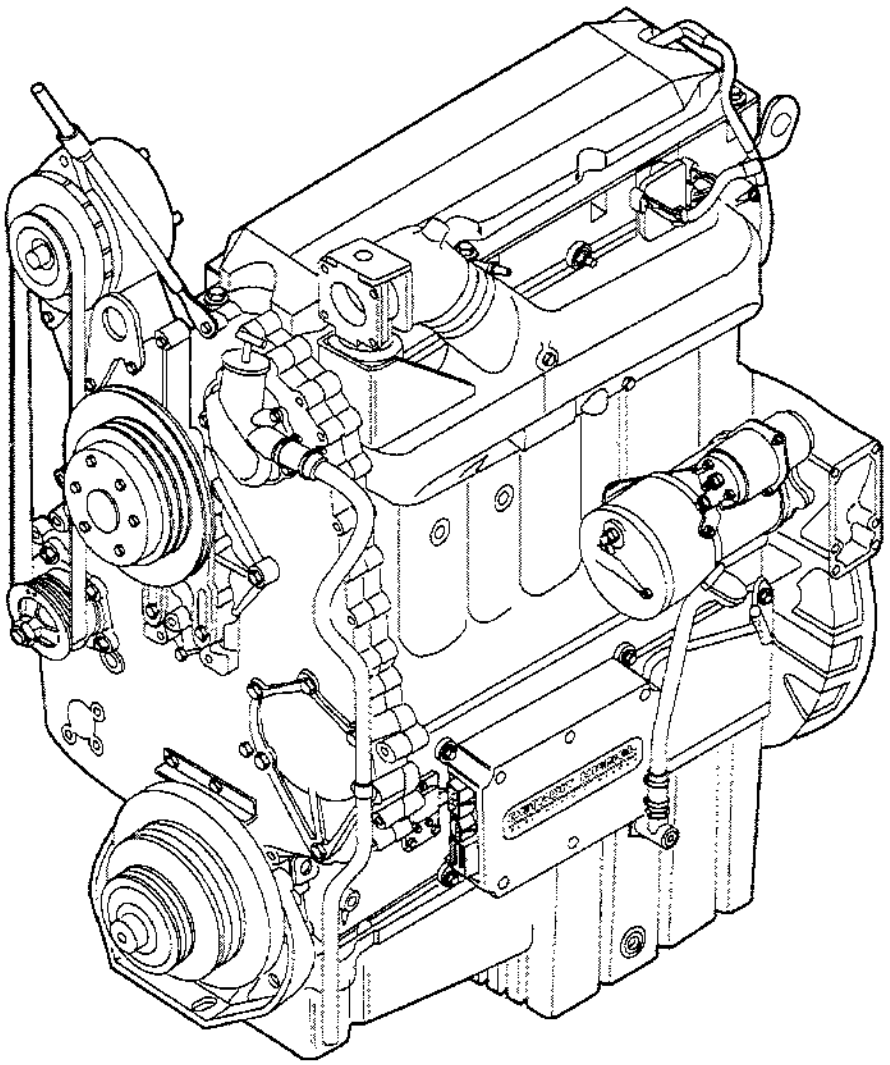
DETROIT DIESEL

Series 50G/60G



Natural Gas Generator Set Engine Operator's Guide

TP-5830

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.

42824

To the Operator

This guide contains instructions on the safe operation and preventive maintenance of your Detroit Diesel Series 50G or 60G natural gas engine used in a continuous-duty or standby-duty generator set application. 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, pulleys, 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.

NOTICE:

Failure to check and maintain SCA (supplemental coolant additive) levels at required concentrations will result in severe damage (corrosion) to the engine cooling system and related components. Coolant must be inhibited with the recommended SCAs 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.

WARRANTY

Refer to the WARRANTY INFORMATION section of this guide for the applicable Series 50G/60G generator set engine warranty. For more detailed information, contact an authorized Detroit Diesel distributor.

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

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INTRODUCTION

This guide is intended for use by the operator of a Detroit Diesel Series 50G or Series 60G natural gas-fueled engine used in a continuous duty or standby duty generator set application.

Non-Genuine and Rebuilt Component Quality Alert

In recent years, 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 are to 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 (Environmental Protection Agency) or CARB (California Air Resources Board) regulations.

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

CAUTION SUMMARY

The following cautions must be observed by the operator of the 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 equipment or performing basic engine preventive maintenance may result in personal injury and engine and/or equipment damage.

1. ***Observe the following cautions when performing basic preventive maintenance on the engine:***

⚠ 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.

⚠ CAUTION:

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

- ☐ **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.**

⚠ CAUTION:

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

CAUTION:

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

CAUTION:

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

CAUTION:

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

CAUTION:

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

CAUTION:

To avoid injury from fire caused by heated lubricating-oil vapors:

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

Lubricating oil is relatively harmless at ambient temperatures.

⚠ CAUTION:

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

⚠ CAUTION:

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.

⚠ CAUTION:

To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

⚠ CAUTION:

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

⚠ CAUTION:

To avoid injury, use care when working around moving belts and rotating parts on the engine.

2. ***Observe the following cautions when using compressed air:***

⚠ CAUTION:

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

3. *Observe the following cautions when using starting aids:*

⚠ CAUTION:

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.**

⚠ CAUTION:

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

- ☐ **Always wear goggles when testing.**
- ☐ **If fluid enters the eyes or if fumes irritate the eyes, wash eyes with large quantities of clean water for 15 minutes. A physician, preferably an eye specialist, should be contacted.**
- ☐ **Contents of cylinder are under pressure. Store cylinders in a cool dry area. Do not incinerate, puncture or attempt to remove cores from cylinders.**

4. *Observe the following cautions when jump starting an engine, charging a battery, or working with the application electrical system:*

⚠ CAUTION:

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

⚠ CAUTION:

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. Always establish correct polarity before connecting cables to the battery or battery circuit. 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.**

⚠ CAUTION:

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

5. *Observe the following cautions when fueling, replacing fuel filters or working with the engine fuel system.*

⚠ CAUTION:

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

CAUTION:

To avoid injury from an explosion of natural gas, the following precautions must be taken:

- ❑ Do not smoke when installing or servicing the engine or fuel system.
- ❑ Installation or servicing of natural-gas equipment must only be conducted in well-ventilated, natural gas compatible areas. Do not install or service equipment in an enclosed area where ignition sources are present without first ensuring that an undetected gas leak may be safely vented without being ignited.
- ❑ Bleed natural gas lines before installing or servicing any component connected to the fuel lines.
- ❑ Natural gas fuel systems are pressurized. Relieve pressure from any fuel system component prior to installation or service of that component.

Natural gas is highly flammable and explosive and may be extremely cold (-260°F [-162°C]).

6. *Observe the following cautions when servicing the cooling system:*

CAUTION:

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

CAUTION:

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

7. *Observe the following cautions when working on the engine air intake system:*

CAUTION:

To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

CAUTION:

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.

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

CAUTION:

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

CAUTION:

To avoid injury from fire caused by heated lubricating-oil vapors:

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

Lubricating oil is relatively harmless at ambient temperatures.

VENTING THE ENGINE FUEL SYSTEM

⚠ CAUTION:

To avoid injury from an explosion of natural gas, the following precautions must be taken:

- ☐ **Do not smoke when installing or servicing the engine or fuel system.**
- ☐ **Installation or servicing of natural-gas equipment must only be conducted in well-ventilated, natural gas compatible areas. Do not install or service equipment in an enclosed area where ignition sources are present without first ensuring that an undetected gas leak may be safely vented without being ignited.**
- ☐ **Bleed natural gas lines before installing or servicing any component connected to the fuel lines.**
- ☐ **Natural gas fuel systems are pressurized. Relieve pressure from any fuel system component prior to installation or service of that component.**

Natural gas is highly flammable and explosive and may be extremely cold (-260°F [-162°C]).

Before working on the engine, vent the fuel system as follows:Use one of the following procedures to vent the fuel system.

Venting an Operable Engine Fuel System to Relieve Natural Gas Pressure

If the engine can run, relieve natural gas pressure downstream of the shutoff valve as follows:

1. Close the main shutoff valve on the natural gas fuel supply line.
2. Start and run the engine until it stalls due to fuel starvation.
3. Make sure the gauge pressure on the natural gas line to be vented has been reduced to zero. If not, repeat steps 1 and 2.

