

**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.



To the Operator

This guide contains instructions on the safe operation and preventive maintenance of your Detroit Diesel EPA07 MBE 4000 engine. Maintenance instructions cover routine engine services such as lube oil and filter changes in enough detail to permit self-servicing if desired.

The operator should become familiar with the contents of this guide before operating the engine or carrying out maintenance procedures.

Power-driven equipment is only as safe as the person operating the controls. You are urged, as the operator of this diesel engine, to keep fingers and clothing away from the revolving belts, drive shafts, etc. on engine installation.

Throughout this guide **CAUTIONS** regarding personal safety and **NOTICES** regarding engine performance or service life will appear. To avoid personal injury and ensure long engine service life, always heed these instructions.

Whenever possible, it will benefit you to rely on an authorized Detroit Diesel® service outlet for all your service needs from maintenance to major parts replacement. Authorized service outlets worldwide stock factory original parts and have the specialized equipment and

experienced, trained personnel to provide prompt preventive maintenance and skilled engine repairs.

The information and specifications in this publication are based on the information in effect at the time of approval for printing. Contact an authorized Detroit Diesel service outlet for information on the latest revision. The right is reserved to make changes at any time without obligation.

The MBE 4000 engine is built in accordance with sound technological principles and based on state-of-the-art technology.

Despite this, the engine may constitute a risk of damage to property or injury to persons if it is not used for its intended purpose.

The engine should not be modified or converted in an incorrect manner or the safety instructions included in this manual disregarded.

NOTICE:

Coolant must be inhibited with the recommended SCAs (supplemental coolant additives) listed in the **How To** section of this engine operator's guide. In addition, the engine can be equipped with a coolant filter/inhibitor system as an installed option or as an after-sale item. **Failure to check and maintain SCA levels at required concentrations will result in severe damage (corrosion) to the engine cooling system and related components.**

WARRANTY

The applicable engine warranty is contained in the booklet "Warranty Information for MBE 4000 Engines," available from authorized Detroit Diesel service outlets.

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Keep this Operator's Guide with the engine installation at all times. It contains important operating, maintenance, and safety instructions.

Trademark Information

DDC®, Detroit Diesel®, DDEC®, Optimized Idle®, Diagnostic Link®, reliabilt®, *POWER Trac*®, *POWER COOL*®, and *POWER GUARD*®

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INTRODUCTION

This guide is intended for use by the operator of an MBE 4000 diesel engine used in the following applications:

- On-Highway Vehicles
- Fire Truck or Crash/Rescue Vehicles

Non-Genuine and Rebuilt Component Quality Alert

Electronic engine controls have been instrumental in aiding engine manufacturers in meeting the stringent emission requirements of the U.S. Environmental Protection Agency (U.S. EPA) and the California Air Resources Board (CARB) and also in meeting the ever-increasing performance demands of the customer.

Maintenance procedures must be followed in order to continue satisfactory performance and durability and to ensure coverage of the engine under the manufacturer's warranty. Many of these maintenance procedures also ensure that the engine continues to comply with applicable emissions standards. Proper maintenance procedures, using specific components engineered to comply with emissions regulations, may be performed by an authorized Detroit Diesel distributor or dealer, an independent outlet or the operator

or owner. The owner is responsible for determining the suitability of components to maintain emissions compliance during the engine's useful emission life.

Detroit Diesel cautions that the indiscriminate rebuilding of precision components, without the benefit of specifications, specialized equipment, and knowledge of the electronic operating system, will jeopardize performance or lead to more serious problems, and can take the engine outside of compliance with U.S. EPA or CARB emissions standards.

There are other components in an engine, such as turbocharger, camshaft, piston, etc., which are specifically designed and manufactured to exacting standards for emissions compliance. It is important that these components, if replaced, modified or substituted, can be verified to ensure that the engine remains in compliance with emissions standards. The use of inadequately engineered, manufactured or tested components in repair or rebuild of the engine may be in violation of the federal Clean Air Act and applicable U.S. EPA or CARB regulations.

Furthermore, modern engines exhibit operating parameters which require the use of proper fluids, such as fuel, coolant and lubricating oil, to maintain long engine life. The use of fluids that do not meet Detroit Diesel specifications may result in early wear out or engine failure.

Personnel Requirements

Work on the engine should be carried out only by skilled technicians who have been instructed in the specific skills necessary for the type of work being performed.

Engine Conversions and Modifications

The function and safety of the engine could be affected if unauthorized modifications are made to it. Detroit Diesel will not accept responsibility for any resulting damage.


Tampering with the fuel injection system and engine electronics could also affect the engine's power output or exhaust emission levels. Compliance with the manufacturer's settings and with statutory environmental protection regulations cannot then be guaranteed.


CAUTION SUMMARY


The following cautions must be observed by the operator of the vehicle or equipment in which this engine is installed and/or by those performing basic engine preventive maintenance. Failure to read and heed these cautions and exercise reasonable care for personal safety and the safety of others when operating the vehicle/equipment or performing basic engine preventive maintenance may result in personal injury and engine and/or vehicle/equipment damage.

Engine Operation

Observe the following cautions when operating the engine.

 WARNING: FIRE
<p>To avoid injury from fire, keep all potential ignition sources away from diesel fuel, including open flames, sparks, and electrical resistance heating elements. Do not smoke when refueling.</p>

 WARNING: HOT EXHAUST
<p>During parked regeneration the exhaust gases will be extremely HOT and could cause a fire if directed at combustible materials. The vehicle must be parked outside.</p>

 WARNING: PERSONAL INJURY
<p>Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.</p> <ul style="list-style-type: none"> □ Always start and operate an engine in a well ventilated area. □ If operating an engine in an enclosed area, vent the exhaust to the outside. □ Do not modify or tamper with the exhaust system or emission control system.

Preventive Maintenance

Observe the following cautions when performing preventative maintenance.



WARNING:

HOT OIL

To avoid injury from hot oil, do not operate the engine with the rocker cover(s) removed.



WARNING:

PERSONAL INJURY

To avoid injury from slipping and falling, immediately clean up any spilled liquids.



CAUTION:

USED ENGINE OIL

To avoid injury to skin from contact with the contaminants in used engine oil, wear protective gloves and apron.



WARNING:

PERSONAL INJURY

To avoid injury when working near or on an operating engine equipped with an hydraulic clutch fan, remove loose items of clothing and jewelry. Tie back or contain long hair that could be caught in any moving part causing injury. The hydraulic fan may start without warning.



WARNING:

HOT COOLANT

To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.



WARNING:
PERSONAL INJURY

To avoid injury from the projection of tools or other objects that may fall on or behind the vibration damper of an engine, always check and remove these items before starting the engine.



WARNING:
FIRE

To avoid injury from combustion of heated lubricating-oil vapors, stop the engine immediately if an oil leak is detected.



WARNING:
PERSONAL INJURY

To avoid injury from contact with rotating parts when an engine is operating with the air inlet piping removed, install an air inlet screen shield over the turbocharger air inlet. The shield prevents contact with rotating parts.



WARNING:
FIRE

To avoid injury from fire, do not smoke or allow open flames when working on an operating engine.



WARNING:
FIRE

To avoid injury from fire from a buildup of volatile vapors, keep the engine area well ventilated during operation.



WARNING:
PERSONAL INJURY

To avoid injury when using caustic cleaning agents, follow the chemical manufacturers usage, disposal, and safety instructions.

Electrical System

Observe the following cautions when jump starting an engine, charging a battery, or working with the vehicle electrical system.



WARNING: PERSONAL INJURY

To avoid injury from accidental engine startup while servicing the engine, disconnect/disable the starting system.



CAUTION: Electrical Shock

To avoid injury from electrical shock, use care when connecting battery cables. The magnetic switch studs are at battery voltage.



WARNING: Battery Explosion and Acid Burn

To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:

- Flush your skin with water.
- Apply baking soda or lime to help neutralize the acid.
- Flush your eyes with water.
- Get medical attention immediately.





WARNING: ELECTRICAL SHOCK

To avoid injury from electrical shock, do not touch battery terminals, alternator terminals, or wiring cables while the engine is operating.

Cooling System

Observe the following cautions when servicing the cooling system.


 WARNING: HOT COOLANT
To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

 WARNING: PERSONAL INJURY
To avoid injury from slipping and falling, immediately clean up any spilled liquids.

Air Intake System

Observe the following cautions when working on the air intake system.

 WARNING: PERSONAL INJURY
To avoid injury from hot surfaces, wear protective gloves, or allow engine to cool before removing any component.

 WARNING: PERSONAL INJURY
To avoid injury from contact with rotating parts when an engine is operating with the air inlet piping removed, install an air inlet screen shield over the turbocharger air inlet. The shield prevents contact with rotating parts.

Fuel System

Observe the following cautions when fueling the vehicle or working with the fuel system.



CAUTION:

PERSONAL INJURY

To avoid injury from fuel spills, do not overfill the fuel tank.



WARNING:

FIRE

To avoid injury from fire, contain and eliminate leaks of flammable fluids as they occur. Failure to eliminate leaks could result in fire.



WARNING:

FIRE

To avoid injury from fire, keep all potential ignition sources away from diesel fuel, including open flames, sparks, and electrical resistance heating elements. Do not smoke when refueling.



WARNING:

FIRE


To avoid injury from fire caused by heated diesel-fuel vapors:

- Keep those people who are not directly involved in servicing away from the engine.
- Stop the engine immediately if a fuel leak is detected.
- Do not smoke or allow open flames when working on an operating engine.
- Wear adequate protective clothing (face shield, insulated gloves and apron, etc.).
- To prevent a buildup of potentially volatile vapors, keep the engine area well ventilated during operation.

Starting Aids


Compressed Air


Observe the following cautions when using compressed air.

 WARNING: EYE INJURY
<p>To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.</p>


Lubricating Oil and Filters

Observe the following cautions when replacing the engine lubricating oil and filters.

 WARNING: PERSONAL INJURY
<p>To avoid injury from slipping and falling, immediately clean up any spilled liquids.</p>

 WARNING: FIRE
<p>To avoid injury from combustion of heated lubricating-oil vapors, stop the engine immediately if an oil leak is detected.</p>

 WARNING: FIRE
<p>To avoid injury from fire, do not smoke or allow open flames when working on an operating engine.</p>

 WARNING: FIRE
<p>To avoid injury from fire from a buildup of volatile vapors, keep the engine area well ventilated during operation.</p>

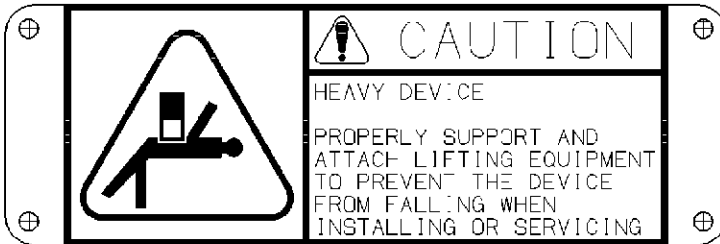
Aftertreatment System

Observe the following cautions when servicing the Aftertreatment System (ATS). Be advised that these two labels are attached to the Aftertreatment Device (ATD).



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Figure 1 Hot Surfaces External and Internal Caution



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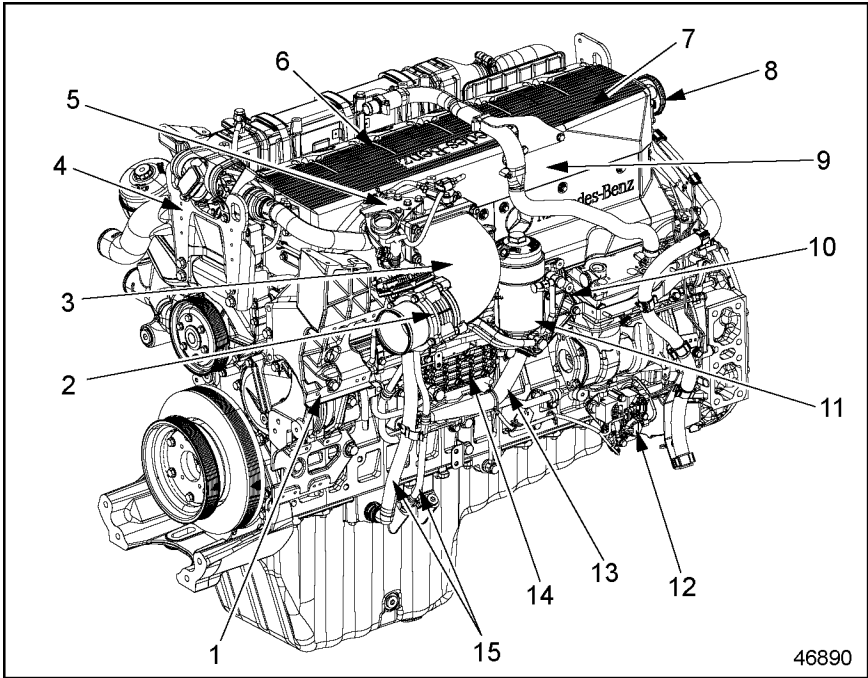
Figure 2 Heavy Aftertreatment Device Caution

ENGINE IDENTIFICATION

The MBE 4000 engine has a certification label, engine model and serial number for identification.

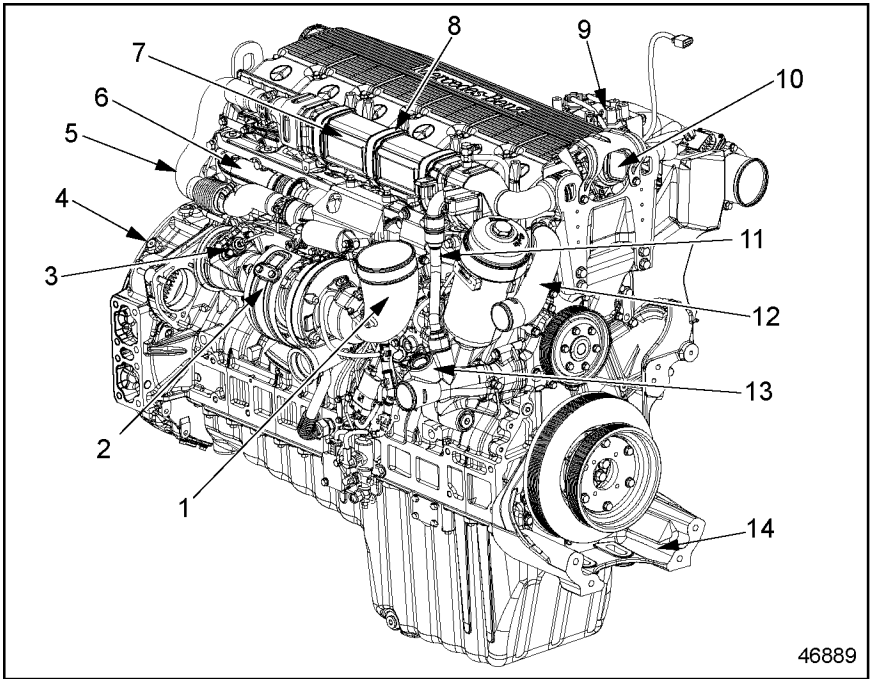
Engine Components

For a general view of the MBE 4000 engine, showing major components, see Figure 3 for the left-hand side, and Figure 4 for the right-hand side. See Figure 5 for left side sensor locations and see Figure 6 for right side sensor locations.



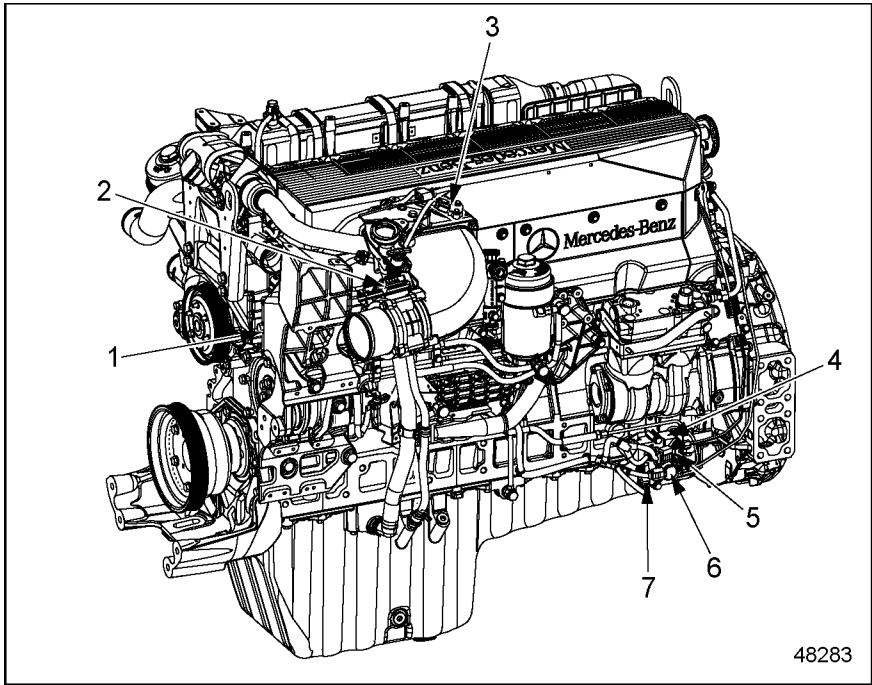
- | | |
|--|---------------------------|
| 1. Fuel Pump | 9. Air Intake Manifold |
| 2. Intake Throttle Valve | 10. Fuel Filter Bracket |
| 3. Air Intake Elbow | 11. Fuel Filter and Lines |
| 4. Alternator & A/C Mounting Bracket | 12. Doser Block Assembly |
| 5. Gas Mixer Housing | 13. Engine Harness |
| 6. Smart Injector Adaptor Frame (Internal) | 14. MCM |
| 7. Constant Throttle Valve (Internal) | 15. Dipstick and Oil Fill |
| 8. Electrostatic Crankcase Breather | |

Figure 3 Major Engine Components, Left Side



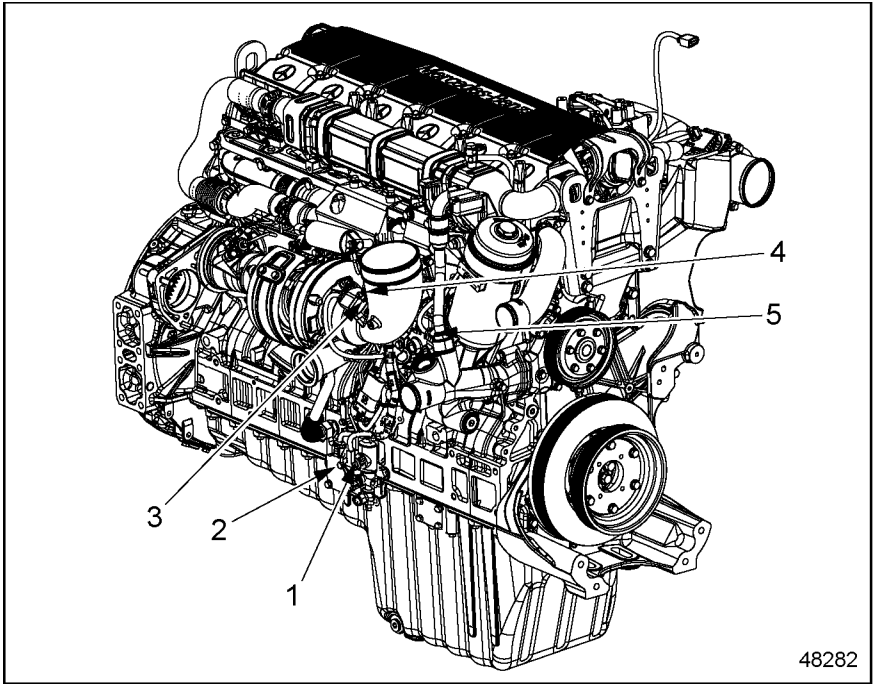
- | | |
|------------------------|------------------------|
| 1. Air Intake Elbow | 8. EGR Cooler Bracket |
| 2. Turbocharger | 9. Grid Heater |
| 3. Fuel Doser Valve | 10. EGR Valve |
| 4. Flywheel Housing | 11. EGR Coolant Return |
| 5. Hot EGR Cooler Pipe | 12. Coolant Outlet |
| 6. Exhaust Manifold | 13. Coolant Inlet |
| 7. EGR Cooler | 14. Front Mount |

Figure 4 Major Engine Components, Right Side



- | | |
|--|--------------------------------------|
| 1. Fuel Temperature Sensor | 5. Fuel Compensation Pressure Sensor |
| 2. Intake Throttle Valve | 6. Fuel Cut-off |
| 3. Intake Manifold Pressure/Temperature Sensor | 7. Fuel Line Pressure Sensor |
| 4. Doser Block Assembly | |

Figure 5 Left Side Sensor Locations



- | | |
|---|------------------------------------|
| 1. EPV-1 | 4. EGR Delta-P Sensorr |
| 2. Wastegate Actuator | 5. Oil Pressure/Temperature Sensor |
| 3. Turbocharger Pressure/Temperature Sensor | |

Figure 6 Right Side Sensor Locations

Engine Model And Serial Number Designation

The fourteen-digit engine model and serial number is located on the left front of the engine cylinder block, on the DDEC-MCM label and on the oil filter housing on the right-hand side of the engine. See Figure 7.

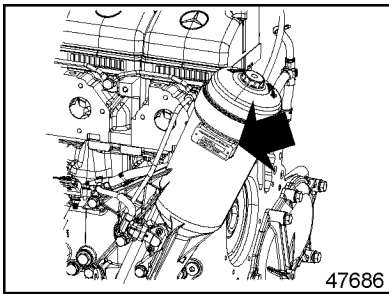


Figure 7 Location of Engine Type Plate

Details on the Plate

The engine type reference, OM 460 LA, is the production code. The first three numbers of the engine serial number are the engine series number, the next three number are the engine model number. See Figure 8.

The engine type reference and the complete engine model and serial number appears beside the name of the manufacturer. The engine type reference, OM 460 LA is the production code. The engine model

and serial number contains the type reference followed by a sequential manufacturing number. The last six digits of the engine model and serial number is the serial number for the engine. See Figure 8.

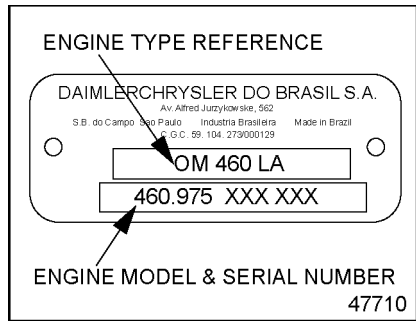


Figure 8 Engine Type Plate

Certification Labels

The MBE 4000 engine complies with all United States Environmental Protection Agency (USEPA) and California Air Resources Board

(CARB) emission standards. An emission label is attached to the cylinder head cover, as required by law. See Figure 9.


Important Engine Information		
DETROIT DIESEL CORPORATION		
Mercedes-Benz Engine, Model	OM 460 LA	CID 781
Engine Family	7DDXH12.8DJA CODE I	
Date of engine manufacture	2007	
Advertised output (SAE gr.)	335 kW (450 HP) / 1900 rpm	
Fuel rate at adv. output	259 - 274 mm ³ / stroke	
Valve lash cold (Ins.)	0.016 int	0.024 exh.
Basic injection timing	8.5±1 degrees BTDC	
Idle speed	600±50 rpm	
FEL	NOX+NMHC 1.3 G/BHP-HR	
Displacement	12.8 L	
<p>This engine conforms to US, EPA, California and Canada regulations applicable to 2007 model year new heavy duty diesel cycle engines. This engine has a primary intended service application as a heavy heavy-duty engine.</p> <p>This engine is not certified for use in an urban bus as defined at 40 CFR 86.093-2. Sales of this engine for use in an urban bus is a violation of Federal Law under the Clean Air Act. This engine is certified to be operated on ultra low sulfur diesel fuel.</p>		
		48257

Figure 9 Emission Label, MBE 4000

OPERATING INSTRUCTIONS FOR STARTING THE ENGINE

Following are instructions for starting the engine.

First Time Start Preparation

When preparing to start a new or newly overhauled engine which has been in storage, perform all of the operations listed below. Also refer to the “ENGINE STORAGE” section of this guide. Failure to follow these instructions may result in serious engine damage.

Be sure you are familiar with all of the instruments, gauges and controls which are needed to operate the engine.

Note especially the location and function of the following:

- Oil pressure gauge
- Low oil pressure warning light
- Coolant temperature gauge
- High coolant temperature warning light
- Water in fuel warning light
- Tachometer
- Air restriction indicator

Watch for any signs of engine problems when starting or driving. If

the engine overheats, uses excessive fuel or lubricating oil, vibrates, misfires, makes unusual noises, or shows an unusual loss of power, turn the engine off as soon as possible and determine the cause of the problem. Engine damage may be avoided by a quick response to early indications of problems.

