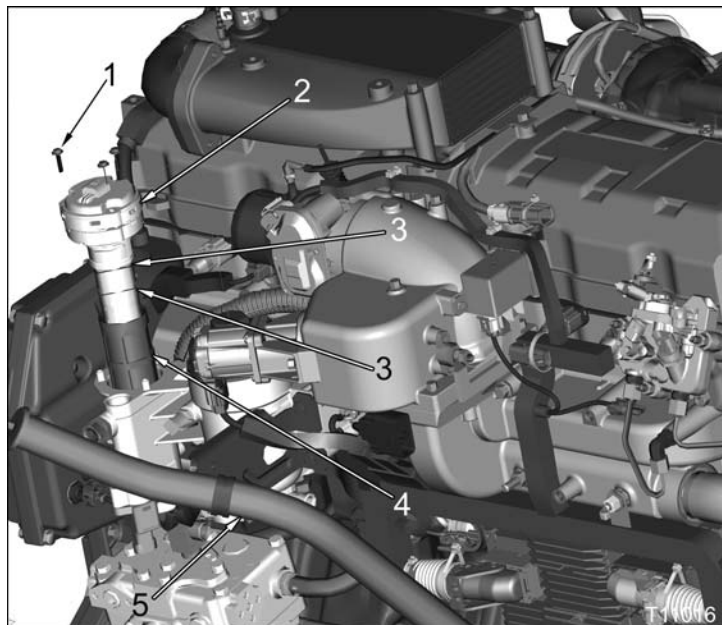


Figure 40 Fuel strainer

1. Pump cover bolt (3)
2. Electric fuel pump
3. Fuel pump O-ring (2)
4. Fuel strainer
5. Fuel filter housing

3. Remove three pump cover bolts. Do not discard bolts, these will be reused when installing the fuel pump.
4. Using a flat blade screw driver gently pry up the fuel pump from the fuel filter housing.
5. Once the fuel pump is loose, pull the fuel pump out of the fuel filter housing.
6. Remove the fuel strainer and O-rings from the fuel pump. Discard the O-rings.
7. Do one of the following:
 - If fuel strainer is not damaged - clean fuel strainer, coat two new O-rings with clean diesel fuel, and install O-rings onto fuel pump.
 - If strainer is damaged - coat two new O-rings with clean diesel fuel, and install O-rings onto fuel pump. Install a new fuel strainer onto the fuel pump.
8. Lower fuel pump assembly (with strainer) into the fuel filter housing. Align the three bolt holes in the fuel pump cover with the bolt threads of the fuel filter housing. Place palm of hand on top of fuel pump and push down firmly. This will seat the fuel pump into the fuel filter housing.
9. Secure the fuel pump to the fuel filter housing by installing and tightening the three pump cover bolts to 5 N·m (44 lbf-in).

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

FUEL STRAINER (cont.)

10. Depress clutch pedal if equipped.
11. Turn ignition switch to ON for approximately 60 seconds allowing fuel pump to prime the fuel system.
12. Start the engine and check for leaks. See Starting the Engine (page 48).
13. Check for leaks. If leaks are found, shutdown the engine and correct the problem.
14. Once leaks are fixed or no leaks are found, shutdown the engine.

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 chaffing.
 - Corroded or loose connections.
4. Repair items identified.

Electronics

Check for diagnostic fault codes and repair as required. After repairs are made, clear fault codes and verify they do not reappear. For correct procedures, see the MaxxForce® DT, 9, and 10 *Engine Diagnostic Manual* or contact an authorized service provider.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

VIBRATION DAMPER

Service Interval: 193,000 km (120,000 miles) or 5,000 hours

Have the vibration damper inspected by an authorized service provider for deterioration of rubber, dents, and runout.

ENGINE VALVE LASH

Service Interval: 193,000 km (120,000 miles) or 5,000 hours

- For inspection procedures, see the MaxxForce® DT, 9, and 10 *Engine Service Manual*.
- Have an authorized service provider adjust the valve lash at the correct service interval.