⚠ CAUTION:

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

4. Disconnect batteries using switch(es) in battery compartment or by disconnecting the battery ground cable.
5. Slightly loosen the NG fuel line fitting to be serviced to allow any remaining gas to vent.
6. Fully open the fitting slightly opened previously and allow any remaining gas to vent.
7. After installation, service, and troubleshooting are completed, check all connections that were loosened for leaks .

Venting an Inoperable Engine to Relieve Natural Gas Pressure

If the engine cannot run, use the following venting procedure to relieve the natural gas pressure downstream of the shutoff valve.

1. Close the main shutoff valve on the natural gas fuel supply line.

⚠ CAUTION:

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

2. Disconnect batteries using switch(es) in battery compartment or by disconnecting the battery ground cable.
3. Loosen a fitting to ensure all pressure has been relieved in the natural gas fuel line.
4. After installation, service, and troubleshooting are completed, check all connections that were loosened for leaks .

Leak Checking the Natural Gas Fuel System

Use the following procedure to check the fuel system for leaks:

1. Spray soapy water or a commercially available leak checking solution on connections that have been pressurized to working pressure. Bubbles will form where there is a leak.
2. If leaks are found, repair by using one or more of these steps:

[a] Tighten connections using fitting manufacturer's torque/technique.

[b] Replace leaking components.

[c] Replace a threaded pipe connector a with new one if the leak is in a threaded connection. Apply anaerobic sealant with Teflon®, such as SWAK®, to the threads.

3. Recheck connection using soapy water procedure in step 1.
4. Use a combustible gas detector to check for the presence of natural gas.
5. Continue inspecting for leaks until the locations of all leaks are determined.
6. Repair any additional leaks using the procedure(s) in step 2.

ENGINE MODEL AND SERIAL NUMBER DESIGNATION

The engine serial number and model number are stamped on the cylinder block in the following location (as viewed from the flywheel end):

- ☐ Left side just below the intake manifold and above the cast-in Detroit Diesel logo. See Figure 1.

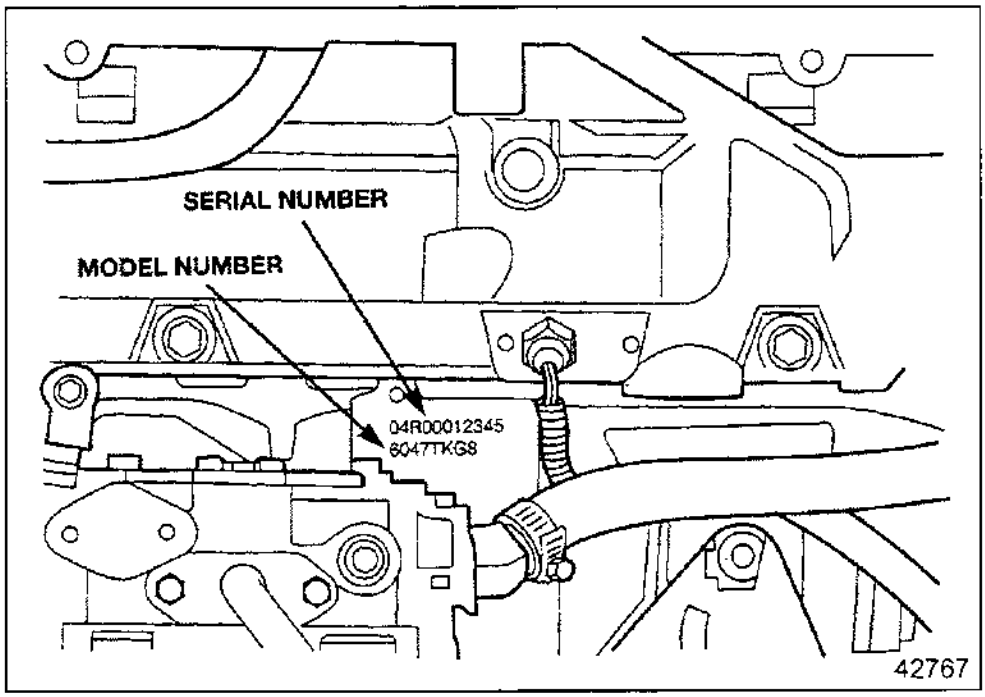


Figure 1 Location of Engine Serial and Model Numbers

Option Labels

Computerized engine option labels are attached to the valve rocker cover. These labels contain the engine serial number and model number and, in addition, list any optional equipment used on the engine. Labels also include required tune-up information (injection timing, valve lash, maximum no-load rpm, etc.). With any order for parts, the engine model and serial number must be given. If a type number is shown on the option label covering the equipment required, this number should also be included on the parts order. See Figure 2.

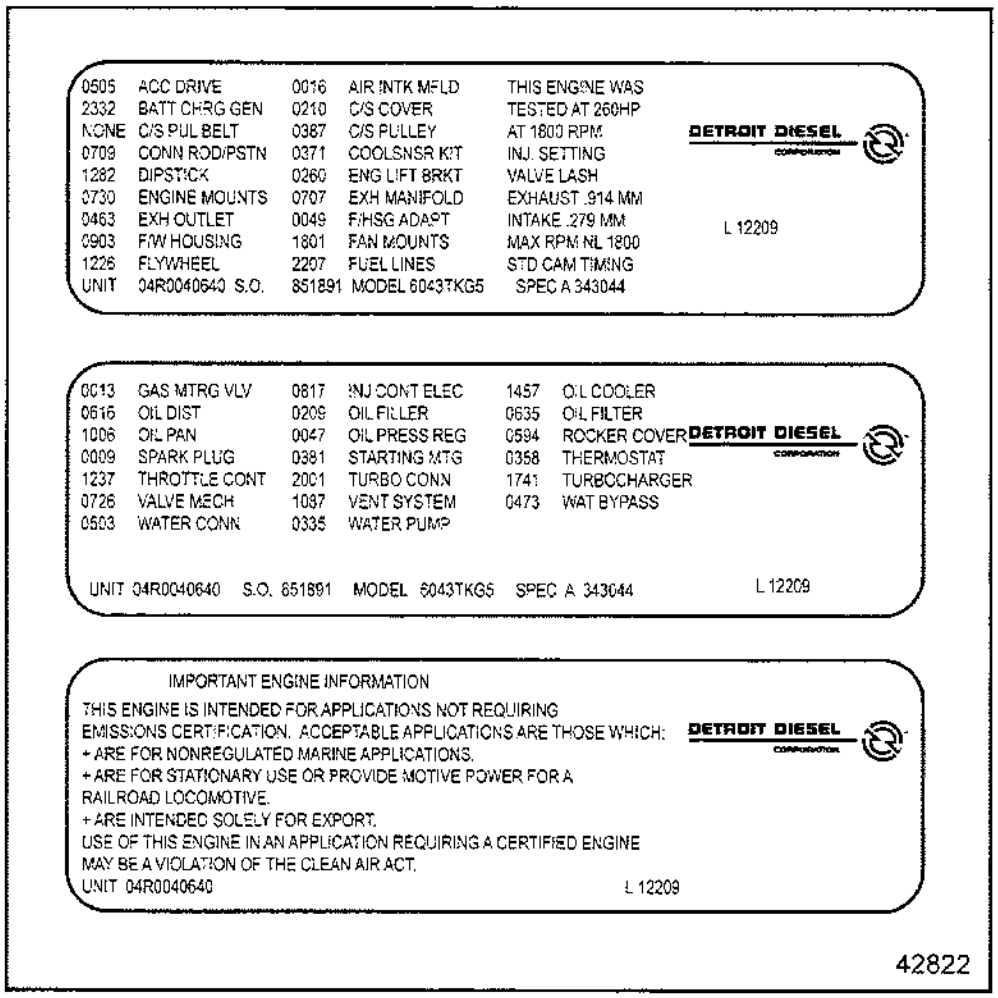


Figure 2 Typical Engine Option and Certification Labels

Certification Label

If required, a certification label is attached to the valve rocker cover. This label certifies that the engine conforms to federal and certain state emissions regulations for its particular application. It also gives the operating conditions under which certification was made. See Figure 2.