When starting the engine in cold weather, refer to “*How to Select Coolant*” in the “HOW-TO SECTION” of this guide.

System Checks

Perform the following system checks before starting for the first time.

Cooling System Checks

Check the cooling system as follows:

1. Make sure all drain cocks in the cooling system are installed (drain cocks are often removed for shipping) and are closed tightly.
2. Remove the radiator pressure control cap and fill with genuine Detroit Diesel *POWER COOL*® antifreeze or an equivalent quality ethylene glycol (EG) or propylene glycol (PG) base antifreeze solution in the required

concentration. In extremely hot environments, **properly inhibited** water may be used in the summer. Keep the coolant level at the bottom of the filler neck to allow for expansion of the coolant. For more detailed recommendations, Refer to “*How to Select Coolant*” in the “*HOW-TO SECTION*” of this guide.

3. Entrapped air must be purged after filling the cooling system. To do this, allow the engine to warm up with the pressure cap removed. With the transmission in neutral, increase engine speed above 1,000 rpm and add coolant to the radiator as required.
4. Check to make sure the front of the radiator and air-to-air charge cooler (if equipped) are unblocked and free of debris.

Lubrication System Checks

The lubricating oil film on the rotating parts and bearings of a new or newly overhauled engine, or one which has been in storage for six months or more, may be insufficient when the engine is started for the first time.

NOTICE:


Insufficient lubrication at startup can cause serious damage to engine components.

To insure an immediate flow of oil to all bearing surfaces at initial engine startup, the engine lubrication system should be charged with a commercially available pressure pre-lubricator. If this is impractical, rocker covers should be removed and clean lubricating oil should be poured over the rocker arms. The oil should be the same weight and viscosity as that used in the crankcase. After pre-lubricating, add additional oil to bring the level to the proper mark on the dipstick.

For lubricant recommendation, Refer to “*How to Select Lubricating Oil*” in the “*HOW-TO SECTION*” of this guide.

Checking the Oil Level — Check the oil level as follows:

1. Check the oil level using the oil dipstick (See Figure 10).

 WARNING:
PERSONAL INJURY
To avoid injury from slipping and falling, immediately clean up any spilled liquids.

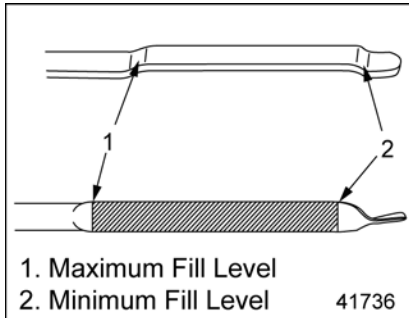


Figure 10 Oil Dipstick

2. If necessary, top off by filling engine oil through the oil fill tube (See Figure 11) to the maximum fill level on the oil dipstick. Do not overfill.

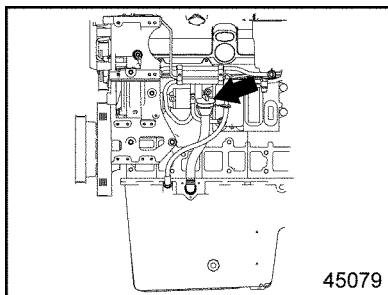


Figure 11 Oil Fill Tube

Extended Storage — An engine in storage for an extended period of time (over winter, for example) may accumulate water in the oil pan through normal condensation of moisture (always present in the air) on the cold, internal surfaces of the engine.

NOTICE:
Failure to eliminate water-diluted lubricating oil may lead to serious engine damage at startup.

Lube oil diluted by water cannot provide adequate bearing protection at engine startup. For this reason, Detroit Diesel recommends replacing the engine lubricating oil and filters after extended storage.

Fuel System Checks

Fill the tanks with the recommended fuel. Keeping tanks full reduces water condensation and helps keep fuel cool, which is important to engine performance. Full tanks also reduce the chance for microbe (black slime) growth. For fuel recommendations, Refer to “*How to Select Diesel Fuel*” in the “*HOW-TO SECTION*” of this guide. Make sure the fuel shutoff valve (if used) is open.

NOTICE:

Prolonged use of the starting motor and engine fuel pump to prime the fuel system can result in damage to the starter, fuel pump and injectors.

This may cause erratic engine operation due to the amount of air in the lines and filters from the fuel supply tank to the cylinder head

NOTICE:

Under no circumstances should a starting aid such as ether be used to run the engine until the fuel system is primed. Injector damage will result if this method is used.

If an external starting aid is used, the heat generated by the external fuel source will cause the injector tips to be damaged when the fuel cools them. The injector plunger and bushing can be scored from running without lubrication.

NOTICE:

Engines equipped with starting devices dependent on compressed air or gas reservoirs should always be primed before initial startup. Otherwise, reserve pressure can be exhausted and injectors may be damaged from lack of lubrication and cooling.

To insure prompt starting and even running, the fuel system *must* be primed if air has entered the fuel system. Priming is done by connecting a manual or electric priming pump to the *secondary* fuel filter adaptor.

Authorized Detroit Diesel service outlets are properly equipped and have the trained technicians to perform this service.

Priming is not normally required if the filter elements are filled with clean fuel when installed and the lines are not drained of fuel.

If the engine is equipped with a fuel/water separator, drain off any water that has accumulated. Water in fuel can seriously affect engine performance and may cause engine damage. Detroit Diesel recommends installation of a fuel/water separator wherever water contamination is a concern.

Adding Fuel — When adding fuel, pay attention to the following:

- Add winter or summer grade fuel according to the season of the year.
- Work in the cleanest conditions possible.
- Prevent water from entering the fuel tank.

For further information, Refer to the “HOW-TO SECTION” of this guide.

Priming the Fuel System —

Prime the fuel system as follows:

1. If equipped with a hand pump on the fuel filter or fuel/water

separator, work the hand pump until resistance is felt.


NOTE:

There should be a strong resistance in the hand pump, caused by the pressure buildup within the fuel system.

2. Crank the engine for 30 seconds at a time, but no longer. Wait at least two minutes. The engine should start within four 30-second attempts.

Other Checks

Make sure the transmission is filled to the proper level with the fluid recommended by the gear manufacturer. Do not overfill.


WARNING:
Battery Explosion and Acid Burn
<p>To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:</p> <ul style="list-style-type: none"> □ Flush your skin with water. □ Apply baking soda or lime to help neutralize the acid. □ Flush your eyes with water. □ Get medical attention immediately.

Manufacturer	Lubricant or Part Number
Shell Oil Co.	No. 71032; No. 71306
Texaco, Inc.	No. 955
Quaker State	No. NYK-77

Table 1 Approved Electrical Lubricants

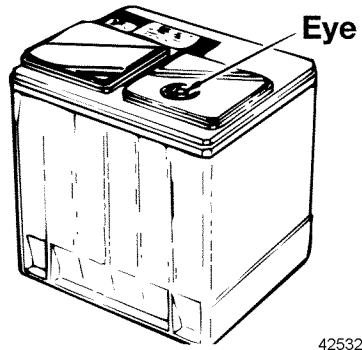


Figure 12 Maintenance-Free Battery "Eye"

Make sure cable connections to the storage batteries are clean and tight. Check the hydrometer "eye" of maintenance-free batteries for charge. See Figure 12.

If lead-acid or low-maintenance batteries are used, make sure battery electrolyte level is normal.

Use only batteries that have been correctly filled and serviced. To provide corrosion protection, apply dielectric grease liberally to the terminal pads. Approved suppliers are Listed in Table 1.

Check the turbocharger for signs of oil or exhaust leaks. Leaks should be corrected before starting the engine. Check engine mounting bolts for tightness. Bolts should be retightened, if necessary.

Starting the Engine-For The First Time

Before starting the engine the first time, perform the operations listed in the *System Checks* section.

NOTICE:

The turbocharger may be seriously damaged if the engine is cranked with the air shutdown in the *closed* position.

The engine may require the use of a cold weather starting aid if the ambient temperature is below 4°C (40°F).



WARNING: FLAMES, EXPLOSION AND TOXICITY

To avoid injury from flames, explosion, and toxicants when using ether, the following precautions must be taken:

- Do not smoke when servicing ether system.
- Work in well ventilated area.
- Do not work near open flames, pilot flames (gas or oil heaters), or sparks.
- Do not weld or carry an open flame near the ether system if you smell ether or otherwise suspect a leak.

To start an MBE 4000 engine, make sure the transmission is in neutral and turn the ignition key on.



WARNING: ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.



WARNING: PERSONAL INJURY

To avoid injury when working near or on an operating engine, remove loose items of clothing and jewelry. Tie back or contain long hair that could be caught in any moving part causing injury.

You will notice that both the Amber Warning Lamp (AWL)/Check Engine and the Red Stop Lamp (RSL)/Stop Engine will come on. This is the result of the Detroit Diesel Electronic Controls (DDEC®) diagnosing the system to ensure everything is functional, including the light bulbs for the warning lights. If everything is OK, both lights will go out in approximately five seconds.

Start the engine *after* the lights go out. If starting a vehicle, start the engine with foot *off* the foot pedal.

NOTICE:

If the warning lights stay on, or do not come on momentarily after turning on the ignition, contact the Detroit Diesel Customer Support Center at 313-592-5800. Operating the engine under these circumstances may result in engine damage.

Electric Starter — Start an engine equipped with an electric starting motor as follows:

NOTICE:

To prevent serious starting motor damage, do not press the starter switch again after the engine has started.

Important: At outside temperatures below -25°C (-13°F), a coolant preheater is recommended.

1. Chock the tires, place the transmission in neutral, and set the parking brake.
2. With foot OFF the foot pedal, turn on the ignition switch and start the engine

3. If the engine doesn't start after 30 seconds, stop. Try again after waiting two minutes. The engine should start within four 30-second attempts.

NOTICE:

Do not rev the engine if the oil pressure gauge indicates no oil pressure. To avoid engine damage, shut down the engine within approximately ten seconds. Check to determine the cause of the problem.

4. Monitor the oil pressure gauge immediately after starting the engine.

NOTE:

Do not place the engine under full load until it reaches operating temperature.

Running the Engine

While the engine is operating, monitor the battery charge indicator light, the oil pressure and avoid excessive idling.

Oil Pressure

Observe the oil pressure gage immediately after starting the engine. A good indicator that all moving parts are getting lubrication is when the oil pressure gage registers pressure (7 psi or 50 kPa at idle speed). If no pressure is indicated within 10 to 15 seconds, stop the engine and check the lubrication system. The pressure should not drop below 36 psi or 250 kPa at 1800 rpm, and normal operating pressure should be higher. If oil pressure does not fall within these guidelines, it should be checked with a manual gage.



WARNING:

HOT OIL

To avoid injury from hot oil, do not operate the engine with the rocker cover(s) removed.

Warm-up

Run the engine at part throttle for about five minutes to allow it to warm up before applying a load.

Inspection

While the engine is idling, inspect the transmission, check for fluid leaks, check the crankcase and turbocharger.

Transmission — While the engine is idling, check the automatic transmission (if equipped) for proper oil level and add oil as required.

Fluid Leaks — Look for coolant, fuel or lubricating oil leaks. If any are found, shut down the engine immediately and have the leaks repaired after the engine has cooled.

Crankcase — If the engine oil was replaced, stop the engine after normal operating temperature has been reached. Allow the oil to drain back into the crankcase for about twenty minutes, then check the oil level. If necessary, add oil to bring the level to the proper mark on the dipstick. Use only the heavy-duty oils recommended. Refer to "How to Select Lubricating Oil" in this guide.

Turbocharger — Make a visual inspection of the turbocharger for oil leaks, exhaust leaks, excessive noise or vibration. Stop the engine immediately if a leak or unusual noise or vibration is noted. ***Do not restart the engine until the cause of the concern has been investigated and***

corrected. Authorized Detroit Diesel service outlets are properly equipped to perform this service.

Avoid Unnecessary Idling

Whenever possible, avoid unnecessary idling.

Never allow the engine to idle for more than 30 minutes. Excessive idling can cause oil to leak from the turbocharger.

During long engine idling periods with the transmission in neutral, the engine coolant temperature may fall below the normal operating range. The incomplete combustion of fuel in a cold engine will cause crankcase oil dilution, formation of lacquer or gummy deposits on the valves, pistons, and rings, and rapid accumulation of sludge in the engine. When prolonged idling is necessary, maintain at least 850 rpm spring/summer and 1200 rpm fall/winter.

Stopping the Engine

Stop an engine under normal operating conditions as follows:

1. Reduce engine speed to idle and put all shift levers in the neutral position.

NOTICE:

Stopping a turbocharged engine immediately after high-speed operation without allowing a sufficient cool-down period may cause damage to the turbocharger, as it will continue to turn without an oil supply to the bearings.

2. Allow the engine to run between idle and 1000 rpm with no load for four or five minutes. This allows the engine to cool and permits the turbocharger to slow down. After four or five minutes, shut down the engine.

Emergency Jump Starting

The DDEC VI system operates on 12 volts DC. If a DDEC VI engine with an electric starting motor requires emergency jump starting, *do not exceed 16 volts DC.*



WARNING:
BATTERY EXPLOSION

To avoid injury from battery explosion when jump starting the engine, do not attach the cable end to the negative terminal of the disabled battery.

Before attempting to jump start the engine, make sure the jumper cables are connected properly (positive to positive, negative to negative ground) and in the proper sequence (negative to negative ground *last*).

NOTICE:

Jump starting with voltages greater than those indicated or reversing battery polarity may damage the MCM.



WARNING:
Battery Explosion and Acid Burn

To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:


- Flush your skin with water.
- Apply baking soda or lime to help neutralize the acid.
- Flush your eyes with water.
- Get medical attention immediately.


NOTICE:

Failure to connect jumper cables in the proper sequence can result in alternator and/or equipment damage.

Routine Engine Start

Following are procedures for a routine everyday engine start.

 WARNING: ENGINE EXHAUST
To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

 WARNING: PERSONAL INJURY
To avoid injury when working near or on an operating engine, remove loose items of clothing and jewelry. Tie back or contain long hair that could be caught in any moving part causing injury.

Starting the Engine-Routine

Before a routine start, Refer to the “*Maintenance*” section and see the daily checks for your engine.

Important: Before starting the engine, carefully read all operating instructions in this manual and do all the recommended pretrip inspections and daily maintenance. Check the engine oil and fuel levels, and drain contaminants from the fuel/water separator (optional).

NOTE:

If you drain the fuel/water separator completely, you may have to prime the fuel system.

NOTE:

As a safety function, the electronic engine control system may be wired to start the engine only if the transmission is in neutral. This is vehicle application specific.

NOTICE:
Never attempt to start the MBE 4000 electronic engine using ether or any other starting fluid. Serious engine damage could result.

1. Turn on the ignition switch.
2. With the accelerator pedal in the idle position, start the engine. If the engine doesn't start after 30 seconds, stop. Try again after waiting two minutes. The engine should start within four 30-second attempts.
3. Check the engine for leaks.
 - [a] Check all hoses, hose clamps, and pipe unions on the engine for tightness. Shut down the engine and tighten them if necessary.

- [b] Check the oil feed and return lines at the turbocharger for tightness. Shut down the engine and tighten them if necessary.
- 4. Shut down the engine.
- 5. Approximately five minutes after shutdown, check the engine oil level. If necessary, add oil up to the maximum fill level on the oil dipstick. (See Figure 13). Do not overfill.

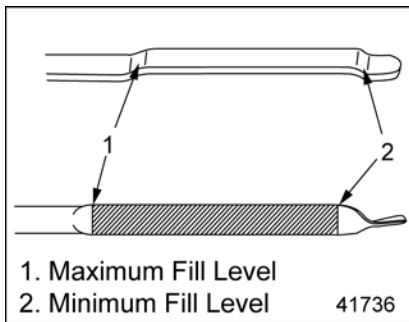


Figure 13 Oil Dipstick

- 6. Check all the mounting fasteners on the engine for tightness.

Checking the Coolant Level (Cold Check)

Check coolant level as follows:

- 1. Ensure that all coolant plugs in the bottom of the radiator and on

the radiator outlet pipe are secure and tight.

- 2. Check the coolant level. The cooling system is correctly filled when the coolant is between the maximum and minimum marks on the surge tank.


NOTE:

For more information, Refer to the "Maintenance" section.

Checking the Coolant Level (Hot Check)

Check the coolant levels as follows:

- 1. Allow the engine to run for approximately five minutes at a moderate speed.

 WARNING: HOT COOLANT
<p>To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.</p>

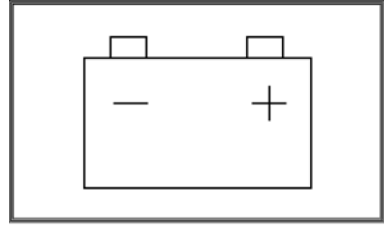
- Then, with the coolant temperature above 50°C (122°F), recheck the coolant level.
- Add more coolant if necessary. Open the heater valves (if equipped) before adding coolant.
- Do not close the heater valves until the engine has been run briefly and the coolant level again checked and corrected as necessary.

Monitoring Engine Operation

While the engine is operating, monitor the battery charge indicator light, the oil pressure and avoid excessive idling.

Battery Charge


The battery charge indicator light (See Figure 14) must go out once the engine starts.



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Figure 14 Battery Charge Indicator Light

If the indicator light comes on while the engine is running, do the following:

 WARNING: FIRE
<p>To avoid injury from fire, keep all potential ignition sources away from diesel fuel, including open flames, sparks, and electrical resistance heating elements. Do not smoke when refueling.</p>

- Shut down the engine.
- Check the poly-V belt for tightness.

3. Do a load test on the batteries. Charge or replace the batteries as needed.
4. If necessary, visit the nearest authorized dealer to have the alternator voltage and output checked.

Oil Pressure

When the engine has reached its normal operating temperature, the engine oil pressure must not drop below the following values:

- 250 kPa (36 psi) at rated speed
- 50 kPa (7 psi) at idling speed

If oil pressure drops below these values, stop the engine and determine the cause.

Excessive Idling

Never allow the engine to idle for more than 30 minutes. Excessive idling can cause oil to leak from the turbocharger.

Changing the Idle Speed

The rpm range of the MBE 4000 engine is 600 to 850 rpm if the parameters in the Common Powertrain Controller (CPC) are set to the default range.

Change the idle speed as follows:

1. Turn the cruise control switch to the OFF position.
2. To increase the idle speed, push the "Resume" switch until the idle is fast enough.
3. To decrease the idle speed, push the "Decel" switch until the idle is slow enough.

Shutting Down the Engine

If the engine has been running at full output or the coolant temperature has been high, allow the engine to idle for one or two minutes without load. Then turn off the ignition key switch.

If any of the following occur, shut down the engine immediately.

- The oil pressure swings back and forth or falls sharply.
- Engine power and rpm fall, even though the accelerator pedal remains steady.
- The exhaust pipe gives off heavy smoke.
- The coolant and/or oil temperature climb abnormally.
- Abnormal sounds suddenly occur in the engine or turbocharger.

Shutting Down After High Load Operation

After high load operation, do the following:

NOTICE:
After high load operation, if the engine has been running at full output or the coolant temperature has been high, allow the engine to idle for one or two minutes without load. Shutting down the engine without idling may cause damage to the turbocharger.

Turn off the ignition switch and shut down the engine.

Emergency Running Mode

The engine is equipped with the electronic engine control system, which monitors the engine as it is running.

As soon as a fault is detected, it is evaluated and one of the following measures is initiated.

NOTICE:
To prevent possible serious engine damage, have any faults corrected without delay by an authorized dealer.

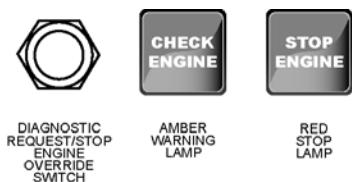
- In conjunction with any dashboard or instrument panel display, the code for the electronic control unit reporting the fault can be read immediately on the display.
- Complete fault codes are transmitted and can be read using DDDL 7.0 or latest version.
- If the fault is serious enough to impair normal operation, the electronic engine system switches over to emergency running mode. When in emergency running mode, the engine operates at a constant 1300 rpm. This allows you to move the vehicle to a service location.

For fault codes and their meanings, see the *DDEC VI MBE 4000 Troubleshooting Guide (6SE568)*.

Stop Engine Override Option

The Stop Engine Override Option is used for a momentary override. The Motor Control Module (MCM) will record the number of times the override is activated after a fault occurs.

Momentary Override – A Stop Engine Override (SEO) switch is used to override the shutdown sequence (see Figure 15). This override resets the 60 second (30 seconds for oil pressure) shutdown timer, restoring power to the level when the RSL (Stop Engine) was illuminated. The switch must be recycled after five seconds to obtain a subsequent override.



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Figure 15 Typical SEO Switch and Warning Lamps

NOTE:

The operator has the responsibility to take action to avoid engine damage.

Cold Weather Operation

Special precautions must be taken during cold weather. To protect your engine, special cold weather handling is required for fuel, engine oil, coolant, and batteries.

The engine will not require starting aids down to -15°C (5°F). Between -15°C (5°F) and -25°C (-13°F), a grid heater is required. Temperatures below -25°C (-13°F), will require a grid heater, block heater, and oil pan heater.

Winter Fronts

A winter front may be used to improve cab heating while idling. At least 25% of the grill opening should remain open in sectioned stripes that run perpendicular to the charge air cooler tube flow direction. This assures even

cooling across each tube and reduces header to tube stress and possible failure. Winter fronts should only be used when the ambient temperature remains below -12.2°C (10°F).

DDEC VI SYSTEM

The engine is equipped with a fully electronic control system, which regulates the fuel injection quantity and timing using solenoid valves, allowing extremely low-emission operation. Besides the engine and its related sensors, the system is composed of the following:

- The Motor Control Module (MCM)
- The Common Powertrain Controller (CPC) located under the right-hand dash panel

The two control units are connected by a proprietary datalink through which all necessary data and information can be exchanged.

The CPC then broadcasts all information on the J1587 and J1939 datalinks, where it can be read by the diagnostic tool.

The engine control system monitors both the engine and the datalink. When a malfunction or other problem is detected, the system selects an appropriate response; for example, the emergency running mode may be activated.

The Accelerator Pedal Assembly (AP) eliminates the need for any throttle linkage.

Motor Control Module

The MCM (See Figure 16) is located on the left-hand side of the engine.

The MCM processes the data received from the CPC, for example the position of the accelerator pedal, engine brake, etc.

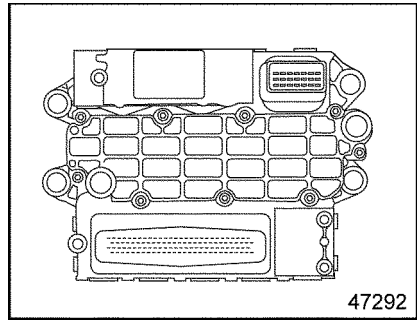


Figure 16 MCM

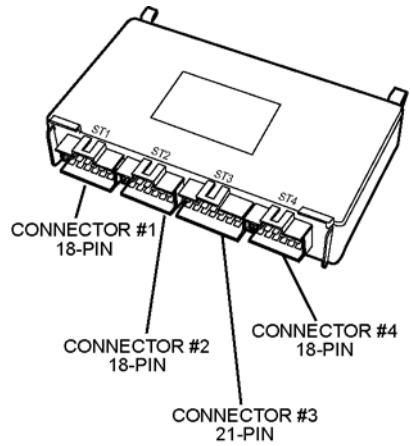
These data are evaluated together with the data from the sensors on the engine, such as coolant and fuel temperature and oil and charge pressure.

The data is then compared to the characteristic maps or lines stored in the MCM. From these data, quantity and timing of injection are calculated and the unit pumps are actuated accordingly through the solenoid valves.

NOTE:

To obtain a replacement MCM, all the data given on the MCM label are required.

The MCM data label has the 10 digit engine serial number.



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Common Powertrain Controller

The CPC communicates with the other MCM units installed on the vehicle over the J1587 and J1939 data link. See Figure 17.

Data for specific applications is stored in the CPC. These include idle speed, maximum running speed, and speed limitation.

Figure 17 CPC

The CPC receives data from the following sources:

- The operator (accelerator pedal position, engine brake switch)
- Other electronic control units (for example, the anti-lock brake system)
- The MCM (oil pressure and coolant temperature)

From these data, instructions are computed for controlling the engine and transmitted to the CPC via the proprietary datalink.

The CPC controls various systems, for example, communications with the datalink, the engine brake, and the constant-throttle valves.

DDEC Features

DDEC offers a variety of features and options designed to warn the operator of an engine malfunction.

Options can range from warning panel lights to automatic reduction in engine power followed by automatic engine shutdown.

DDEC has the ability to perform diagnostics for self-checks and continuous monitoring of other system components.

