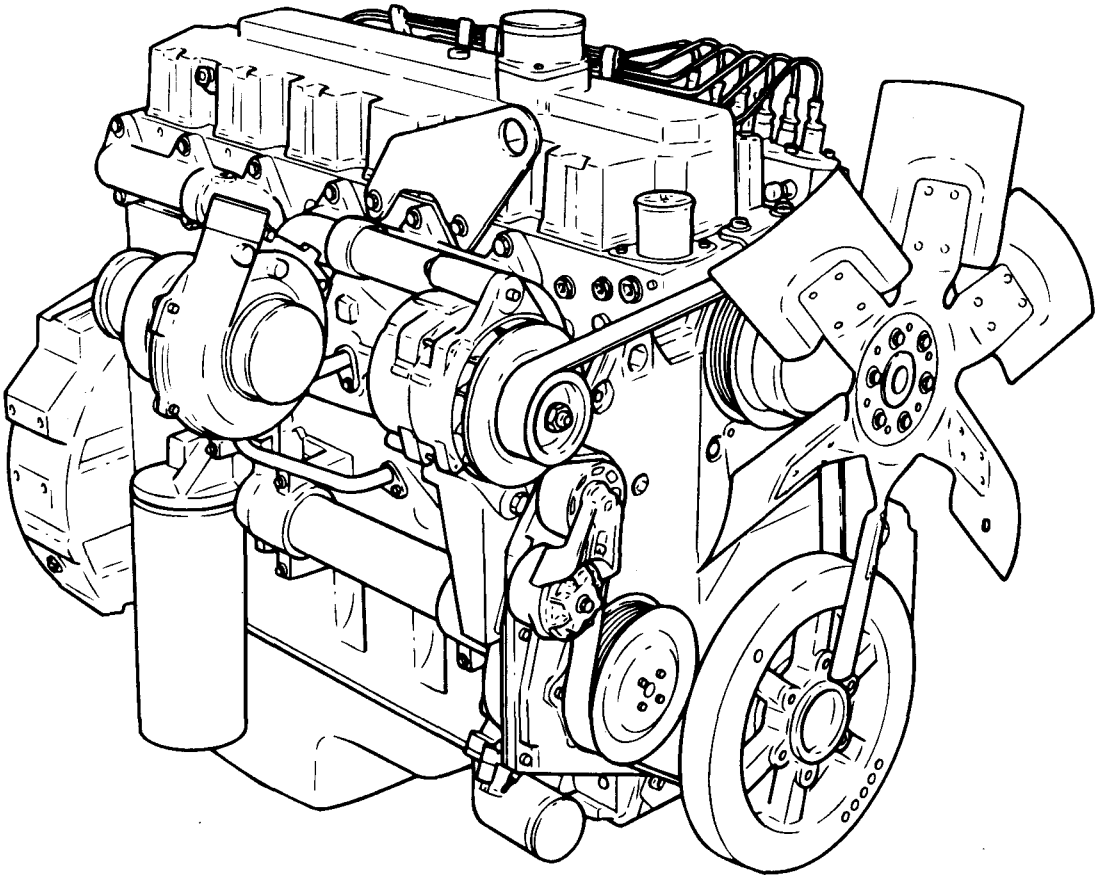
DETROIT DIESEL

Series 40



Engine Operator's Guide

To the Operator

The Series 40 is a new family of inline six-cylinder diesel engines offered by Detroit Diesel Corporation.

The design, development and manufacture of this engine is by Navistar International Transportation Corporation. It is made available for distribution by Detroit Diesel in the United States and Canada through agreement with Perkins Engines, Ltd.

This guide contains instructions on the safe operation and preventive maintenance of your Series 40 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 the 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.

WARRANTY

The applicable engine warranty is contained in the booklet entitled "Warranty Information for Series 40 Engines," available from authorized Detroit Diesel service outlets.

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

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ENGINE SERIAL NUMBER AND MODEL NUMBER LOCATIONS

The **engine serial number** is stamped on a pad on the left side of the crankcase (as viewed from the flywheel end) below the center of the intake manifold. The **engine model number** is shown on the emissions label mounted on the valve cover. The 13-digit engine serial number is structured as follows:

Build List W (Alphanumeric)	**Country of Origin** N	**Serial Sequence Number** 00000
WD — 6.7 T WE — 6.7 TA WF — 7.6 T WG — 7.6 TA WH — 8.7 T WJ — 8.7 TA	N = U.S.A.	000000

Injection Pump Number

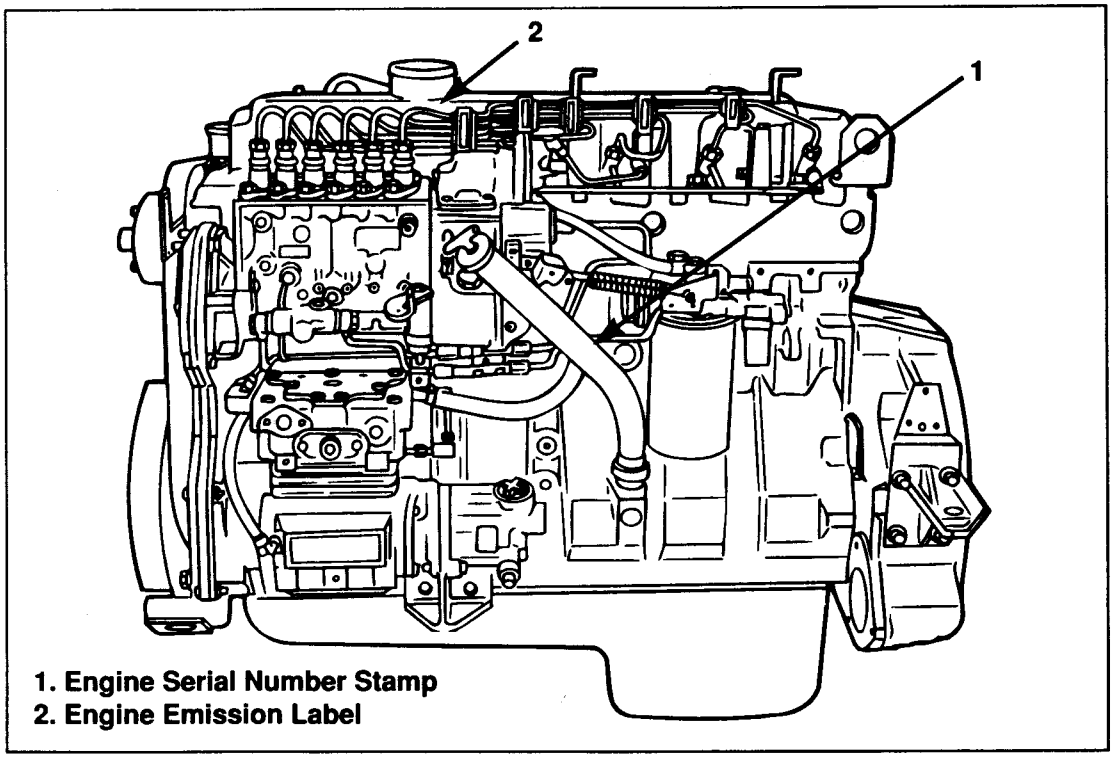
The **injection pump serial number** and pump part number are located on a plate attached to the outboard side of the pump. The **injection pump governor number** is shown on a plate attached to the fuel inlet end of the governor.

Emissions Label

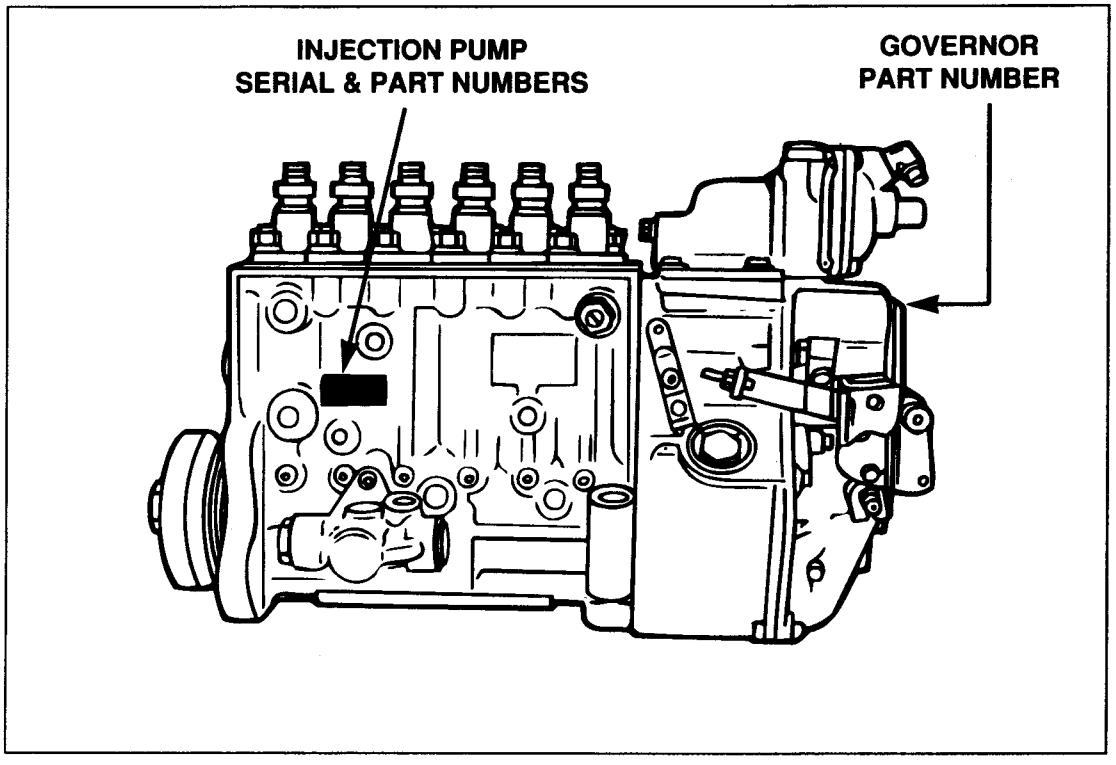
The **emissions label** certifies that the engine conforms to federal and certain state emissions regulations for its particular application. It also gives the operating conditions (fuel rate, injection timing, curb idle, valve lash, etc) and the specific application for which certification was made.

Turbocharger Number

The **turbocharger part number** appears on a plate attached to the back of the compressor housing.



Engine Serial Number Stamp and Emission Label Locations **10001**



Injection Pump and Governor Number Locations **EG-2695**

Engine, Injection Pump, Governor, and Turbocharger Identification

Please locate the engine serial and model numbers, the injection pump serial and part numbers, the injection pump governor part number, and the turbocharger part number (see previous page) and write them on the lines below. These numbers will provide a quick reference if service or parts are required.

Engine Orientation

The terms *front, rear, left,* and *right* must be understood when following instructions in this operator's guide. The *front* of the engine is the fan drive pulley end. The *rear* is the flywheel end.

The *left* and *right* sides of the engine are described when facing the engine from the flywheel (rear) end. The *left* is the injection pump side. The *right* is the oil cooler side.

Engine Serial Number _____

Engine Model Number _____

Injection Pump Serial Number _____

Injection Pump Part Number _____

Injection Pump Governor Number _____

Turbocharger Part Number _____

OPERATING INSTRUCTIONS

Preparations for Starting the Engine the First Time

When preparing to start a new or newly overhauled engine or an engine which has been in storage, perform all of the operations listed below. Failure to follow these instructions may result in serious engine damage. Before a routine start, see "Daily" checks in the **Engine Maintenance Schedule** (page 20).

> **CAUTION:**
>
> **When working near the engine, always remove loose items of clothing or jewelry that could get caught in a moving part of the engine and cause personal injury. Also wear safety glasses and hearing protection.**

Cooling System Checks

1. Make sure all drain cocks in the cooling system are installed and are closed tightly.
2. Remove the radiator pressure control cap and install genuine Detroit Diesel **Power Cool** antifreeze or equivalent ethylene glycol-base permanent antifreeze in the required concentration. Quality propylene glycol-base antifreeze with equivalent freeze, boilover, and inhibitor protection may be used as an alternative. Keep the coolant level at the bottom of the radiator filler neck to allow for expansion of the coolant. Fill the coolant recovery bottle. For detailed coolant recommendations refer to **How to Select Engine Coolant** (page 37).

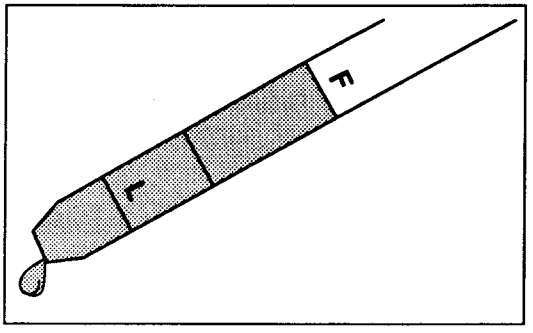
> **NOTICE:**
>
> To prevent engine overheating, entrapped air must be purged from the cooling system after initial fill. Refer to "After Engine Startup" (page 9).

3. Make sure the front of the radiator is unblocked and free of debris.

Lubricating 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 30 days or more may not be adequate when the engine is started for the first time. Lack of lubrication at start-up can cause serious damage to engine components.