Component Identification

Power generators generally carry their own name plates. The model and serial number information on these plates is useful when ordering parts for these assemblies. Name plates with the part numbers, models and/or serial numbers of the engine components below may be found in the locations shown.

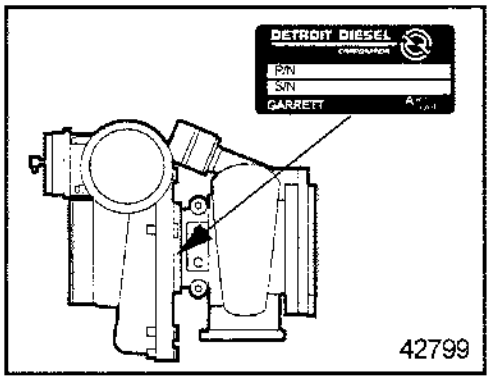


Figure 3 Turbocharger (Series 50G)

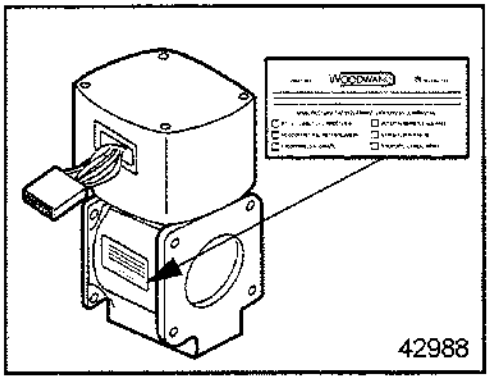


Figure 6 Throttle Actuator

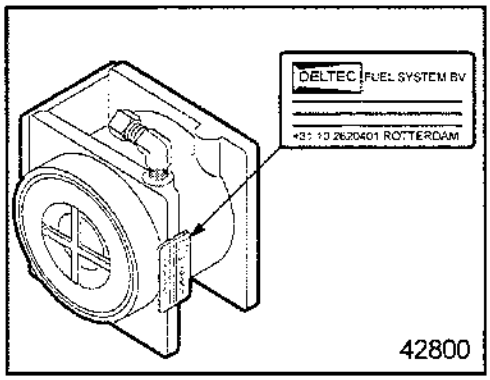


Figure 4 Fuel Mixer

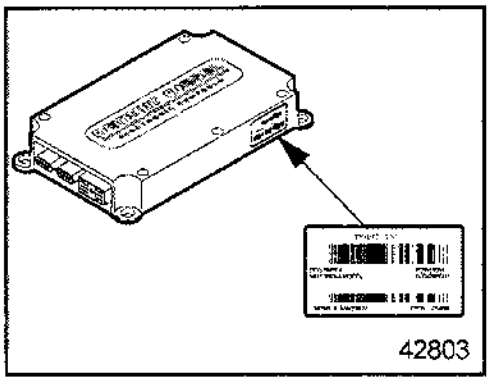


Figure 7 Electronic Control Module

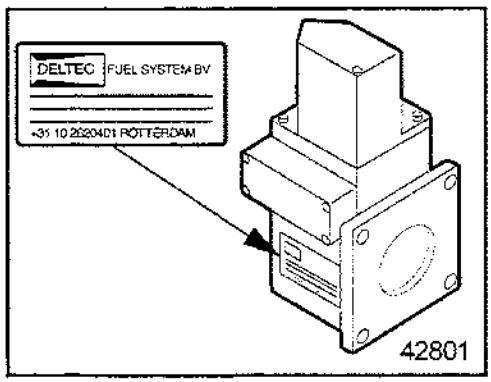


Figure 5 PSV (Pulse Width Modulated Stepper Motor Valve)

OPERATING INSTRUCTIONS

Preparations for Starting the Engine the First Time

When preparing to start a new or newly overhauled 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 the "Daily" checks for your engine. Refer to section MAINTENANCE SCHEDULES.

⚠ CAUTION:

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

- ☐ **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.**

⚠ 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.

Cooling System Checks

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 or propylene glycol-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 section E. How to Select Coolant in this guide.
3. Turn the coolant inhibitor element shut-off valve to the ON position.

4. Entrapped air must be purged after filling the cooling system. To do this, allow the engine to warm up with the pressure cap removed. Increase engine speed above 1,000 rpm and add coolant to the radiator as required.
5. 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. See Figure 8.

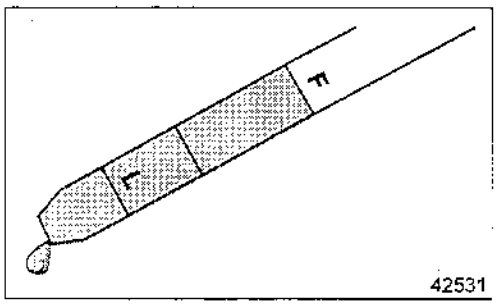


Figure 8 Check Lube Oil Level Before Starting

For lubricant recommendation, refer to A. How to Select Lubricating Oil in the "How-To" section of this guide.

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 engine lubricating oil and filters after extended storage.

NOTICE:

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

Fuel System Checks

Ensure the engine is properly connected to a supply of compressed natural that meets required specifications. For CNG requirements, refer to D. How to Select Fuel in the " How-To" section of this guide.

Other Checks

Make sure cable connections to the storage batteries are clean and tight. Check the hydrometer "eye" of maintenance-free batteries for charge. See Figure 9.

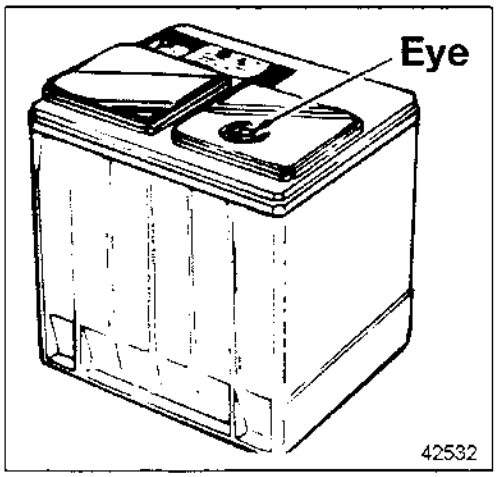


Figure 9 Check "Eye" of Maintenance-Free Batteries

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

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.

Check drive belts to make sure they are in good condition (not cracked, torn, worn or glazed) and are properly adjusted.

Starting the Engine

Before starting the engine the first time, refer to section Preparations for Starting the Engine the First Time in the **Operating Instructions** section and perform the operations listed.

⚠ CAUTION:

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

- ☐ **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.**

Initial Engine Start

To start a Series 50G or Series 60G natural gas-fueled engine, turn the ignition key on.

You will notice that both the "Check Engine" and "Stop Engine" lights will come on. See Figure 10.

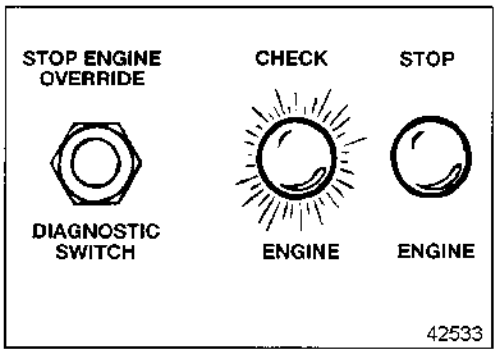


Figure 10 Typical Shutdown Override Switch and Engine Lights

This is the result of the DDEC® computer diagnosing the system to ensure everything is functional, including the light bulbs for the "Check Engine" and "Stop Engine" warning lights. If everything is OK, both lights will go out in approximately five seconds.

NOTICE:

If the warning lights stay on, consult with a DDEC technician. Operating the engine under these circumstances may result in engine damage.

Start the engine *after* the lights go out, as follows:

1. Press the starter switch firmly.

NOTICE:

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

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

Running the Engine

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 (12 psi or 83 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 28 psi or 193 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.

⚠ CAUTION:

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

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 20 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 in this guide. Refer to section A, How to Select Lubricating Oil.

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.