Depending on the application, DDEC can monitor oil temperature, coolant temperature, oil pressure, fuel pressure, coolant level and remote sensors (if used).

DDEC connects to the AWL (Check Engine) and the RSL (Stop Engine) to provide a visual warning of a system malfunction.

Cruise Control

Cruise Control is available with any DDEC engine. Cruise Control will operate in either Engine or Vehicle Speed Mode and maintain a targeted speed (MPH or RPM) by increasing or decreasing fueling. The targeted speed can be selected and adjusted with dash-mounted switches. See Figure 18.



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Figure 18 Typical Cruise Control Switches

Cruise Control may also be programmed to permit fast idle using the Cruise Control switches. With the engine at normal idle, transmission in neutral and service brakes on, depress the SPD CNTL Switch, and use the RSM/ACC Switch. The engine rpm should increase to a pre-defined speed. The engine rpm can be raised or lowered from this point using the SET/CST and RSM/ACC switches.

Cruise Control will maintain the set speed under normal road and load conditions.

**CAUTION:****LOSS OF VEHICLE CONTROL**

To avoid injury from the loss of vehicle control, do not use cruise control under these conditions:

- **When it is not possible to keep the vehicle at a constant speed (on winding roads, in heavy traffic, in traffic that varies in speed, etc.).**
- **On slippery roads (wet pavement, ice-or snow-covered roads, loose gravel, etc.).**

NOTICE:

When descending a hill with Cruise Control OFF, do not allow the engine to exceed 2500 rpm under any conditions. Failure to observe this precaution can result in overspeeding and serious engine damage.

It cannot limit vehicle speeds on down grades if available engine braking effort is exceeded, nor can it maintain speed on upgrades if power requirements exceed engine power capability.

Engine speed and power are varied under Cruise Control to maintain the

set vehicle speed. The vehicle speed must be above Min. Cruise Set Speed and below Max. Cruise Set Speed. It is recommended that Max Cruise Set Speed be set to the default to allow proper operation of other features such as Fuel Economy Incentive and PasSmart. The Vehicle Speed Limit should be used to limit vehicle throttle speed.

When the SPD CNTL is in the ON position, Cruise Control is engaged by momentarily contacting the SET/CST Switch. As a check after each engine start, DDEC looks for a one time activation of the clutch (if equipped) and service brake before DDEC allows Cruise Control to be enabled. The MCM must also recognize that the Cruise Enable Switch has changed. If the Cruise Enable Switch is off, it needs to be turned on. If the Cruise Enable Switch is on, it must be turned off then on for cruise to operate.

Holding the switch in the SET/CST position allows the vehicle to slow to a lower speed. Toggling the switch will result in a one mile-per-hour (1.6 kph) decrease in vehicle speed. If Cruise Control has been disabled, toggling the RSM/ACC Switch restores the vehicle to the previously set cruise speed.

Cruise Control can be overridden at any time with the throttle pedal if the vehicle is operating at less than the programmed Max Road Speed. Additionally, using either the brake or the clutch will disable Cruise Control.

Data Recording Capability

The DDEC VI contains the ability to extract detailed data on the engine's use and performance using DDEC Reports software. This data, known as DDEC Data, is stored in the CPC and contains information on engine performance (such as fuel economy, idle time, time in top gear) and critical incidents (such as detailed diagnostic data records and hard braking events). DDEC Data can be downloaded using DDEC Reports software to produce reports.

DDEC Reports software is part of the Detroit Diesel Diagnostic Link® 7.0 (DDDL 7.0) software package. DDDL 7.0 requires at least a Pentium II computer with at least 256 MB of RAM.

Engine Brakes

Engine brakes are enabled by a dash-mounted On/Off switch with a separate intensity switch to select low, medium or high braking power.



CAUTION:

LOSS OF VEHICLE CONTROL

To avoid injury from loss of vehicle control, do not activate the Engine Brake system under the following conditions:

- On wet or slippery pavement, unless the vehicle is equipped with ABS (anti-lock braking system) and you have had prior experience driving under these conditions.
- When driving without a trailer (bobtailing) or pulling an empty trailer.
- If the tractor drive wheels begin to lock or there is fishtail motion after the Engine Brake is activated, deactivate the brake system immediately if this occurs.

The engine brakes will only operate when the Accelerator Pedal is fully released. Disengaging the clutch will prevent the engine brakes from operating.

Engine brakes will supply braking power even when in Cruise Control. MCM will control the amount of engine braking with respect to the Cruise Control set speed. The maximum amount of braking (low, medium, high) is selected with the dash switches.

Engine Protection

The DDEC engine protection system monitors all engine sensors and electronic components, and recognizes system malfunctions. If a critical fault is detected, the AWL (Check Engine) and RSL (Stop Engine) illuminate. The malfunction codes are logged into the MCM's memory.

The standard parameters which are monitored for engine protection are: low coolant level, high coolant temperature, low oil pressure, and high oil temperature.

This system features a 30-second, stepped-power shutdown sequence or an immediate speed reduction without shutdown in the event a major engine malfunction occurs, such as low oil pressure, high oil or coolant temperature, or low coolant level.



WARNING: **PERSONAL INJURY**

To avoid injury from engine shutdown in an unsafe situation, ensure the operator knows how to override the stop engine condition on a DDEC-equipped unit.

NOTICE:

Engines equipped with the power-down/shutdown option have a system override button or switch to allow engine operation for a short period of time. Using the override button so the engine does not shutdown in 30 seconds but operates for an extended period may result in engine damage.

California Engine Idle Limiting

In order to meet the California Engine Idle Limiting Standard, an engine idle shutdown feature has been built into the DDEC VI Engine Control Strategy. When the California Engine Idle Limiting feature is enabled, the engine will generally shut down after five minutes of continuous idling when the transmission is in neutral or park and the parking brake is set or after fifteen minutes when the transmission is in neutral or park and

the parking brake is not set. Activating or momentarily changing the position of the service brake pedal, the clutch pedal, Stop Engine Override, the accelerator pedal, or park brake status during the final 30 seconds before a shutdown would otherwise occur will prevent the engine from shutting down and will reset the shutdown timer. After an automatic shutdown, the engine may be restarted and operated normally. The automatic shutdown feature is generally disabled on engines certified by the US EPA for use outside California but is required to be enabled for all California certified engines with the exception of engines used in specific vehicle types which the state of California has determined to be exempt from the idle shutdown requirement. These include buses, school buses, recreational vehicles, medium duty vehicles, military tactical vehicles, and authorized emergency vehicles as they are defined by the state of California. Owners of these vehicle types that wish to have the shutdown feature disabled should consult with California authorities to determine if their vehicles qualify for the exemption.

Idle Shutdown Timer

This feature is an optional 1 – 100 minute idle shutdown system. Its purpose is to conserve fuel by

eliminating excessive idling and allowing a turbocharger cool-down period. To activate the shutdown, the transmission must be in neutral with the vehicle parking brakes set and the engine in idle or fast-idle mode.

DDEC VI Operation

NOTE:

This engine is equipped with DDEC software. This software generally assures optimal engine performance. The installation of software upgrades may cause minor changes in features and engine performance.

Since the DDEC system is electronic, a battery is required to operate the computer. The system operates at 12 volts. However, in the event of a power supply malfunction, the system will continue to operate at reduced voltage. When this occurs, the AWL (Check Engine) will come on. See Figure 19



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Figure 19 Warning Lamps and SEO Switch

The engine will only operate at reduced rpm until the battery voltage reaches a point where the MCM will no longer function and the engine shuts down.

Should the AWL (Check Engine) come on for any reason, the vehicle can still be operated and the driver can proceed to the required destination.

This condition should be reported to an authorized Detroit Diesel distributor or dealer.

NOTICE:

When the RSL (Stop Engine) comes on, the computer has detected a major malfunction in the engine that requires immediate attention. **It is the operator's responsibility to shut down the engine to avoid serious damage.**

The engine can be configured to give a warning only, to ramp down (reduce power) or to shut down. Ramp down will reduce engine rpm to a pre-determined speed, but will not shut down the engine. With the 30-second shutdown option, the engine will begin a 30-second, stepped power-down sequence until it shuts down completely.

A "Stop Engine Override" can be procured in case the vehicle is to operate in a critical location.

Stop Engine Override Switch

This feature allows the operator to override the automatic stop engine sequence.

This is done by pressing the Stop Engine Override Switch every 15 to 20 seconds to prevent engine shutdown from occurring.

NOTE:

The Stop Engine Override Switch and the Diagnostic Request Switch are the same.

NOTE:

Holding down the Stop Engine Override Switch will not prevent the engine shutdown sequence. You must continue to reset the automatic shutdown system by pressing the Stop Engine Override Switch at intervals of approximately 15 to 20 seconds.

It takes 30 seconds from the time the automatic shutdown sequence begins until engine shutdown. Therefore, the operator *must* press the override switch just prior to engine shutdown and continue to do so until the vehicle can be brought to a stop in a safe location.

Immediate Speed Reduction

The immediate speed reduction option will bring engine rpm back to a predetermined speed, but will not shut down the engine.

The engine should not be restarted after it has been shut down by the engine protection system, unless the problem has been located and corrected.

Red Stop Lamp

The conditions that will cause the RSL (Stop Engine) to come on are:

- High coolant temperature
- Loss of coolant
- High oil temperature
- Low oil pressure
- Auxiliary shutdown

Whenever the AWL (Check Engine) or the RSL (Stop Engine) come on, the DDEC computer will determine where the problem is and will then store this information in its memory.

If the malfunction is intermittent, the lights will come on and go off as the computer senses the changing engine condition.

Diagnostic Tool

The diagnostic tool for DDEC VI is DDDL 7.0. which requires at least a

Pentium II computer with at least 256 MB of RAM.

Once the malfunction has been corrected, the DDEC system will return the engine to normal operation.

The temperature of air in the intake system is increased with the addition of an EGR. DDEC is programmed to reduce fueling (power) for a short time to reduce air and coolant temperatures when necessary. DDEC will store an information code that this event occurred, but no corrective action is required as this action is designed to maintain operation without a noticeable affect on vehicle performance.

Flashing Malfunction Codes —

All malfunction codes are four digits. The malfunction code recorded in the computer memory will remain until it is erased by a technician.

The flashing malfunction code can also be obtained by the operator. To support flashing codes, a Stop Engine Override/Diagnostic Request Switch must be configured and the AWL (Check Engine) and RSL (Stop Engine) must be hard-wired. The CPC cannot flash these lamps if they are not hard-wired.

The flashing code feature may be activated by satisfying one of the following conditions:

- Engine speed is <100 rpm and the SEO switch is put in the ON position.
- Idle Governor is activated and the SEO switch is put in the ON position.

- Vehicle speed is <3 mph and Park Brake is activated and the SEO switch is put in the ON position.

The flashing code feature is deactivated to the OFF position or the listed conditions are no longer satisfied. See Figure 20.

RED - RSL

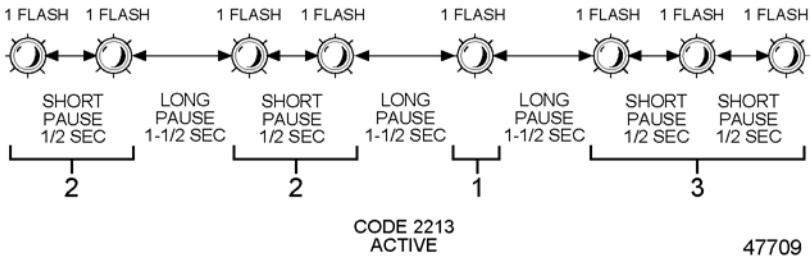


Figure 20 RSL (Stop Engine) Flashing Code Example

Only one light will be flashing codes at any time. All codes will be flashed twice. The inter-digit pause is 1.5 seconds. The pause between codes is 3.5 seconds. The same 3.5 second pause occurs as the switch is made from RSL (Stop Engine) to AWL (Check Engine).

When code flashing is initiated, the active codes will be flashed on the RSL (Stop Engine). Then the inactive codes will be flashed on the AWL (Check Engine). When all the inactive codes have been flashed, the process of flashing all the active codes

followed by all the inactive codes will repeat until the conditions for code flashing are no longer satisfied.

If there are no active or inactive faults the number 3 is flashed once followed by an inter-code gap of 3 seconds.

To Read Codes: Press and hold the SEO/Diagnostic Request Switch. Active codes will be flashed on the RSL (Stop Engine) first, followed by inactive codes being flashed on the AWL (Check Engine).

The codes will continue to flash and repeat as long as the Diagnostic Request Switch is held in the ON position. Both CPC and MCM faults are included.

Active Codes – The active codes will be flashed on the RSL (Stop Engine) in the order of most recent to least recent occurrence based on engine hours.

Inactive Codes – The inactive codes will be flashed on the AWL (Check Engine) in the order of most recent to least recent occurrence based on engine hours.

DDEC VI ENGINE DRIVING TIPS

Driving with an electronically controlled engine feels different from driving with a mechanically governed engine.

Accelerating the Vehicle

Engine response versus pedal movement may feel different from the mechanical-governed engine you were driving. The Accelerator Pedal (AP) was designed to communicate “percentage” foot pedal travel to the engine's Motor Control Module (MCM). The engine will respond accordingly to the driver's demand.

Another throttle or governor characteristic you may need time to get used to is the DDEC Limiting Speed Governor. This allows the driver to command total engine response between idle and rated speed, such as accelerating at half throttle – an advantage when driving under slippery conditions.

If you require wide-open throttle engine response, either accelerating or just plain pulling hard, the throttle AP will have to be held to the floor. To obtain 100% fueling at any speed, the AP will have to be maintained at the fully pressed position.

Cruise Control

For added driver convenience and comfort, DDEC VI also features a Cruise Control option that works just like the system in your car. It can be operated in any gear above 1000 rpm or road speed faster than 32 kph (20 mph), up to the rated engine speed. And it can be programmed to hold your road speed at or below the maximum vehicle speed. The switch to energize Cruise Control is usually mounted on the instrument panel. See Figure 21.



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Figure 21 Typical Cruise Control Switches

Turn the switch ON to energize the system. Remember as a check after each engine start, DDEC VI looks for a one time activation of the clutch (if equipped) and service brake before DDEC VI allows Cruise Control to be enabled.

DDEC VI must also see or recognize that the Cruise Enable Switch has changed. If the Cruise Enable Switch is OFF it needs to be turned ON. If the Cruise Enable Switch is left in the ON position at key OFF, the switch must be cycled OFF then ON for DDEC VI to see a status change to allow Cruise Control activation. The status of DDEC VI inputs to activate Cruise Control at key ON is Listed in Table 2 below.

Once Cruise Control is enabled and you reach your road speed, press the Set Switch to activate Cruise Control. The cruise light will come on. To increase road

speed in one mile-per-hour (1.6 kilometer-per-hour) increments, press the RSM/ACL Switch. To reduce road speed, press and hold the SET/CST Switch until the lower speed is reached.

Cruise Control is deactivated by slightly pressing the service brakes, clutch pedal, or trailer brake. The On/Off Switch will also deactivate Cruise Control.

Cruise Control will maintain vehicle speed even on up grades, unless power requirements demand a downshift. And, of course, Cruise Control does not limit your speed on down grades. Most likely, Cruise Control will feel stronger than driving with the foot pedal because of the instantaneous and wide-open throttle response. That's why Cruise Control use is not suggested during slippery driving conditions.

Input	Status of Input at Key ON	Status of Input Before Cruise Control Activates
Service Brake Switch	ON	OFF
Clutch Release Switch (Manual Trans only)	ON	OFF
Cruise Control Enable Switch	OFF	ON

Table 2 Input Status to Activate Cruise Control

Use Cruise Control after down shifting on a hill to pull the hill. Hitting the RSM/ACL Switch (not the Set Switch) will keep the truck accelerating in the lower gears up to the rated engine speed.

Cruise Control will disengage below 1000 rpm or 20 mph (32 kph) road speed. When using Cruise Control, if you want to pull the engine below 1000 rpm, remember to hold the throttle pedal to the floor to keep the engine pulling at wide-open throttle. Realistically, the engine will pull to about 1050 rpm.

Remember: The electronic data programmed into the DDEC VI system will not allow you to hurt or overfuel the engine at low or “lug” engine speeds. There is enough oil pressure to withstand hard pulls at low engine speeds.

Engine Brakes and Cruise Control

If your engine is equipped with both Cruise Control and engine brake retarders, the engine retarders can operate automatically while you are in Cruise Control. If the Cruise Control/Engine Brake function is turned ON in the MCM programming, the engine retarders will come on “low” when your set road speed increases a few miles-per-hour (kilometers per hour) above your

cruise set speed. If your speed continues to increase, the MCM will increase the engine retarders' braking power progressively. When the vehicle returns to the set cruise speed, the engine retarders will turn off until you need them.

For safety reasons, don't use Cruise Control when it is not possible to keep the vehicle at constant speed due to:

- Winding roads
- Heavy traffic
- Slippery pavement
- Descending grades that call for engine brake assistance.

For an explanation of the engine brake retarder system and recommendations for proper operation, refer to “ENGINE BRAKE SYSTEM”.

Shifting

Depending on your transmission model, the gear split may vary from 500 to 300 rpm. The electronic governor provides almost no overrun capability; and, if the transmission is downshifted too early, you will experience a temporary loss of pulling power until the engine speed falls below rated speed.

In general, when using a 7 or 9-speed transmission, you should always downshift between 1250 and 1300 rpm. This is true even on steep grades with heavy loads. When using an 18-, 15- or 13-speed transmission, you will need to downshift at an rpm that allows “less than rated” rpm before throttle application in the next gear down. You may want to limit engine speed to 1900 rpm in all gears. The Series 60 provides horsepower through 2100 rpm, but fuel economy is not as efficient above 1800 rpm.

Low rpm operation should feel greatly enhanced due to the characteristics of the variable nozzle turbocharger. Engine response should be almost instantaneous below peak torque engine speeds. This should encourage progressive shifting especially during slow vehicle speed operation.

If you decide to drive at lower rpm's for improved fuel economy, don't let different engine noises throw you off guard. The Series 60 sounds quiet at 1400 rpm, almost as if it had quit pulling. Don't believe it! If you had a boost gage to look at while driving, you would notice the turbocharger maintaining steady intake manifold pressure, even as rpm's fall. Depending on the air intake arrangement, you may also experience a “chuffing” sound as the engine starts to pull hard at lower rpm's. This is caused by the velocity

changes of the air flow within the air intake plumbing. Electronic engines can actually deliver more fuel at lower engine speeds than at rated speed.

One difference you may notice with the EGR equipped engine is under hood noise. The gear train has been redesigned for quieter operation, and the EGR gas flow may be noticeable to the tuned attentive ear. The turbocharger operates at higher boost pressure forcing EGR gas flow through the EGR plumbing. In some situations the driver may believe he/she has experienced a charge air cooler system leak. Even connecting trailer light and air hoses, the driver may hear a different tone (exhaust and under hood with the engine idling.) If equipped with a turbo boost gage, the driver may occasionally note intake manifold pressure exceeds 35 psi.

Idling

The common belief that idling a diesel engine causes no engine damage is wrong. Idling produces sulfuric acid, which breaks down the oil and eats into bearings, rings, valve stems and engine surfaces. If you must idle the engine for cab heat or cooling, the *high idle* function of the Cruise Control switches should be used. An idle speed of 1100 rpm should be enough to provide cab heat in above 0° C (32° F) ambients.

ENGINE BRAKE SYSTEM

Certain MBE 4000 vehicle engines are equipped with engine brakes, commonly referred to as *retarders*. Before operating the vehicle, you *must* familiarize yourself with the retarder system to obtain optimum benefit from it. Engine brake control systems may vary slightly, depending on the engine brake configuration and cab design. However, basic operator controls are similar for all models.

Exhaust Brake/Constant-Throttle Valves

When the driver activates the engine brake, the MCM energizes the brake gate solenoid. The solenoid valve supplies air pressure to the brake gate actuator, closing the brake gate, which closes off the large entry to the turbocharger and the combined exhaust stream flows through the small entry to the exhaust turbine.

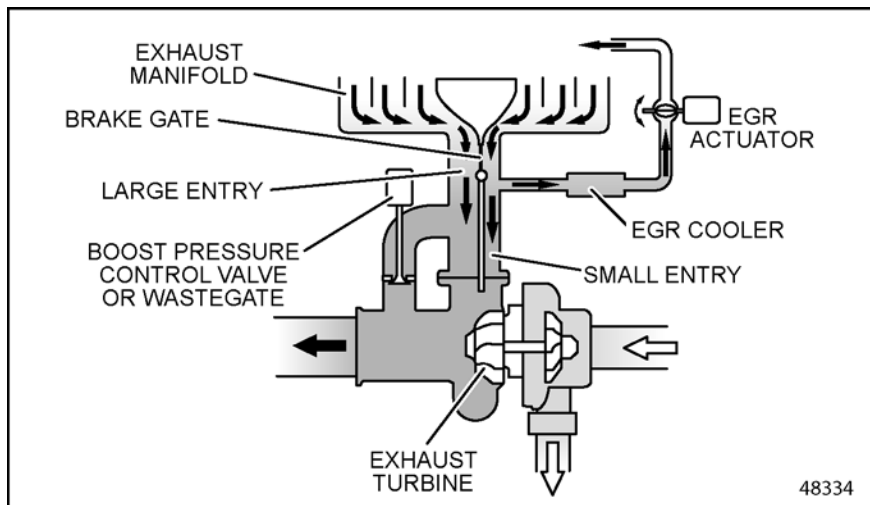


Figure 22 Brake Gate Open

The smaller cross-sectional area, of the small entry, increases the flow and speed of the exhaust stream to the exhaust turbine, which increases the exhaust turbine speed and increases the boost pressure. The small cross-sectional flow of the small entry will increase the total exhaust manifold pressure. This increased boost pressure will increase the airflow forced into the cylinders, which results in increased resistance to the pistons during a compression stroke and increases the engine braking power.

At the same time, the Constant Throttle Valve (CTV) solenoid is energized allowing the CTV to be open. The CTV partially releases the increased compression pressure allowing less compression on the piston during the end of the stroke.

Increased exhaust effort is required for the next exhaust stroke, all the exhaust flows across the small entry, which causes a deceleration of the engine speed.

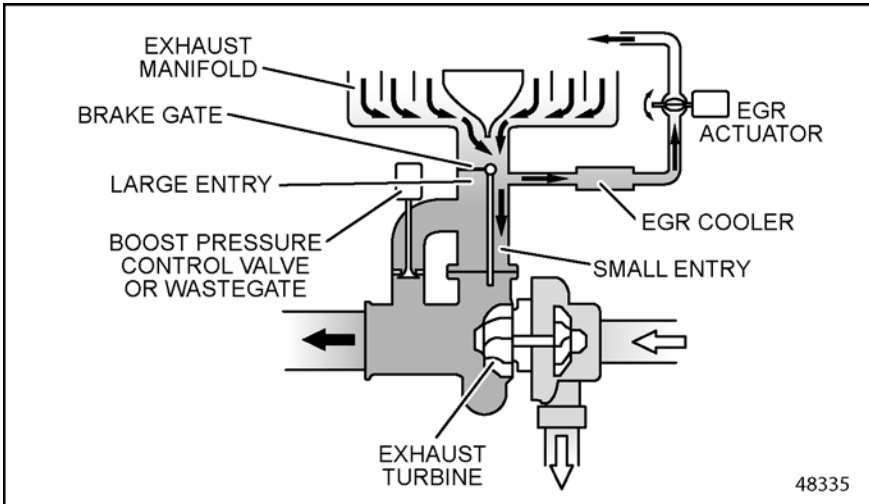


Figure 23 Brake Gate Closed

Controlling the exhaust to the turbine through the small entry, the EGR valve now controls the brake effect

by removing the necessary exhaust through the EGR system.

The engine brake is activated by the Common Powertrain Controller (CPC). In engine braking mode, an engine rpm range of up to 2500 rpm can be used by the operator. 2500 rpm, however, may never be exceeded. The engine is turned off automatically when the engine rpm is:

- Below 900 rpm for Allison Automatic Transmissions
- Below 1100 rpm for all other transmissions

Also, the engine brake is automatically turned off when the accelerator pedal is pressed.

NOTE:

When in emergency running mode (constant rpm), the engine brake can be activated only when the engine is in overrun. When constant rpm has been attained, the engine brake is automatically turned off.

Anti-Lock Braking Systems

Vehicles equipped with ABS (anti-lock braking systems) have the ability to turn the engine brake retarder OFF if a wheel-slip condition is detected. The engine brake will automatically turn itself ON once the wheel slip is no longer detected. The DDEC system will deactivate the engine brake system when the engine speed falls below 1000 rpm

or when the vehicle slows down to a pre-set speed, depending on DDEC programming. This prevents stalling the engine. Engine brakes can also be used with vehicle Cruise Control TURNED ON.