To ensure an immediate flow of oil to all bearing surfaces at initial engine start-up, the lubrication system should be charged with a commercially available pressure pre-lubricator. After pre-lubricating, additional oil should be added to bring the level to the proper mark on the dipstick. Refer to **How to Select Lubricating Oil** (page 28) for lubricant requirements.



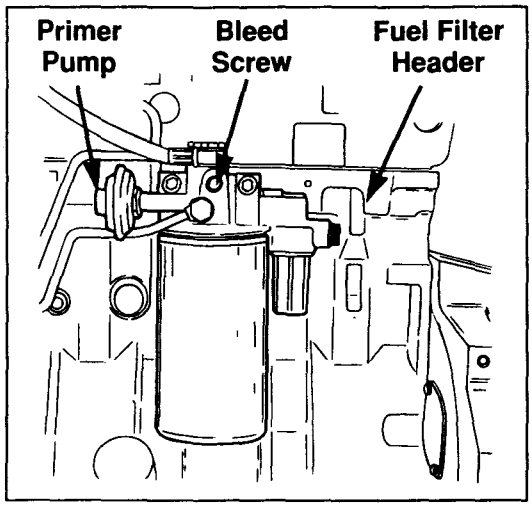
Check Lube Oil Level Before Starting

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. Lube oil diluted by water cannot provide adequate bearing protection at engine startup. For this reason, Detroit Diesel recommends replacing the lube oil and filter before starting an engine that has been in extended storage.

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

Fuel System Checks

1. Fill the tank 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. Refer to **How to Select Fuel Oil** (page 32) for fuel requirements.
2. If the engine is equipped with a fuel/water separator, drain off any water that has accumulated. Detroit Diesel recommends installing a fuel/water separator wherever water contamination is a concern.
3. If a fuel shutoff valve is installed, make sure it is open.
4. Prime the fuel system by loosening the bleed screw on the fuel filter header and operating the primer plunger on the filter header until a solid stream of fuel (no bubbles) flows from the bleed screw opening. Retighten the bleed screw.

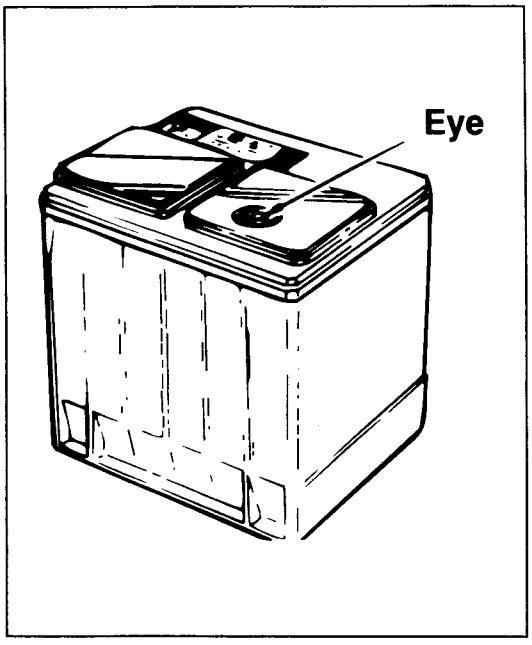


Bleed Air from Fuel System **EG-2679**

NOTICE:
Failure to prime the fuel system before initial engine start may result in stalling or erratic engine operation.

Other Checks

1. Check the drive belt to make sure it is in good condition (not cracked, torn, worn, or glazed).
2. Make sure cable connections to storage batteries are clean and tight. Check the hydrometer "eye" of maintenance-free batteries for charge. If lead-acid or low maintenance batteries are used, make sure battery electrolyte level is normal.



Check "Eye" of Maintenance-Free Batteries

3. Check turbocharger for signs of oil or exhaust leaks. If signs of leakage are found, determine the cause and correct before starting.
4. Check under the engine for fuel, lubricating oil, or coolant leaks. If leaks are found, determine the cause and correct before starting.
5. Make sure the transmission is filled to the proper level with the fluid recommended by the gear manufacturer.
6. Make sure a clean air cleaner element is installed and all air inlet piping is leak-free and fastened securely.

Starting the Engine

Before starting the engine the first time, perform the operations listed under **Preparations for Starting the Engine the First Time** (pages 5-7). If the engine has an emergency manual or automatic shutdown installed in the air intake system of the vehicle, make sure the control is set in the *open* position before starting. The turbocharger may be damaged if the engine is cranked with the shutdown closed.

If the engine is located in a closed room, start the room ventilating fan or open the windows, as weather conditions permit, so that ample air is available for the engine.

Starting Aid Chart

Starting Temperature	Starting Aid	Accelerator Position
Above +60°F (+15°C)	None	Not Depressed (Low Idle)
+60°F (+15°C) to +10°F (–12°C)	None	Fully Depressed
Below +10°F (–12°C)	Ether	Fully Depressed

Starting the Engine at Temperatures Above +10°F (-12°C)

1. Set the parking brake and place the transmission in neutral. If equipped with a Bowden wire shut-off control, place the engine shut-off in the *start* position.
2. Turn the ignition key to the *on* position and then to the *start* position. If the engine has push button starting, press and hold the starter button.
3. Engage the starter and crank the engine.

NOTE: At temperatures between +10° - +60° F (-12° - +16°C), fully depress the accelerator to provide starting fuel quantity when cranking.

4. If the engine fails to start within 15 seconds, release the starter switch and allow the starting motor to cool for 15 seconds before trying again. If the engine fails to start after 3 attempts, an inspection should be made to determine the cause.

NOTICE:
Starting motor damage may result if starting attempts are continued.

5. As soon as the engine starts, release the key or starter button. The key switch will return to the *on* position and the engine will continue to run.

NOTICE:
To prevent series starting motor damage, do not press the starter switch after the engine has started.

6. Allow the engine to run at about 1000 rpm and warm up for 3 to 5 minutes before applying a load. Check all gauges during warm-up.

NOTICE:
If the engine starts then stops, repeat the starting procedure. Crank engine for no more than 15 seconds at a time with a 15 second cool down period between attempts. If more than 3 attempts are required to start the engine, investigate for causes of non-start. Starting motor damage may result if starting attempts are continued.

Starting the Engine at Temperatures Below +10°F (-12°C) with Ether Injector

NOTICE:
Ether capsule starting aids are not recommended. Before starting, check the ether container to ensure that a supply of starting fluid is available under pressure. The ether injector valve inlet on the engine must be sealed against dirt entry at all times by having the ether container installed or by installing the dust cap provided with the engine.

⚠ CAUTION:
Ether starting fluid is highly flammable, toxic, and possesses sleep-inducing properties.

1. Set the parking brake, depress the clutch pedal (if equipped), and place the transmission in neutral. **Do not depress the accelerator pedal.**
2. If the engine is equipped with a Bowden wire shut-off control, place the engine shut-off in the *run* position.

3. Turn the ignition key to the *start* position or press and hold the starter button (if equipped) and simultaneously press the ether injection switch button. Allow one or two seconds for the ether injection system to fill. Then, with the engine cranking, release the ether injector switch button to inject a measured shot of ether into the engine.

4. Depress the accelerator to the floor (full speed position) to provide starting fuel quantity.

NOTICE:
Do not release the ether *before* the engine is cranked. Releasing ether into the cylinders before the engine is cranked may damage cylinder components when the engine starts due to uncontrolled combustion of this highly volatile fluid.

5. When the engine starts, release the key or start button immediately. Release the accelerator and reduce engine speed to 1,000 rpm or less.

6. Allow the engine to warm up from 3 to 5 minutes before applying a load. Check all gauges during warm-up until all systems reach normal operating temperature.

NOTICE:
In extremely cold ambient temperatures, if initial engine operation is rough or the engine dies, inject a shot of ether *while the engine is running* to facilitate smooth operation. To avoid engine overspeeding and/or possible damage, *do not inject ether into a warm engine (coolant at normal operating temperature of 170 - 200° F or 77 - 93° C).*

After Engine Startup

Oil Pressure - Within seconds after starting, engine oil pressure should exceed 10 psi (69 kPa) *minimum.* If oil pressure does not meet this minimum limit, stop the engine, locate and correct the cause.

NOTICE:
To avoid engine damage, shut down the engine if oil pressure is not registered on the gauge within 20 - 30 seconds.

After the engine has reached operating temperature, oil pressure should be within a range of 20 - 50 psi (138 - 345 kPa) at high idle rpm. If oil pressure does not fall within this range with the engine warm, stop the engine, locate and correct the cause

NOTICE:
If the oil pressure gauge fluctuates or drops to 40 psi (276 kPa) or less at 2400 rpm under load, stop the engine immediately, determine the cause, and correct.

Leaks - Look for coolant, fuel, or lubricating oil leaks at this time. If any are found, shut down the engine immediately and have leaks corrected after the engine has cooled.

Transmission - While the engine is idling, check the transmission for proper oil level and add recommended oil as required.

Cooling System - Entrapped air must be purged after the cooling system is filled. To do this, allow the engine to warm up without the pressure cap installed. With the transmission in neutral, increase engine rpm above 1,000 rpm and add coolant as required. Install the pressure cap after the coolant level has stabilized at the bottom of the radiator tank filler neck. Refill the recovery bottle as needed if coolant is drawn into the engine while purging the air.

If all of the coolant is drawn out of the recovery bottle when the engine cools, remove the pressure cap from the radiator and check to make sure the coolant level is at the bottom of the filler neck. Add coolant as required, replace the pressure cap, and fill the recovery bottle to the "Full Cold" level, or no more than one-quarter of its volume. Do not overfill the recovery bottle, since this can result in spillage as the coolant expands during engine operation.

NOTICE:
Failure to properly fill the cooling system and purge it of air can result in engine overheating and serious engine damage.

Crankcase - If engine oil was replaced, stop the engine after normal operating temperature (180 - 202°F (82 - 94°C) has been reached. Allow oil to drain back into the crankcase for approximately 15 — 20 minutes and check the oil level. If necessary, add oil to bring the level to the *full* mark on the dipstick. Use the heavy-duty oil specified in **How to Select Lubricating Oil** (page 28).

Turbocharger - Make a visual inspection of the turbocharger for oil or exhaust leaks, excessive noise, or vibration. Stop the engine immediately if a leak or unusual noise or vibration is noted.

NOTICE:
To avoid possible engine damage, do not restart the engine until the cause of the noise or vibration has been investigated and corrected.

Stopping the Engine

1. Reduce engine speed to normal idle and put all shift levers in the *neutral* position.
2. Let the engine idle with no load for 3 to 5 minutes. This allows the engine to cool and permits the turbocharger to slow down. After 3 to 5 minutes, shut down the engine.

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

Shutdown Warning Light or Buzzer

Vehicles may be equipped with an automatic shutdown system which stops the engine in the event of high coolant temperature or low engine oil pressure. A warning light on the instrument panel along with a buzzer or bell will indicate these conditions. If coolant temperature and/or oil pressure continue to exceed normal

levels beyond a certain point, the engine will automatically shut down. Most systems have an override feature which allows the engine to be restarted so that the vehicle can be moved to a safe off-road location. Under these conditions, the engine should be run no longer than absolutely necessary.

Extended Idling Periods

Normal low idle speed for Series 40 engines is 650 ± 50 rpm. If operation of the engine includes extended periods of idling, set idle speed between 900 and 1,000 rpm during these periods. Diesel engine efficiency is improved when cylinder temperature remains high. Return the engine to the required low idle speed before resuming normal operation.

Avoid excessive idling, especially at low engine rpm. If cylinder temperatures are too low, the following may occur:

1. Unburned fuel may build up and cause exhaust "slobber" in exhaust manifolds and piping.
2. If cylinder temperatures are too low to allow complete combustion, unburned fuel will wash lubricating oil from the cylinder sleeves, resulting in dilution of the lubricating oil and reduced lubricant efficiency.
3. Carbon will form on injector tips, causing nozzle plugging.
4. Carbon will build up on the turbine wheel of the turbocharger, causing reduced turbocharger efficiency.

Cold Weather Operation

Observe the following instructions when operating the engine in temperatures of 32° F (0° C) or lower:

1. Make sure batteries are of sufficient size and are fully charged. Make sure all other electrical equipment is in optimum condition.
2. Use genuine Detroit Diesel **Power Cool** antifreeze or equivalent ethylene glycol-base antifreeze solution in the required concentration to protect against freezing and cooling system corrosion. Quality propylene glycol-base antifreeze solution with equivalent freeze, boilover, and inhibitor protection may be used as an alternative. Install required cooling system filter/inhibitor element.
3. At the end of each daily operation, drain water from the water separator (if equipped) to prevent freezing. Fill the fuel tank to prevent condensation.
4. Use the required viscosity cold weather lubricating oil and check crankcase for proper level. See **How to Select Lubricating Oil** (page 28) for lubricant requirements.
5. At temperatures of -4° F (-20° C) and below, use a crankcase-mounted coolant heater to improve cold weather starting.
6. If operating in arctic temperatures of -20° F (-29° C) and below, consult with an authorized Detroit Diesel service outlet for information on special cold weather equipment and operating precautions.

Hot Weather Operation

1. Check electrolyte level in non-maintenance free batteries and add water as required.
2. Use genuine Detroit Diesel **Power Cool** antifreeze in the required concentration to protect against overheating and cooling system corrosion. Quality propylene glycol-base antifreeze solution with equivalent freeze, boilover, and inhibitor protection may be used as an alternative. Install required cooling system filter/inhibitor element.
3. At the end of each daily operation, drain water from the water separator (if equipped). Refill the fuel tank to prevent condensation.
4. Keep external surfaces of the engine, radiator, and accessories clean to avoid dirt buildup.