⚠ CAUTION:

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

Avoid Unnecessary Idling

Whenever possible, avoid unnecessary idling. During long engine idling periods, the engine coolant temperature may fall below the normal operating range. When prolonged idling is necessary, maintain at least 850 rpm spring/summer and 1200 rpm fall/winter.

Stopping the Engine

Normal Stopping

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

DDEC III and DDEC IV Electronic Control Systems –These systems operate on 12 or 24 volts DC. If a DDEC III or IV engine with an electric starting motor requires emergency jump starting, *do not exceed 32 volts DC.*

⚠ CAUTION:

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.

NOTICE:

Jump starting with voltages greater than those indicated *or* reversing battery polarity may damage the ECM (electronic control module).

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:

Failure to observe this precaution can result in alternator and/or equipment damage.

⚠ CAUTION:

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. Always establish correct polarity before connecting cables to the battery or battery circuit. 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.**

DDEC III/IV OPTIONS

DDEC System

Detroit Diesel Series 50G/60G engines equipped with DDEC III or DDEC IV electronic control systems are identified by a letter "K" in the sixth position of the model number. Example: 6047TKG8.

Detroit Diesel electronic controlled Series 50G/60G engines can be equipped with a variety of options designed to warn the operator of an engine malfunction. Options can range from "Check Engine" and "Stop Engine" panel lights to automatic reduction in engine power followed by automatic engine shutdown. See Figure 11.

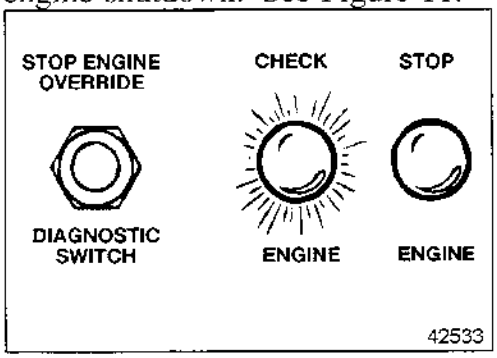


Figure 11 Typical Shutdown Override Switch and Engine Lights

The power-down/shutdown option may be activated by a low coolant level, low oil pressure or high engine oil or coolant temperature.

NOTICE:

If the warning lights stay on, or if they do not come on momentarily after turning on the ignition, consult with a DDEC technician. Operating the engine under these circumstances may result in engine damage.

The Series 50G/60G natural gas engine is equipped with an electronically controlled fuel system and throttle control system. There is no mechanical linkage to adjust. This system not only helps to improve fuel economy and engine performance, it also helps to reduce cold starting time and increase initial idle speed for fast engine warm-up.

Engine horsepower, torque, idle, and engine speed are contained in the internal electronics. Therefore, there are no mechanical adjustments for idle and high-speed control.

Emission control is performed through the electronic control module (ECM).

The DDEC engine has the ability to perform diagnostics for self-checks and continuous monitoring of other system components. Depending on the application, DDEC can also monitor oil temperature, coolant temperature, oil pressure, fuel pressure, coolant level and remote sensors (if used). This diagnostic system is connected to the "Check Engine" light (CEL) and the "Stop Engine" light (SEL) to provide a visual warning of a system malfunction.

The DDEC engine can be equipped with an engine protection system. 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.

NOTICE:

If the engine is equipped with the power-down/shutdown option, there will be a system override button or switch which may be used to allow engine operation for a short period of time. If the shutdown override button is not used, the shutdown will occur in 30 seconds. Using the override button so that the engine operates for an extended period may result in engine damage.

The DDEC engine may also have an optional 1 – 100 minute idle shutdown system. The purpose of this system is to conserve fuel by eliminating excessive idling and to allow for a turbocharger cool-down period. To activate the shutdown, the engine must be in idle or fast-idle mode.

Data Recording Capability

DDEC Reports – A data recording capability called "DDEC Reports" is standard on all DDEC IV engines. DDEC Reports contains information on driver activities, engine performance and critical incidence reporting. This information is also available on DDEC III systems, but must be activated by Detroit Diesel Corporation at the request of the customer. The information in both DDEC III and DDEC IV can be extracted with Detroit Diesel Data Link 2.0 (DDDL 2.0) software. DDEC III information can only be extracted with ProManager® 2.0 software. To perform the extraction, at least a 486 computer with a 16-MB RAM is required.

DDEC III/IV 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 or 24 volts. However, in the event of a power supply malfunction, the system will continue to operate at reduced voltage. When this occurs, the "Check Engine" light will come on. See Figure 12.

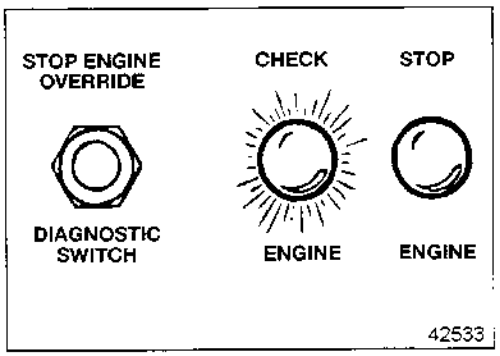


Figure 12 Typical Shutdown Override Switch and Engine Lights

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

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

NOTICE:

When the "Stop Engine" light 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.

NOTE:
The "Stop Engine Override" switch and the "Diagnostic Request" switch are the same.

In this situation the operator may elect to override the automatic stop engine sequence by pressing the "Stop Engine Override" switch every 15 to 20 seconds to prevent engine shutdown from occurring.

NOTICE:

For some applications, 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.

Immediate Speed Reduction Option – 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.

Stop Engine Light – The conditions that will cause the "Stop Engine Light" to come on are:

- ☐ High coolant temperature
- ☐ Loss of coolant
- ☐ High oil temperature
- ☐ Low oil pressure
- ☐ Engine knock
- ☐ External input protection
- ☐ Throttle fault

It is important to point out that whenever the "Check Engine" light (CEL) or the "Stop Engine" light (SEL) comes 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 Data Reader

The diagnostic data reader (DDR) is a special diagnostic tool that can be plugged into the engine computer memory to extract information related to the cause of the problem. See Figure 13.

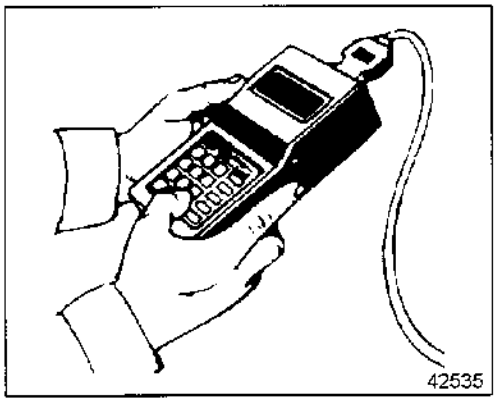


Figure 13 Diagnostic Data Reader J 38500

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

The DDR can distinguish between codes now active and those stored in the ECM memory (inactive).

The malfunction code recorded in the computer memory will remain until it is erased by a technician.

The malfunction code can also be obtained by the operator. A "Diagnostic Request" switch is provided which, when pressed, will cause the "Check Engine" light (CEL) to flash a code number. It will, for example, flash twice. . . pause . . . flash once. . . pause. In other words, a code 21. Code 21 indicates the throttle position sensor input voltage is high. See Figure 14.

NOTE:
A code 25 (two flashes followed by 5 flashes) indicates all systems are working satisfactorily.