Driving on Flat, Dry Pavement

Use the following guidelines when driving on flat, dry pavement:

1. If driving on flat, dry, open stretches with a light load and greater slowing power is not required, place the progressive braking switch in the LOW position.
2. If you find you are still using the service brakes, move the switch to a higher position until you do not need to use the service brakes to slow the vehicle down.
3. If you are carrying a heavier load and road traction is good, move the progressive braking switch to the "High" position.
4. Check your progressive braking switch often for proper position, since road conditions can change quickly. *Never skip a step when operating the progressive braking switch.* Always go from OFF to LOW, and then to a higher position.

Descending a Long, Steep Grade

An explanation of “control speed” may be helpful in understanding how to use the engine brake system while descending a grade. *Control Speed* is the constant speed at which the forces pushing the vehicle forward on a grade are equal to the forces holding it back, without using the vehicle service brakes. In other words, *this is the speed the vehicle will maintain without using the service brakes or fueling.*



CAUTION:

BRAKE FADE

To avoid injury, do not over apply the vehicle service brakes when descending a long, steep grade. Excessive use of the vehicle brakes will cause them to heat up, reducing their stopping ability. This condition, referred to as “brake fade”, may result in loss of braking, which could lead to personal injury or vehicle/property damage or both.

Use the following guidelines when descending a long, steep grade:

1. Before beginning the descent, determine if your engine brake system is operating properly by

lifting your foot briefly off the throttle. You should feel the system activate.

2. Ensure the progressive braking switch is in the appropriate power position.



WARNING:

PERSONAL INJURY

Failure to keep the vehicle within safe control speed limits while descending a grade may result in loss of vehicle control, which could cause personal injury.

NOTICE:

Failure to keep the vehicle within safe control speed limits while descending a grade may result in vehicle or property damage or both.

3. Do not exceed the *safe control speed* of your vehicle. Example: You could descend a 6% grade, under control only at 16 kph (10 mph) without an engine brake, but at 40 kph (25 mph) with an engine brake. You could not descend that same hill at 80 kph (50 mph) and still expect to remain under control. Get to know how much slowing power your engine brake can provide. So get to know

your engine brake system *before* climbing hills and do not exceed a safe control speed.

4. Check your progressive braking switch often for proper position, since road conditions can change quickly. *Never skip a step when operating the progressive braking switch.* Always go from OFF to LOW and then to a higher position when on slippery roads.

Driving on Wet or Slippery Pavement

Do not attempt to use the engine brake system on wet or slippery roads until you have some experience with it on dry pavement.



CAUTION:

LOSS OF VEHICLE CONTROL

To avoid injury from loss of vehicle control, do not activate the Engine Brake system under the following conditions:

- On wet or slippery pavement, unless the vehicle is equipped with ABS (anti-lock braking system) and you have had prior experience driving under these conditions.**
- When driving without a trailer (bobtailing) or pulling an empty trailer.**
- If the tractor drive wheels begin to lock or there is fishtail motion after the Engine Brake is activated, deactivate the brake system immediately if this occurs.**

NOTE:

On single trailers or combinations, a light air application of the trailer brakes may be desirable to help keep the trailer stretched out. Follow the manufacturer's recommended operating procedure when using your trailer brakes.

On wet or slippery pavement, start with the master switch in the OFF position and use the gear you would normally use under these conditions.

If the vehicle is maintaining traction, place the selective braking switch in the LOW position and turn ON the engine brake system. If the drive wheels are maintaining traction and you desire greater slowing power, move the braking switch to the next highest position.

However, if the tractor drive wheels begin to lock or there is a fishtail motion, *turn the engine brake system OFF immediately and do not activate it until road conditions improve.*

Check your progressive braking switch often for proper position, since road conditions can change quickly. Never skip a step when operating the progressive braking system. Always go from OFF to LOW and then to a higher position.

ENGINE SYSTEMS

The engine systems are the following:

Fuel System

The fuel system consists of DDEC, fuel injectors, fuel manifolds (integral with the cylinder head), Electronic Unit Pumps (EUP), fuel pump, a cooling plate for the Motor Control Module (MCM) on non-automotive engines, primary and secondary fuel filters, and the necessary connecting fuel lines.

The gear-type fuel pump is located near the front of the crankcase on the left hand side. The pump is driven from the forward end of the camshaft.

Lubrication System

The lubricating oil system consists of an oil pump, oil cooler, full-flow oil filter, bypass at the oil filter housing stand pipe, oil level dipstick and an oil pressure regulator at the oil pump.

There is a force-feed lubricating oil circuit supplied by a gear-type oil pump. This pump is positioned at the rear of the oil pan and driven by gears from the crankshaft. The oil cooler is integrated with the oil filter housing on the right-hand side.

Air System

The outside air drawn into the engine passes through the air filter and is pulled into the turbocharger and compressed. It then moves to the air-to-air charge cooler (heat exchanger) and is cooled. Next it flows to the intake manifold and into the cylinders, where it mixes with atomized fuel from the injectors.

For optimum protection of the engine from dust and other airborne contaminants, service the dry type air cleaners used *when the maximum allowable air restriction has been reached, or annually, whichever occurs first.*

Cooling System

A radiator/thermo-modulated fan cooling system is used on MBE 4000 engines. This system has a centrifugal type fresh water pump to circulate coolant within the engine. Two full-blocking type thermostats located in a housing attached to the right side of the cylinder head control the flow of coolant.

Electrical System

The electrical system consists of a starting motor, starting switch, battery-charging alternator, storage batteries, and the necessary wiring.

Exhaust System

Exhaust gases exit the cylinders through exhaust ports and the exhaust manifold. These exhaust gases expand through the exhaust turbine and drive the turbocharger compressor impeller. The gases are then released through the exhaust pipes and the muffler to the atmosphere.

Exhaust Gas Recirculation System

The purpose of the Exhaust Gas Recirculation System (EGR) is to reduce engine exhaust gas emissions in accordance with EPA regulations.

The MBE 4000 engines for on-highway EPA 2007 regulation applications use a cooled EGR system consisting of an EGR cooler, EGR control valve, and an EGR mixer.

In the cooled EGR system, part of the exhaust gasses from the front three cylinders are routed from the exhaust manifold through the EGR cooler, past control, and are mixed with the intake manifold charge air.

The addition of cooled exhaust gasses back into the combustion airflow reduces the peak in cylinder combustion temperature. Less oxides of nitrogen (NOx) are produced at lower combustion temperatures.

The recycled exhaust gases are cooled before engine consumption in a tube and shell engine water cooler.

AFTERTREATMENT SYSTEM

In order to meet current emissions regulations, the traditional muffler has been replaced by a new Aftertreatment Device (ATD). This device consists of a Diesel Oxidation Catalyst (DOC) and a Diesel Particulate Filter (DPF). Together these two components burn off collected particulate matter in a process called “regeneration.” The

key to successful regeneration is high exhaust temperature for an extended period of time. Without adequate temperatures for regeneration, the filter will continue to trap particulates and eventually plug. In order to avoid plugging, Detroit Diesel has designed an actively regenerated Aftertreatment System (ATS). See Figure 24.

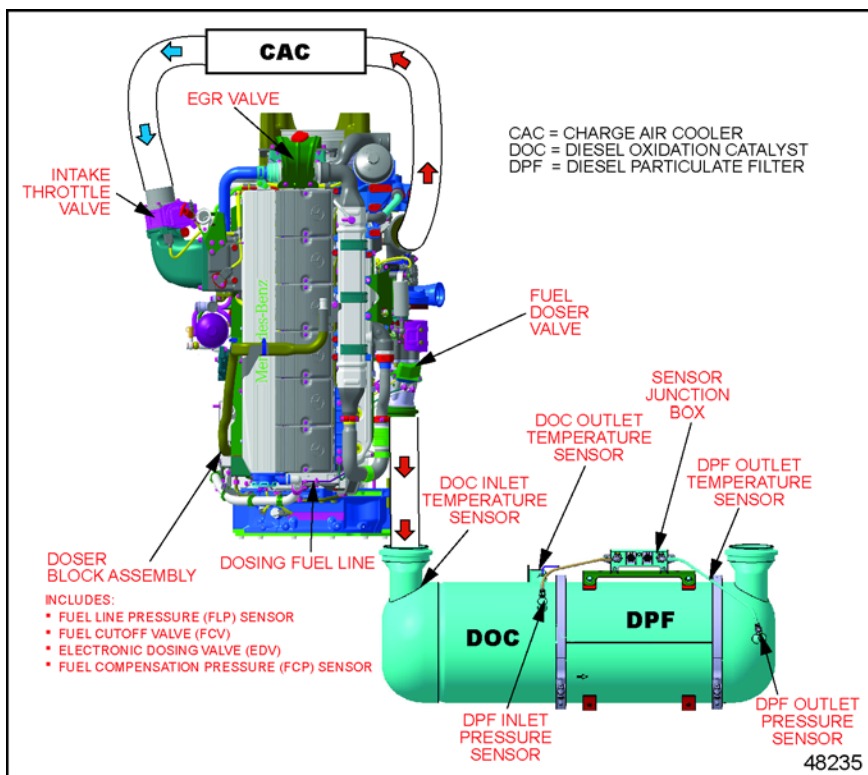


Figure 24 Aftertreatment System Schematic

Operating Requirements

Oxidation of the particulate matter is the key to filter performance. This requires that the catalyzing agent (platinum coated passages) are providing optimum enhancement to the oxidation process. The following requirements must be met, otherwise the ATD warranty may be compromised:

NOTICE:

Do not use kerosene or fuel blended with used lube oil.

- Use Ultra-Low Sulfur Diesel (ULSD) fuel with (15 ppm sulfur content maximum), based on ASTM D2622 test procedure
- Lube oil must have a sulfated ash level less than 1.0 wt %; currently referred to as CJ-4 oil

NOTICE:

Not following the operating requirements may result in damage to the ATD or accelerated ash plugging of the diesel particulate filter.
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Parked Regeneration Procedure

Regeneration of the ATS is fundamental for the oxidation of

soot. This process happens during the normal operation cycle of the vehicle; it can occur both passively and actively. Regardless of this, the operator will see no difference in vehicle performance or vehicle control. If the ATS is not capable of completing an over-the-road regeneration due to duty cycle constraints or other restrictions, a parked regeneration may need to occur.

The driver will be notified of the need for a DPF regeneration by illumination of the DPF Regeneration Lamp. Refer to section DRIVER ACTIONS .

NOTE:

If the DDEC VI electronics have not requested the initiation of a parked regeneration (the DPF Regeneration Lamp is not illuminated), the Regen request switch is disabled.

NOTE:

The driver **MUST** stay with the vehicle throughout the regeneration process.

NOTE:

Not all vehicles may be equipped with a Regen request switch due to application or user specification.

NOTE:

The procedure will take up to 40 minutes (depends on engine type and the amount of soot accumulated in the filter).

To initiate a parked regeneration, perform the following:

1. Keep engine at slow idle (cannot be in PTO mode).
2. Transmission is in neutral with parking brake ON.
3. Cycle the parking brake from OFF to ON.

NOTE:

Air tank pressure must be high enough for the parking brake switch to hold in the OFF position.

4. Press and release clutch pedal (if equipped with clutch pedal).
5. Cycle transmission to DRIVE and back to NEUTRAL (if not equipped with clutch pedal).
6. Hold DPF Switch in the ON position for five seconds and then release (engine speed will increase and DPF Lamp will go out).



DPF Switch

The regeneration will take up to 40 minutes.

The regeneration is completed when the engine returns to low idle and the DPF Lamp remains off. The High Exhaust System Temperature (HEST) Lamp will remain on but the vehicle can be driven.

If the Parked Regeneration exits and the DPF Lamp remains on, repeat the procedure. If the second try also fails, contact the Detroit Diesel Customer Support Center at (313) 592-5800.

NOTE:

A Parked Regeneration will stop if the key is turned to the OFF position, the vehicle is put into gear, or the parking brake is released.

Hazardous Applications

The MCM should be configured to not allow automatically triggered over-the-road regenerations (DPF Manual Regen Only Enable = Enabled).

NOTE:

This is for hazardous applications only.

There are two CPC options:

- DPF Stationary Regen Only = 0-Disabled
- DPF Stationary Regen Only = 1-Enabled

DPF Stationary Regen Only = 0-Disabled — This option allows the DPF Regen Switch to request a parked regeneration if the parked regeneration entry conditions are met. This option also allows MCM-initiated over-the-road regenerations to occur.

DPF Stationary Regen Only = 1-Enabled — This option **only** allows a parked regeneration to occur by using the DPF Regeneration Switch. The MCM will be unable to initiate an active over-the-road regeneration when this option is enabled.

Service Record

It is mandatory that customers or distributors maintain a proper record of the particulate filter servicing and cleaning. This record is an agent to warranty considerations. The record must include information such as:

- Date of cleaning or replacement
- Vehicle mileage at the time of cleaning or replacement

- Particulate filter part number and serial number






Maintenance

A high amount of black smoke emitting from the vehicle or illumination of an AWL (Check Engine) or RSL (Stop Engine) are indications of a system problem. Should this occur, refer to the *Aftertreatment System Technician's Guide* (7SE63), or contact the Detroit Diesel Customer Support Center at 313-592-5800.

Illumination of the Diesel Particulate Filter (DPF) lamp indicates that a parked regeneration is required.

There is a need to periodically remove accumulated ash, derived from engine lube oil, from the filter. This ash does not oxidize in the filter during the regeneration process and must be removed through a cleaning procedure. All Detroit Diesel ATD device equipped engines will illuminate a dashboard warning lamp indicating the need for ash cleaning. For information on this cleaning procedure, refer to the *Aftertreatment System Technician's Guide* (7SE63), or contact the Detroit Diesel Customer Support Center at 313-592-5800.

DRIVER ACTIONS

Name	Indicator Lamp	Description	Driver Action
High Exhaust System Temperature (HEST) Lamp		<p>SOLID: Exhaust is at high temperature and vehicle is at low speed or parked.</p> <p>FLASHING: A Parked Regeneration is in process and the system is not up to temperature.</p>	No change in driving style is required.
Malfunction Indicator Lamp (MIL)		Indicates a failure of an Emission Control Device. The MIL may illuminate at the same time as the Check Engine Lamp.	Vehicle can be driven to end of the shift. If the MIL remains on after three drive cycles, call for service.
DPF Regeneration Lamp		<p>SOLID: Indicates that a Regeneration may be needed.</p> <p>FLASHING: Indicates that a Regeneration is required as soon as possible.</p>	Perform a Parked Regeneration OR bring vehicle to highway speeds to allow for an Automatic Regeneration.
DPF Regeneration Lamp + Check Engine Lamp	 FLASHING + 	Indicates that a Parked Regeneration MUST be performed.	A Parked Regeneration must be performed. <u>ENGINE DERATE</u>




Name	Indicator Lamp	Description	Driver Action
DPF Regeneration Lamp + Check Engine Lamp + Red Stop Lamp (RSL)	 FLASHING +  + 	Indicates that a Parked Regeneration <u>MUST</u> be performed.	A Parked Regeneration must be performed. <u>ENGINE DERATE</u>

Table 3 Driver Actions

INSTRUMENT PANEL LAMPS






Lamp	Indicator	Description	Results
	Amber Warning Lamp (AWL)	Indicates a fault with the engine controls.	Vehicle can be driven to end of shift. Call for service.
	Red Stop Lamp (RSL)	Indicates a major engine fault that may result in engine damage. Engine derate and/or shutdown sequence will be initiated.	Move the vehicle to the nearest safe location and shutdown the engine. Call for service.
	DPF Regeneration Lamp	Solid yellow indicates a parked regeneration is required. Blinking yellow, derate, and/or shutdown are possible as soot load continues to increase. Lamp will shut off during regeneration.	<u>Lamp Solid</u> - parked regeneration required. <u>Lamp Flashing</u> - parked regeneration required immediately.
	High Exhaust System Temperature (HEST) Lamp	This is an information indicator. Indicates exhaust temperature is above a preset limit and the unit is operating at low vehicle speed. Lamp flashes once every ten seconds during a parked regen. Lamp is yellow.	Vehicle can be driven.
	Malfunction Indicator Lamp (MIL)	Yellow lamp Indicates a failure of an Emission Control device. May illuminate at the same time as the Amber Warning Lamp	Vehicle can be driven to end of shift. Call for service.

Table 4 Instrument Panel Lamps

The activation conditions are listed in Table 5.






Lamp	Lamp Solid	Lamp Flashing
	<ul style="list-style-type: none"> □ At the start of every ignition cycle (a bulb check). □ When an electronic system fault occurs (problem should be diagnosed as soon as possible). 	<ul style="list-style-type: none"> □ Diagnostic Request Switch is used to activate the AWL to flash inactive codes. □ Last 90 seconds before idle shutdown if programmed for override. □ Idle shutdown or the Optimized Idle shutdown occurs.
	<ul style="list-style-type: none"> □ At the start of every ignition cycle (a bulb check). □ A potential engine damaging fault is detected. 	<ul style="list-style-type: none"> □ When Engine Protection Shutdown occurs. □ Diagnostic Request Switch is used to activate the RSL to flash active codes.
	<ul style="list-style-type: none"> □ Parked regeneration is required. □ At the start of every ignition cycle (a bulb check). 	When a parked regeneration is required immediately (If the lamp flashing is ignored, derate and/or shutdown could occur).
	<ul style="list-style-type: none"> □ At the start of every ignition cycle (a bulb check). □ Vehicle speed is less than 5 mph and the DPF outlet temperature is greater than 525°C (977°F). 	Flashes every 10 seconds during a parked regen
	<ul style="list-style-type: none"> □ At the start of every ignition cycle (a bulb check). □ For any emission related fault (light out when the fault is inactive) 	Never flashes

Table 5 Lamp Activation Conditions

MAINTENANCE

When performed on a regular basis, changing the engine oil and filters is the least costly way of obtaining safe and reliable vehicle operation. Added benefits and savings occur when you check that the valves, fuel injectors, and oil and cooling circuits are in good working order during oil changes.

The maintenance section of this manual explains when you should change your oil and what to look for when checking for wear or damage.

For additional information, please contact the Detroit Diesel Customer Support Center at 313-592-5800.

Scheduled Intervals

All service intervals and maintenance operations are based on the parts and accessories expressly approved for your engine.

The scope and frequency of maintenance work are determined by the engine's operating conditions: severe duty, short haul, or long haul.

Evidence of regular maintenance is essential if a warranty claim has to be submitted.

If optional equipment is installed, be sure to comply with the maintenance requirements for these extra items.

Important: If the engine is stored for more than 18 months, the oil must be changed and the lubrication system must be primed before the engine can be brought into service. See *MBE 4000 Service Manual (6SE420)*.

Maintenance Schedule Types

There are three types of maintenance schedule:

- Severe Service
- Short Haul
- Long Haul

To determine which schedule to use, find the distance traveled by the vehicle in a year, regardless of vehicle type.

Severe Service — Applies to vehicles that annually travel up to 10,000 miles (16,000 kilometers) or that operate under severe conditions. Examples of Severe Service usage include: operation on extremely poor roads or where there is heavy dust accumulation; constant exposure to extreme hot, cold, salt-air, or other extreme climates; frequent short-distance travel; construction-site operation; city operation (fire truck, garbage truck), or farm operation.

Short-Haul — Applies to vehicles that annually travel up to 15,000 miles (24,000 kilometers) and operate under normal conditions. Examples of Short-Haul usage are: operation primarily in cities and densely populated areas; local transport with infrequent freeway travel; or high percentage of stop-and-go travel.

Long-Haul — Long Haul (over-the-road transport) is for vehicles that annually travel more than 30,000 miles (48,000 kilometers), with minimal city or stop-and-go operation. Examples of Long-Haul usage are: regional delivery that is mostly freeway miles; interstate transport; or any road operation with high annual mileage.

Maintenance Intervals — The three tables show which maintenance operation must be performed at the actual distances (in miles or kilometers) for each maintenance operation. The schedule of actual distances is based on the intervals given in the Maintenance Tables

The three maintenance tables are: referred to in section “Maintenance Tables.”

- Maintenance Interval Table, Severe Service (listed in Table 7)
- Maintenance Interval Table, Short Haul (listed in Table 8)

- Maintenance Interval Table, Long Haul (listed in Table 9)

Schedule Use

Before placing your new vehicle in service, determine the correct maintenance intervals that apply to your intended use of the vehicle. Refer to section “Maintenance Tables” to determine the distance interval at which each maintenance operation must be performed to comply with your vehicle’s schedule.

When the vehicle reaches the actual distance given for an interval, refer to section “Maintenance Tables”.

When maintenance is required for hours of engine operation for severe applications refer to section “Maintenance Tables”. Listed in Table 6 provides an engine hours conversion for applications that may require service intervals based on hours and not mileage. The intervals are based on a collaboration of field and fleet data. For a more accurate analyst of when fluids should be changed, such as engine oil, refer to publication *Engine Requirements – Lubricating Oil, Fuel and Filters*, (7SE270), available from authorized Detroit Diesel distributors.

Complete each maintenance operation at the required interval.

Maintenance Tables

Procedure	Severe (hrs)	Short-Haul (hrs)	Long-Haul (hrs)
Engine Oil and Filter	300 - or 3 Months	500 - or 6 months	—
Fuel Filter	600	—	—
Valve Lash Adjustment	600 then every 1200	—	—

Table 6 Maintenance Intervals by Engine Hours

Miles (X 1000)	10	12	20	24	30	36	40	48	50	60	70	72
Km (X 1000)	17	19	32	38	50	57	68	77	84	100	113	116
Item	Procedure											
1. Lubricating Oil/Filter	R		R		R		R		R	R	R	
2. Cooling System	Intervals are based on type of coolant used as listed in Table 17 in the How to Select Coolant section of this guide.											
3. Valve Lash Checking and Adjustment	First adjustment at 20,000 mi. (32,000 Km) and then every 40,000 mi. (68,000 Km)											
4. Drive Belts	I		I		I		I		I	I	I	
5. Fuel/Water Separator	Inspect at every fuel fill. Replace when fuel level is at top of filter.											
6. Fuel Filters		R		R		R		R		R		R
7. Air System	I		I		I		I		I	I		
8. Exhaust System	I		I		I		I		I	I	I	
9. Air Compressor	I		I		I		I		I	I	I	
10. Aftertreatment Device	Inspect same as exhaust system interval, ash removal at 300,000 Miles (480,000 Km)											
11. Vibration Damper	Replace at major overhaul or earlier if dented or leaking.											
12. REPTO torsional damper checking	10,000 mi. (16,000 Km) or 300 hours or 1 year, whichever comes first.											

All items are described in refer to section "Preventive Maintenance Intervals"

I – Inspect, service, test, correct or replace as necessary.

R – Replace.

Table 7 Maintenance Intervals (Severe Service)

Miles (X 1000)	15	30	45	60	75	90	105	120	135	150	165	180
Km (X 1000)	25	50	75	100	125	150	169	193	217	241	266	290
Item	Procedure											
1. Lubricating Oil/Filter	R	R	R	R	R	R	R	R	R	R	R	R
2. Cooling System	Intervals are based on type of coolant used as listed in Table 17 in the How to Select Coolant section of this guide.											
3. Valve Lash Checking and Adjustment	First adjustment at 30,000 mi. (50,000 Km) and then every 60,000 mi. (100,000 Km)											
4. Drive Belts	I	I	I	I	I	I	I	I	I	I	I	I
5. Fuel/Water Separator	Inspect at every fuel fill. Replace when fuel level is at top of filter.											
6. Fuel Filters		R		R		R		R		R		R
7. Air System	I	I	I	I	I	I	I	I	I	I	I	I
8. Exhaust System	I	I	I	I	I	I	I	I	I	I	I	I
9. Air Compressor	I	I	I	I	I	I	I	I	I	I	I	I
10. Aftertreatment Device	Inspect same as exhaust system interval, ash removal at 300,000 miles (480,000 Km)											
11. Vibration Damper	Replace at major overhaul or earlier if dented or leaking.											
12. REPTO torsional damper checking	First inspection at 60,000 mi. (100,000 Km) or 3000 hours and then every 30,000 mi (50,000 Km) or 1500 hours.											

All items are described in refer to section "Preventive Maintenance Intervals."

I – Inspect, service, test, correct or replace as necessary.

R – Replace.