Emergency Starting - Engine Out of Fuel

Use the following procedure to restart the engine if the engine has run out of fuel:

1. Refill the fuel tank with clean diesel fuel.
2. Loosen the bleed screw at the fuel filter header. Refer to **How to Replace the Fuel Filter** (page 35) for location of bleed screw.
3. Operate priming pump on the injector pump until solid fuel squirts from bleed screw hole. Close bleed screw.
4. Place injection pump shutoff lever in *run* position with electric shutoff or mechanical cable.
5. Start the engine.

NOTICE:
To avoid starter damage, do not crank the engine longer than 15 seconds at a time. Allow a 15 second starter cool-down period between starting attempts.

Emergency Starting - Low Battery Charge

Use the following procedure to start the engine of a vehicle with a "low battery" or one that will not crank the engine fast enough to start.

NOTICE:
Do not use this procedure if the battery of the disabled vehicle will not accept a charge or is frozen. Attempting to start the vehicle under these conditions may result in cranking system damage.

NOTICE:
If the battery is a maintenance-free type, do not attempt to jump start the engine. Charge or test the battery if the "eye" of the battery is bright or light yellow. Install a new battery if unable to recharge the old.

CAUTION:

The following procedure must be performed exactly as outlined. Failure to observe precautions and/or follow this sequence may result in injury to the face, eyes, body, limbs, and respiratory system caused by fire or acid from battery explosion. Property damage may also result.

1. Prevent shorting of the system by removing metal rings, watches, or jewelry and by not allowing metal tools to contact the positive (+) terminal of the battery.
2. Place the transmission of the disabled vehicle in neutral, set the parking brake, and turn the ignition to the *off* position.
3. Turn off lights, heater, air conditioner, and any other electrical loads in the disabled vehicle and the booster vehicle.
4. Wear eye protection if available, or shield eyes when near either battery.
5. Do not allow vehicle bodies or bumpers to touch.
6. Connect one end of the first jumper cable to the positive (+) terminal of the dead battery. Connect the other end to the positive (+) terminal of the booster battery.
7. Connect one end of the second jumper cable to the negative (-) terminal of the booster battery. Connect the other end to an engine bolt head or good metallic contact (ground) on the disabled vehicle.

CAUTION:

To avoid a spark, do not attach the cable end to the negative terminal of the disabled battery. A spark could cause exposion of gases normally present around the battery, resulting in battery rupture and possible personal injury and/or property damage.

8. Start the engine of the booster vehicle and allow it to run for a minute or two to help charge the battery of the disabled vehicle.
9. Turn the ignition of the disabled vehicle to the *on* position and attempt to start the engine.
10. As soon as the engine starts, remove jumper cables in reverse order of attachment (negative ground cable on newly started engine *first*, then negative cable, then positive cable).
11. Allow the engine to warm up before putting a load on the vehicle.

ENGINE SYSTEMS

Fuel System

The fuel system consists of the fuel injection pump, the injection pump governor, the fuel pipes, the injection nozzles, the fuel strainer and filter, and the fuel lines, and the fuel pipes.

Lubrication System

The lubrication system consists of the oil pump, oil cooler, oil strainer and filter, bypass and pressure regulator valves, oil temperature control valve, and lubricating oil lines.

Cooling System

A radiator/thermo-modulated fan cooling system is used. A centrifugal type fresh water pump circulates coolant within the engine. A full blocking thermostat controls the flow of coolant through the engine, oil cooler, and radiator.

Electrical System

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

Air System

Outside air is drawn through the air cleaner and into the turbocharger, where it is compressed. It then flows through the air-to-air charge cooler where it is cooled and then into the intake manifold and cylinders where it mixes with atomized fuel from the injector nozzles.

Exhaust System

Hot exhaust gas flowing from the exhaust manifold into the exhaust riser is used to drive the turbocharger.

Engine Warning System

CAUTION:

Vehicles may have automatic shutdown or powerdown devices installed as options by the vehicle manufacturer. The operator of this engine should know the extent of the warning system on his vehicle in order to bring it to a safe stop in the event of an engine malfunction. A description of the warning system and detailed instructions regarding its operation should be obtained from the owner, the seller, or the manufacturer of the vehicle. This information may also be obtained from any authorized Detroit Diesel service outlet.

To be confronted with a powerdown shutdown situation without knowing how these systems function could cause the vehicle to stop in an unsafe location, posing the possibility of damage to the vehicle and a threat to the safety of the operator.

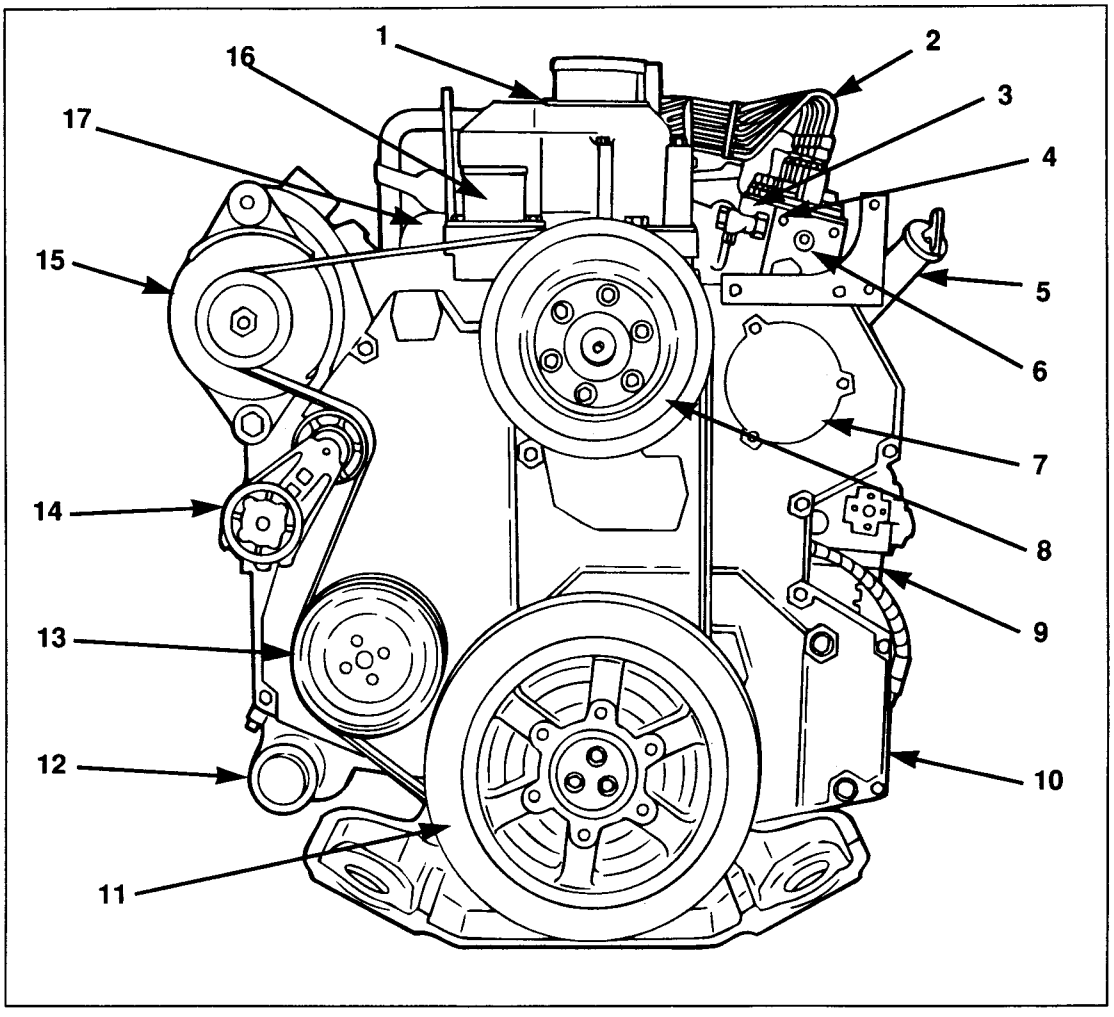


Figure 1. Major Component Location (Front) **EG-2682**

1. **Valve Cover/Intake Manifold**
2. **High Pressure Fuel Lines (6)**
3. **Fuel Supply Line from Fuel Filter to Fuel Injection Pump**
4. **Fuel Return Line from Fuel Injection Pump to Fuel Filter**
5. **Oil Fill Tube and Oil Level Gauge**
6. **Fuel Injection Pump**
7. **Fuel Injection Pump Timing Gear Access Cover**
8. **Fan Drive Pulley**
9. **Air Compressor**
10. **Front Cover**
11. **Vibration Damper**
12. **Water Inlet Tube**
13. **Water Pump Pulley**
14. **Fan Belt Auto Tensioner**
15. **Alternator**
16. **Water Outlet Tube**
17. **Exhaust Manifold**

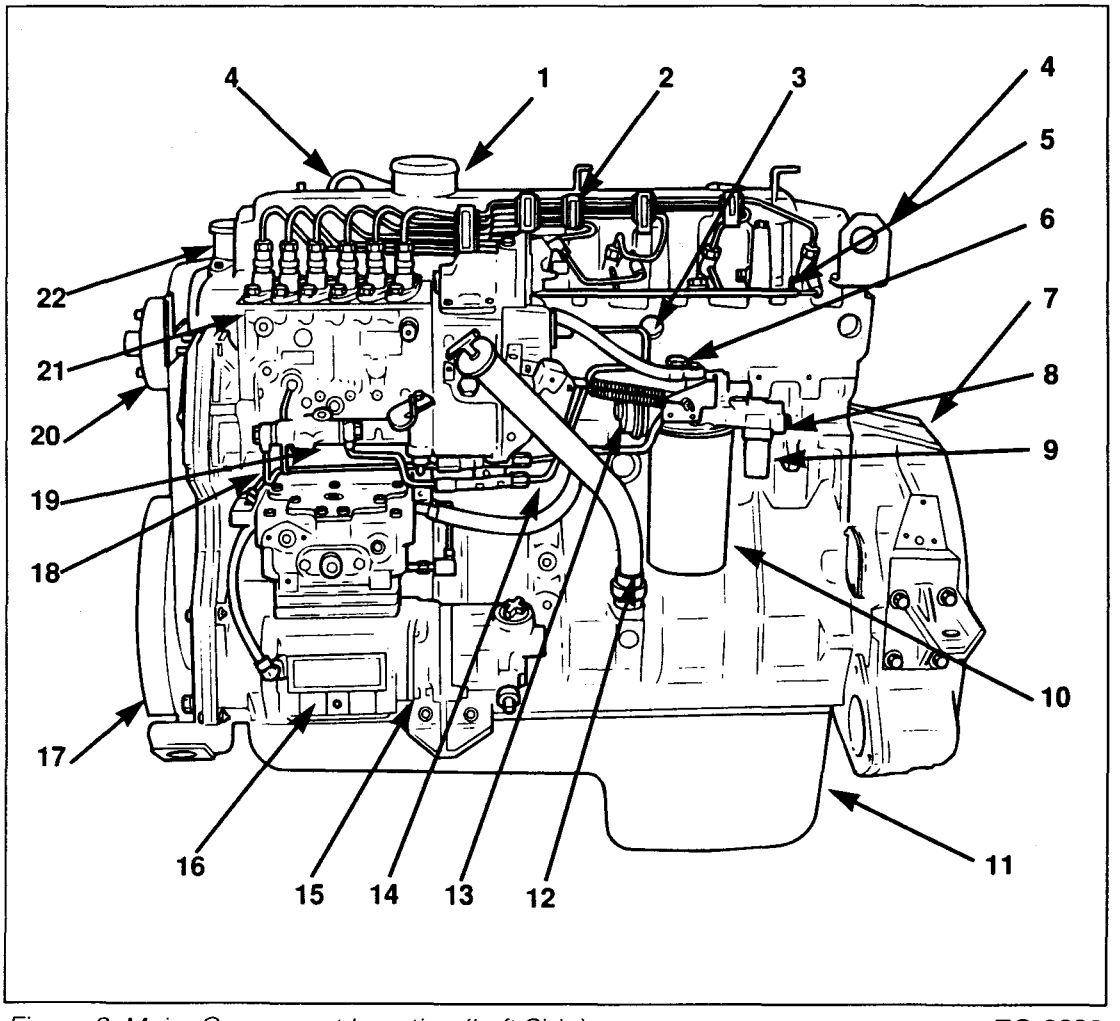


Figure 2. Major Component Location (Left Side) **EG-2686**

1. Valve Cover/Intake Manifold
2. High Pressure Fuel Lines (6)
3. Fuel Return Line from Fuel Injection Pump to Fuel Filter
4. Lifting Eye (2)
5. Low Pressure Fuel Return Hose
6. Fuel Supply Hose from Fuel Filter to Injection Pump
7. Flywheel Housing
8. Fuel Inlet Port
9. Strainer Assembly
10. Fuel Filter
11. Oil Pan
12. Oil Fill Tube and Oil Level Sight Gauge
13. Fuel Primer Pump
14. Fuel Line from Fuel Filter to Transfer Pump
15. Steering Pump
16. Air Compressor
17. Vibration Damper
18. Fuel Line from Transfer Pump to Fuel Filter
19. Transfer Pump
20. Fan Drive Pulley
21. Fuel Injection Pump
22. Water Outlet Tube