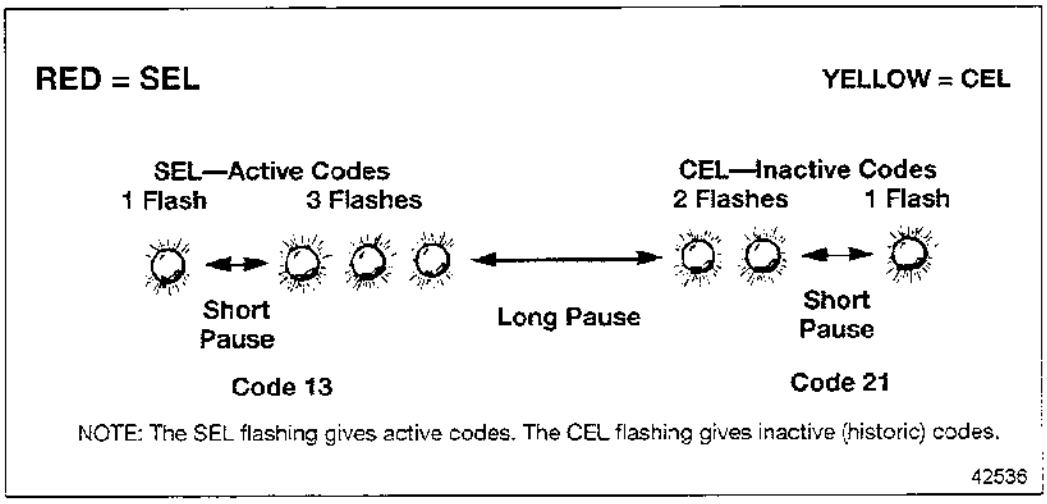


Figure 14 SEL/CEL Flashing Code Examples

Active Codes – The active codes will be flashed on the "Stop Engine" light (SEL) in the order of most recent to least recent occurrence based on engine hours. If there are no active codes, a code 25 will be flashed.

Inactive Codes – The inactive codes will be flashed on the "Check Engine" light (CEL) in the order of most recent to least recent occurrence based on engine hours. If there are no inactive codes, a code 25 will be flashed.

Only One Light Flashes at a Time – Only one light will be flashing codes at any time. When code flashing is initiated, the active codes (or code 25) will be flashed on the SEL. Then the inactive codes (or code 25) will be flashed on the CEL. When all the inactive codes (or code 25) 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.

To Read Codes: Use the diagnostic data reader (DDR) or depress and hold the diagnostic request switch with the ignition ON and the engine AT IDLE or NOT RUNNING. Press and hold the switch. Active codes will be flashed on the "Stop Engine" light (SEL) first, followed by inactive codes being flashed on the "Check Engine" light (CEL).

The codes will continue to flash and repeat as long as the diagnostic request switch is held in the ON position with the ignition on. Diagnostic codes are listed in Table 1, Table 2, and Table 3.

Flash Code	DDEC III/IV Description	Flash Code	DDEC III/IV Description
11	VSG sensor input voltage low	26	Aux. engine shutdown #1 or #2 input active
12	VSG sensor input voltage high	27	Air inlet or intake air temp. sensor input voltage high
13	Coolant level sensor input voltage low	28	Air inlet or intake air temp. sensor input voltage low
13	Second coolant level sensor input voltage low	31	Aux. high side open circuit or short to ground
14	Oil or coolant temp. sensor input voltage high	32	CEL or SEL short to battery (+) or open circuit
15	Oil or coolant temp. sensor input voltage low	33	Turbo boost sensor input voltage high
16	Coolant level sensor input voltage high	34	Turbo boost sensor input voltage low
16	Second coolant level sensor input voltage high	35	Oil pressure sensor input voltage high
17	Throttle valve position sensor input voltage high	36	Oil pressure sensor input voltage low
18	Throttle valve position sensor input voltage low	37	Fuel pressure sensor input voltage high
21	TPS input voltage high	37	Fuel restriction sensor input voltage high
22	TPS input voltage low	38	Fuel pressure sensor input voltage low
23	Fuel temp. sensor input voltage high	38	Fuel restriction sensor input voltage low
23	Oxygen sensor input voltage high	39	EGR valve not responding
24	Fuel temp. sensor input voltage low	39	VNT vanes not responding
24	Oxygen sensor input voltage low	41	Too many SRS (missing TRS)
25	No active codes	42	Too few SRS (missing SRS)

Table 1 DDEC III/IV System Diagnostic Codes

Flash Code	DDEC III/IV Description	Flash Code	DDEC III/IV Description
43	Coolant level low	**55**	Proprietary link fault slave/master
44	Oil, coolant, intake manifold or air inlet temp. high	**56**	J 1587 data link fault
45	Oil pressure low	**57**	J 1922 data link fault
46	ECM battery voltage low	**58**	Torque overload
46	RTC backup battery voltage low	**61**	Injector response time long
46	Sensor supply voltage low	**62**	Auxiliary output fault
47	Fuel or air inlet or turbo boost pressure high	**63**	PWM fault
48	Fuel or air inlet or turbo boost pressure low	**64**	Turbo speed sensor input fault
48	EGR temperature low	**64**	Turbo overspeed
48	TCO temperature low	**65**	Throttle valve position input fault
48	EGR delta pressure low	**65**	Air filter restriction sensor fault
51	TCO temperature failed high	**66**	Knock control or oil filter restriction fault
52	ECM A/D conversion fail	**67**	Air inlet pressure circuit failed high/low
53	ECM non-volatile memory fault	**68**	Idle validation switch open circuit or short to ground
53	EEPROM write error	**71**	Injector response time short
53	Out of calibration	**72**	Engine overspeed
54	Speed sensor fault	**72**	Oxygen sensor fault
55	J 1939 data link fault	**73**	Gas valve position input fault or ESS fault
55	Missing other ECU information	**73**	Air filter restriction high

Table 2 DDEC III/IV System Diagnostic Codes (continued)

Flash Code	DDEC III/IV Description	Flash Code	DDEC III/IV Description
74	Optimized Idle® safety loop short to ground	82	Injection control pressure circuit failed low
74	Oil filter restriction high	83	EGR gas temp high
75	Sensor supply or ECM battery voltage high	83	EGR delta pressure high
75	RTC backup battery voltage high	83	Oil level, crankcase pressure, exhaust temp. input voltage high
76	Engine overspeed with engine brake	84	Oil level, crankcase pressure low
77	Miscellaneous faults – Refer to section BASIC TROUBLESHOOTING	85	Engine overspeed
78	Cruise control/ Adaptive cruise control	86	Baro. pressure circuit failed high
81	EGR temperature circuit failed high	86	External pump pressure sensor input voltage high
81	EGR delta pressure circuit failed high	87	External pump pressure sensor input voltage low
81	Oil level, crankcase pressure, exhaust temp. input voltage high	87	Baro. pressure circuit failed low
81	Injection control pressure circuit failed high	88	Coolant pressure low
82	EGR temperature circuit failed low	89	Fuel filter restriction high
82	EGR delta pressure circuit failed low	89	Maintenance monitor coolant level fault
82	Oil level, crankcase pressure, exhaust temp. input voltage low		

Table 3 DDEC III/IV System Diagnostic Codes (continued)

ENGINE SYSTEMS

Fuel System

The Series 50G and 60G engine fuel system consists of a venturi type fuel mixer, stepper motor-driven gas flow control valve (PSV), throttle actuator, low pressure regulator and DDEC electronic fuel system controls. The fuel system includes the necessary connecting fuel lines, valves, fuel cylinder or tanks, coalescing fuel filters, and regulators. The purpose of the fuel system is to keep the natural gas clean and free from air, water or other impurities, and to deliver it to the engine combustion chamber at the correct pressure, temperature and air/fuel (A/F) mixture.

Lubrication System

The lubricating oil system consists of an oil pump, oil cooler, two full-flow oil filters, bypass valves at the oil pump and oil filter adaptor, and oil pressure regulator valve in the cylinder block vertical oil gallery. Lubricating oil is drawn from the oil pan through the strainer and suction tube to the inlet port at the rear of the front cover by the oil pump. The cored passage in the front cover channels the oil leaving the pump to the cylinder block. Oil is then channelled through the two passages in the block to the oil reservoir and the oil cooler header.

The oil reservoir provides lubrication to the gear train and idler gear support. Oil flows around the oil cooler tubes to the oil filter assembly and then into the main oil gallery. The oil filter adaptor head includes a bypass valve that allows oil to pass directly to the main oil gallery should the filter become excessively restricted.

Oil is then distributed throughout the engine to lubricate gears, bearings, piston rings, rocker arms, valve lifters, turbocharger, and other moving engine components. Oil is also used to provide piston cooling. Oil temperature and pressure are monitored by the DDEC system.

Air System

The air inlet system includes an air cleaner, associated pipe work, fuel mixer, compressor side of the turbocharger, air-to-air charge cooler, throttle body, and intake manifold. In the air system used on Series 50G/60G engines, outside air drawn into the engine passes through the air filter and is pulled into the turbocharger, where it is compressed. It then moves to the air-to-air charge cooler, where it is cooled. From here it flows through the fuel mixer and throttle body to the intake manifold and into the cylinders.