Table 8 Maintenance Intervals (Short Haul)

MAINTENANCE

Miles (X 1000)	30	60	90	120	150	180	210	240	270	300	330	360
Km (X 1000)	50	100	150	198	241	290	338	386	435	483	531	579
Item	Procedure											
1. Lubricating Oil/Filter	R	R	R	R	R	R	R	R	R	R	R	R
2. Cooling System	Intervals are based on type of coolant used as listed in Table 17 in the How to Select Coolant section of this guide.											
3. Valve Lash Check and Adjustment	First adjustment at 60,000 mi. (100,000 Km) and then every 120,000 mi. (198,000 Km)											
4. Drive Belts	I	I	I	I	I	I	I	I	I	I	I	I
5. Fuel/Water Separator	Inspect at every fuel fill. Replace when fuel level is at top of filter.											
6. Fuel Filters		R		R		R		R		R		R
7. Air System	I	I	I	I	I	I	I	I	I	I	I	I
8. Exhaust System	I	I	I	I	I	I	I	I	I	I	I	I
9. Air Compressor	I	I	I	I	I	I	I	I	I	I	I	I
10. Aftertreatment Device	Inspect same as exhaust system interval, ash removal at 300,000 Miles (480,000 Km)											
11. Vibration Damper	Inspect at oil changes. Replace at major overhaul or earlier if dented or leaking.											
12. REPTO Torsional Damper Checking	First inspection at 60,000 mi. (100,000 Km) or 3000 hours and then every 30,000 mi (50,000 Km) or 1500 hours.											

All items are described in refer to section "Preventive Maintenance Intervals."

I – Inspect, service test, correct or replace as necessary.

R – Replace.

Table 9 Maintenance Intervals (Long Haul)

Preventive Maintenance Intervals

This section describes the items listed in the tables.

As the operator of a vehicle, routine “Daily” inspections of the engine and chassis should be performed. This will provide the best opportunity to identify major concerns or concerns that could stretch a longer time span like slow coolant loss.

For new or stored engines, refer to section “OPERATING INSTRUCTIONS FOR STARTING THE ENGINE” in this guide.

Item 1 – Lubricating Oil Filter

Lubricating Oil: – Check the oil level daily with the engine stopped. If the engine has just been stopped and is warm, wait approximately 20 minutes to allow the oil to drain back into the oil pan before checking. Add the proper grade of oil to maintain the correct level on the dipstick. See Figure 25.

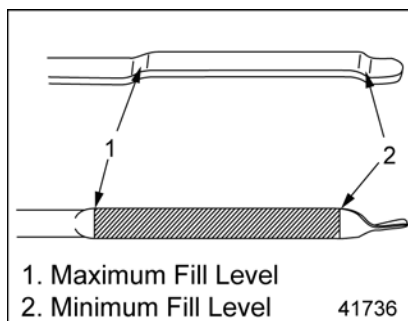


Figure 25 Oil Dipstick

NOTICE:

When adding lubricating oil, do not overfill. Oil may be blown out through the crankcase breather and/or aeration of the oil can occur.

All diesel engines are designed to use some oil, so the periodic addition of oil is normal.

NOTICE:

If the oil level is constantly above normal and excess oil has not been added to the crankcase, consult with an authorized Detroit Diesel service outlet for the cause. Fuel or coolant dilution of lubricating oil can result in serious engine damage.

Before adding lubricating oil, refer to section “How to Select Lubricating Oil” in this guide.

Lubricating Oil Filter: – The oil filter is a cartridge style element and is located on the front right side of the engine. See Figure 26. If followed correctly, an oil filter change can be performed quickly with minimal oil cleanup. Refer to section “How to Replace the Lube Oil and Filter” in this guide.

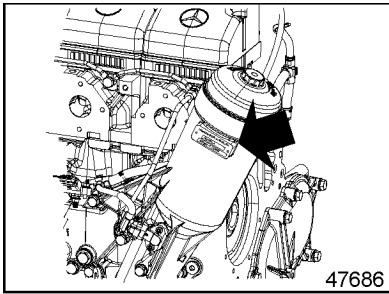



Figure 26 Lubricating Oil Filter

 WARNING: PERSONAL INJURY
To avoid injury from slipping and falling, immediately clean up any spilled liquids.


Make a visual check of all lubricating oil lines for wear and/or chafing. If any indication of wear is evident, replace the oil lines and correct the cause.

Check for oil leaks after starting the engine.

Item 2 – Cooling System

Coolant Flush and Fill – Proper maintenance of the cooling system is vital to its performance and longevity. The cooling system must, on a constant basis, deal with cavitation, temperature/pressure variations, and continuous threats on the additive package. Once the additives have been depleted from the coolant, it will only be a matter of time until the engine components suffer. Refer to section “How to Select Coolant” in this guide.

Cooling System Inspection – Inspect the cooling system as follows:

 WARNING: HOT COOLANT
To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

1. Inspect the radiator, condenser, coolant pump, engine oil cooler, freeze plugs, and heat exchanger for damage and leaks.
2. Check all cooling system pipes and hoses for damage and leaks;

ensure they are positioned to avoid chafing, and are securely fastened.

3. Check the outside of the radiator and condenser for blockage. Check fins for damage; straighten them if necessary.

Proper maintenance of the cooling system is vital to its performance and longevity. The cooling system must, on a constant basis, deal with cavitation, temperature/pressure swings, and continuous threats on additive package. Once the additives have been depleted from the coolant, it is only be a matter of time until the engine components suffer. Refer to section “How to Select Coolant” in this guide.

Coolant Inhibitor Test Intervals

– Coolant inhibitor level should be checked at the intervals as listed in Table 17 in the How to Select Coolant section of this guide.

If topping off is needed, add coolant which is identical to the initial fill coolant.

Item 3 – Valve Lash Checking and Adjustment

Valve lash checking and adjustment should be performed per the prescribed under the proper service category for the engine, refer to section “Scheduled Intervals” in this guide. All three

service categories (Severe, Short Haul, and Long Haul) require a “first time” valve lash adjustment at a shorter interval. After the initial adjustment, all others are based on the same mileage intervals. Refer to section “Maintenance Tables” in this guide. Proper valve lash clearance allows the engine to produce the best possible performance with the lowest emissions. Valve lash adjustments should be performed by an authorized Detroit Diesel maintenance or repair facility.

Item 4 – Drive Belts

Belts should be neither too tight nor too loose. Belts that are too tight impose extra loads on the crankshaft, fan and/or alternator bearings, shortening both belt and bearing life. Excessively overtightened belts can result in crankshaft breakage. A loose belt will slip and generate excessive heat that may cause damage to the belt and accessory drive components.

 WARNING: PERSONAL INJURY
To avoid injury from rotating belts and fans, do not remove and discard safety guards.

Belt Replacement – Drive belts (V and poly-V) should be replaced every 2,000 hours or 100,000 miles (160,000 km).

After an extended time in service, minor rib cracks may appear, usually one or two cracks per inch is considered normal. See Figure 27. A concern occurs when the belt ribs exhibit severe multiple cracking or “chunking”. At this point, the belt should be replaced.

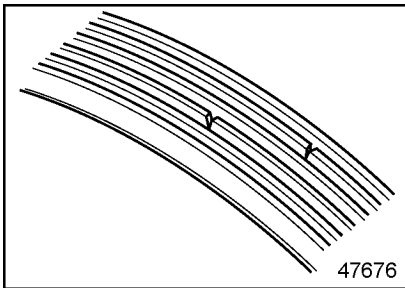


Figure 27 Minor Rib Cracking

Auto Tensioner – Auto tensioners are usually maintenance free for the life of the engine. However, routine inspections should be performed.

Uneven belt wear can indicate a loose, wore out, or bad bearing on the auto tensioner. A build up of dirt or grime around the front bearing surface of the wheel can indicate a future bearing failure due to inadequate lubrication.

Item 5 – Fuel/Water Separator

If the vehicle is equipped with a fuel/water separator located on the frame rail, follow the manufactures recommendation on draining the trapped water and priming the fuel system. Refer to section “Fuel/Water Separator Prefilter Element Cleaning” or refer to section “Replace Davco 382 Fuel Pro®Fuel/Water Separator Element” in this guide.

Item 6 – Fuel Filters

The engine uses a cartridge style fuel filter. If followed correctly, a fuel filter change can be performed quickly with minimal cleanup. Refer to section “How to Replace the Fuel Filters” in this guide.

One method of determining when filters are plugged to the extent that they need replacing is based on the fuel pressure at the fuel filter housing. See an authorized Detroit Diesel repair facility to determine a clogged filter. The maximum pressure difference between the inlet and outlet of the fuel filter housing is 0.3 bar (4.0 psi).

NOTE:

Filter change intervals may be shortened to conform to established preventive maintenance schedules, but should never be extended.

Item 7– Air System

Air Cleaner – The air cleaner element should be inspected per the scheduled maintenance or more often if the engine is operated under severe dust conditions.

Replace the element, if necessary. Check the gaskets for deterioration and replace, if necessary. If the dry type air cleaner is equipped with an aspirator, check for aspirator damage or clogging. Clean, repair or replace, as necessary.

NOTICE:

Do not allow the air inlet restriction to exceed 5.0 kPa (20 in. H₂O) under any engine operating conditions. A clogged air cleaner element will cause excessive intake restriction and reduced air supply to the engine resulting in increased fuel consumption, inefficient engine operation and reduced engine life.

Inspect the entire air system for leaks daily. Look especially for torn air inlet piping or boots and loose or damaged clamps. Have worn or damaged parts repaired or replaced, as required. Retighten loose connections.

Air Cleaner Replacement – Dry type air cleaner elements should be replaced after one year of service or when the maximum allowable air intake restriction has been reached, whichever comes first.

Air-to-Air Charge Cooler – Periodically inspect the air-to-air charge cooler for buildup of dirt, mud, etc. and wash off using a mild soap solution. Check the charge cooler, ductwork, and flexible connections for leaks and have repaired or replaced, as required.

Item 8 – Exhaust System

The exhaust manifold retaining bolts and other connections should be inspected for leaks. The exhaust pipe rain cap should be checked for proper operation, if so equipped. With the introduction of an Aftertreatment system, the sealing of the exhaust system is critical and should be inspected regularly.

Item 9 – Air Compressor

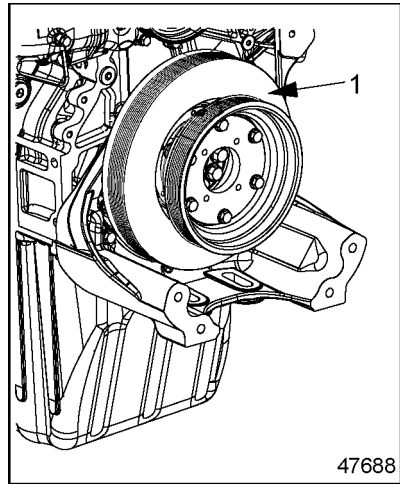
The air compressor incorporates three of the major systems of a diesel engine (air, lubrication, and coolant). Proper inspection of air compressor would include inspecting for air, oil, and coolant leaks. Due to inadequate internal sealing air compressors, when failed, can produce excessive crankcase pressure or allow an engine to ingest oil.

Item 10 – Aftertreatment System (ATS)

There is a need to periodically remove accumulated ash, derived from engine lube oil, from the filter. The ash does not oxidize in the filter during the regeneration process and must be removed through a cleaning procedure. All Detroit Diesel ATD equipped engines will illuminate a dashboard warning lamp indicating the need for ash cleaning.

Item 11 – Vibration Damper

The viscous vibration damper should be inspected periodically and replaced if dented or leaking. See Figure 28 for “Viscous Vibration Damper”



1. Viscous Vibration Damper

Figure 28 Viscous Vibration Damper

Heat from normal engine operation may, over a period of time, cause the fluid within the damper to break down and lose its dampening properties. For this reason, the viscous vibration damper must be replaced at time of normal major engine overhaul, regardless of apparent condition.

Item 12 – REPTO Torsional Damper Checking

The REPTO accessory drive is an option on the MBE4000 engine. The drive provides continuous live power anytime the engine is operating. The REPTO is driven by the camshaft gear and is an integral part of a unique SAE#1 flywheel housing. All REPTO installations require a torsional coupling installed at the flange of the drive unit (i.e. hydraulic pump). The torsional coupling incorporates a rubber element designed to reduce the unwanted stresses from reaching the engine. See Figure 29.

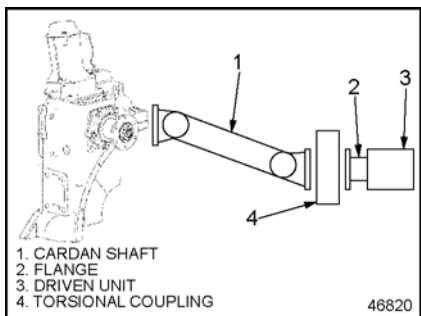


Figure 29 MBE4000 REPTO Connection Illustration

REPTO Torsional Damper Inspection

— Inspect the REPTO torsional damper as follows:

1. Inspect the outer casing of the torsional damper for dents or bulges. If damage is found

replace the damper. Regardless of the condition, the torsional coupling must be replaced at normal engine overhaul.

2. Inspect the torsional damper rubber element as follows:
 - [a] Check the rubber element for bulges or cracks. If damage is found replace the damper.
 - [b] Inspect the rubber element teeth for wear. If the teeth are worn to less than one-half of the new part length (11.0 mm [0.433 in.]), replace the torsional damper. See Figure 30.

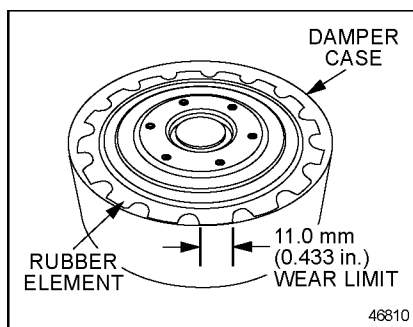


Figure 30 REPTO Torsional Damper

REPTO Torsional Damper Cleaning

— Clean the REPTO torsional damper as follows:

The torsional damper coupling will withstand normal exposure to hydraulic oil, diesel fuel, anti-freeze solutions, and muriatic acid. The coupling should be washed with a mild soap solution and rinsed with water after contact with the above items. The coupling can be power washed without damage as long as it is installed in the vehicle. If the coupling is power washed when not connected to a cardan shaft, debris may be forced internally at the bolt flanges damaging the coupling.

positioned to avoid chafing, and properly secured.

Required Maintenance Operations

The following sections describe the required maintenance operations .

Engine Inspecting

Inspect engine as follows:

1. Visually check the engine for signs of leakage. A slight dampness at the sealing points is no cause for concern.

NOTE:

More severe leaks, combined with a continual loss of oil, must be corrected without delay.

2. Visually inspect all lines and hoses. Listen for any sound of leaking. Make sure all pipes and hoses are undamaged, correctly

HOW-TO SECTION

This section covers Detroit Diesel's recommendations on how to select lubricating oil, diesel fuel, and coolant and includes basic engine maintenance procedures which can be performed by the operator.

NOTICE:

The manufacturer's warranty applicable to MBE 4000 engines provides in part that the provisions of such warranty shall not apply to any engine unit that has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

How to Select Lubricating Oil

The selection of the proper lubricating oil is important to achieve the long and trouble-free service which Detroit Diesel engines are designed to provide. The proper lubricating oil for model year 2007 MBE 4000 engines is selected based on SAE viscosity grade and API (American Petroleum Institute) service designation. Only oils licensed to display the API symbol should be used. See Figure 31.

NOTICE:

Lubricating oil must have a sulfated ash level less than 1.0% mass; currently referred to as CJ-4 oil



47442

Figure 31 API Lubricant Symbol

Lubricant Requirements

API CJ-4 oils *must* be used in engines meeting January 2007, and later build, exhaust emission regulations.

Cold Weather Starting

At ambient temperatures below -20°C (-4°F) when sufficient starter speed cannot be achieved with SAE 15W-40 oils, the use of 5W-XX oils and 10W-XX oils (XX =30 or 40) is allowed to improve starting.

NOTICE:

Monograde oils should not be used in MBE 4000 engines, regardless of API service classification. Monograde oils gel at lower ambient temperatures, reducing lubricant flow, and they do not provide adequate lubricity at higher engine operating temperatures. These factors can result in severe engine damage.

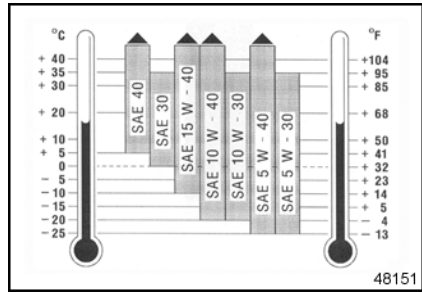


Figure 32 Engine Oil Temperature Ranges

Synthetic Oils

Synthetic oils may be used in Detroit Diesel engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils outlined in this publication. Synthetic oils offer improved low-temperature flow properties and high-temperature oxidation resistance. However, they are generally more costly than non-synthetic oils.

Product information about synthetic oils should be reviewed carefully. Performance additive systems often respond differently in synthetic oils.

Their use does not permit extension of recommended oil drain intervals.

The oils must be API CJ-4 that have demonstrated field performance in Detroit Diesel engines. These oils must possess a High Temperature/High Shear (HT/HS) viscosity of 3.7 minimum. For further information, refer to publication *Engine Requirements – Lubricating Oil, Fuel and Filters*, (7SE270), available from authorized Detroit Diesel distributors.

Select the SAE class (viscosity) on the basis of the average air temperature for the season. See Figure 32.

NOTE:

Continued use of a single SAE class will result in frequent oil changes. For this reason, view the temperature ranges for the various SAE classes.

The Use of Supplemental Additives

Lubricants meeting the Detroit Diesel specifications outlined in this publication already contain a balanced additive treatment. Supplemental additives are generally not necessary and can even be harmful. These additives may be marketed as either oil treatments or engine treatments and are discouraged from use in Detroit Diesel engines.

Engine damage resulting from the use of such materials is not covered by your Detroit Diesel Corporation warranty. Detroit Diesel will not provide statements beyond this publication relative to their use.

When to Change Oil

The length of time an engine may operate before an oil change depends upon the lubricant and fuel used, engine oil consumption, and the operating cycle.



CAUTION:

USED ENGINE OIL

To avoid injury to skin from contact with the contaminants in used engine oil, wear protective gloves and apron.

The maximum interval at which the engine may operate before the oil and filters must be changed is listed in Table 10.

Engine Application	Drain Interval
Long Haul — Highway Truck & Motor Coach — operates more than 60,000 miles (100,000 kilometers) per year	30,000 Miles (50,000 km)
Sort Haul — City Transit — operates up to 60,000 miles (100,000 kilometers) per year	15,000 Miles (25,000 km)
Severe Service — Fire Truck or Crash/Rescue Vehicle — operates up to 6000 miles (9,600 kilometers) or under severe conditions	10,000 Miles (16,000 km), 300 hours or 1 year, whichever comes first

Table 10 Oil Drain and Filter Change Interval

Oil analysis may be used to determine whether this interval should be shortened, but it should not be used to lengthen the interval. For detailed information refer to publication *Engine Requirements – Lubricating Oil, Fuel and Filters (7SE270)*, available from authorized Detroit Diesel distributors.

Disposing of Waste Oil — Dispose of used lubricating oil and filters in an environmentally responsible manner, according to federal (EPA) and/or state recommendations. The disposal of waste oil may be best addressed by the engine oil supplier, who may accept responsibility for proper disposal of this material as part of the business of providing lubricant.

How to Replace the Lube Oil and Filter

Filters are an integral part of the lubricating oil system. Proper filter selection and maintenance are important to satisfactory engine performance and service life.

Filters should be used to maintain a clean system, not to clean up a contaminated system.

Replace Lubricating Oil and Filter

Drain oil as follows:

1. Chock the tires, place the transmission in neutral, and set the parking brake.

NOTE:

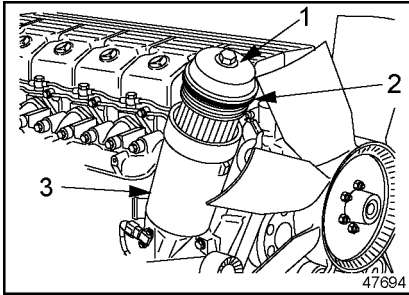
Change the engine oil only when the engine is at a temperature of approximately 60°C (140°F).

2. Clean the outside of the oil filter housing, then unscrew the oil filter cap from the housing.

NOTE:


Use care to prevent foreign objects from entering the filter housing.

3. Using a 36-mm socket, unscrew the cap and filter and allow the oil to drain into the housing. After draining, remove the assembly from the housing. (see Figure 33).



- 1. Oil Filter Cap
- 2. O-ring
- 3. Oil Filter Housing

Figure 33 Oil Filter Element



WARNING:

FIRE

To avoid injury from fire, keep open flames, sparks, electrical resistance heating elements, or other potential ignition sources away when draining lubrication oil. Do not smoke when draining lubricating oil.

- 4. Remove the element by pressing and twisting the side and detaching it from the cap.
- 5. Remove the oil filter O-ring and discard it. Lightly grease a new O-ring with engine oil and install it on the filter cap.
- 6. Check the filter housing for any debris.

- 7. Insert a new filter element into the cap.
- 8. Insert the element and cap assembly into the housing. Torque the cap to 25 N·m (18 lb·ft).
- 9. Drain the oil from the oil pan.
 - [a] Place a suitable receptacle beneath the oil drain plug on the underside of the oil pan.
 - [b] Carefully unscrew the oil drain plug on the oil pan and allow the oil to drain out (See Figure 34).

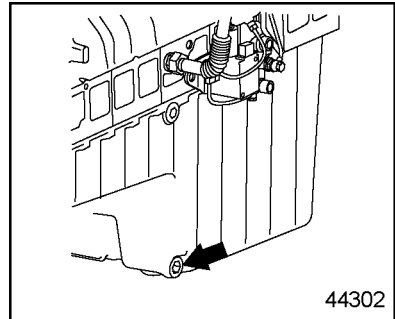


Figure 34 Engine Oil Drain Plug, Oil Pan

- [c] Discard the O-ring on the oil drain plug.
- 10. Install the oil drain plug, using a new O-ring. Tighten the plug to 65 N·m (48 lb·ft).

WARNING:
PERSONAL INJURY

To avoid injury from slipping and falling, immediately clean up any spilled liquids.

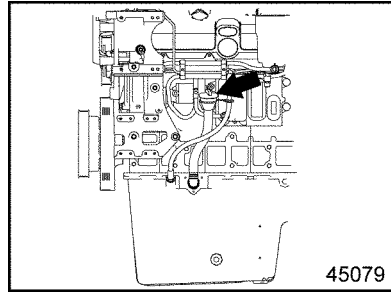


Figure 35 Oil Fill Tube

11. Add new engine oil through the oil fill tube (See Figure 35) until the maximum fill level on the oil dipstick has been reached. Listed in Table 11 are the engine fill capacities.

Oil Pan Capacity	Engine Oil System Fill Capacity (Includes oil filter)
36 L (38 qts)	39.5 L (41.7 qts)

Table 11 Engine Lubricating Oil Capacity

CAUTION:

To avoid injury when working near or on an operating engine, remove loose items of clothing, jewelry, tie back or contain long hair that could be caught in any moving part causing injury.

NOTICE:

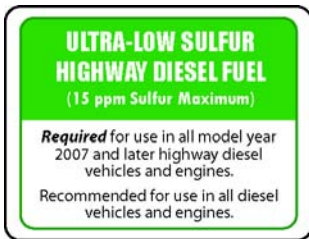
Keep the engine running at idling speed until an oil pressure reading is obtained. If no oil pressure is shown after approximately 10 seconds, stop the engine and determine the cause. Failure to do so could result in engine damage.

12. Start the engine with the accelerator pedal in the idle position. Monitor the oil pressure gauge.
13. Check the filter and oil drain plug for signs of leakage.
14. Stop the engine. Check the oil level again after approximately five minutes. If necessary, add oil

up to the maximum fill level on the oil dipstick.

How to Select Diesel Fuel

Detroit Diesel engines in 2007 are designed to operate ONLY on Ultra-Low Sulfur Diesel (ULSD) fuel, see Figure 36.



47705

Figure 36

Quality

Fuel quality is an important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

In general, fuels meeting the properties of ASTM designation D 975 (grades 1-D and 2-D) have provided satisfactory performance.

The fuels used must be clean, completely distilled, stable, and non-corrosive. For more information regarding the significance of these properties and selection of the proper fuel, refer to publication, *Engine*

Requirements – Lubricating Oil, Fuel and Filters (7SE270), available from authorized Detroit Diesel distributors.

NOTICE:

Use only Ultra-Low Sulfur Diesel (ULSD) fuel (15 ppm sulfur content maximum), based on ASTM D2622 test procedure. Using fuel other than ULSD will damage the Aftertreatment Device.

Fuel Contamination

Generally, fuel contamination occurs as the result of improper fuel handling. The most common types of contamination are water, dirt, and microbial growth (“black slime”). The formation of varnishes and gums resulting from poor stability or extended storage (“stale fuel”) also affects fuel quality. The best treatment for contamination is prevention by maintaining a clean storage system and choosing a reputable fuel supplier.