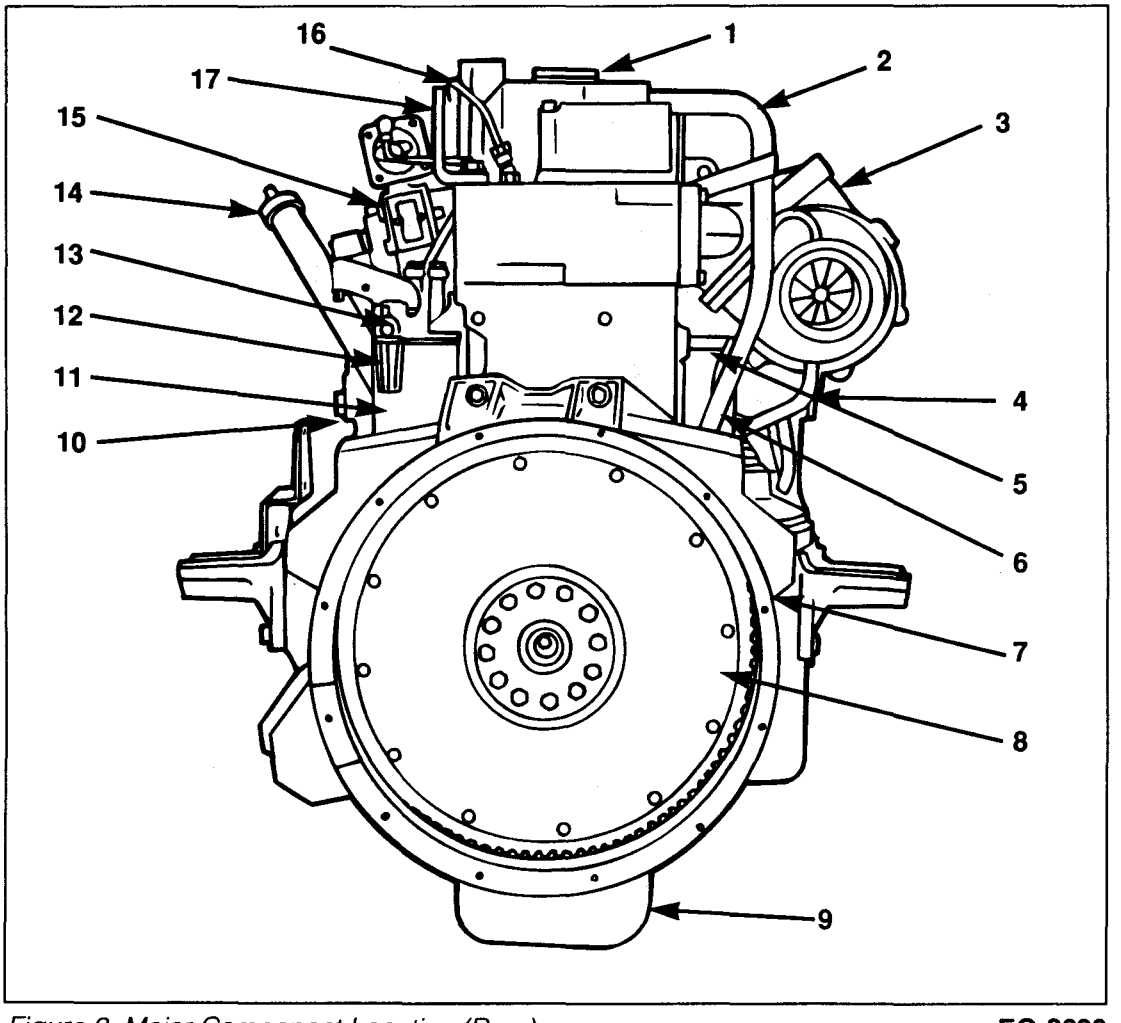


Figure 3. Major Component Location (Rear). **EG-2690**

1. **Valve Cover/Intake Manifold**
2. **Crankcase Breather Tube**
3. **Turbocharger Assembly**
4. **Turbocharger Oil Drain Tube**
5. **Water Coolant Return Tube**
6. **Turbocharger Oil Feed Tube**
7. **Flywheel Housing**
8. **Flywheel**
9. **Oil Pan**
10. **Air Compressor**
11. **Fuel Filter**
12. **Fuel Strainer Assembly**
13. **Fuel Supply Inlet Port**
14. **Oil Fill Tube And Oil Level Gauge**
15. **Fuel Injection Pump**
16. **High Pressure Fuel Lines (6)**
17. **Lifting Eye (2)**

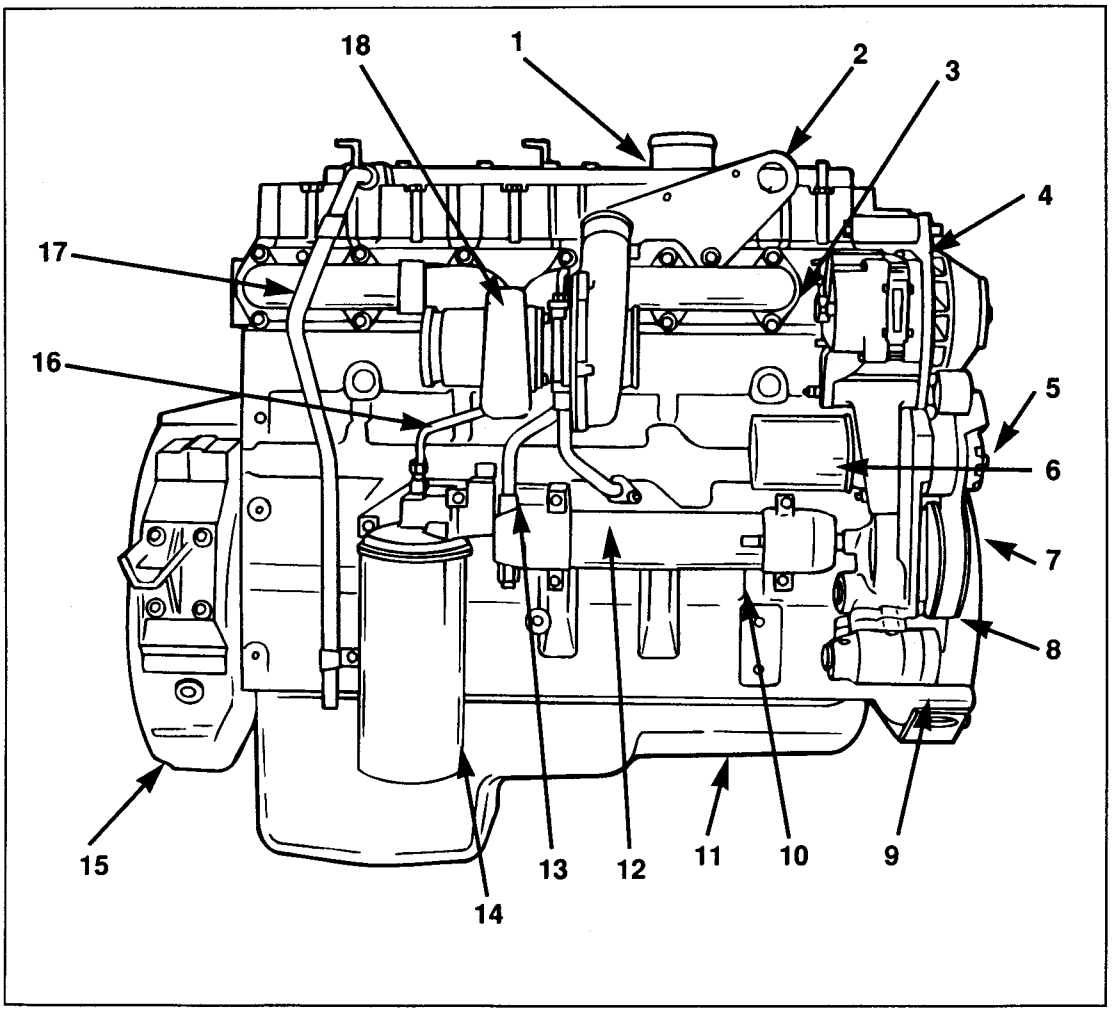


Figure 4. Major Component Location (Right Side). **EG-2692**

1. Valve Cover/Intake Manifold
2. Lifting Eye (2)
3. Exhaust Manifold
4. Alternator
5. Fan Belt Auto Tensioner
6. Coolant Filter
7. Vibration Damper
8. Water Pump Pulley
9. Water Inlet
10. Oil Cooler
11. Oil Pan
12. Turbocharger Oil Drain Tube
13. Water Coolant Return Tube
14. Oil Filter
15. Flywheel Housing
16. Turbocharger Oil Supply Tube
17. Crankcase Breather Tube
18. Turbocharger Assembly

ENGINE MAINTENANCE

DAILY	
1 - Check Lubricating Oil Level①	X
2 - Fill Fuel Tank①	X
3 - Check Coolant Level①	X
4 - Inspect Fuel Lines and Flexible Hoses③	X
5 - Drain Water Separator	X
6 - Inspect Air-to-Air Charge Cooler for Blockage	X
7 - Inspect Low Oil Pressure Alarm (if equipped)	X
8 - Inspect Air Cleaner Restriction Indicator②	X
9 - Check for External Fluid Leaks (Coolant, Lube Oil, Fuel)②	X

① Fill to required level.
② Service as required.
③ Replace if worn, damaged, or defective. See item in text.

ENGINE MAINTENANCE

Miles X 1,000	**12**	**24**	**100**	**120**	**150/200**	
Kilometers X 1,000	**19.2**	**38.4**	**160**	**192**	**240/320**	**Yearly**
Hours	**450**	**900**	**3,800**	**5,000**	**6,700-5,000**	
Months	**6**	**12**	**24**	**30**	**36**	
10 - Change Engine Lube Oil and Filter④	X					
11 - Inspect Throttle Linkage	X					
12 - Measure Low and High Idle	X					
13 - Inspect Drive Belt⑤	X					
14 - Inspect Air Intake Piping, Clamps⑤	X					
15 - Inspect High Temperature Coolant Alarm⑤	X					
16 - Measure Air Cleaner Restriction⑥		X				
17 - Replace Fuel Filter		X				
18 - Replace Coolant Filter/Conditioner Element		X				
19 - Drain, Flush Cooling System, Change Coolant			X			
20 - Inspect Vibration Damper⑤			X			
21 - Measure Crankcase Pressure			X			
22 - Pressurize Air Induction System, Check for Leaks⑥			X			
23 - Adjust Valve Lash				X		
24 - Measure Intake Manifold Pressure				X		
25 - Measure Injector Nozzle Opening Pressure and Spray Pattern					X	
26 - Inspect Turbocharger					X	
27 - Remove and Inspect Thermostat⑤						X
28 - Inspect Electrical System						X

④ Maximum oil drain interval with 0.05% sulfur content fuel. See item in text.
⑤ Replace if worn, damaged, or defective. See item in text.
⑥ Service as required. See item in text.

LUBRICATION AND PREVENTIVE MAINTENANCE INTERVALS

The following is intended as a guide for establishing preventive maintenance intervals. These recommendations should be followed as closely as possible to obtain long life and optimum performance from Series 40 engines.

The intervals shown apply only to the maintenance functions described. These functions should be coordinated with other regularly scheduled maintenance. The "Daily" instructions apply to routine or daily starting of an engine. They do not apply to a new engine or one that has not been operated for a considerable period of time. For new or stored engines, refer to **Preparations for Starting the Engine the First Time** (pages 5-7).

Preventive maintenance other than the "Daily" checks should be performed by *authorized* Detroit Diesel distributors or service outlets. *Authorized service outlets* have the trained personnel and proper tools to perform all services.

Item 1 - Check Lubricating Oil Level

Check the oil level daily with the engine stopped. If the engine has just been shut down and is warm, wait 15 - 20 minutes to allow the oil to drain back to the oil pan before checking. Add the proper grade of oil to maintain the correct level on the dipstick. All diesel engines are designed to use some oil, so the periodic additional of oil is normal.

NOTICE:
Do not overfill. Oil may be blown out through the crankcase dipstick tube or oil filler if the crankcase is overfilled.

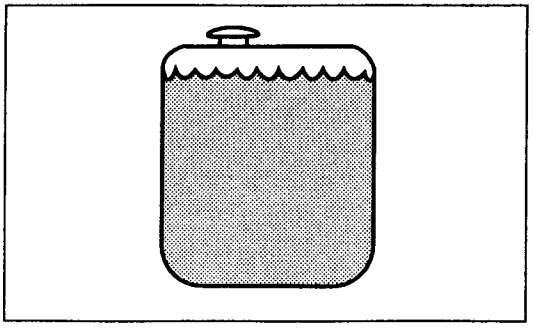
Before adding oil refer to **How to Select Lubricating Oil** (page 28).

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

Change lubricating oil and filters at the intervals shown in Item 10 in this section or in **When to Change Oil** (page 30).

Item 2 — Fill Fuel Tank

Keep the fuel tank filled to reduce condensation. Before adding fuel, refer to **How to Select Fuel Oil** (page 32).



Keep Tank Filled to Reduce Condensation

Refill the tank at the end of each day's operation to prevent condensation from contaminating the fuel. Condensation formed in a partially filled tank promotes the growth of microorganisms that can clog fuel filters and restrict fuel flow.

Open the drain at the bottom of the fuel tank every 30,000 miles or 48,000 km (300 hours for industrial applications) to drain off any water and/or sediment.