Dry type air cleaners are used on Series 50G/60G engines. For optimum protection of the engine from dust and other airborne contaminants, *service these air cleaners when the maximum allowable air restriction has been reached, or annually, whichever occurs first.*

Cooling System

The cooling system includes the water inlet elbow, water pump, oil cooler, thermostat housing, two full-blocking type thermostats, coolant filter/conditioner, thermo-modulated fan, radiator and associated interconnected piping. Coolant flows from the radiator to the water pump, through the front cover to the block, cylinder head, oil cooler, and into the thermostat housing. The turbocharger center housing on the Series 50G only is supplied with coolant from the cylinder head. The coolant returns to the water pump inlet above the coolant filter/conditioner. The engine has a coolant bypass circuit to allow for rapid engine warm-up under cold conditions.

Electrical System

The electrical system consists of a starting motor, starting switch, battery-charging alternator, storage batteries, and the necessary wiring. The electrical system provides the energy to start the engine and supply power to the DDEC system.

Exhaust System

The exhaust system consists of the exhaust valves and ports in the cylinder head, exhaust manifold, turbine side of the turbocharger, exhaust piping, and muffler. In addition, an oxygen sensor and exhaust temperature sensor are located immediately downstream from the turbocharger. Exhaust gases exit the cylinders through the exhaust ports and the exhaust manifold. These exhaust gases expand through the exhaust turbine to drive the turbocharger. The gases then exit through the exhaust pipes and muffler to the atmosphere.

MAINTENANCE SCHEDULES

Maintenance Intervals

Recommended *daily checks* for Series 50G/60G transit coach engines are listed in Table 4. Recommended *regular maintenance intervals* are listed in Table 5 and Table 6.

NOTICE:

Observe all cautions listed at the front of this operator's guide when performing any maintenance.

NOTICE:

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

Item
1 - Check Lube Oil Level*
2 - Check Flexible Hoses for Leaks*
3 - Check Coolant Level*
4 - Check Turbocharger for Oil Leaks*
4 - Check Ducting & Charge Air Cooler for Air Leaks*
6 - Check Condition of Drive Belts*
15 - Check Oil Pressure*

* – See item in text.
I – Inspect, service, correct or replace as necessary.

Table 4 Generator Engine Daily Checks

Item	Hours	250	500	1000	1500	3000
	Months	3	6	12	12	24
1 - Lubricating Oil*		Standby Duty – Replace every 250 Hours or 12 Months, whichever comes first Continuous Duty – Replace every 250 Hours or 3 Months, whichever comes first				
2 - Fuel Lines & Flexible Hoses*				I		
3 - Cooling System*						R
4 - Turbo & Wastegate*				I		I
5 - Battery*		I				
6 - Drive Belts*		I				
7 - Air Cleaner/Aspirator*		I		R		
8 - Lube Oil Filters*		Replace filters when lubricating oil is changed.				
9 - Water Pump/ Inhibitor Level*			I			
10 - Cranking Motor*		Follow manufacturer's recommendations.				
11 - Air System*		I				
12 - Exhaust System*				I		
13 - Engine (Steam Clean)*						I
14 - Radiator*				I		

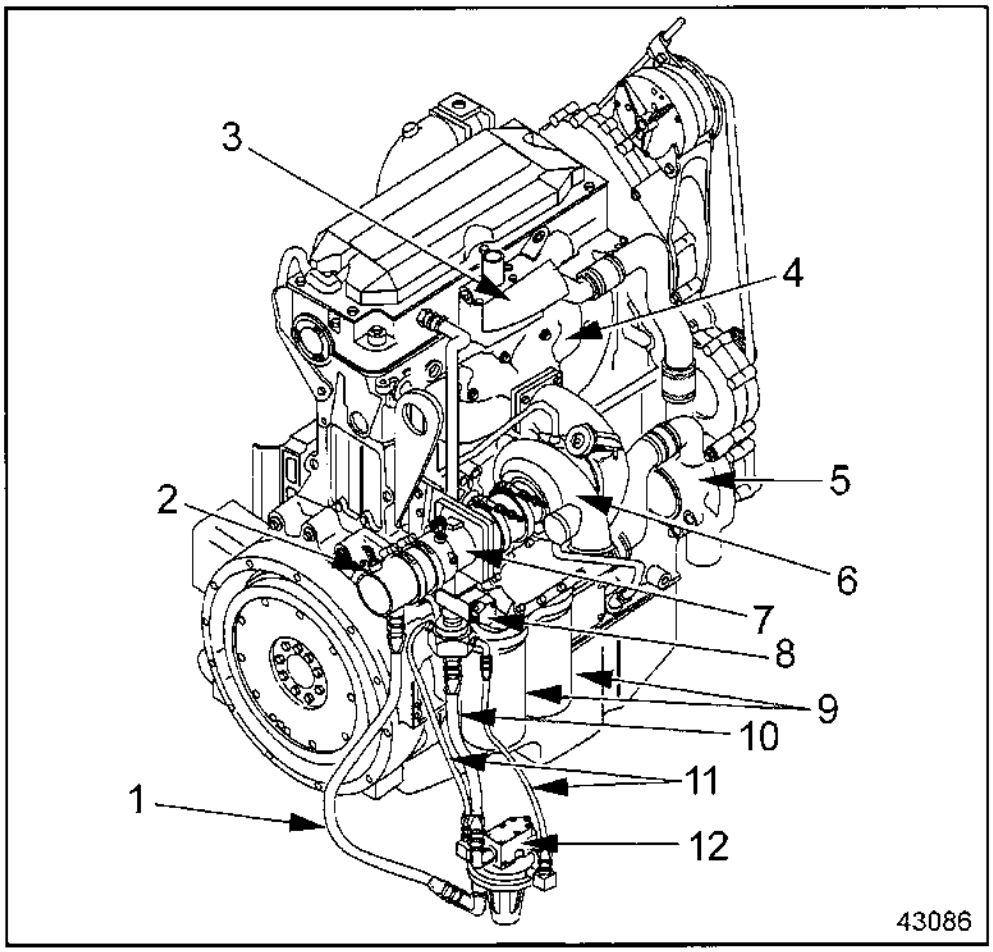
* – See item in text.
I – Inspect, service, correct or replace as necessary.
R – Replace.

Table 5 Generator Engine Regular Maintenance Intervals

Item	Hours	250	500	1000	1500	3000
	Months	3	6	12	12	24
15 - Oil Pressure*				I		
16 - Battery Charging Alternator*				I		
17 - Engine & Generator Mounts*				I		
18 - Crankcase Pressure*			I			
19 - Fan Hub*			I			
20 - Thermostats & Seals*				I		
21 - Spark Plug Boot Asms.*					I	
22 - Spark Plugs*					R	
23 - Vibration Damper*						
24 - Valve Lash*					I	
25 - Electrical System*				I		
26 - PSV*				I		
27 - Fuel Mixer*						I