ENGINE BRAKE LASH

Service Interval: 193,000 km (120,000 miles) or 5,000 hours

- For inspection procedures, see the MaxxForce® DT, 9, and 10 *Engine Service Manual*.
- Have an authorized service provider adjust the valve lash at the correct service interval.

INDUCTION SYSTEM

Service Interval: 24 months

Pressure test the air induction system.


- For inspection procedures, see the MaxxForce® DT, 9, and 10 *Engine Diagnostic Manual*.
- Have an authorized service provider pressure test the air induction system.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

EXTENDED LIFE COOLANT (ELC) EXTENDER

Service Interval: 240,000 km (150,000 miles), 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
22-30 liters (6-8 gallons)	0.2 liter (0.5 quart US)	0.2 liter (0.5 quart US)
30-49 liters (8-13 gallons)	0.5 liter (1.0 quart US)	0.5 liter (1.0 quart US)
49-83 liters (13-22 gallons)	0.7 liter (1.5 quart US)	0.7 liter (1.5 quart US)

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. Coolant service intervals are more frequent with conventional coolants.

4. Add the same volume of Extender to the cooling system.
5. Install and tighten the coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

CRANKCASE PRESSURE

Service Interval: 290,000 - 322,000 km (180,000 - 200,000 miles) or 6,700 - 7,500 hours

- For inspection procedures, see the MaxxForce® DT, 9, and 10 *Engine Diagnostic Manual*.
- Have an authorized service provider measure the crankcase pressure at the correct service interval.

TURBOCHARGERS

Service Interval: 290,000 - 322,000 km (180,000 - 200,000 miles) or 6,700 - 7,500 hours

1. Clean, then remove the turbocharger compressor inlet connections for both turbochargers.
2. Inspect the compressor wheels for the following:
 - Dirt or corrosion
 - Wheel rub damage
 - Wheel blade damage (bent or broken tips)
3. Check condition of turbochargers. (Consult with an authorized service provide if questionable.)

CLEANING DIESEL PARTICULATE FILTER

For Engine Using CJ-4 Engine Oil

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

Clean DPF at designated service interval. The ECM will illuminate the MIL and generate an Ash Servicing Required message on the integral digital display at or if necessary before the specified interval. Take vehicle to your MaxxForce certified dealer for cleaning.

For Engines Using CI-4 Engine Oil

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

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

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

SERVICE COOLING SYSTEM

Service Interval for Extended Life Coolant: 500,000 km (300,000 miles) or 12,000 hours

⚠ WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels 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, 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. Park vehicle on level ground. Set parking brake and shift transmission to park or neutral.
2. Place a drain pan under the radiator.
3. Remove coolant tank cap.
4. Place coolant drain pan under radiator drain valve and open radiator drain valve to drain coolant.
5. After radiator has drained, close the drain valve and move the drain pan beneath the oil system module.

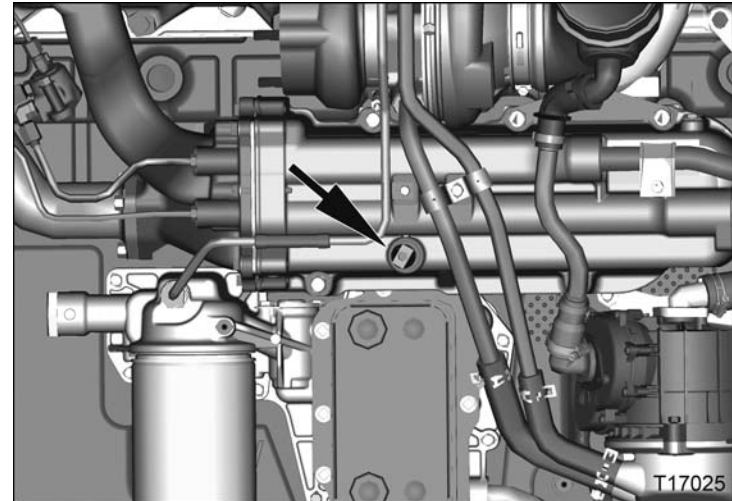


Figure 41 EGR coolant drain plug

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

SERVICE COOLING SYSTEM (cont.)