Every 12 months or 120,000 miles (192,000 km) (600 hours for industrial applications) tighten all fuel tank mountings and brackets. At the same time, check the seal in the fuel tank cap, the breather hole in the cap and the condition of the flexible fuel lines. Repair or replace the parts, as necessary.

NOTICE:

A galvanized steel tank should never be used for fuel storage, because the fuel oil reacts chemically with the zinc coating to form powdery flakes which can quickly clog the fuel filters and damage the fuel pump and injectors.

Item 3 — Inspect Fuel Lines, Flexible Hoses

Pre-Start Inspection—Make a visual check for fuel leaks at all engine-mounted fuel lines and connections, and at the fuel tank suction and return lines. Since fuel tanks are susceptible to road hazards, leaks in this area may best be detected by checking for accumulation of fuel under the tanks. Check hoses daily as part of the pre-start inspection. Examine hoses for leaks, and check all fittings, clamps, and ties carefully. Make sure that hoses are not resting on or touching shafts, couplings, heated surfaces including exhaust manifolds, any sharp edges, or other obviously hazardous areas. Since all machinery vibrates and moves to a certain extent, clamps and ties can fatigue with age. To ensure continued proper support, inspect fasteners frequently and tighten or replace them as necessary.

If fittings have loosened or cracked or if hoses have ruptured or worn through, take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but they can also result in added expense caused by the need to replace lost fluids.

CAUTION:

Personal injury and/or property damage may result from fire due to the leakage of flammable fluids such as fuel or lube oil.

Service life—A hose has a finite service life. With this in mind, all hoses should be thoroughly inspected at least every 500 operating hours (1,000 hours for fire-resistant fuel and lubricating oil hoses) and/or annually. Look for cover damage and/or indications of twisted, worn, crimped, brittle, cracked, or leaking lines. Hoses with their outer cover worn through or damaged metal reinforcement should be considered unfit for further service.

All hoses in and out of machinery should be replaced during major overhaul and/or after a maximum of five years of service. Fire resistant fuel and lube oil hose assemblies do not require automatic replacement after five years service or at major overhaul, but should be inspected carefully before being put back into service.

Item 4 - Check Coolant Level

CAUTION:

Do not remove the pressure control cap from the radiator or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. The sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding, eye injury, etc.) from the hot liquid.

Check the coolant level daily and maintain it near the bottom of the filler neck on the radiator. On some installations this is done by checking an overflow bottle or sight glass. Add coolant as necessary, but do not overfill. Before adding coolant, refer to **How to Select Engine Coolant** (page 39).

Make a daily visual check for cooling system leaks. Look for an accumulation of coolant when the engine is running and when it is stopped.

Coolant Drain Interval—Detroit Diesel recommends replacing coolant every 100,000 miles (160,000 km), 3800 hours, or 24 months, whichever comes first. At this interval, the coolant *must* be drained and the cooling system cleaned thoroughly. The cooling system should then be replenished with genuine Detroit Diesel **Power Cool** or an equivalent ethylene glycol-base antifreeze/water solution in the required concentration and required coolant filter inhibitor element should be installed. A quality propylene glycol-base antifreeze solution may be used if it provides required freeze, boilover, and inhibitor protection. Refer to **How to Select Engine Coolant** (page 39).

Item 5 - Drain Water Separator

If equipped, drain the fuel/water separator daily by loosening the valve on the bottom of the separator. Allow the water to drain out, then tighten the drain valve.

Item 6 - Inspect Air-to-Air Intercooler (Charge Cooler)

With the engine off, inspect the intercooler core daily. Look for debris and clogging of external fins. Remove any debris blocking the core.

Item 7 - Inspect Low Oil Pressure Alarm

With the engine off, inspect the low oil pressure alarm by turning the ignition key to the *on* position but do not start. The oil pressure will be zero with the engine off, so the red light and the buzzer should operate.

Item 8 - Inspect Air Cleaner Restriction Indicator

Check the air cleaner restriction indicator daily. If "popped" or with a yellow or red button showing the maximum air inlet restriction has been reached, replace the air cleaner element. Refer to **How to Service the Dry Type Air Cleaner** (page 38).

NOTICE:
Failure to replace air cleaner elements when required may result in engine overheating, inefficient fuel combustion, lack of power, and engine damage.

While checking the air cleaner, also look for damage to the air intake piping (holes or restrictions) and loose piping or air cleaner mounting clamps.

Item 9 - Inspect for External Leakage

Check for leaks daily. Look for coolant, lube oil, and fuel stains; wetness at the water pump; cracked or damaged hoses and loose clamps. Repair, replace, or retighten as required.

Item 10 - Change Engine Oil and Filter

Change engine oil and filters at the maximum oil drain intervals shown in the chart. If fuel sulfur content exceeds 0.05 mass percent for on-highway vehicles or 0.5 mass percent for all other applications, shorten oil drain intervals as directed in **When to Change Oil** (page 30). Refer to **How to Replace the Lube Oil and Filter** (page 31) for oil drain and filter change procedures.

Maximum Oil Drain Interval

Engine Application	Max Oil Drain Interval	Fuel Sulfur Mass %	Max. Filter Change Interval
On-Highway Vehicles	12,000 Miles 19,200 KM	0.05	12,000 Miles 19,200 KM
Industrial, Agricultural	450 Hours or 1 Year*	0.5	450 Hours or 1 Year*
Stationary Units Continuous	450 Hours or 1 Year*	0.5	450 Hours or 1 Year*
Stationary Units Standby	450 Hours or 6 Months*	0.5 0.5	450 Hours or 6 Months*

** Whichever comes first*

Item 11- Inspect Throttle Linkage

To ensure efficient throttle linkage operation, inspect throttle linkage for proper travel and cable operation at the required interval. Refer to **How to Inspect Throttle Linkage** (page 38) for procedure.

Item 12 - Measure Low and High Idle

To ensure proper engine idling, have your authorized Detroit Diesel service outlet check low and high idle speed settings at the required interval.

Item 13 - Inspect Drive Belt

Check belt and replace if cracked, worn, torn, brittle, greasy, or oil soaked. Refer to **How to Install Drive Belt** (page 37) for procedure.

Item 14 - Inspect Air Intake Piping

Check for damage to the air intake piping (holes, dents, or restrictions), loose piping , and loose or broken clamps. Check air cleaner housing for cracks. Retighten or have repaired, as required.

Item 15 - Inspect High Temperature Coolant Alarm

If the engine is equipped with a high temperature coolant alarm, have the alarm switch checked to ensure adequate warning if a low engine coolant condition should occur. Your authorized Detroit Diesel service outlet is properly equipped to perform this service.

Item 16 - Measure Air Intake Restriction

A *low power* or *poor fuel economy* concern is often due to a dirty air cleaner. As the air cleaner accumulates dirt, the restriction to air flow increases. If the service indicator is locked at maximum restriction, replace the air cleaner(s). Refer to **How to Service the Dry Type Air Cleaner** (page 38) for procedure.

NOTICE:
If low power or poor fuel economy is still experienced after changing the air cleaner(s), contact an authorized Detroit Diesel service outlet.

Item 17 - Replace Fuel Filters

Replace fuel filters at the required interval and if plugging occurs. Plugging is indicated if pump inlet pressure drops to 4" of mercury (14 kPa) or less. Refer to **How to Replace the Fuel Filter and Strainer** (page 35) for filter change procedures.

Item 18 - Replace Coolant Filter/Conditioner Element

Replace the coolant filter/conditioner element at the required interval . Refer to **How to Replace the Coolant Filter** (page 37) for procedure.

Item 19 - Drain, Flush Cooling System, Install New Coolant

Replace engine coolant with genuine Detroit Diesel **Power Cool** antifreeze or equivalent ethylene glycol-base antifreeze solution in the required concentration every 100,000 miles (160,000 km), 3,800 hours, or 24 months, whichever comes first. Quality propylene glycol-base antifreeze with equivalent freeze, boilover, and inhibitor protection may be used as an alternative. Drain and flush the cooling system thoroughly before adding new coolant. Refer to **How to Replace Engine Coolant** (page 41) for procedure.

Item 20 - Inspect Vibration Damper

A dented, damaged damper or one that has lost its fluid cannot provide proper crankshaft vibration dampening. At the required interval, have the vibration damper inspected by your authorized Detroit Diesel service outlet and replaced, if necessary.

NOTICE:
Failure to replace a damaged vibration damper when required may result in excessive crankshaft vibration, resulting in crankshaft, seal, and/or bearing damage.

Item 21 - Measure Crankcase Pressure

At the required interval, have crankcase pressure measured by your authorized Detroit Diesel service outlet.

Item 22 - Pressurize Air Induction System, Check for Leaks

At the required interval, have the air induction system pressurized and checked for leaks by your authorized Detroit Diesel service outlet .

Item 23- Adjust Valve Lash

At the required interval, have engine valve lash checked by your authorized Detroit Diesel service outlet.

Item 24 - Measure Valve Cover/Intake Manifold Pressure

At the required interval, have the valve cover/intake manifold pressure measured by your authorized Detroit Diesel service outlet.

Item 25 - Measure Nozzle Opening Pressure and Spray Pattern

At the required interval, have your authorized Detroit Diesel service outlet measure injector nozzle opening pressure and spray pattern.

Item 26 - Inspect Turbocharger

At the required interval, have your authorized Detroit Diesel service outlet inspect the turbocharger for dirt, wheel rub, wheel blade damage, excessive end play, and free wheel spin.

Item 27 - Remove and Inspect Thermostat

At the required interval, have your authorized Detroit Diesel service outlet remove and inspect the thermostat for required opening and closing temperatures.

NOTICE:
Failure to replace a defective thermostat when required may result in overheating and serious engine damage.

Item 28 - Inspect Electrical System

Inspect the electrical system at the required interval. Also check battery cables and electrical connections for looseness, broken insulation, rubbing or chafing. Retighten, replace, or reposition, as required. Check the serpentine drive belt for wear. Replace as required. Refer to **How to Install the Drive Belt** (page 39) for replacement procedure.

"HOW TO" SECTION

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

NOTICE:

The manufacturer's warranty applicable to Series 40 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.

A. How to Select Lubricating Oil

Lubricant Selection in North America

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 all Detroit Diesel engines is selected based on SAE viscosity grade and API (American Petroleum Institute) service designation. Only oils licensed to display the American Petroleum Institute (API) symbol shown should be used.

Lubricant Requirements

SAE Viscosity Grade: 15W-40
API Classification: CF-4
HT/HS Viscosity:
3.7 cP minimum

Lubricants meeting these criteria have provided maximum engine life when used in conjunction with specified oil drain and filter maintenance schedules.

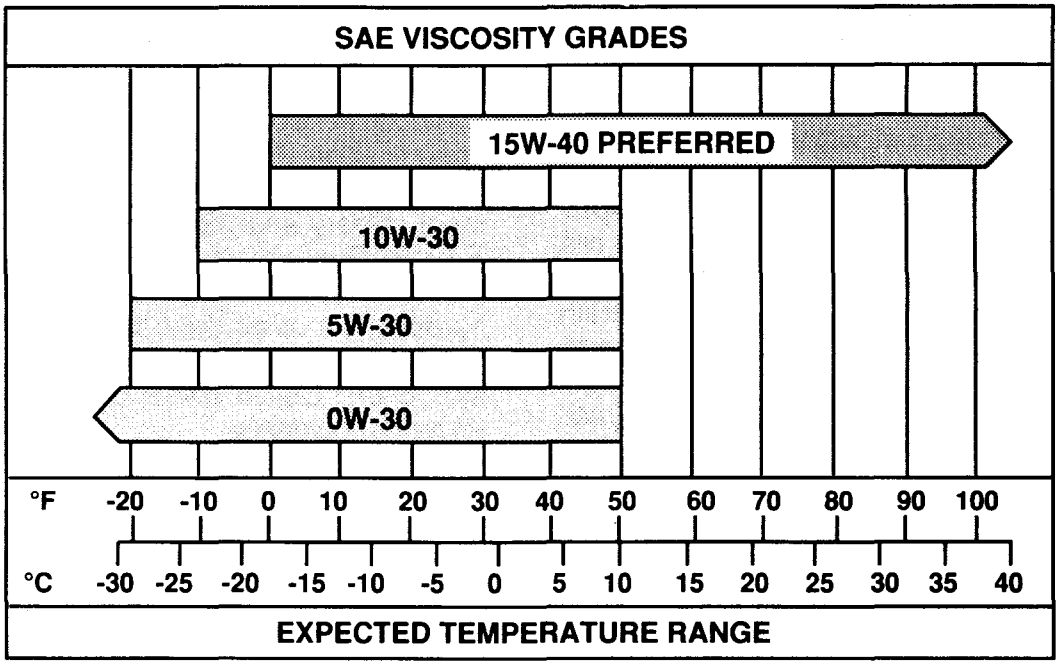
API Performance category CF-4 represents an enhanced level of lubricant performance over the API CE category which it replaces. Lubricants meeting this new performance level are preferred for use in all four-stroke cycle engines.

NOTICE:

Monograde oils should not be used in these engines regardless of API Service Classification.

Oil Viscosity

SAE 15W-40 grade lubricating oil is preferred when engines are operated in ambient temperatures of 0° F (-18° C) or above. Colder temperatures require lower viscosity oils to ensure good flow during starting. Operating in temperatures below 0° F (-18° C) may require the use of lower viscosity oils to ensure good flow during starting .