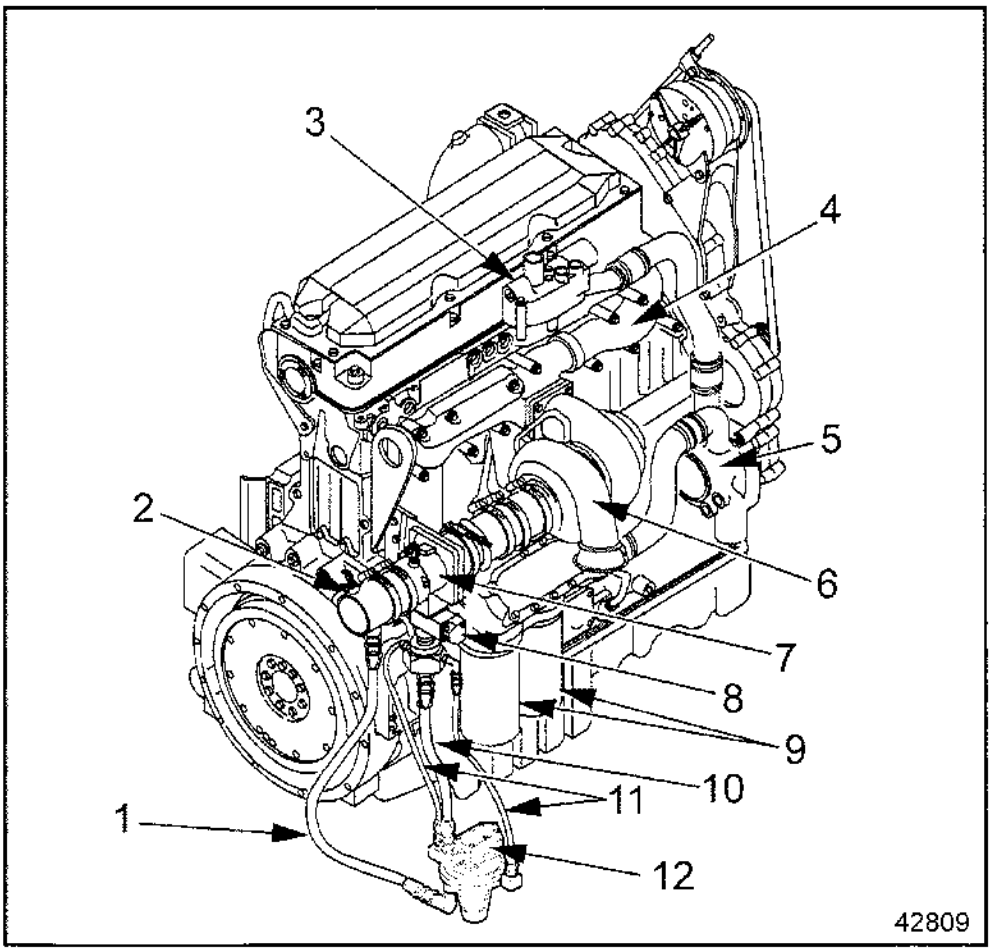
* – See item in text.
I – Inspect, service, correct or replace as necessary.
R – Replace.

Table 6 Generator Engine Regular Maintenance Intervals (continued)



1. Air Balance Hose
2. Air Inlet Tube
3. Thermostat Housing
4. Exhaust Manifold
5. Fresh Water Pump
6. Turbocharger
7. Fuel Mixer Assembly
8. Pulse Width Modulated Stepper Motor Valve (PSV)
9. Lube Oil Filters
10. Fuel Supply Hose
11. Fuel Balance Hose (2)
12. Low Pressure Regulator

Figure 15 Typical Series 50G Generator Set Engine (Right Side Rear View)



1. Air Balance Hose
2. Air Inlet Tube
3. Thermostat Housing
4. Exhaust Manifold
5. Fresh Water Pump
6. Turbocharger
7. Fuel Mixer Assembly
8. Pulse Width Modulated Stepper Motor Valve (PSV)
9. Lube Oil Filters
10. Fuel Supply Hose (2)
11. Fuel Balance Hose
12. Low Pressure Regulator

Figure 16 Typical Series 60G Generator Set Engine (Right Side Rear View)

LUBRICATION AND PREVENTIVE MAINTENANCE INTERVALS

The following is intended as a guide for establishing preventive maintenance intervals. The recommendations given should be followed as closely as possible to obtain long life and optimum performance from your engine. Maintenance intervals indicated are time (hours) of actual operation.

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 the engine. They do not apply to a new engine or to one that has not been operated for a considerable period of time.

For new or stored engines, refer to the *Series 50 Service Manual* (6SE50) or the *Series 60 Service Manual* (6SE483). Follow instructions in Section 13.1 under ***Preparations for Starting the Engine the First Time***.

Preventive maintenance other than the "Daily" checks should be performed by authorized Detroit Diesel service outlets. These outlets have the trained personnel and special tools to properly perform all services.

Item 1 – 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 17.

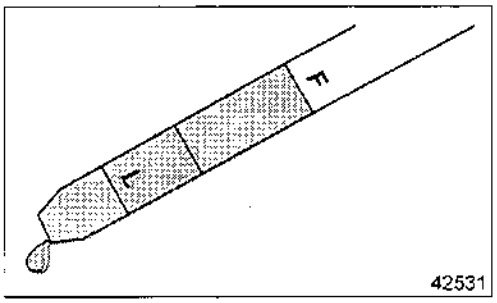


Figure 17 Check Oil Level Daily

NOTICE:
When adding lubricating oil, do not overfill. Oil may be blown out through the crankcase breather if the crankcase is overfilled.

All Series 50G/60G engines are designed to use some oil, so the periodic addition of oil is normal.

Before adding lubricating oil, refer to A. How to Select Lubricating Oil in the "How-To" section. Change lubricating oil and filters at the intervals listed in Table 7, Table 8, or Table 9, depending on fuel sulfur content. Also refer to B. When to Change Oil in the "How-To" section.

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.

Application	Lube Oil and Filter Change Interval*
Standby Duty	250 Hours or 12 Months, whichever comes first
Continuous Duty	250 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 7 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur 16 ppm or Less)

Application	Lube Oil and Filter Change Interval*
Standby Duty	200 Hours or 6 Months, whichever comes first
Continuous Duty	200 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 8 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur Greater than 16 ppm, but Less than 24 ppm)

Application	Lube Oil and Filter Change Interval*
Standby Duty	150 Hours or 3 Months, whichever comes first
Continuous Duty	150 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 9 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur Greater than 24 ppm, but Less than 32 ppm)

NOTICE:
Operation with fuels having total sulfur greater than 32 ppm, on a mass basis, may result in engine damage, and is not recommended by Detroit Diesel Corporation.

Item 2 – Fuel Lines, Flexible Hoses

⚠ CAUTION:

To avoid injury from an explosion of natural gas, the following precautions must be taken:

- ☐ **Do not smoke when installing or servicing the engine or fuel system.**
- ☐ **Installation or servicing of natural-gas equipment must only be conducted in well-ventilated, natural gas compatible areas. Do not install or service equipment in an enclosed area where ignition sources are present without first ensuring that an undetected gas leak may be safely vented without being ignited.**
- ☐ **Bleed natural gas lines before installing or servicing any component connected to the fuel lines.**
- ☐ **Natural gas fuel systems are pressurized. Relieve pressure from any fuel system component prior to installation or service of that component.**

Natural gas is highly flammable and explosive and may be extremely cold (-260°F [-162°C]).

Pre-Start Inspection

Leaks –

Make a visual check for leaks at all engine-mounted connections. Leaks are not only detrimental to machine operation, but they can also result in added expense caused by the need to replace lost fluids.

Hoses and Fittings– Check hoses daily as part of the pre-start inspection. Examine hoses for leaks, and check all fittings, clamps and ties carefully. Make sure 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.

Hose 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 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 with damaged metal reinforcements 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 (5) years of service.

NOTE:
Fire-resistant hose assemblies do not require automatic replacement after five years of service or at major overhaul, but should be inspected carefully before being put back into service.

Item 3– Cooling System

Coolant Level

The cooling system must be *full* for proper operation of the engine.

⚠ CAUTION:

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

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 required, but do not overfill. Before adding coolant, refer to section E. How to Select Coolant in this guide.

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 leaks may be more apparent on a engine when it is cold.

Coolant Inhibitors

The inhibitors in antifreeze solutions *must* be replenished with a non-chromate corrosion inhibitor supplement when indicated by testing the coolant.

NOTICE:

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

Refer to section E. How to Select Coolant for required test intervals and inhibitor levels.

Coolant Drain Interval

Detroit Diesel recommends replacing coolant at the intervals listed in Table 10. A coolant system properly maintained and protected with supplemental coolant inhibitors can be operated up to the intervals listed. At these intervals the coolant *must* be drained and disposed of in an environmentally responsible manner according to state and/or federal (EPA) recommendations.