Supplemental additives are not recommended due to potential injector system or engine damage.

Our experience has been that such additives increase operating costs without providing benefit.

The use of supplemental fuel additives does not necessarily void the engine warranty. **However, repair expenses which result from fuel system or engine component malfunctions or damage attributed to their use will not be covered.**

These products should be accompanied by performance data supporting their merit. It is not the policy of Detroit Diesel Corporation to test, evaluate, approve or endorse such products.

Biodiesel — Biodiesel fuels meeting ASTM D 6751 specification, prior to blending can be mixed up to 5% maximum by volume in petroleum diesel fuel. Detroit Diesel highly recommends biodiesel fuels made from soybean or rapeseed oil through the proper transesterification reaction process. Other feedstock source of biodiesel fuels such as animal fat and used cooking oils are not recommended by Detroit Diesel. The resulting mixture must meet ASTM D 975 specification. More information is available in the Detroit Diesel publication *Lubricating Oil, Fuel, and Filters* (7SE270).

Failures attributed to the use of biodiesel fuel will not be covered by Detroit Diesel product warranty. Also, any engine performance problem related to the use of biodiesel fuel would not be recognized

nor considered Detroit Diesel's responsibility.

Prohibited Additives

The following fuel additives are not allowed and MUST NOT be mixed with diesel fuel:

Used Lubricating Oil — Do not use fuel blended with used lubricating oil. Detroit Diesel specifically prohibits the use of used lubricating oil in diesel fuel.

NOTICE:
Burning used lubricating oil in fuel cannot be tolerated as it will cause the diesel particulate filter to prematurely plug with ash.

Used lubricating oil contains combustion acids and particulate materials which can severely erode fuel injector components, resulting in loss of power and increased exhaust emissions. In addition, the use of drained lubricating oil will increase maintenance requirements due to filter plugging and combustion deposits.

Fuel Additives with Sulfur or Sulfated Ash — Do not use non-approved fuel additives containing sulfur or sulfated ash.

Gasoline — The addition of gasoline to diesel fuel will create a serious fire hazard. The presence of gasoline in diesel fuel will reduce fuel cetane number and increase combustion temperatures.

 WARNING: FIRE
To avoid increased risk of a fuel fire, do not mix gasoline and diesel fuel.

Tanks which contain a mixture of gasoline and diesel fuel should be drained and cleaned as soon as possible.

Detroit Diesel Corporation will not be responsible for any detrimental effects it determines resulted from adding drained lubricating oil or gasoline to the diesel fuel.

How to Replace the Fuel Filters

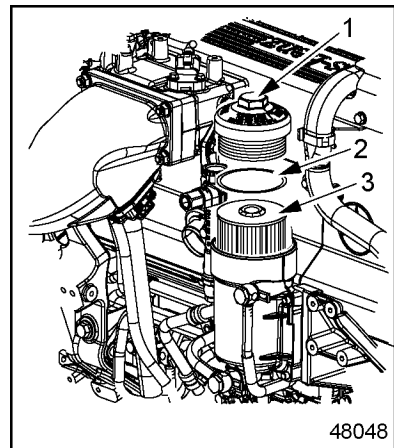
Filters are an integral part of the fuel system. Proper filter selection and maintenance are important to satisfactory engine operation and service life. Filters should be used to maintain a clean system, not to clean up a contaminated system.

An optional fuel/water separator may be installed in place of the standard primary filter.

Replace Main Fuel Filter Element

Change the main fuel filter element as follows:

1. Open the fuel tank fill cap to release pressure in the fuel system. Replace and tighten the cap.
2. Clean the outside of the fuel filter housing (See Figure 37).



1. Filter Housing Cap
2. O-ring
3. Filter Element

Figure 37 Main Fuel Filter

- Using a 36-mm socket, unscrew the cap on the main fuel filter housing. Remove the cap and lift the filter element a short distance within the filter housing allowing the fuel to drain off the filter.
- Remove the filter element from the cap and clean the filter cap. Discard the filter element and the O-ring from the cap.

NOTICE:

To prevent damage to the filter housing, do not allow dirt to get into the filter housing.

- Clean the filter housing cap.
- Replace the O-ring.
- Lubricate the rubber seal, on the bottom of the filter element with a light coat of fuel oil and insert it into the filter housing. Push down and rotate the filter element while installing to ensure it is seated properly at the base of the housing.
- Fill fuel filter housing with clean fuel oil.
- Install a new O-ring on the filter cap and screw the cap onto the filter housing. Tighten the cap to 25 N·m (18 lb·ft).
- Prime the fuel system by working the hand pump until resistance is felt.
- Crank the engine for 30 seconds at a time, but no longer. Before cranking again, wait at least two minutes, then crank again. The engine should start within four 30-second attempts.
- Once the engine starts allow it to idle for at least one minute or until idle is smooth before applying the throttle. Check the fuel filter housing for leaks.

NOTE:

A properly seated filter element will hold the fuel in the filter housing and prevent it from draining back to the tank. If the fuel does not stay in the housing the element is not seated properly, repeat steps 1 and 2.

NOTE:

There should be a strong resistance in the hand pump, caused by the pressure build-up within the fuel system.

Fuel/Water Separator Prefilter Element Cleaning

Clean the prefilter element as follows:

1. Loosen the bleed screw.
See Figure 38.
2. Unscrew the drain plug and drain the fuel in the prefilter.
3. Twist off the sight bowl and remove the filter element from the separator head.
4. Separate the sight bowl from the filter element. Clean the sight bowl. Discard the old filter element and both O-rings.
5. Replace the filter element and O-rings.
6. Assemble the sight bowl and the prefilter element.
 - [a] Lubricate one O-ring with a light coating of engine oil and insert it into the sight bowl.
 - [b] Screw the prefilter element and sight bowl together.
7. Assemble the prefilter element and the separator head.
 - [a] Lubricate the other O-ring with a light coating of engine oil and insert it into the open end of the prefilter element.
 - [b] Screw the prefilter element onto the separator head and

tighten firmly, using hands only.

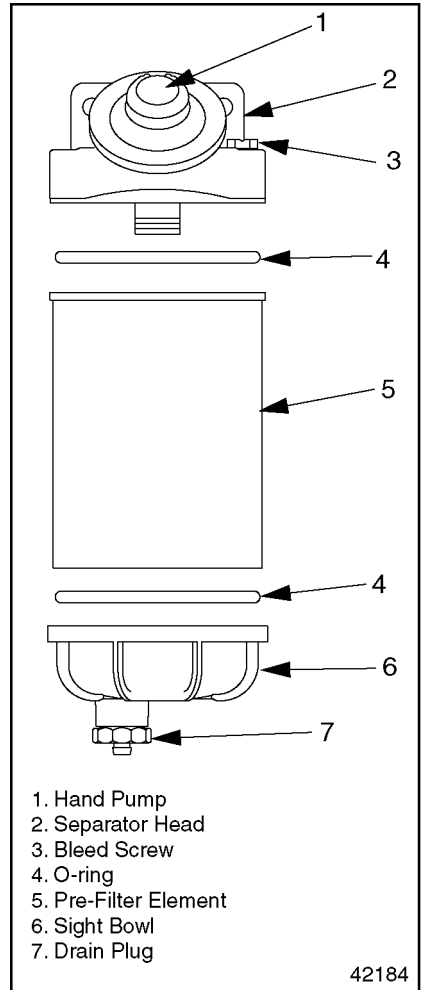


Figure 38 Fuel/Water Separator

NOTE:

Do not use tools to tighten the prefilter element.

- 8. Tighten the drain plug.
- 9. Prime the fuel system.

[a] If equipped with a hand pump on the fuel/water separator, work the hand pump until resistance is felt.

NOTE:

There should be a strong resistance in the hand pump, caused by the pressure build-up within the fuel system.

[b] Crank the engine for 30 seconds at a time, but no longer. Before cranking the engine again, wait at least two minutes. The engine should start within four 30 second attempts.

Replace Davco 382 Fuel Pro®Fuel/Water Separator Element

Replace the fuel/water separator element as follows:

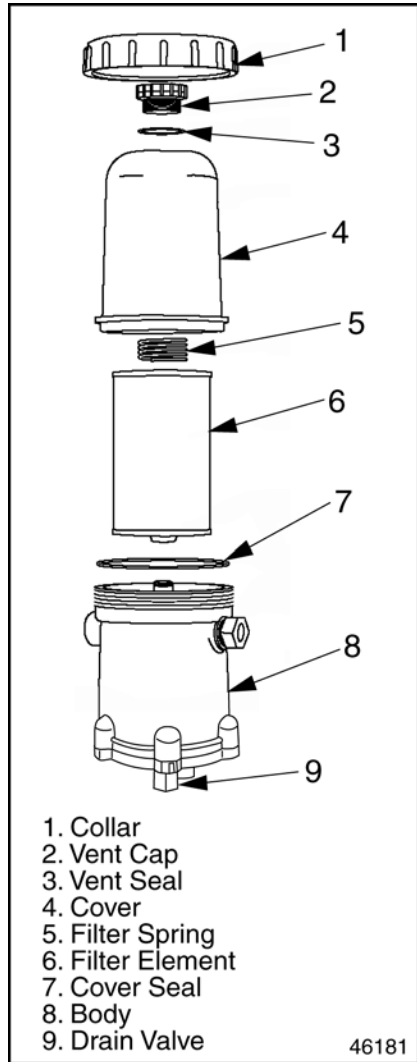


Figure 39 Davco 382 Fuel Pro®Fuel/Water Separator

1. Remove the vent cap, open the drain valve and drain fuel into approved container, until level is below the collar. See Figure 39.
2. Using a collar wrench remove collar and cover.
3. Remove the filter element from the separator head and discard filter cover seal and vent seal. Dispose of filter properly.
4. Clean the cover and the mounting surface on the body.
5. Install the filter element with bottom grommet and new cover seal. Install the cover and collar. Hand tighten only.
6. Fill cover completely with clean fuel through the vent cap opening.
7. Replace seal on the vent cap and install in cover. Hand tighten only.
10. Start the engine and raise the rpm for one minute to purge the air. After the air is purged stop the engine, loosen the vent cap until the fuel level lowers to just above the collar. Tighten the vent cap by hand. Check for leaks.

Replace Davco 382/382E Fuel Pro® Fuel Filter Element

The Davco 382/323E Fuel Pro diesel fuel filter system consists of a permanently mounted fuel processor, a replaceable filter element and sealing grommet assembly, a filter spring, a see-thru cover and seal, a cover collar, and a vent cap and seal. See Figure 40.

NOTE:

Do not use tools to tighten the collar or vent cap.

8. Tighten the drain plug.
9. Crank the engine for 30 seconds at a time, but no longer. Before cranking the engine again, wait at least two minutes. The engine should start within four, 30 second attempts.

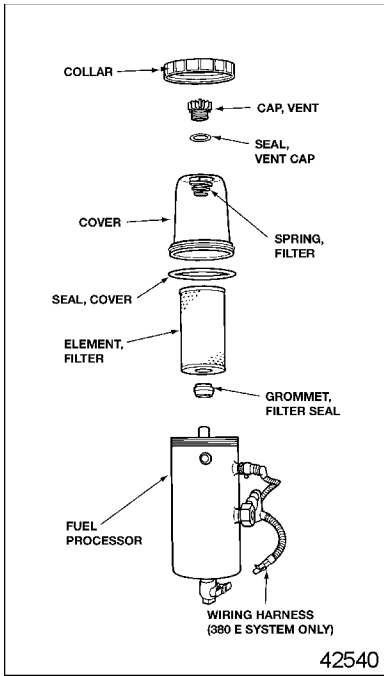


Figure 40 Davco 382E Fuel Pro Fuel Processor Assembly

The system also includes a fuel heater element, thermostatic switch and wiring harness.

Replace the element as follows:

1. Shut down the engine and allow it to cool.
2. With the engine at ambient temperature and cool to the touch, place a suitable container under the filter.

3. A fuel shutoff valve may be installed on the discharge side of the fuel filter. If installed, turn the handle on the shutoff valve to the **closed** position (perpendicular to the valve).
4. Open the drain valve at the base of the fuel processor and drain the fuel until it is below the bottom of the filter in the see-thru cover. Close the drain valve. The fuel may be returned to the tank.
5. Using filter collar/vent cap wrench Davco part number 382002 or equivalent, remove the collar by turning counterclockwise. Remove the cover, filter spring and cover seal ring by lifting straight up and over the filter element.
6. Remove the element from the center stud (fuel outlet pipe) by pulling upward and twisting slightly.

NOTE:

Current filter elements include an integral sealing grommet. If a former element is replaced, make sure the separate sealing grommet is removed from the center stud before installing the new element.

7. Dispose of the used element and grommet in an environmentally responsible manner, according

to federal (EPA) and/or state recommendations.

8. Check to make sure the sealing grommet is included in the base of the replacement filter element, then install the element onto the center stud by pushing down and twisting slightly.
9. Check to make sure the spring is installed at the top of the cover. If missing, this spring must be replaced to insure proper filter operation. Wipe the cover lip and cover seal clean.

NOTICE:

Do not use a wrench of any kind to tighten the collar, since this may lead to overtightening, which can damage the collar and/or the cover.

10. After making sure the seal is properly positioned at the base of the cover, install the cover and collar onto the fuel processor. Tighten the collar **by hand** until secure.
11. Using filter collar/vent cap wrench 382002 or equivalent, remove the vent cap from the top of the cover by turning the cap counterclockwise. Fill the cover full of clean fuel. After making sure the O-ring seal is installed on the vent cap, reinstall the cap and tighten **by hand**.

NOTICE:

To avoid cover or vent cap damage, do not use tools to tighten the vent cap.

12. Open the fuel shutoff valve (if installed) and start the engine. When the lubrication system reaches its normal operating pressure, increase engine speed to high idle for 2 to 3 minutes.

NOTICE:

Do not allow the fuel level in the see-thru cover to fall below the top of the collar, since this may lead to interruption of the fuel flow and engine stalling.

13. After the air is purged and with the engine still running, loosen the vent cap. The fuel level in the cover will start falling. When the fuel level falls to the top of the collar, tighten the vent cap quickly **by hand**.
14. Shut down the engine and tighten the collar again **by hand**. Restart the engine and check for leaks.

NOTE:

The filter cover will not fill completely during engine operation. It will gradually fill over time, and the fuel level will rise as the filter medium becomes clogged. **The filter element**

does not require changing until the fuel level has risen to the top of the element, or after one year of service, whichever comes first.

Engine Out of Fuel — How to Restart

When an engine has run out of fuel, there is a definite procedure to follow when restarting it.

NOTICE:

The starting motor and fuel pump should **never** be used to prime the fuel filters. Prolonged use of the starting motor and fuel pump to prime the fuel system can result in damage to the starter, fuel pump and injectors and cause erratic running of the engine due to the amount of air in the fuel lines and filters.

Engines with Fuel Pro Filters

Use the following procedure for an engine with Fuel Pro filters.

1. Remove the vent cap from the top of the filter by turning counterclockwise. Fill the cover full of *clean* fuel. After making sure the O-ring seal is installed on the vent plug, reinstall the plug and tighten **by hand** only.

NOTICE:

To avoid cover or vent cap damage, do not use tools to tighten the vent cap.

NOTICE:

Do not allow the fuel level in the see-thru cover to fall below the top of the collar, since this may lead to interruption of the fuel flow and engine stalling.

2. Start the engine and allow the lubrication system to reach its normal operating pressure, then increase engine speed to high idle for 2 to 3 minutes.
3. After the air is purged and with the engine still running, loosen the vent cap on the filter cover. The fuel level in the cover will start falling. When the fuel level falls to the top of the collar on the Fuel Pro cover, tighten the vent cap quickly **by hand**.

Engine Mounted Fuel Filter

Use the following procedure for an engine mounted fuel filter.

1. If the engine is equipped with a hand priming pump located on the fuel filter module, operate the

priming pump for two to three minutes or until resistance is felt.

2. If the engine is equipped with only a priming port located on the fuel filter module, have an authorized repair facility prime the fuel system.
3. Crank the engine for 30 seconds at a time, but no longer. Before cranking the engine again, wait at least two minutes. The engine should start within four 30 second attempts.
4. If the engine fails to start, ensure the vehicle has adequate fuel and the fuel system is not leaking externally.
5. If problem persists, call an authorized repair facility.

How to Clean the Engine

Important: Observe all environmental protection regulations.

High-Pressure Cleaning Equipment

Information on suitable cleaning and protective products is available from any authorized dealer. Note the equipment manufacturer's operating instructions.

NOTICE:

To prevent damage to engine components, keep the water moving at all times while cleaning. Never direct water onto electrical components, plug connectors, seals or flexible hoses.



CAUTION:

To avoid injury, wear a face shield or goggles.

Comply with the minimum working distance between the high-pressure nozzle and the surface being cleaned:

- Approximately 700 mm (28 inches) for circular pattern jets
- Approximately 300 mm (12 inches) for 25-degree flat jets and dirt cutters

How to Clean the Cooling System

Important: Collect the used coolant, cleaning solutions, and washing liquids and dispose of them in an environmentally responsible manner.

Clean as follows:

NOTICE:

Clean at moderate pressures only; otherwise the fins of the radiator grille could be damaged.

1. First remove debris (dust, insects, etc.) from the fins of the radiator grille.



WARNING:

EYE INJURY

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.

2. Remove the debris by blowing them through with compressed air or spraying them out with water. Work from the rear of the radiator (in the opposite direction of the normal cooling air flow).
3. Drain the coolant when the engine is cold. For detailed procedures, see the vehicle/chassis maintenance manual. For types of coolant, Refer to the "How to Select Coolant" section.
4. If the HVAC unit is connected to the cooling system, open the regulating valves all the way.

Degreasing

Degrease as follows:

1. Fill the cooling system with a 5% solution (1.6 ounces per quart of water — 50 grams per liter) of a mildly alkaline cleaning agent, such as sodium carbonate.
2. Run the engine at moderate speed until the thermostat starts to open, at an operating temperature of approximately 80°C (176°F). Then run it for about five minutes longer. Shut down the engine and allow it to cool to approximately 50°C (112°F).

**WARNING:****HOT COOLANT**

To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

3. Drain all the cleaning solution.
4. Flush the cleaning solution from the cooling system.
 - [a] Immediately after draining the cleaning solution, flush the system with clean water.
 - [b] Once the clean water has drained, fill the system again with clean water.
 - [c] Run the engine. Allow the engine to warm up to approximately 80°C (176°F), and then run it about five minutes longer.
 - [d] Drain the hot water.
5. Fill the cooling system with new coolant. For detailed procedures, see the vehicle/chassis maintenance manual. For types of coolant, refer to the

“How to Select Coolant” section in this guide.

How to Select Coolant

This section covers selection of the required coolant for MBE 4000 engines.

Definitions

To help ensure complete understanding of the information, the definitions of the following terms are provided:

Antifreeze — Ethylene Glycol (EG) or Propylene Glycol (PG) containing a corrosion inhibitor package and meeting an appropriate heavy-duty specification, i.e., TMC RP-329 “Type A” EG, TMC RP 330 “Type A” PG or TMC RP organic acid ethylene glycol.

NOTE:

TMC RP-329 and TMC RP-330 “Type A” formulations are phosphate free.

Coolant — The fluid mixture circulating in the engine cooling system, typically a mixture of 50% water and 50% antifreeze.

Drop-Out — Precipitated sludge or deposit formation in or on cooling system components.

Fully Formulated Antifreeze —

Contains all the necessary inhibitors to protect a diesel engine and does not, therefore, require a pre-charge of SCA before its first use.

Initial-Fill Coolant — The coolant that is used in a new or rebuilt engine, or any time the cooling system is emptied and then refilled with new coolant.

OAT — Organic Acid Technology: An inhibitor system based on organic acid inhibitors.

SCA — *Supplemental Coolant Additive* – SCAs are used in a preventive maintenance program to prevent corrosion, cavitation and the formation of deposits.

Approved Coolants

The approved and preferred coolants for MBE 4000 are .Listed in Table 12.

Once installed, these coolants should be maintained according to the procedures discussed under **Maintenance** in this section.

NOTICE:

Required specifications for water, ethylene glycol, propylene glycol, inhibitor packages and inhibitor concentration are included in this publication. To avoid possible engine damage from inadequate or over-concentrated coolant, this publication should be read thoroughly before replacing coolant.

Coolant Fill Option	Product
Ethylene Glycol and Water + Conventional Corrosion Inhibitors ¹	DDC <i>Power Cool</i>
Commercial Equivalent of DDC <i>Power Cool</i>	Fully Formulated TMC RP-329 Type A Antifreeze and Water
Propylene Glycol and Water + Conventional Corrosion Inhibitors ¹	Fully formulated TMC RP-330 "Type A" Antifreeze and Water
Ethylene Glycol & Water + OAT Inhibitors	DDC <i>Power Cool Plus</i>
Water Only + Conventional Corrosion Inhibitors ²	Water + DDC <i>Power Cool</i> 3000
Water Only + OAT Inhibitors ²	Water + DDC <i>Power Cool Plus</i> 6000

¹ Preferred Coolant

² Water-only coolant systems offer no freeze protection and should not be used where ambient temperatures can fall to 32° F (0° C).

Table 12 Initial Fill Coolant Options

Ethylene Glycol / Water + CONVENTIONAL CORROSION Inhibitor, propylene Glycol / Water + CONVENTIONAL CORROSION Inhibitor —

These products are available as Fully Formulated, Phosphate-Free, Extended Service Interval (ESI) coolants. They are commercially available from Detroit Diesel (recommended) and other manufacturers as either a concentrated antifreeze or as a pre-mixed antifreeze. The pre-mixed antifreeze is ready to use, while the concentrated coolant must be mixed with water prior to use.

Detroit Diesel *Power Cool*[®] Engine Coolant (P/N 23512138) is the preferred ethylene glycol coolant as Listed in Table 12. If other

commercial brands of ethylene glycol are used, they must be equivalent to *Power Cool*. Detroit Diesel does not market a propylene glycol coolant. If a propylene glycol coolant is used, it must also meet the following requirements:

- Fully formulated ethylene glycol-based, low silicate antifreeze or coolant must meet TMC RP-329 "Type A" requirements.
- Fully formulated propylene glycol-based, low silicate antifreeze or coolant must meet TMC RP-330 "Type A" requirements.

NOTE:

Fully formulated antifreeze **does not** require a dosage of SCA prior to initial use.

Mixing EG or PG Antifreeze and

Water — If a concentrated Ethylene Glycol (EG) or Propylene Glycol (PG) antifreeze is purchased, mix the antifreeze with water meeting the required quality standards and fill the cooling system. For *water requirements*, If a concentrated EG or PG antifreeze is purchased, mix the antifreeze with water meeting the required quality standards and fill the cooling system. For *water requirements*, refer to section Water Requirements. If a pre-diluted, fully formulated coolant is purchased, simply fill the cooling system.

For best overall performance, a coolant consisting of 50% concentration of antifreeze (50% antifreeze, 50% water) is *recommended*. An antifreeze concentration of over 67% (67% antifreeze, 33% water) is *not recommended* due to poor heat transfer, reduced freeze protection (IEG only), and possible silicate dropout. An antifreeze concentration below 33% (33% antifreeze, 67% water) offers too little freeze and/or corrosion protection and is *not recommended*.

Always verify that the freeze point and nitrite concentration of the antifreeze/water mix are correct by using a *POWER Trac*® 3-Way Test

Strip. If chemical analysis is used, elements in the coolant must fall within the limits as listed in Table 13

Fully Formulated Glycol Coolant Concentration Limits	
Boron	125 – 500 PPM
Nitrite	900 – 3200 PPM
Nitrate	200 – 3200 PPM
Silicon	50 – 250 PPM
Phosphorous	0 PPM
pH	8.0 – 11.0

Table 13 Fully Formulated Glycol Coolant Limits with TMC RP-329, TMC RP-330 Chemistry Type A (50/50 Coolant/Water Mixture)

Recycled Antifreeze — Antifreeze or coolant recycled by reverse osmosis, distillation, and ion exchange, properly re-inhibited to meet TMC RP-329 “Type A” or RP-330 “Type A” requirements has been demonstrated to provide service equivalent to virgin antifreeze. Recycled antifreeze or coolants of these types are preferred. Other recycled coolants, especially coolants recycled through filtration processes, are *not recommended*.

Technology (OAT) corrosion inhibitor package. These coolants require less maintenance over the useful life of the engine. The cooling system should either be equipped with a “blank” coolant filter or the coolant filter and piping may be omitted from the system.

ETHYLENE GLYCOL / WATER + OAT INHIBITOR, PROPYLENE GLYCOL / WATER + OAT INHIBITOR — Ethylene glycol and propylene glycol are also available with an Organic Acid

OAT fully formulated antifreezes are available as concentrated and pre-mixed. Concentrated antifreezes should be mixed at 50% (50% antifreeze 50% water). OAT coolants should not be mixed with conventional coolants. If OAT and conventional coolants are mixed, no damage will result, but the long-life advantages of the OAT coolant will be lost. In this event, the coolant should be maintained as a fully formulated ESI (Extended Service Interval) coolant, not as an OAT coolant.