Based upon the ambient temperature range expected before the next oil change, use the chart above to select the proper viscosity grade.

NOTICE:
Using viscosity grades other than these or using viscosity grades outside the recommended temperature ranges may cause engine damage.

NOTE: Some increase in oil consumption may be expected when SAE 10W-30, 5W-30, or 0W-30 are used. Check oil level more frequently and add oil as required.

When the use of high sulfur fuel (greater than 0.5 mass percent sulfur) is unavoidable, higher alkalinity lubricants are recommended. High sulfur fuels require modification to oil drain intervals. For further information, contact an authorized Detroit Diesel Distributor.

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 Use of Supplemental Additives

Lubricants meeting the Detroit Diesel specifications outlined in this publication already contain a balanced additive treatment. The use of supplemental additives such as break-in oils, top oils, graphitizers and friction-reducing compounds, 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.

Lubricant Selection Outside North America

Although the API service classification system is generally utilized worldwide, lubricants meeting Detroit Diesel requirements may not be marketed in all areas of the world. Selection of lubricants in these situations should be made based on viscosity grade first, ash content second, and performance specification third. Oils meeting API CD or CC may be used if they also meet military specification Mil-L-2104 E or F. Oils which meet European CCMC D4 or D5 may also be used. Modification of oil drain interval may be necessary, depending on fuel quality. Contact Detroit Diesel Corporation for further guidance.

B. When to Change Oil

The length of time an engine may operate before an oil change depends upon the lubricant and the fuel used, engine oil consumption, and the operating cycle. The following table lists the maximum interval at which the engine may operate before the oil and filter must be changed. Oil analysis may be used to determine if this interval should be shortened, but should not be used to lengthen the interval.

Maximum Oil Drain Interval

Engine Application	Max Oil Drain Interval	Fuel Sulfur Mass %	Max. Filter Change Interval
On-Highway Vehicles	12,000 Miles 19,200 KM	0.05	12,000 Miles 19,200 KM
Industrial, Agricultural	450 Hours or 1 Year*	0.5	450 Hours or 1 Year*
Stationary Units Continuous	450 Hours or 1 Year*	0.5	450 Hours or 1 Year*
Stationary Units Standby	450 Hours or 6 Months*	0.5 0.5	450 Hours or 6 Months*

** Whichever comes first*

These oil drain intervals are based on the use of diesel fuel with a maximum sulfur content of 0.05 mass percent for on-highway vehicles and 0.5 mass percent for all other applications. If sulfur content exceeds these limits, reduce oil change intervals as follows:

Sulfur Content (Mass Percent)	Oil Change Interval
0.05% and Below	Normal
0.05% to 0.5%	3/4 Normal
0.5% to 1.0%	1/2 Normal

NOTE: It is not necessary to reduce filter change intervals when oil change intervals are reduced. As long as the engine is not operated in extremely dusty or dirty conditions, change oil filters at the normal recommended intervals shown on the chart.

Crankcase Refill Capacities

The crankcase refill capacities with rear sump oil pan are:

- 26 quarts (24.6 litres) with filter change
- 22 quarts (20.8 litres) without filter change

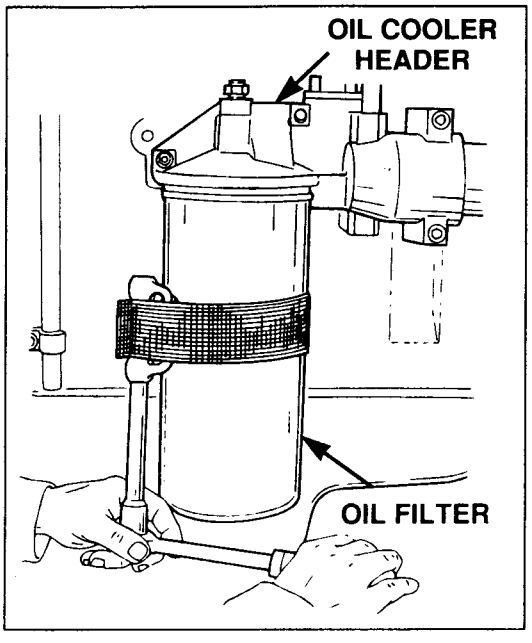
Disposing of Waste Oil

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

C. How to Replace the Lube Oil and Filter

Filters are an integral part of the lube oil 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. Refer to **Specifications** (page 50) for filter part number.

1. Run the engine until it reaches operating temperature, then shut it down.
2. Remove the drain plug and drain the oil pan. Replace drain plug with a new gasket, if needed.
3. Using strap wrench tool J 29917 (or equivalent) and a 1/2" drive socket wrench and extension, remove the spin-on filter from the oil cooler header by turning in a counter-clockwise direction.



Removing Oil Filter **EG-2676**

4. Dispose of the used oil and filter in an environmentally responsible manner, according to state and/or federal (EPA) recommendations.
5. Clean the filter adapter with a clean, lint-free cloth.
6. Lightly coat the filter gasket (seal) with clean engine oil.
7. Start the new filter on the adaptor and tighten by hand until the gasket touches the mounting adaptor head. Tighten an additional 1/2 to 3/4 turn by hand.

NOTICE:
Overtightening may crack or distort the filter adapter.

8. Add oil as required to bring the level to the *full* mark on the dipstick.
9. Start the engine, run at low idle, and check oil pressure. Lube oil pressure should be 20 - 50 psi (137 - 344 kPa) at 700 rpm. If there is no gauge reading, stop the engine immediately and investigate the cause.
10. Allow the engine to warm up to operating temperature and check for leaks. After any leaks have been corrected, stop the engine and allow the oil to drain back to the crankcase (about 15 - 20 minutes). Add oil as required to bring the level to the *full* mark on the dipstick. *Do not overfill.*

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

D. How to Select Fuel Oil

Quality—Fuel quality is an important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. Detroit Diesel engines are designed to operate on most diesel fuels marketed today.

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 service outlets.

Fuel Sulfur Content

The sulfur content of the fuel should be as low as possible to avoid premature wear of piston rings and liners, avoid excessive deposit formation, and minimize sulfur dioxide exhausted into the atmosphere. Limited amounts of sulfur can be tolerated, but the amount in the fuel and engine operating conditions can influence corrosion and deposit

formation tendencies. **The use of fuel containing greater than 0.5 mass percent sulfur will require more frequent oil changes.**

All 1994 model year on-highway diesel engines manufactured for use in the United States must meet a new reduced exhaust particulate content of 0.10 gram/horsepower-hour. To meet this requirement, all diesel fuel sold in the United States for **on-highway use** will be limited to 0.05% maximum sulfur content. The sulfur content of diesel fuel for **off-highway use** will continue to be specified at 0.5% maximum. Off-highway fuel will be dyed blue for identification.

NOTE: The use of low sulfur diesel fuel does not permit extension of engine lube oil drain and filter change intervals.

Cold Weather Operation

In cold weather, diesel fuel will form wax crystals which can restrict flow and clog filters. Fuel oil suppliers approach this problem several ways. Some provide a specially refined product, while others may use flow-improving additives or winter blends. Winter blended fuel will likely contain kerosene or 1-D fuel, which provide good cloud point temperatures, but result in a lighter fuel with a lower heat content. These fuels may be used, but they may result in reduced engine power and/or fuel mileage.

Fuel Cleanliness

Fuel should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water, or water-emulsion sludge, and cleaned if contaminated. Storage instability of the fuel can lead to the formation of varnish or sludge in the tank. The presence of these contaminants from storage instability must be resolved with the fuel supplier. If fuel is stored on site, the following is recommended:

1. Do not use galvanized steel or sheet metal tanks and galvanized pipes or fittings in any diesel fuel storage, delivery, or fuel system. The fuel oil will react chemically with the zinc coating, forming a compound which can clog filters and cause engine damage.
2. Keep the storage tank filler cap covered to prevent contamination by rain water.
3. Keep the tank clean, especially around the filler cap and tap areas.
4. Position the tank so that it is tilted slightly toward the bottom drain. This will make draining of accumulated water and sediment a little easier.
5. Minimize condensation by keeping the tank reasonably filled at all times.
6. After filling the fuel storage tank, wait a few hours before filling equipment tanks to allow contaminants to settle.

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.

Fuel Additives

Refiner/Blender Additives—Detroit Diesel engines are designed to operate satisfactorily on a wide range of diesel fuels. Some fuels may be marketed which contain performance additives and are identified as "premium" diesel fuels. Detroit Diesel engines do not require the use of such fuels; however, they may be used at the customer's discretion.

Aftermarket Supplemental Fuel Additives—There are many aftermarket products available today which are intended to be added to the fuel by the customer. These include a variety of independently marketed products which claim to be:

— Cetane Improvers
— Emission Control Additives
— Detergents
— Combustion Improvers
— Smoke Suppressants
— Cold Weather Flow Improvers

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.

Prohibited Additives

The following Fuel Additives are NOT allowed and MUST NOT be mixed with diesel fuel:

Used Lubricating Oil—Detroit Diesel specifically prohibits the use of drained lubricating oil in diesel fuel. Used lubricating oil contains combustion acids and particulate materials which can severely erode fuel injection 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.

Gasoline—

> **CAUTION:**
>
> **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. Tanks which contain such mixtures should be drained and cleaned as soon as possible.

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

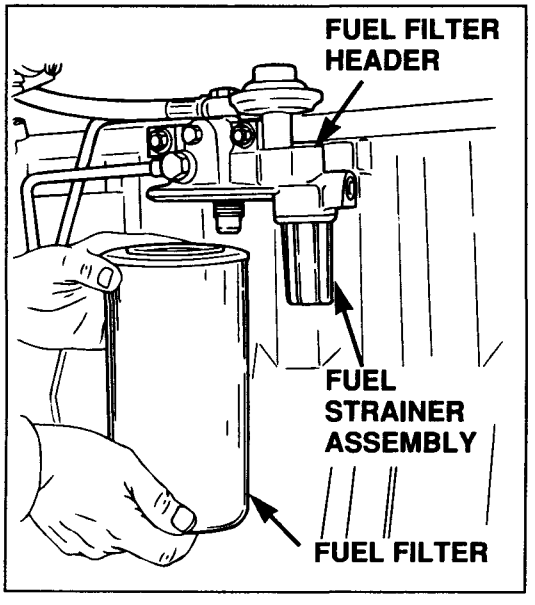
For more detailed information on fuel selection, refer to "Engine Requirements—Lubricating Oil, Fuel, and Filters" (form 7SE270), available from authorized Detroit Diesel service outlets.

E. How to Replace the Fuel Filter and Strainer

Filters are an integral part of the lube oil 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. Refer to **Specifications** (page 50) for filter part number.

NOTE: Fuel filters are normally replaced every 24,000 miles (38,400 km), 900 hours, or 12 months, whichever comes first. Using fuel with more than average impurities may require changing the filter and/or strainer at shorter intervals.

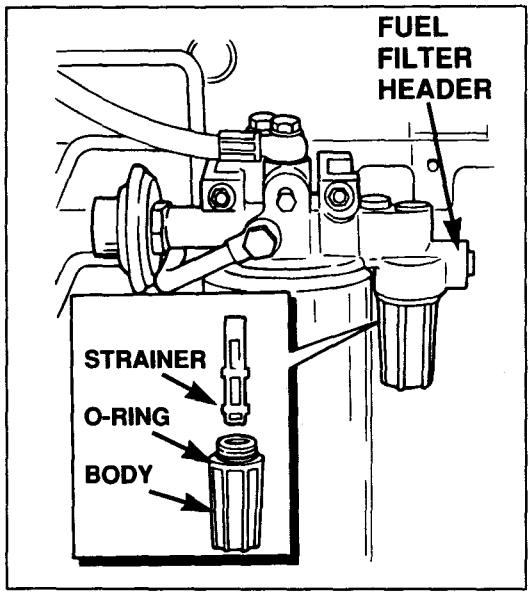
1. Using an appropriate filter strap wrench, remove the spin-on fuel filter from the header by turning in a counter-clockwise direction. Dispose of the element in an environmentally responsible manner, according to state and/or federal (EPA) recommendations.



Removing Fuel Filter **EG-2675**

2. Remove and replace the strainer assembly as follows:

   A. Using a 1 1/8 inch or 29 mm socket, remove the plastic cover from the filter/strainer header.



Removing Strainer Assembly **EG-2704**

B. Inspect the strainer for plugging or signs of damage and clean or replace as required. If serviceable, clean in pure mineral spirits and allow to air dry.

C. Reinstall the strainer and cover to the header assembly. Make sure the open end of the strainer is toward the header.

3. Install a new fuel filter as follows:

NOTICE:
Do not add fuel to the new filter before installing. Unfiltered fuel will contaminate the fuel system.

A. Lubricate the filter gasket with clean diesel fuel.

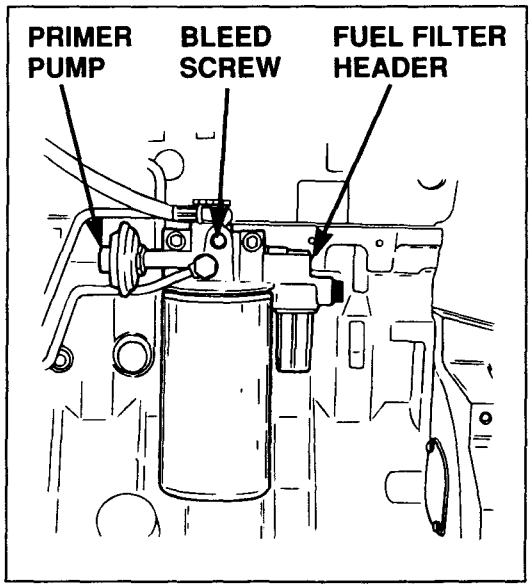
B. Thread the filter onto the header and tighten until the gasket touches the header.