6. If the Exhaust Gas Recirculation (EGR) cooler must be removed from the engine the coolant should be drained before removal. See *Engine Service Manual* for the removal and installation procedure.
8. After coolant has drained, install the coolant drain plug and tighten to 28 N·m (18 lbf·ft).

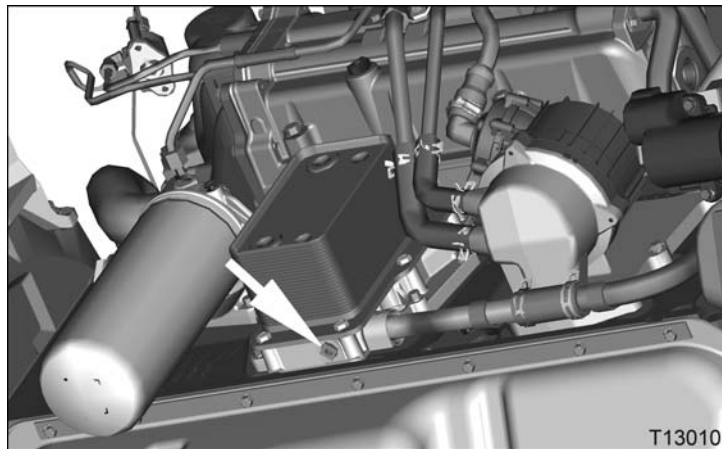


Figure 42 Coolant drain plug for oil system module

7. Remove coolant drain plug from bottom of oil system module.

SECTION 5 – MAINTENANCE SCHEDULE AND SERVICE PROCEDURES

Service Procedures (cont.)

SERVICE COOLING SYSTEM (cont.)


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.

9. Slowly fill cooling system with new ELC 50/50 Premix or Concentrate and water mixture until coolant is at the mid point between the ADD and FULL levels of the coolant tank.
10. Install and tighten the coolant tank cap until the plastic cap clicks or the metal cap runs up against the detent.

CAUTION: To prevent engine damage, disconnect electrical connector at the EGR valve before running engine to purge air from cooling system. Failure to do so could cause failure of EGR cooler.

11. Disconnect electrical connector at the EGR valve.
12. Start the engine.
13. Allow the engine to operate at a fast idle until the engine reaches normal operating temperature.
14. As the engine warms up, make sure coolant is flowing through coolant line – the coolant line will feel warm to the touch.

15. After engine reaches normal operating temperature and the thermostat has opened, allow engine to run for 5 to 10 minutes, then shut engine off.
16. Connect electrical connector at the Exhaust Gas recirculation (EGR) valve. Clear any Diagnostic Trouble Codes (DTC) that may have occurred. See the *Engine Diagnostic Manual* for further information.

 **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.
17. If necessary, add coolant to the coolant tank to bring the level up to the COLD MAX mark.

SECTION 6 – LONG TERM STORAGE

General Information

To maintain warranty coverage, engines intended to be taken out of service or stored 30 days or longer require the following procedures. these procedures are also recommended for engines outside of warranty to assure maximum engine life:


- 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.
- Before storage, change the engine oil and filter with the appropriate engine oil for conditions the engine will experience during storage.
- Cover air intake ducts to prevent moisture and debris intrusion during storage.
- Cover vertical exhaust stack.
- Check the battery charge and recharge if needed. Disconnect the battery cables between batteries and between the batteries and vehicle. If freezing temperatures are expected, remove batteries and store in an area with temperature above freezing. 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.

SECTION 6 – LONG TERM STORAGE

SECTION 7 – SERVICE RECORDS

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, shift transmission to park or neutral, set parking brake, and block wheels 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.

SECTION 7 – SERVICE RECORDS

Maintenance Service Record (cont.)


Maintenance Service Record

Date	Service Month	Service Hours	km (Miles)	Item Serviced

SECTION 7 – SERVICE RECORDS

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, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

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

- Oil level.
- Oil, air, fuel or coolant leaks.
- Cooling system hoses for leaks
- 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 before engine operation 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.

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.