Detroit Diesel markets OAT-inhibited ethylene glycol coolants – DDC *POWER COOL* Plus and *POWER COOL* Plus Marine (30% glycol, 70% water). *POWER COOL* Plus coolants contain all of the required inhibitors. If a non-DDC OAT antifreeze is used, it must conform to TMC RP-338 specification. **Do not add extender to new OAT antifreeze or coolant.**

**WATER ONLY + SCA,
WATER ONLY + OAT
INHIBITOR** — In *warm climates*

where freeze protection is not required, water only with corrosion inhibitors is approved for use. Water-only systems need to be treated with the proper dosage of corrosion inhibitors. Detroit Diesel-approved conventional SCA or OAT corrosion inhibitors must be added to the water to provide required corrosion and

cavitation erosion protection. Initial fill options are listed in Table 1. OAT inhibitors such as *POWER COOL* Plus 6000 are available for water-only systems. OAT inhibitor should be mixed at 7.5% – 10% by volume with water. Refer to section *POWER COOL* ENGINE PRODUCTS for a listing of *POWER COOL* products.

Conventional SCA (*POWER COOL* 3000) can also be used to protect the engine. Listed in Table 14 are *POWER COOL* 3000 coolant concentration limits.

NOTE:

Do not use Power Trac 3-Way Test Strips to test OAT coolant.

Power Cool 3000 Coolant Concentration Limits	
Boron	125 – 500 PPM
Nitrite	900 – 3200 PPM
Nitrate	0 – 1000 PPM
Silicon	50 – 250 PPM
Phosphorous	0 PPM
pH	8.0 – 11.0

Table 14 Power Cool 3000 Concentration Limits (5% Power Cool 3000/ 95% Water)

POWER COOL 3000 SCA inhibitors should be mixed at 5% by volume with water (1 quart per 5 gallons of water). These additions can be made by adding liquid SCAs available in a variety of sizes. Coolant filters are also available for different cooling system capacities. These filters release the proper amount of SCA at initial fill.

Water Requirements —

Distilled or de-ionized water, which eliminates the adverse effects of minerals in tap water, is preferred.

High levels of dissolved chlorides, sulfates, magnesium, and calcium in some tap water causes scale deposits, sludge deposits and/or corrosion. These deposits have been shown to result in water pump failures and poor heat transfer, resulting in overheating. If tap water is used, the mineral content in the water must be

below the maximum allowable limits listed in Table 15.

NOTICE:

Do not add additional SCA to new, fully formulated antifreeze or coolant. This can result in dropout and/or the formation of deposits.

Coolants Not Recommended

The following coolants are *not recommended* for use in Detroit Diesel engines.

All Antifreezes And Coolants Containing Phosphate —

These coolants are not recommended. Drop out, overheating and water pump seal failures can result from the use of coolant or inhibitor packages based on phosphate.

Automotive Type Coolants —

These coolants generally contain high levels of phosphate and silicate, offer no liner pitting protection, and are *not suitable* for use in Detroit Diesel engines.

Methyl Alcohol-Based

Antifreeze — This must not be used because of its effect on the non-metallic components of the cooling system and its low boiling point.

	Maximum Allowable	
	Parts per Million	Grains per Gallon
Chlorides	40	2.5
Sulfates	100	5.8
Total Dissolved Solids	340	20
Total Hardness – Magnesium and Calcium	170	10

Table 15 Satisfactory Water Limits – Make-Up Water Only

Glycol-based Coolants Formulated For HVAC —

These coolants formulated for Heating/Ventilation/Air Conditioning (HVAC) should not be used. These coolants generally contain high levels of phosphates, which can deposit on hot internal engine surfaces and reduce heat transfer.

heat transfer. For example, a 1.25% concentration of soluble oil increases fire deck temperature 6%. A 2.50% concentration increases fire deck temperature 15%. The use of soluble oil additives may result in engine overheating and/or failure.

Additives Not Recommended

The following additives are *not recommended* for use in MBE 4000 engines.

Chromates — Chromate additives are not approved for use in Detroit Diesel engine cooling systems. Chromate additives can form chromium hydroxide, commonly called “green slime.” This, in turn, can result in engine damage due to poor heat transfer. Cooling systems operated with chromate-inhibited coolant must be chemically cleaned with **POWER COOL Twin Pack** cooling system cleaner/conditioner

Soluble Oils — Soluble oil additives are not approved for use in Detroit Diesel engine cooling systems. A small amount of oil adversely affects


(or equivalent sulfamic acid/sodium carbonate cleaner) and flushed. *POWER COOL* cleaners are listed in Table *POWER COOL* Cooling System Cleaners

Coolant Inhibitor Test Intervals

The coolant inhibitor level should be checked at the intervals listed in Table 16.

Service Application	Inhibitor Test Interval
Long Haul — Highway Truck & Motor Coach — operates more than 60,000 miles (100,000 kilometers) per year	20,000 Miles (32,000 km)
Sort Haul — City Transit — operates up to 60,000 miles (100,000 kilometers) per year	6,000 Miles (9,600 km) or three months, whichever comes first
Severe Service — Fire Truck or Crash/Rescue Vehicle — operates up to 6000 miles (9,600 kilometers) or under severe conditions	6,000 Miles (9,600 km) or three months, whichever comes first

Table 16 Required Coolant Inhibitor Test Intervals

 <p>WARNING: HOT COOLANT</p>
<p>To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.</p>

Supplemental Coolant Additives for Fully Formulated Coolant —

The concentrations of some inhibitors will gradually deplete during normal engine operation. SCAs replenish the protection for cooling system components. The coolant *must* be maintained with the proper concentration of SCA. Detroit Diesel *Power Cool* maintenance SCAs are recommended.

The proper application of SCA will provide:

- pH control.
- Restored inhibitor levels to prevent corrosion.

If topping off is needed, add coolant which is identical to the initial fill coolant.

- Water softening to deter formation of mineral deposits.
- Cavitation protection to protect wet sleeve cylinder liners.

Maintenance Intervals — Check the nitrite concentration at the regular intervals listed in Table 17 with a *Power Trac 3-Way Test Strip*.

Coolant	Interval ¹	Action
Antifreeze / Water + SCA Inhibitor (DDC <i>Power Cool</i>)	20,000 Miles (32,000 km) or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 Miles (480,000 km)	Drain and clean system. Refill with new coolant.
Ethylene Glycol / Water + SCA Inhibitor or Propylene Glycol / Water + SCA Inhibitor	20,000 Miles (32,000 km) or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 Miles (480,000 km)	Drain and clean system. Refill with new coolant.
Ethylene Glycol / Water + OAT Inhibitor or Propylene Glycol / Water + OAT Inhibitor	Test at 1 Year.	—
	300,000 Miles (480,000 km) or 2 Years*	Add <i>Power Cool</i> Plus Extender
	600,000 Miles (960,000 km)	Drain and clean system. Replace with new coolant.
Water Only + SCA Inhibitor	20,000 Miles (32,000 km) or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	300,000 Miles (480,000 km)	Drain and clean system. Replace with new coolant.
Water Only + OAT Coolant	300,000 Miles (480,000 km) or 2 Years*	Add <i>Power Cool</i> Plus Extender
	600,000 Miles (960,000 km)	Clean and drain. Replace with new coolant.

¹ based on application. Drain interval dependent on proper maintenance.

Table 17 Coolant Maintenance Intervals

Nitrite levels *must* be within the ranges listed in Table 13.

NOTICE:

Failure to properly maintain coolant with SCA can result in damage to the cooling system and its related components. Conversely, over-concentration of SCA inhibitor can result in poor heat transfer, leading to engine damage. Always maintain concentrations at recommended levels. *Do not use traditional SCAs with OAT coolant.*

Additional SCA *must* be added to the coolant when it becomes depleted, as indicated by a nitrite concentration of 900 PPM or less. *If the nitrite concentration is greater than 900 PPM, do not add additional SCA.* If the nitrite concentration is above 3200 PPM, the system is over-inhibited and should be partially drained and filled with a 50/50 mix of water and EG or PG.

In this case the EG or PG should contain no inhibitors and should conform to ASTM D4985. This will dilute the over-concentrated inhibitors.

NOTE:

In non-OAT systems, nitrite concentration of 5000 PPM or higher on a MBE 4000 engine suggests problematic additive over-concentration. This condition *must* be corrected by immediate draining and flushing of the cooling system. Refill the system with new fully formulated or pre-charged coolant. Check the nitrite concentration level at the next with a Power Trac 3-Way Test Strip.

SCA Test Procedures

Detroit Diesel Power Trac 3-Way Coolant Test Strips should be used to measure nitrite and glycol concentrations. Part numbers are in refer to section *POWER COOL ENGINE PRODUCTS* and refer to section *POWER TRAC Coolant Testing And Analysis Products*. Cavitation/corrosion is indicated on the strip by the level of nitrite concentration. Freeze/boil over protection is determined by glycol concentration.

**WARNING:****HOT COOLANT**

To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

For best results make the test while the coolant is between 50° – 140° F (10° – 60° C). Wait at least 60, but not longer than 75, seconds before reading the nitrite level. Use the test strips as follows:

1. Dip the strip into coolant for one second. Remove and shake briskly to eliminate excess fluid.
2. Immediately compare the pad end (% glycol) to the color chart on the container.
3. Sixty seconds (one minute) after dipping, compare the nitrite pad to the color chart.
4. Color change of the additive indicator (middle pad) indicates the presence of inhibitor that is not approved by Detroit Diesel.

Promptly replace and tighten the test strip container cap after each use.

Discard unused strips if they have turned light pink or tan.

A factory coolant analysis program is available through authorized Detroit Diesel service outlets. Part numbers are in refer to section POWER TRAC Coolant Testing And Analysis Products in the **Specifications** section. To verify coolant acceptability, submit a sample for coolant analysis every two (2) years, 300,000 miles (480,000 km), or 10,000 operating hours, whichever comes first.

Need Release Coolant Filters (Non-OAT Systems)

Spin-on coolant filters are available for Detroit Diesel engines. Membranes in the filters release SCAs before the coolant approaches a corrosive condition, protecting the engine from corrosion. The elements release the SCA charge as needed, as opposed to the maintenance SCA elements, which instantaneously release the SCA charge. Coolant filter elements should be replaced after one (1) year, 120,000 miles (192,000 km) or 2,000 operating hours, whichever comes first.

Dropout

Excessive amounts of some inhibitors in the coolant can cause a gel or crystalline deposit that reduces heat transfer and coolant flow. The deposit, called “dropout,” takes the color of the coolant when wet, but appears as a white or gray powder when dry. It can pick up solid particles in the coolant and become gritty, causing excessive wear of water pump seals and other cooling system components.



WARNING:

PERSONAL INJURY

To avoid injury when using caustic cleaning agents, follow the chemical manufacturers usage, disposal, and safety instructions.

The wet gel can be removed by using a non-acid (alkali) type heavy-duty cleaner, such as Detroit Diesel *Power Cool On-Line Cleaner* (sodium nitrite/sodium tetraborate). Part numbers are in refer to section *POWER COOL ENGINE PRODUCTS*.

NOTE:

If the gel is allowed to dry, it is necessary to disassemble the engine and clean it with a caustic solution or physically clean individual components.

Coolant Extender Inhibitor Additive for “OAT” Coolant

The inhibitors in OAT coolant must also be maintained, but less often than traditional SCA-type coolants. A portable test is available to test the levels of OAT inhibitors in coolant. Where this is not used, fleet testing has determined that a OAT coolant extender package should be added to the coolant at 300,000 miles (480,000 km), two (2) years, or 5,000 hours, whichever comes first. The proper maintenance dosages for all OAT coolants are listed in Table 17 , reflecting 0.6% by volume extender. This dosage should be added to the water-only and the glycol systems at the same interval.

The proper application of extender to OAT coolant will provide:

- pH Control
- Restored inhibitor levels to prevent corrosion
- Cavitation protection to protect wet sleeve cylinder liners

NOTE:

Do not use traditional SCAs in OAT coolant, and do not use OAT extender in traditional coolant.

OAT Coolant Drain Interval —

A properly maintained OAT-inhibited coolant will last 600,000 miles (960,000 km), four (4) years, or 10,000 operating hours, whichever comes first. At this time the coolant should be drained, and the cooling system should be thoroughly cleaned, flushed, and filled with new, properly inhibited OAT coolant.

Chronic Coolant System Problems

The most commonly seen coolant system problems result from maintenance and formulation factors such as:

- Hard water
- Dilution of the coolant by the addition of untreated water
- Over dosage or under dosage of corrosion inhibitors
- Improper corrosion inhibitor (most often phosphated)
- Mixing SCAs
- Improper testing

Detroit Diesel Cooling System Maintenance Products

The following products are available to do maintenance on the cooling system.

Power Cool SCAs — *Power Cool* SCAs are water-soluble chemical compounds. These products are available in coolant filter elements, liquid packages, and in fully formulated *Power Cool* antifreeze.

NOTE:

Power Cool 3000 liquid SCA is more compatible with hard water than Power Cool 2000 SCA.

Power Cool Coolant Filter

Elements — *Power Cool* coolant filter elements (spin-on canisters) are available in various sizes suitable for cooling systems of varying capacities. Selection of the proper element size is vital when pre-charging non-fully formulated coolant at initial fill and at s. **A fully formulated antifreeze must not have SCA added at initial fill. Do not use SCA-containing filters with OAT antifreeze or coolant.** The need for maintenance elements is determined by the results of the nitrite concentration test performed at each cooling system interval. *Do not automatically install maintenance elements at maintenance intervals, unless the nitrite concentration falls below 900 parts per million.*

Power Cool Cleaners — *Power Cool* Liquid On-Line Cleaner is used for light deposits. *Power Cool* Dry

Chemical Cleaner/Conditioner is used for heavy deposits or scale.

Summary of Coolant Recommendations



WARNING:

HOT COOLANT

To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

1. Always maintain the engine coolant to meet Detroit Diesel specifications.
2. Only use water that meets the specifications listed in Table 15. Distilled, de-mineralized (reverse osmosis) or de-ionized water is preferred.
3. The proper dosage of inhibitors *must* be included in the coolant at initial fill for all Detroit Diesel engines. This dosage is usually included in the fully formulated antifreeze used, or it may need to be added if water alone or if less than 50% antifreeze is used. *The*

user is urged to refer to the full text of this section to determine the proper dosage. Mixing of different manufacturers' technologies (brands) could cause cooling system problems.

4. Maintain the inhibitor at the prescribed concentration. Test the nitrite concentration by using a titration kit or Detroit Diesel Power Trac 3-Way Coolant Test Strips. Add SCA only if the nitrite concentration is below 900 PPM. *Do not use SCA in OAT coolant, and do not use Power Trac 3-Way Coolant Test Strips to test OAT coolant.*

NOTE:

If the nitrite concentration exceeds 3200 PPM, the coolant must be drained and replaced with new coolant. A thorough cleaning of the cooling system may be required.

5. Do not use another manufacturer's test kit to measure the SCA concentration of Detroit Diesel maintenance products.
6. Pre-mix coolant makeup solutions to the proper concentration before adding to the cooling system.
7. Do not mix OAT and other coolants in the same engine.
8. Do not use automotive coolants.

9. Where antifreeze/boil over protection is required, use only antifreeze that meets TMC RP-329 "Type A" EG or TMC RP-330 "Type A" PG specifications. Always maintain coolant at the proper level.
10. Do not use the following in Detroit Diesel engine cooling systems:
 - Soluble oil
 - High silicate, automotive-type antifreeze
 - Chromate SCAs
 - Methoxy propanol-base coolant
 - Methyl alcohol-base coolant
 - Sealer additives or coolant containing sealer additives.
 - HVAC coolant
 - Phosphated coolants

Coolant life of Glycol Coolant —

A *properly maintained* cooling system, filled with phosphate-free coolant consisting of a 50/50 mix of antifreeze and water per TMC RP-329 "Type A" EG or TMC RP-330 "Type A" PG specifications can be operated to the limits recommended. The proper maintenance involves periodic evaluation using Power Trac 3-Way Coolant Test Strips and the addition of

SCA as needed, indicated by the strip test. To verify coolant acceptability, submit a sample for coolant analysis every 300,000 miles (480,000 km), three (3) years, or 5,000 operating hours, whichever comes first. Submit the sample in a DDC Power Trac Coolant Test Bottle. Required part numbers are in refer to section *POWER COOL ENGINE PRODUCTS*.

Coolant Life of OAT Coolant —

A properly maintained OAT coolant may be operated 600,000 miles (960,000 km), four (4) years, or until overhaul, whichever comes first. At this time the system *must* be completely drained, thoroughly cleaned, and refilled. OAT Coolants require the addition of an extender at 300,000 miles (480,000 km), two (2) years, or 5,000 hours, whichever comes first. Use 1 pint of extender for every 20 gallons of coolant.

Coolant Life of Other Coolants —

Other properly maintained coolants may be operated up to 250,000 miles (480,000 km), two (2) years, or 4,000 operating hours, whichever comes first. At this time the system *must* be completely drained, thoroughly cleaned, and refilled.

Coolant Flushing and Changing

Flush and change the coolant as follows:



WARNING: **HOT COOLANT**

To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.

1. Open the cap on the surge tank slowly, to allow excess pressure to escape. Set the cap aside.
2. Open the water regulating valve for the heating system.
3. Place a large receptacle underneath the coolant drain plug and open the coolant drain plug on the bottom of the radiator.

NOTE:

Make sure the coolant can flow unobstructed into the receptacle.

NOTICE:

Do not apply more than 140 kPa (20 psi) air pressure for a radiator flush; more pressure could damage the radiator or heater core.

4. Start radiator flushing by attaching a flushing gun nozzle to the radiator outlet and run water in until the radiator is full.



WARNING: **EYE INJURY**

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.

5. Apply no more than 140 kPa (20 psi) air pressure intermittently to help dislodge sediment buildup in the core.
6. Drain the radiator, and flush the radiator until clean water flows from the radiator. Remove the flushing gun.
7. When the coolant has drained, install the coolant drain plug on the radiator.


8. Add coolant in the specified concentration until the maximum mark on the surge tank is reached.
 9. Start the engine and run it for about one minute at varying speeds to release air pockets in the cooling system. Ensure the heater valve is still open. Check the coolant level and add more coolant if necessary.
 10. Shut down the engine, close and tighten the cap on the surge tank.
1. Inspect the radiator, condenser, water pump, engine oil cooler, freeze plugs, and heat exchanger for damage and leaks.
 2. Check all cooling system pipes and hoses for damage and leaks; ensure they are positioned to avoid chafing, and are securely fastened.
 3. Check the outside of the radiator and condenser for blockage. Check fins for damage; straighten them if necessary.

Cooling System Inspecting

NOTE:

Before doing this inspection, do either "Coolant Concentration Checking," or "Coolant Flushing and Changing."

Inspect the cooling system as follows:

 WARNING: HOT COOLANT
<p>To avoid scalding from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Wear adequate protective clothing (face shield, rubber gloves, apron, and boots). Remove the cap slowly to relieve pressure.</p>

TROUBLESHOOTING

In addition to operating the engine carefully and maintaining it properly, make sure to correct any malfunction promptly.

When the electronic engine control system detects a fault, it broadcasts a message on the datalink. The dash display will show the code "Motor Control Module (MCM) 128," indicating there is an engine fault.

Important: To read the complete fault code, bring the vehicle to an authorized dealer. Complete fault

codes can be read using the Nexiq DDR or DDDL 7.0 version or later.

For fault codes and their meanings, see the next section in this guide.

The tables that follow are designed to identify the causes of common problems, suggest further checks and appropriate remedies. When dealer service is necessary, this is mentioned in the table.

NOTE:

Remember to follow all cautions when troubleshooting the engine.

Problem - The Engine Will Not Crank	
Cause	Remedy
The batteries are damaged or weak.	Test the batteries. Replace them, if needed.
The ignition switch is damaged.	Replace the ignition switch.
The battery cables are damaged and/or corroded.	Replace the battery cables.
The starter is damaged and/or worn.	Have an authorized repair facility replace the starter.
The clutch or transmission is damaged.	Bring the vehicle to an authorized repair facility for service.
There is internal damage to the engine.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Turns Over Slowly	
Cause	Remedy
The batteries are damaged or weak.	Test the batteries. Replace them, if needed.
The ignition switch is damaged.	Replace the ignition switch.
The battery cables are damaged and/or corroded	Replace the battery cables.
The starter is damaged and/or worn.	Have an authorized repair facility replace the starter.
The engine oil does not meet the correct specifications.	Change the engine oil, using the correct type of oil.
The transmission fluid does not meet the correct specifications.	Change the transmission fluid, using the correct type of fluid.

Problem—The Engine Cranks, But Won't Start	
Cause	Remedy
The batteries are damaged or weak.	Test the batteries. Replace them, if needed.
The cranking speed is not set correctly.	Bring the vehicle to an authorized repair facility for service.
No intake air preheater is installed, and it is too cold to start without one.	Install an intake air preheater.
The intake air preheater is malfunctioning.	Check the intake air preheater, and replace it, if necessary.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are out of adjustment.	Push both sensors into their holes as far as they will go. If this does not solve the problem, bring the vehicle to an authorized repair facility for service.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are damaged.	Bring the vehicle to an authorized repair facility for service.
There is air in the fuel system.	Check the fuel lines for air pockets. Prime the fuel system and start the engine.
The air filter is clogged.	Clean or replace the air filter.
The fuel filter is clogged.	Replace the filter element.
The exhaust brake valve is malfunctioning.	Have an authorized repair facility check the operation of the valve.
The valves are not adjusted properly.	Check the valve lash.
There are other problems in the fuel system.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Starts Only After Cranking for a Long Time	
Cause	Remedy
The fuel tank is low or empty.	Add fuel and prime the fuel system, if necessary.
There are leaks in the fuel lines.	Check the fuel lines for leaks and repair them, if necessary.
The fuel filter is clogged.	Replace the filter element.
The fuel line, the fuel prefilter, or the screen in the fuel tank is blocked.	Clean and prime the system. Have the fuel lines and filters checked by an authorized repair facility.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are out of adjustment.	Push both sensors into their holes as far as they will go. If this does not solve the problem, bring the vehicle to an authorized repair facility for service.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are damaged.	Bring the vehicle to an authorized repair facility for service.
There are other problems in the fuel system.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Starts, But Dies	
Cause	Remedy
The fuel tank is low or empty.	Add fuel and prime the fuel system, if necessary.
The fuel filter is clogged.	Replace the filter element.
The fuel line, the fuel prefilter, or the screen in the fuel tank is blocked.	Clean and prime the system. Have the fuel lines and filters checked by an authorized repair facility.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are out of adjustment.	Push both sensors into their holes as far as they will go. If this does not solve the problem, bring the vehicle to an authorized repair facility for service.
The camshaft position (CMP) sensor and/or the crankshaft position (CKP) sensor are damaged.	Bring the vehicle to an authorized repair facility for service.
The constant-throttle valves are malfunctioning.	Bring the vehicle to an authorized repair facility for service.
There are other problems in the fuel system.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Fan Doesn't Work	
Cause	Remedy
The fan hub is damaged.	Replace the fan hub.
The fan wiring is damaged.	Repair the fan wiring.
The parameter settings in the MCM or Common Powertrain Controller (CPC) are incorrect.	Have an authorized repair facility reprogram the control unit.

Problem—The Engine Fan Is Constantly On	
Cause	Remedy
The fan override switch is on.	Check the operation of the fan override switch.
The fan hub is damaged.	Replace the fan hub
The parameter settings in the MCM or CPC are incorrect.	Have an authorized repair facility reprogram the control unit.
AC switch is damaged	Check AC switch.

Problem—Fuel Consumption Is Too High	
Cause	Remedy
The tires are not properly inflated.	Check all tires for correct pressure.
The air filter and/or intake air system is clogged.	Check the air restriction indicator. Clean the intake air system and replace the air filter if necessary.
The exhaust brake valve is malfunctioning.	Have an authorized repair facility check the operation of the valve.