C. Tighten by hand an additional 1/2 turn.

NOTICE:
Overtightening may crack or distort the filter header.

4. Always bleed the air from the fuel system to ensure fast engine start-up after filter replacement. Use this procedure:

A. Loosen the bleed screw at the fuel filter header.



Bleeding Air from Fuel System **EG-2679**

B. Operate the priming pump on the injection pump assembly until solid fuel squirts from the bleed screw hole. Close the bleed screw.

C. Place the injection pump shut-off lever in the *run* position with the electric shutoff or mechanical cable.

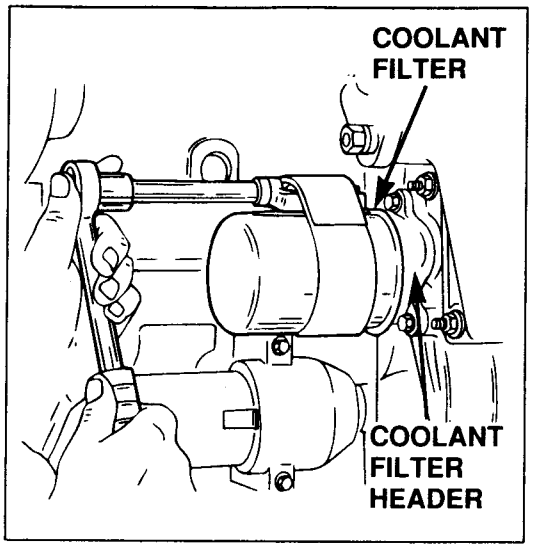
D. Start the engine.

NOTICE:
To avoid starter damage, do not crank the engine longer than 15 seconds at a time. Allow a 15 second starter cool down interval between starting attempts.

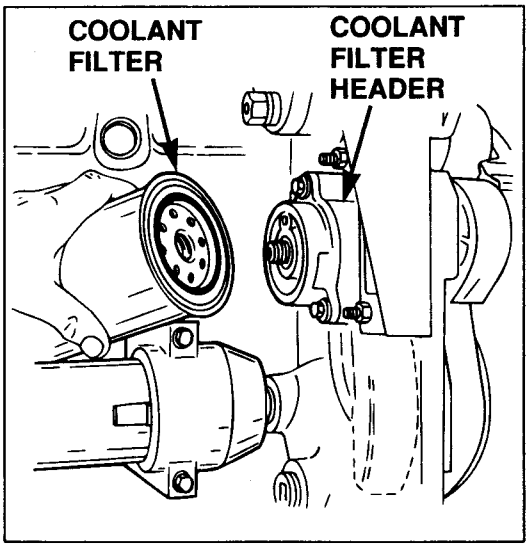
F. How to Replace the Coolant Filter

The spin-on coolant filter/conditioner element must be replaced every 24,000 miles (38,400 km), 900 hours, or 12 months, whichever comes first. This filter is located on the right-hand side of the engine, just rear of the front cover. Refer to **Specifications** (page 50) for required element part number. Replace element as follows:

NOTE: It is not necessary to drain the coolant from the engine before changing the filter. The filter header has two check valves to stop the flow of coolant when the filter is removed.



Removing Coolant Filter **EG-2677**



Installing Coolant Filter **EG-2678**

1. Using the appropriate filter strap wrench, remove the filter by turning in a counter-clockwise direction.
2. Apply a thin coat of coolant to the gasket of the new filter and thread the filter element onto the header.
3. Tighten by hand until the gasket touches the header. Tighten an additional 1/2 turn *by hand.*

NOTICE:
Overtightening may crack or distort the filter adapter.

G. How to Service the Dry Type Air Cleaner

Replace dry type air cleaner elements with new elements when the maximum allowable air cleaner restriction (25 inches of water or 6.2 kPa) has been reached, or annually. Some air cleaners are equipped with a restriction indicator which aids in determining the servicing interval. *Detroit Diesel does not recommend cleaning or reusing dry type air cleaner elements.*

NOTICE:

Failure to replace air cleaner elements when required may result in engine overheating, inefficient fuel combustion, lack of power, and engine damage.

Service the air cleaner as follows:

1. Remove the dirty air cleaner element and discard.
2. Clean any dirt from the air cleaner housing. Wipe or vacuum the dirt, if possible. Do not use shop air, since this may blow dirt into the engine.
3. Visually inspect the air cleaner housing for damage or distortion which could allow unfiltered air to enter the engine. Correct as required.
4. Install a new air cleaner element.
5. Reset the restriction indicator by pushing the reset button and releasing it. The red or yellow indicator will drop below the window so the gauge can be reused.

H. How to Inspect Throttle Linkage

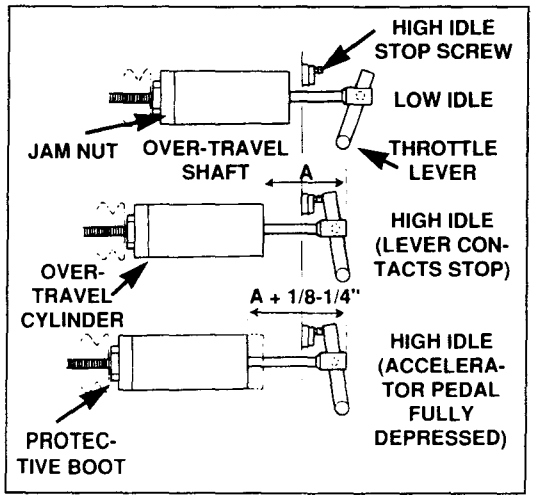
NOTICE:

Two people are required to properly check throttle cable operation and overtravel. One person visually inspects throttle cable movement, while the other depresses the accelerator pedal in the cab with the engine running and the transmission in neutral.

CAUTION:

To avoid possible personal injury when performing this check, set the parking brake or block the wheels to prevent vehicle movement.

1. With the engine running, transmission in neutral, parking brake set or wheels blocked to prevent vehicle movement, and accelerator pedal in cab *not depressed*, visually inspect the throttle lever. It should contact the low idle stop screw.



Checking Throttle Linkage

2. The person inspecting throttle cable movement should direct the operator in the cab to *slowly* depress the accelerator pedal. When the throttle lever just contacts the high idle stop ("A"), the observer should instruct the operator to stop depressing the accelerator pedal and hold that pedal position momentarily.
3. The observer should then direct the operator to continue depressing the accelerator pedal to full depression. The observer should see a throttle travel of 1/8 inch to 1/4 inch (3 mm to 6 mm).
4. If the throttle cable is not within specifications, have the linkage adjusted to required overtravel by an authorized Detroit Diesel service outlet.

I. How to Install the Drive Belt

Install a new belt as follows:

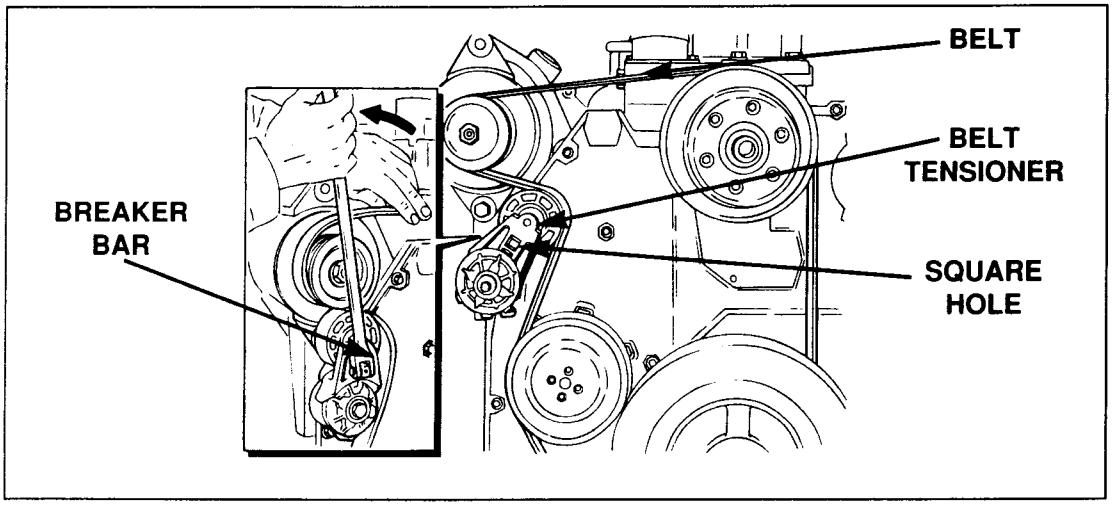
1. Place the belt around the pulleys and around the inside edge of the belt tensioner.
2. Install a breaker bar in the square hole of the belt tensioner.
3. Pull the breaker bar back and then allow it to move forward. The belt tension is automatically adjusted.
4. Remove the pry bar.

J. How to Select Engine Coolant

Antifreeze

Use genuine Detroit Diesel Power Cool antifreeze or an equivalent ethylene glycol-base coolant (low silicate formulation) that meets or exceeds the standard of either the GM 6038-M formulation (GM 1899-M performance), or ASTM D 4985 requirements. A quality propylene glycol solution may be used as an alternative if it provides required freeze, boilover, and inhibitor protection.

A 50% **Power Cool antifreeze**/water solution is normally used as a factory fill. Concentrations over 70% are not recommended because of poor heat transfer capability, adverse freeze protection and possible silicate dropout. Concentrations below 30% offer little freeze, boilover or corrosion protection.



Setting Belt Tensioner **EG-2680**

Although some coolants contain inhibitor packages, Detroit Diesel requires that a genuine *Fleetrite* coolant filter/inhibitor element be installed at initial fill and replaced at required intervals. See Specifications (page 50) for element number.

Antifreeze solution should be used year-round to provide freeze and boil-over protection as well as a stable environment for seals and hoses.

Coolant and inhibitor concentration must be checked at each oil change (150 hours or 15,000 miles [24,000 km] maximum). Adjust the concentration, if not at the proper protection level.

Mix coolant/water solution at the proper concentration before adding to the cooling system. This should prevent over- or under-coolant concentration problems.

Methyl alcohol-based antifreeze is not recommended for use in Detroit Diesel engines because of its effect on the non-metallic components of the cooling system and its low boiling point.

Methoxy propanol-based antifreeze is also not recommended for Detroit Diesel engines because it is not compatible with fluoroelastomer seals found in the cooling system.

Coolant Drain Interval

A cooling system properly maintained and protected with required inhibitors can be operated up to these intervals:

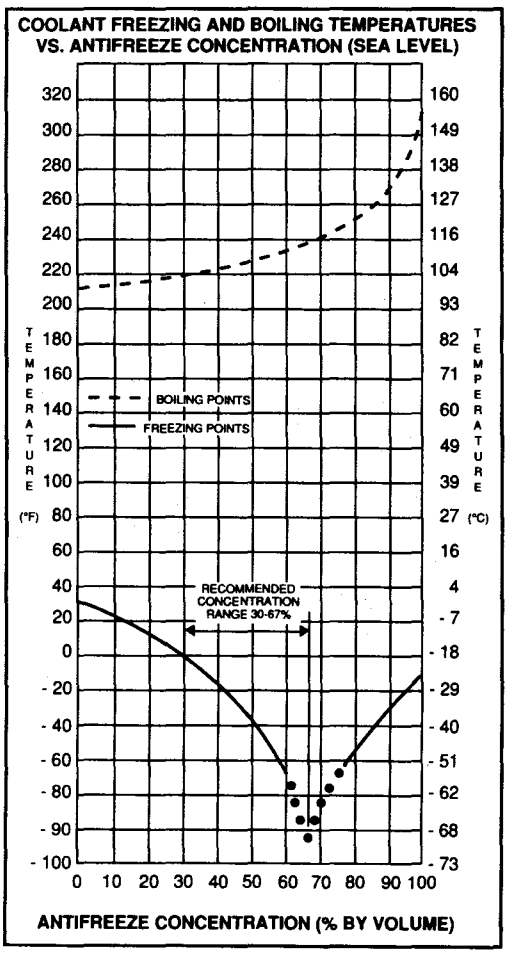
- **On highway — 24 months or 100,000 miles (160,000 km)***
- **Industrial, Gen Set — 24 months or 3,800 hours***

***Whichever comes first**

At these intervals the coolant must be drained and disposed of in an environmentally responsible manner, according to state and/or federal (EPA) recommendations, and the cooling system thoroughly cleaned.

Inspect all components that make up the cooling system and make necessary repairs at this time. Refill the cooling system with a recommended ethylene glycol-base coolant and water solution at the required concentration. Add required Detroit Diesel maintenance product cooling system inhibitors. After filling, run the engine until thermostat opens and top off the coolant to the recommended *full* level. Reinstall fill/pressure cap.

NOTICE:
Do not use sealer additives in the cooling system. The presence of the gumming and gelling material in stop-leak additives could cause plugging in the cooling passages, which will adversely affect the cooling system.



Coolant Freezing and Boiling Temperatures vs. Ethylene Glycol Antifreeze Concentration (Sea Level)

K. How to Replace Engine Coolant

NOTE: Use this procedure if the coolant is not to be recycled.

Drain, flush, and fill the cooling system as follows:

CAUTION:

Do not remove the pressure control cap from the radiator or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. The sudden release of coolant from a heated cooling system can result in a loss of coolant and possible personal injury (scalding, eye injury, etc.) from the hot liquid.

1. Make sure the vehicle is level so all the coolant can drain from the cooling system.
2. With the engine cold, remove the cooling system pressure cap and open the radiator drain. Remove the drain plug on the left side of the engine and the oil cooler drain plug from the rear of the cooler. Allow the coolant to drain
3. After all coolant has drained from the engine, replace drain plugs and close all drains.
4. Open the cab heater valve (if equipped) and all other chassis heater shutoff valves.
5. Fill the system with clean fresh water and install the radiator pressure cap.

NOTE: If the system is dirty or rusty, add a quality cooling system cleaner, such as Nalprep® 2001, or equivalent and follow instructions on the container.

6. Set the parking brake, start the engine, and allow it to operate at fast idle until the engine reaches its normal operating temperature.

7. Shut down the engine and allow it to cool.

8. With the engine cool, carefully remove the radiator pressure cap. Remove drain plugs and open all drains. When all the water is drained, replace the drain plugs and close all drains.

NOTE: Replace the coolant filter/inhibitor element with a new element at this time. Refer to **How to Replace the Coolant Filter** (page 37).

9. Slowly fill the cooling system with genuine Detroit Diesel **Power Cool** antifreeze or equivalent ethylene glycol-base antifreeze solution in the required concentration. A quality propylene glycol-base antifreeze solution may be used if it provides required freeze, boilover, and inhibitor protection. When the coolant reaches the bottom of the radiator filler neck, install the pressure cap.

NOTICE:

Do not mix ethylene glycol and propylene glycol-based antifreeze in the same engine. The operating characteristics of these coolants will be altered if mixed.

10. Set the parking brake, start the engine, and allow it to reach its normal operating temperature. Watch for engine overheating during this step.

11. After the engine reaches its normal operating temperature, shut it down and allow it to cool. With the engine cool, carefully remove the pressure cap, add sufficient coolant to fill the system, and replace the cap.

BASIC TROUBLESHOOTING

HARD STARTING

Probable Causes:

	Engine Will Not Rotate	Low Cranking Speed	Engine Cranks But Will Not Start
Low battery voltage	X	X	
Loose cranking motor connections	X		
Faulty cranking motor	X	X	
Faulty cranking motor switch	X	X	X
Internal seizure	X		
Improper lube oil		X	
Circuit breaker/electronic control malfunction			X
Fuse blown or missing			X
Insufficient Fuel Supply			
Air in fuel			X
Out of fuel			X
Loose fuel connections			X
Cracked fuel lines			X
Obstructed fuel filters/lines			X
Faulty fuel pump			X
Faulty injector operation			X
Restricted fuel-fitting missing			X
Installation/operation of fuel check valve or shut-off valve			X
Low Compression			
Worn intake and exhaust valves			X
Worn piston rings/liners			X
Leaking cylinder head gasket			X
Improper intake and exhaust valve adjustments			X

OBJECTIONABLE EXHAUST

Probable Causes:	Black or Gray Smoke	Blue Smoke	White Smoke
Damaged or dirty air cleaner	X		
Improper grade of fuel	X		
Excessive exhaust back pressure	X		
Misfiring cylinders			X
Lubricating oil not burned in cylinder (being burned in exhaust manifold or turbocharger)		X	
Faulty injection setting	X		
Faulty oil control rings		X	
Excessive installation angle		X	
Excessive oil in crankcase		X	
High ambient air temperature	X		
Thin air (high altitude	X		
Cetane rating of fuel too low			X
Air in the fuel system			X

ABNORMAL ENGINE OPERATION

Probable Causes:	Rough Running or Frequent Stalling	Low Power	Detonation
Misfiring cylinder	X	X	
Insufficient fuel	X	X	
High return fuel temperature	X	X	
Low compression	X	X	
High air inlet restriction/exhaust back pressure		X	
Engine application		X	
High air inlet temperature		X	
High altitude operation		X	
Incorrect engine gear train timing		X	
Low coolant temperature			X
Oil picked up by inlet airstream			X
Faulty injector operation			X

ABNORMAL OPERATING CONDITIONS

Probable Causes:	High Lubricating Oil Consumption	Low Oil Pressure
Loose connections	X	
Cracked lines	X	
Damaged gaskets or seal rings	X	
*Lube oil loss at breather tube	X	
*Lube oil loss at dipstick tube	X	
*Indicates high crankcase pressure		
Leaking oil cooler	X	
Leaking valve stem seals	X	
Worn/broken oil control rings	X	
Scored liner and/or piston	X	
Excessive engine installation angle	X	
Crankcase overfilled	X	
Oil in air tanks (air compressor malfunction)	X	
Plugged crankcase breather	X	
Damaged rocker cover gasket	X	
Oil level low		X
Improper engine oil viscosity (fuel in the oil)		X
Faulty oil pressure regulator valve		X
Worn crankshaft bearings		X
Worn camshaft or connecting rod bearings		X
Missing cup plugs in rocker arm shafts		X
Faulty oil pressure relief valve		X
Air leaks in oil pump (suction side)		X
Worn or damaged oil pump		X
Faulty oil pressure gage		X
Faulty electrical components (for gage)		X
Plugged oil orifice		X
Obstructed oil line		X

ABNORMAL COOLANT TEMPERATURES

Probable Causes:	Above Normal	Below Normal
Restricted cooling system passages	X	
Restricted radiator core passages	X	
Slipping fan drive belt	X	
Faulty temperature-controlled fan	X	X
Obstruction in front of radiator or intercooler	X	
Low coolant level	X	
Damaged hoses	X	
Faulty thermostat	X	
Faulty water pump	X	
Faulty radiator pressure cap	X	
Air in coolant	X	
Thermostat not fully closed		X
Leakage around thermostat seal		X

SERVICE PUBLICATIONS

The service manual covering Detroit Diesel Series 40 engines is shown below. Also listed are reference works which may be of interest to the owner/operator.

To purchase a copy of any of these publications, contact an authorized Detroit Diesel service outlet. Check the Yellow Pages under "Engines, Diesel" or refer to the Worldwide Distributor and Dealer Directory (form 6SE280) for the distributor or service outlet nearest you.

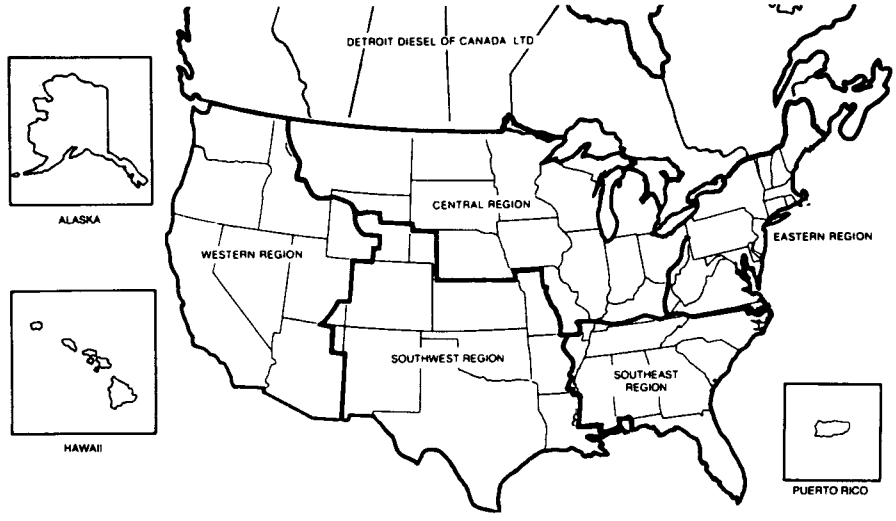
Description	Form No.
Series 40 Engine Service Manual	6SE44
Worldwide Distributor/Dealer Directory	6SE280
Lube Oil, Fuel, Filter Requirements	7SE270
Coolant Selections for Engine Cooling Systems	7SE298

CUSTOMER ASSISTANCE

The satisfaction and goodwill of the owners of Detroit Diesel engines are of primary concern to Detroit Diesel Corporation and its distributor/dealer organizations.

As the owner of a Detroit Diesel product you have a complete network of over 2,000 Detroit Diesel service outlets in the U.S. and Canada, plus many outlets worldwide that are prepared to meet your parts and service needs:

Identify the U.S. regional area from the map below:



EASTERN REGION
Long Branch, New Jersey
187 Monmouth Park Highway
West Long Branch, NJ 07764
Phone: (908) 222-1888
Fax: (908) 222-3411

SOUTHEASTERN REGION
Jacksonville, Florida
5105 Bowden Road
Jacksonville, FL 32245-6426
Phone: (904) 448-8833
Fax: (904) 448-2444

CENTRAL REGION
Detroit, Michigan
13400 Outer Drive, West
Detroit, MI 48239-4001
Phone: (313) 592-5990
Fax: (313) 592-5158

SOUTHWESTERN REGION
Dallas, Texas
2711 LBJ Freeway
Suite 1036
Dallas, TX 75234
Phone: (214) 247-4313
Fax: (214) 247-4316

WESTERN REGION
Downey, California
10645 Studebaker Road
Downey, CA 90241
Phone: (310) 929-7016
Fax: (310) 864-0502

CANADIAN REGION
London, Ontario
Detroit Diesel of Canada Ltd.
150 Dufferin Ave., Suite 701
London, ON N6A 5N6
Phone: (519) 661-0149
Fax: (519) 661-0171

LATIN AMERICAN REGION
Miami, Florida
2277 N.W. 14th Street
Miami, FL 33125-0068
Phone: (305) 637-1555
Fax: (305) 637-1580

ASIAN REGION
Singapore
7 Jurong Pier Rd.
Singapore 2261
Phone: (65) 265-4697
Fax: (65) 265-9530

PACIFIC REGION
Australia
13 Lynette Ave.
Beaumaris, Victoria 3193
Australia
Phone: (61) 3-5895181
Fax: (61) 3-5893424

EUROPE, MIDDLE EAST, AFRICA (EMA) REGION
The Netherlands
Ridderpoort 9
2980 GD Ridderkerk
The Netherlands
Switzerland
Phone: (31) 1804-10388
Fax: (31) 1804-62062

MEXICO
Detroit Diesel-Allison de Mexico, S.A.
Reforma 2977
Colonia, Cuajimalpa
Mexico, D.F. 05000, Mexico
Phone: (52) 5-570-3860
Fax: (52) 5-570-3109

- 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*** ® and **Fleetrite**® components.
- 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 for the Detroit Diesel service outlet nearest you.

To further assure your complete satisfaction, we have developed the following procedure to be followed in the event you have a problem that has not been handled satisfactorily.

Step One

Discuss your 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 you have already discussed the problem with the Sales or Service Manager, contact the General Manager. If your complaint originates with a dealer, explain the matter to a management member of the distributorship with whom the dealer has his service agreement.

Step Two

When it appears that your problem cannot readily be resolved at the distributor level without additional assistance, contact the Detroit Diesel Regional Product Support or Operations Manager responsible for your local distributor. You will be assisted by a member of the Manager's staff, depending upon the nature of your problem.

Prior to this contact, have the following information available:

- Engine serial number*
- Name and location of authorized service outlet.
- Type and make of equipment.
- Engine model.
- Engine delivery date and accumulated miles or hours of operation.
- Nature of problem.
- Chronological summary of engine's history.

***Important:** Your engine serial number should be written on the line provided in the "Engine, Injection Pump, Governor, and Turbocharger Identification" Section (page 4). It will identify your model and all service parts, plus provide warranty and extended coverage information.

Step Three

If you are still not satisfied, present the entire matter in writing or by phone to:

Director, Reliability and Service
Detroit Diesel Corporation
13400 Outer Drive, West
Detroit, Michigan 48239-4001
Phone: (313) 592-7357

When contacting the regional or home office, please keep in mind that ultimately your problem will likely be resolved at the distributorship or dealership, utilizing their facilities, equipment, and personnel. Therefore, it is suggested that you follow the above steps in sequence when experiencing a problem.

SPECIFICATIONS

FILTER TYPE	PART NUMBER
Fuel Secondary Filter Element	1-809-789C1
Lube Oil Full Flow Filter Element	1-819-452C1
Coolant Filter/Conditioner Element	1-819-109C1

ADDITIONAL COOLANT INHIBITOR TREATMENT PRODUCTS		
Item	**Size**	**Detroit Diesel Part No.**
Power Cool® -Antifreeze/Coolant	Gallon Jug (6 per carton) 55 Gallon Drum	23512138 23512139
NALCOOL 2000® -Liquid	Pint (12 per case) Half Gallon (6 per case) 5 Gallon 55 Gallon Drum	23507858 23507859 23507860 23507861
NALCOOL 3000® -Liquid	Pint (12 per case) Half Gallon (6 per case) 5 Gallon 55 Gallon Drum	23507854 23507855 23507856 23507857
NALPREP 2001® -Liquid On-Line Cleaner *Use for mildly corroded system.*	Half Gallon (6 per case) 5 Gallon 55 Gallon Drum	23507862 23507863 23507864
NALPREP 2015® Twin Pac- Dry Chemical Heavy-Duty Cleaner/Conditioner *Use for heavily corroded system.*	2 per case	23507867

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