Problem—The Engine Performs Poorly, Does Not Develop Full Power	
Cause	Remedy
The air filter and/or intake air system is clogged.	Check the air restriction indicator. Clean the intake air system and replace the air filter if necessary.
The exhaust brake valve is malfunctioning.	Have an authorized repair facility check the operation of the valve.
The fuel filter is clogged.	Replace the filter element.
There are other problems with the fuel system.	Bring the vehicle to an authorized repair facility for service.
The valves are not adjusted properly	Check the valve lash.
The coolant temperature sensor is damaged or reading incorrectly.	Bring the vehicle to an authorized repair facility for service.
The fuel temperature sensor is damaged or reading incorrectly.	Bring the vehicle to an authorized repair facility for service.
The engine oil temperature sensor is damaged or reading incorrectly.	Bring the vehicle to an authorized repair facility for service.
The charge-air temperature sensor is damaged or reading incorrectly.	Bring the vehicle to an authorized repair facility for service.
There are problems with the MCM or CPC.	Bring the vehicle to an authorized repair facility for service.
There is internal damage to the engine.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Is in Emergency Running Mode (constant speed 1,300 rpm)	
Cause	Remedy
The MCM or CPC is damaged.	Bring the vehicle to an authorized repair facility for service.
An incorrect parameter is in the MCM or CPC.	Bring the vehicle to an authorized repair facility and have the parameter settings reprogrammed in the MCM or CPC.

Problem—The Coolant Temperature Is Above Normal	
Cause	Remedy
The coolant level is too low.	Check for coolant leaks, and repair as needed.
The poly-V belt is loose.	Tighten or replace the poly-V belt.
The coolant temperature gauge and/or sensor is not reading correctly.	Bring the vehicle to an authorized repair facility for service.
The radiator is damaged or dirty.	Clean the radiator. Repair or replace the radiator if necessary.
The water pump is damaged.	Have an authorized repair facility replace the water pump.
The thermostat is damaged.	Have an authorized repair facility replace the water pump.
The fan is not operating properly.	Bring the vehicle to an authorized repair facility and have the fan hub checked or have the parameter settings reprogrammed in the MCM or CPC.

Problem—The Coolant Temperature Is Below Normal	
Cause	Remedy
The coolant temperature gauge and/or sensor is not reading correctly.	Bring the vehicle to an authorized repair facility for service.
The thermostat is not operating properly.	Have an authorized repair facility replace the thermostat.
The fan is not operating properly.	Bring the vehicle to an authorized repair facility and have the fan hub checked. Bring the vehicle to an authorized repair facility and have the parameter settings reprogrammed in the MCM or CPC.

Problem—The Cooling System Is Losing Coolant	
Cause	Remedy
There is an external coolant leak.	Repair the leaking component.
The radiator cap is leaking.	Replace the radiator cap.
The air compressor head is damaged.	Have an authorized repair facility replace the air compressor.
The cylinder head gasket is leaking.	Have an authorized repair facility replace the head gasket.

Problem—There Is Coolant in the Engine Oil	
Cause	Remedy
The cylinder head gasket is damaged.	Have an authorized repair facility replace the head gasket.
The oil/water heat exchanger is leaking.	Have an authorized repair facility replace the heat exchanger.
There is an internal coolant leak.	Bring the vehicle to an authorized repair facility for service.

Problem—There Is Foam in the Engine Oil	
Cause	Remedy
The oil level is too low or too high.	Correct the oil level.
The oil has not been changed within the recommended interval.	Change the oil.
The oil is not of the recommended quality.	Change the oil.

Problem—The Engine Oil Pressure Is Low	
Cause	Remedy
The oil pressure gauge and/or sensor is not reading correctly.	Bring the vehicle to an authorized repair facility for service.
There is fuel in the oil.	Bring the vehicle to an authorized repair facility for service.
The oil filter is clogged.	Replace the filter element.
The oil filter bypass valve is damaged.	Replace the bypass valve.
The oil pump and/or relief valve is damaged.	Have an authorized repair facility replace the oil pump.

Problem—The Engine Exhaust Is White	
Cause	Remedy
The fuel is of poor quality.	Add fuel of the right quality.
The intake air preheater is malfunctioning.	Check the intake air preheater, and replace it, if necessary.
The valves are not adjusted properly.	Check the valve lash.

Problem—The Engine Exhaust Is Black	
Cause	Remedy
The air filter and/or intake air system is clogged.	Check the air restriction indicator. Clean the intake air system and replace the air filter if necessary.
The exhaust brake valve is malfunctioning.	Have an authorized repair facility check the operation of the valve.
The intake air preheater is malfunctioning.	Check that the heater is not staying on all of the time.
The valves are not adjusted properly.	Check the valve lash.
There is damage to the fuel system: the fuel pump, one or more fuel injectors, or one or more unit pumps are damaged.	Bring the vehicle to an authorized repair facility for service.
The charge-air temperature sensor is damaged.	Bring the vehicle to an authorized repair facility for service.
There is internal damage to the engine.	Bring the vehicle to an authorized repair facility for service.

Problem—The Engine Exhaust Is Blue	
Cause	Remedy
The engine oil level is too high (engine oil is reaching the combustion chamber).	Adjust the oil level, and then have the oil level checked by an authorized repair facility.
The turbocharger is leaking oil.	Have an authorized repair facility replace the turbocharger
The valve stem seals are loose or damaged.	Have an authorized repair facility replace the seals.
The piston rings are worn.	Have an authorized repair facility replace the piston rings.

Problem—Engine Brake Performance Is Poor	
Cause	Remedy
The engine brake control switch is damaged.	Replace the switch
The exhaust brake is not operating properly.	Have an authorized repair facility check the operation of the valve.
The constant-throttle valves are malfunctioning.	Bring the vehicle to an authorized repair facility for service.
Components of the MCM and/or CPC are damaged.	Bring the vehicle to an authorized repair facility for service.

Problem—Cruise Control Is Not Working	
Cause	Remedy
One or more of the cruise control switches are damaged.	Replace the damaged switch.
Components of the MCM and/or CPC are damaged or not working properly.	Bring the vehicle to an authorized repair facility for service.

Problem—The Battery Charge Indicator Light Does Not Come On When the Engine Is Not Running	
Cause	Remedy
The bulb is bad.	Replace the bulb.
The circuit is broken.	Repair the break in the circuit.

Problem—The Battery Charge Indicator Light Comes On When the Engine is Running	
Cause	Remedy
The poly-V belt is too loose.	Check the belt tension; if necessary, Have an authorized repair facility replace the belt tensioner.
The belt tensioner is damaged.	Have an authorized repair facility replace the belt tensioner.
The poly-V belt is worn or damaged.	Replace the belt.
The alternator is damaged (has a damaged rectifier or voltage regulator).	Have an authorized repair facility replace the alternator.

ENGINE STORAGE

When an engine is to be stored or removed from operation for a period of time, special precautions should be taken to protect the interior and exterior of the engine, transmission and other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

Preparing Engine for Storage

It will be necessary to remove all rust or corrosion completely from any exposed part before applying rust preventive compound. Therefore, it is recommended that the engine be processed for storage as soon as possible after removal from operation.

The engine should be stored in a building that is dry and can be heated during the winter months. Moisture-absorbing chemicals are available commercially for use when excessive dampness prevails in the storage area.

Temporary Storage (30 Days or Less)

To protect the engine for a temporary period of time (30 days or less), follow this procedure:

1. With the engine at ambient temperature and cool to the touch, drain engine crankcase oil into a suitable container. Dispose of the oil in an environmentally friendly manner, according to state and/or federal (EPA) recommendations.
2. Fill the crankcase to the proper level with the recommended viscosity and grade of oil.
3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for two (2) minutes at 1200 rpm and no load. **Do not drain the fuel system or the crankcase after this run.**
4. Check the air cleaner and service it, if necessary.
5. If freezing weather is expected during the storage period, check the antifreeze/coolant for required freeze and inhibitor protection. Add antifreeze solution to the cooling system in accordance with Detroit Diesels recommendations. Refer to "How to Select Coolant" in this guide.

NOTE:

If an antifreeze solution is not required during storage, flush the cooling system with a good soluble oil (3% – 5% by volume) rust inhibitor to prevent

rusting of the outside diameter of the cylinder liners.



WARNING:
EYE INJURY

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.

6. Clean the exterior of the engine (except electrical parts) with fuel oil and dry with compressed air.
7. Seal all engine openings. The material used must be waterproof, vapor proof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

An engine prepared in this manner can be returned to service in a short time by removing the seals at the engine openings and by checking the engine coolant, fuel oil, lubricating oil and transmission oil levels.

Extended Storage (More than 30 Days)

To prepare an engine for extended storage (more than 30 days), follow this procedure:

1. Drain the cooling system and flush with clean, soft water. Refill with clean, soft water and add a rust inhibitor to the cooling system.
2. Circulate the coolant by operating the engine until normal operating temperature is reached.
3. Stop the engine.
4. With the engine at ambient temperature and cool to the touch, drain the engine crankcase oil into a suitable container. Remove the oil filters. Dispose of the oil and filters in an environmentally friendly manner, according to state and/or federal (EPA) recommendations. Replace the drain plug and tighten to 80 N·m (59 lb·ft) torque.
5. Install new lubricating oil filters. Fill the crankcase to the proper level with Tectyl® 930A preservative lubricating oil or an equivalent 30-weight preservative lubricating oil meeting Mil-L-21260C, Grade 2 Specification.
6. Drain the fuel tank. Refill with enough clean No. 1 diesel fuel or pure kerosene to permit the engine to operate for about ten (10) minutes. If draining the fuel tank is not convenient, use

a separate, portable supply of recommended fuel.

NOTE:

If engines are stored where condensation of water in the fuel tank may be a problem, additives containing methyl carbitol or butyl cellulose may be added to the fuel. Follow manufacturer's instructions for treatment. Where biological contamination of fuel may be a problem, add a biocide such as Biobor® JF (or equivalent) to the fuel. When using a biocide, follow the manufacturer's concentration recommendations and observe all cautions and warnings.

7. Drain the fuel system and remove the fuel filters. Dispose of used filters in an environmentally responsible manner, according to state and/or federal (EPA) recommendations. Fill the new filters with No. 1 diesel fuel or pure kerosene and install on the engine.
8. Operate the engine for five (5) minutes to circulate the clean fuel throughout the engine. Be sure the engine fuel system is full.
9. Stop the engine and allow to cool. Then disconnect the fuel return line and the inlet line at the primary filter and securely plug both to retain the fuel in the engine.
10. **Transmission:** Follow the manufacturer's recommendations for prolonged storage.
11. **Power Take-Off:** If equipped, follow manufacturer's recommendations for prolonged storage.
12. **Turbocharger:** Since turbocharger bearings are pressure lubricated through the external oil line leading from the oil filter adaptor while the engine is operating, no further attention is required. However, the turbocharger air inlet and turbine exhaust outlet connection should be sealed off with moisture-resistant tape.
13. Apply a non-friction rust preventive compound to all exposed engine parts. If

NOTICE:

Failure to properly seal off the turbocharger air inlet and exhaust outlet openings before engine storage may permit air drafts to circulate through the turbocharger and rotate the turbine/compressor shaft without an adequate flow of lubricating oil to the center housing bearings. This can result in severe bearing damage.

convenient, apply the rust preventive compound to the engine flywheel. If not, disengage the clutch mechanism to prevent the clutch disc from sticking to the flywheel.

NOTE:

Do not apply oil, grease or any wax-base compound to the flywheel. The cast iron will absorb these substances, which can “sweat” out during operation and cause the clutch to slip.

14. Drain the engine cooling system.
15. Drain the preservative oil from the engine crankcase. Reinstall and torque the oil drain plug to 80 N·m (59 lb·ft).
16. Remove and clean the battery and battery cables with a baking soda-water solution and rinse with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte (if necessary) and fully charge the battery. Store the battery in a cool (never below 0° C or 32° F) dry place. Keep the battery fully charged and check the level and specific gravity of the electrolyte regularly.
17. Insert heavy paper strips between the pulleys and drive belts to prevent sticking.
18. Seal all engine openings, including the exhaust outlet, with moisture-resistant tape. Use cardboard, plywood or metal covers where practical.
19. Clean and dry the exterior painted surfaces of the engine and spray with a suitable liquid automobile body wax, a synthetic resin varnish, or a rust preventive compound.
20. Protect the engine with a good weather-resistant tarpaulin and store it under cover, preferably in a dry building which can be heated during the winter months.

Outdoor storage of the engine is not recommended. If units must be kept out of doors, follow the preparation and storage instructions already given. Protect units with quality, weather-resistant tarpaulins (or other suitable covers) arranged to provide for air circulation.

NOTICE:

Do not use plastic sheeting for outdoor storage. Plastic is fine for indoor storage. When used outdoors, however, enough moisture can condense on the inside of the plastic to rust ferrous metal surfaces and pit aluminum surfaces. If a unit is stored outside for any extended period of time, severe corrosion damage can result.

The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of one year and apply additional treatment as required.

Procedure for Restoring to Service an Engine that Has Been in Extended Storage

If an engine has been in extended storage, prepare it for service as follows:

1. Remove the covers and tape from all the openings of the engine, fuel tank and electrical equipment. Do not overlook the exhaust outlet.
2. Remove the plugs from the inlet and outlet fuel lines and reconnect the lines to their proper positions.
3. Wash the exterior of the engine with fuel oil to remove the rust preventive. **Do not wash electrical components.**
4. Remove the rust preventive from the flywheel. Flush any soluble oil rust inhibitor (if used) in the cooling system.
5. Remove the paper strips from between the pulleys and drive belts.
6. Fill the crankcase to the proper level with the required grade of lubricating oil. Use a pressure lubricator to insure all bearings and rocker shafts are lubricated.
7. Fill the fuel tank with the required fuel.
8. Close all drain cocks and fill the engine cooling system with clean, soft water and required inhibitors. If the engine is to be exposed to freezing temperatures, install genuine Detroit Diesel **Power Cool** antifreeze or an equivalent ethylene glycol-base or propylene glycol-base antifreeze solution which provides required freeze, boil over, and inhibitor protection. Refer to section "How to Select Coolant."
9. Install and connect the battery. Make sure the average specific gravity of the battery is 1.260

or higher. Charge the battery, if necessary.

10. Service the air cleaner, if required.
11. **Transmission:** Follow the manufacturer's recommendations covering the return of the transmission to service.
12. **Power Take-Off:** If equipped, follow the manufacturer's recommendations covering the return of the power take-off to service.
13. **Turbocharger:** Remove the covers from the turbocharger air inlet and turbine outlet connections. Reconnect piping as required. Prelube the turbocharger center bearing housing. Refer to "Lubrication System Checks" in the "*OPERATING INSTRUCTIONS FOR STARTING THE ENGINE*" section of this guide.

NOTE:

The small amount of rust preventive which remains in the fuel system will cause smoky exhaust for a few minutes.

NOTE:

Before subjecting the engine to a load or high speed, allow it to reach normal operating temperature. Then check for trouble codes.



WARNING:

ENGINE EXHAUST

To avoid injury from inhaling engine exhaust, always operate the engine in a well-ventilated area. Engine exhaust is toxic.

14. After all preparations are completed, start the engine.

CUSTOMER ASSISTANCE

The satisfaction and good will of the owners of Detroit Diesel engines are of primary concern to Detroit Diesel and its distributor/dealer organizations. See Figure 41 for Detroit Diesel NAFTA On-Highway service regions.



Figure 41 Detroit Diesel NAFTA On-Highway Service Regions

NAFTA ON-HIGHWAY SERVICE REGIONS

**DETROIT DIESEL REGIONAL
SALES OFFICES**

NORTHEAST REGION

Detroit Diesel
Powder Mill Plaza, Suite 3A
51 Gibraltar Drive
Morris Plains, NJ 07950-1274
Phone: 973-492-6555
Fax: 973-267-5922

CENTRAL REGION

Detroit Diesel
9255 Indian Creek Parkway, Suite 850
Overland Park, KS 66210
Phone: 678-570-2389

SOUTHERN REGION

Detroit Diesel
3325 Paddocks Parkway, Suite 230
Suwanee, GA 30024
Phone: 678-341-6100
Fax: 678-341-6150

WESTERN REGION

Detroit Diesel
7700 Irvine Center, Suite 275
Irvine CA 92618
Phone: 949-753-7710
Fax: 949-753-7711

CANADA REGION

Detroit Diesel of Canada, Ltd.
150 Dufferin Ave., Suite 701
London ON N5A 5N6
Phone: 519-661-0149
Fax: 519-661-0171

**DETROIT DIESEL REGIONAL
SERVICE OFFICES**

NORTH EASTERN REGION

Detroit Diesel
13400 Outer Drive West
Detroit, MI 48239-4001
Telephone: 313-592-5420
Fax: 311-592-5887

**NORTH CENTRAL & WESTERN
REGIONS**

Detroit Diesel
7700 Irvine Center, Suite 275
Irvine CA 92618
Phone: 949-753-7710
Fax: 949-753-7711

SOUTHERN REGION

Detroit Diesel
3325 Paddocks Parkway, Suite 230
Suwanee, GA 30024
Phone: 678-341-6100
Fax: 678-341-6150

CANADA REGION

Detroit Diesel of Canada, Ltd.
150 Dufferin Ave., Suite 701
London ON N5A 5N6
Phone: 519-661-0149
Fax: 519-661-0171

MEXICO REGION

Detroit Diesel Allison de Mexico, S.A.
Av. Santa Rosa 58
Col. Ampliacion Norte
San Juan Ixtacala, Tlanepantla
C.P. 54160, Edo de Mexico
Phone: 525-333-1802
Fax: 525-333-1870

Road Service in the U.S. or Canada

If you require road service for any reason in the U.S. or Canada, you may call the **1-800-445-1980** customer assistance phone number. An operator will assist you in determining what type of service is required. Not all problems are engine related and not all problems are covered by engine or vehicle warranties. *YOU MAY BE RESPONSIBLE FOR REPAIR EXPENSES.*

Before calling Customer Assistance, please do the following:

- Check coolant level
- Check fuel level
- Check DDEC fuses
- Check for fuel leaks
- Make sure manual shutoff valve (if installed) on the fuel filter adaptor, fuel processor body or fuel supply line is open.
- Check the oil level on the dipstick.
- Check diagnostic codes.

If you call, have the following information available:

- Engine serial number
- Vehicle make and model
- Odometer mileage (kilometers) or hourmeter hours

- Vehicle owner/company name

Working with Detroit Diesel Service Outlets

As the owner of a Detroit Diesel product you have a complete network of Detroit Diesel service outlets in the U.S. and Canada, plus many outlets worldwide that are prepared to meet your parts and service needs:

- Service by trained personnel
- Sales teams to help determine your specific power requirements
- In many areas, emergency service 24 hours a day
- Complete parts support including reliabilt® remanufactured parts
- Product information and literature

We recognize however, that despite the best intentions of everyone concerned, misunderstandings may occur. Normally, any situation that arises in connection with the sale, operation, or service of your product will be handled by the authorized service outlet in your area (in the U.S. and Canada check the Yellow Pages or service locator at www.detroitdiesel.com for the Detroit Diesel service outlet nearest you).

Detroit Diesel has established a three-step procedure that customers should follow when experiencing a problem with any Detroit Diesel Product or Part. Detroit Diesel fully realizes that ultimately the customer's concerns will be resolved at the Distributor/Dealer level and therefore encourages customers to follow the procedure outlined below:

Step One

Customers should discuss the problem with a member of management from the authorized service outlet. Frequently, complaints are the result of a breakdown in communication and can quickly be resolved by a member of management. If they have already discussed the problem with the Distributor or Dealer Sales or Service Manager, they should contact the General Manager.

Step Two

When it appears that the problem cannot readily be resolved at the Distributor/Dealer level without additional assistance, the Detroit Diesel Customer Support Center (CSC) should be contacted at 313-592-5800.

The information provided to the CSC will be forwarded to the appropriate Regional Product Support Manager. The customer will then be assisted

be a member of the Regional Product Support Managers staff, depending on the nature of his/her problem.

Prior to this contacting the CSC, the customer should have the following information available:

- Name and location of authorized service outlet
- Type, make and vehicle identification number of equipment
- Engine model and serial number
- Engine delivery date and accumulated miles/kilometers or hours of operation
- Nature of problem
- Chronological summary of engine's repair history

Step Three

If the customer is still not satisfied, he/she should present the entire matter in writing or by phone to:

Director of Technical Service or Manager, Service Operations BX5

Detroit Diesel
13400 Outer Drive, West
Detroit, Michigan 48239-4001
Phone: 313-592-5000
Fax: 313-592-5888

SPECIFICATIONS

This section lists the various *POWER COOL* engine products.

Center (313 592-5800) if you need this specific information.

Fuel and Lubricating Oil Filters

Consult with a Detroit Diesel Distributor to obtain the proper fuel filters and lubricating oil filters.

POWER COOL ENGINE PRODUCTS

Maintenance of the cooling system requires the chemical make-up of the system to be balanced.

OIL PAN CAPACITY

Engine oil capacity can vary, depending on the oil pan used and the engine application. Contact the Detroit Diesel Customer Support

POWER COOL Fully Formulated IEG Coolant

The part numbers and sizes of concentrated *POWER COOL* and pre-blended 50:50 *POWER COOL* are Listed in Table 18

Coolant Type	Part Number	Description
Concentrated	23512138	1 Gallon Jug – 6 Per Case
	23512139	55 Gallon Drum
	23529295	330 Gallon Tote
	23512140	Bulk Delivery – 1,000 Gallon Min.
Pre-Blended 50:50	23528203	1 Gallon Jug – 6 Per Case
	23518918	55 Gallon Drum
	23528544	330 Gallon Tote
	23513503	Bulk Delivery – 1,000 Gallon Min.

Table 18 *POWER COOL* Fully Formulated IEG Coolant

**POWER COOL 2000 and 3000
Supplemental Coolant Additive**

Coolant Type	Part Number	Description
For <i>Power Cool</i> IEG Coolant	23507858	Pint Bottle – 12 Per case
	23507859	Half Gallon Jug – 6 Per Case
	23507860	5 Gallon Pail
	23507861	55 Gallon Drum

Table 19 POWER COOL 2000 Supplemental Coolant Additive

Coolant Type	Part Number	Description
For <i>POWER COOL</i> IEG Coolant	23507854	Pint Bottle – 12 Per Case
	23507855	Half Gallon Jug – 6 Per Case
	23507856	5 Gallon Pail
	23507857	55 Gallon Drum

Table 20 POWER COOL 3000 Supplemental Coolant Additive

POWER COOL 3000
Supplemental Additive Coolant
Filters

Coolant Type	Part Number	Description
For <i>POWER COOL</i> IEG Coolant	23507545	4 Ounce (1 Pint Equivalent)
	23508425	8 Ounce (2 Pint Equivalent)
	23508426	12 Ounce (3 Pint Equivalent)
	23507189	16 Ounce (4 Pint Equivalent)
	23508427	32 Ounce (8 Pint Equivalent)
	23508428	53 Ounce (13 Pint Equivalent)

Table 21 *POWER COOL* 3000 Supplemental Additive Coolant Filters

POWER COOL Supplemental
Additive Need Release Coolant
Filters

Coolant Type	Part Number	Description
For <i>POWER COOL</i> IEG Coolant	NF2091	For 0 – 8 Gallon Systems
	23516489	For 8 – 20 Gallon Systems

Table 22 *POWER COOL* Supplemental Additive Need Release Coolant Filters

**POWER COOL Plus Extended
Life OAT Coolant**

Coolant Type	Part Number	Description
Concentrated	23519397	1 Gallon Jug – 6 Per Case
	23519394	55 Gallon Drum
	23519395	Bulk Delivery – 1,000 Gallon Min.
Pre-Blended 50:50	23519396	One Gallon Jug – 6 Per Case
	23519398	55 Gallon Drum
	23519399	Bulk Delivery – 1,000 Gallon Min.

Table 23 POWER COOL Plus Extended Life OAT Coolant

**POWER COOL Plus Extender
For Use With POWER COOL
Plus OAT Coolant**

Coolant Type	Part Number	Description
For Power Cool Plus	23519400	Quart Bottle – 6 Per Case

**Table 24 POWER COOL Plus Extender for Use with POWER COOL
Plus OAT Coolant**

**POWER COOL Cooling System
Cleaners**

Coolant Type	Part Number	Description
On-Line Cleaner	200164	On-Half Gallon Jug – 6 Per Case
	200105	5 Gallon Pail
	200155	55 Gallon Drum
Twin Pack	201549	Twin Pack – 2 Per Case

Table 25 POWER COOL Cooling System Cleaners

**POWER TRAC Coolant Testing
And Analysis Products**

Application	Part Number	Description
Indicates Nitrite, Molybdate & Glycol Levels	23519401	3-Way Coolant Test Strips (Single Foil Packs)
Indicates Nitrite, Molybdate & Glycol Levels	23519402	3-Way Coolant Test Strips (Bottle of 50)
Indicates Nitrite, Molybdate & Glycol Levels	23522774	3-Way Coolant Test Strips (Bottle of 10)
Complete IEG/IPG Coolant Analysis	23516921	Coolant Analysis Bottle (Carton of 6)
Organic Coolant Analysis	23523398	Laboratory Coolant Analysis Bottle (Carton of 6)

Table 26 Power Trac Coolant Testing and Analysis Products