Coolant Type	Coolant Replacement Interval
A 50/50 mix of *PowerCool*® fully formulated, inhibited ethylene glycol antifreeze and water or a 50/50 mix of fully formulated, inhibited propylene glycol antifreeze and water	With proper maintenance[1] coolant can be operated 2 years or 4,000 hours, whichever comes first. At this time the cooling system must be completely drained and cleaned before refill.
A 50/50 mix of phosphate-free TMC RP-329 "Type A" (propylene glycol) antifreeze and water.	With proper maintenance[1] coolant can be operated for the life of the engine until overhaul.[2] For life to overhaul, pre-charged coolant in combination with a need-release filter *must* be used. At this time the cooling system must be completely drained and cleaned before refill.
A 50/50 mix of OAT (organic acid technology) coolant and water.	With proper maintenance coolant can be operated 4 years , or 10,000 operating hours, whichever comes first. [3] At this time the cooling system must be completely drained and cleaned before refill.

[1] Proper maintenance involves periodic evaluation using PowerTrac® 3-Way Coolant Test Strips and the addition of required SCA, as indicated by the test strip.

[2] To verify coolant acceptability, submit a sample to DDC for coolant analysis every 3 years or 6,000 operating hours, whichever comes first. Submit sample using PowerTrac coolant analysis kit, part number 23516921 (IEG/IPG coolant) or 23523398 (organic coolant).

[3] OAT coolants require the addition of an extender every 2 years or 5,000 hours, whichever comes first. Use 1 pint to 20 gallons of OAT coolant.

Table 10 Coolant Drain Intervals

Item 4– Turbocharger, Air-to-Air Charge Cooler

⚠ CAUTION:

To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

Visually inspect the turbocharger mountings, intake and exhaust ducting and connections for leaks daily. Check the lube oil inlet and outlet lines for leaks or restrictions to oil flow. Check for unusual noise or vibration and, if excessive, stop the engine and do not operate until the cause is determined.

Check turbocharger heat-insulating exhaust system blankets (if used) for damage on a daily basis. Torn, matted, crushed, oil-soaked or otherwise damaged insulation blankets *must* be replaced immediately.

Series 50G Wastegated Turbochargers Series 50G model year 2002-build engines use an electronic actuator to open the wastegate valve and control boost to a specified pressure. Series 50G engines built prior to 2002 model year use a pneumatic actuator. Wastegate actuators are factory calibrated and are not adjustable.

The pneumatic actuator hose fits between the wastegate actuator and the compressor outlet. This hose should be checked for tightness, wear, kinks and restrictions every 1,000 hours or 12 months, whichever comes first. A damaged or brittle hose must be replaced.

The pneumatic actuator *must* be checked for proper operation every 3000 hours or 24 months, whichever comes first.

⚠ CAUTION:

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

NOTICE:

Do not exceed 30 psi (207 kPa) air pressure when checking wastegate actuator operation. Excessive air pressure can damage the actuator.

To verify correct wastegate actuator operation, apply 30 psi (207 kPa) of *regulated* shop air to the actuator hose and watch for actuator rod movement. No movement indicates the actuator may need replacing. Authorized Detroit Diesel distributors are properly equipped and have the trained personnel to perform this service.

Item 5 – Battery

⚠ CAUTION:

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

Check the hydrometer "eye" of maintenance-free batteries for charge. See Figure 18 . If lead-acid or low-maintenance batteries are used, check the specific gravity of each cell every 150 operating hours. Check more frequently in warm weather due to the more rapid loss of water through evaporation.

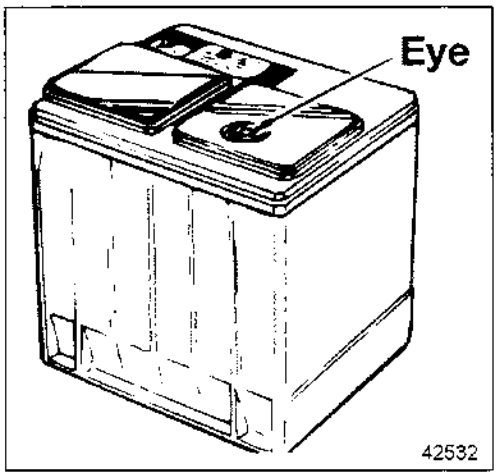


Figure 18 Check "Eye" of Maintenance-Free Batteries

Maintain the electrolyte level according to the battery manufacturer's recommendations, but *do not overfill.* Overfilling can cause poor battery performance or early failure.

Keep the terminal side of the battery clean. When necessary, wash with a solution of baking soda and water. Rinse with fresh water. Do not allow the soda solution to enter the cells.

Inspect the cables, clamps and hold-down brackets regularly. Clean and reapply a light coating of petroleum jelly when needed. Have corroded or damaged parts replaced.

If the engine is to be out of service for more than 30 days, remove the batteries and store in a cool, dry place. Keep batteries fully charged, if possible. Replace any battery that fails to hold a charge.

Periodically check battery connections for corrosion and tightness. If necessary, remove connections and wire brush any corrosion from terminals and cable ends. Replace damaged wiring.

Item 6– 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 may cause damage to accessory components. Drive belt tension should be checked every 250 hours or 3 months, whichever comes first.

⚠ CAUTION:

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

Use a belt tension gage, such as Kent-Moore® tool J 23586–B (V-belt), J 23600–B (poly-V belt), J 41251 (PowerBand® and 12–rib poly-V belt), or equivalent, when tensioning drive belts. Tension belts to the values listed in Table 11.

Fan Drive		
Single Belt	**2 or 3 Belts**	
80 – 100 lbs (36 – 45 kg)	60 – 80 lbs (27 – 36 kg	
Alternator Drive		
Belt	**New**	**Used**
Two 1/2–in. V-Groove	125 lbs (57 kg)	100 lbs (45 kg)
2–Groove PowerBand®	200 lbs (91 kg)	150 lbs (68 kg)
12–Rib Poly-V (50 DN Alternator)	350 lbs (159 kg)	250 lbs (113 kg)

Table 11 Drive Belt Tensioning

V-Belts

New standard V-belts will stretch after the first few hours of operation. Tighten V-belts as listed in Table 11. Run the engine for 10 to 15 minutes to seat the belts, then readjust tension. Check and retension belts after 1/2 hour and again after 8 hours of operation. Thereafter, check the tension of the drive belts every 250 hours or 3 months and adjust, if necessary.

If a belt tension gage is not available, adjust the belt tension so that a firm push with the thumb, at a point midway between the two pulleys, will depress the belt .50 in. – .75 in. (13 mm – 19 mm).

2-Groove PowerBand®

Tighten a new PowerBand® drive belt to 200 lbs (91 kg), then run the engine for 10 minutes at 1200 rpm. Stop the engine and allow a 10 – 15 minute cool down period. Check tension. If less than 150 lbs (68 kg), retension to 150 lbs (68 kg).

12–Rib Poly-V Belt

Tighten a 12–rib poly-V belt to 350 lbs (159 kg), then run the engine at high idle for 30 minutes. Stop the engine and allow a 10 – 15 minute cool down period. Check tension with tool J 41251–B or equivalent. If tension is 250 lbs (113 kg) or more, no retensioning is required. If tension is less than 250 lbs (113 kg), retension to 250 lbs (113 kg).

Belt Replacement

Drive belts (V and poly-V) should be replaced every 2,000 hours.

Replace all belts in a set when one is worn. Single belts of similar size should not be used as a substitute for a matched belt set. Premature belt wear can result because of belt length variation. All belts within a matched set are within .032 in. (0.8 mm) of their specified center distances.

When installing or adjusting an accessory drive belt, be sure the bolt at the accessory adjusting pivot point is properly tightened, as well as the bolt in the adjusting slot. In addition, check the torque on the alternator and bracket mounting bolts. Retighten as required.

Item 7– Air Cleaner/Aspirator

The air cleaner element should be inspected every 250 hours 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. Replace the element every 1000 hours or 12 months, whichever comes first.

NOTICE:

Do not allow the air inlet restriction to exceed 20 inches of water (5.0 kPa) under any engine operating conditions. A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine. This, in turn, can result 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 1000 hours or 12 months or when the maximum allowable air intake restriction has been reached, whichever comes first. Refer to section G. When to Service the Dry Type Air Cleaner in this guide for additional information.

Item 8 – Lubricating Oil Filters

⚠ CAUTION:

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

Install new spin-on oil filters each time the engine oil is changed. Install the new filters, turning them until they contact the gasket fully with no side movement. Turn full-flow filters an additional 2/3 turn **by hand**, or as indicated on the filter. See Figure 19.

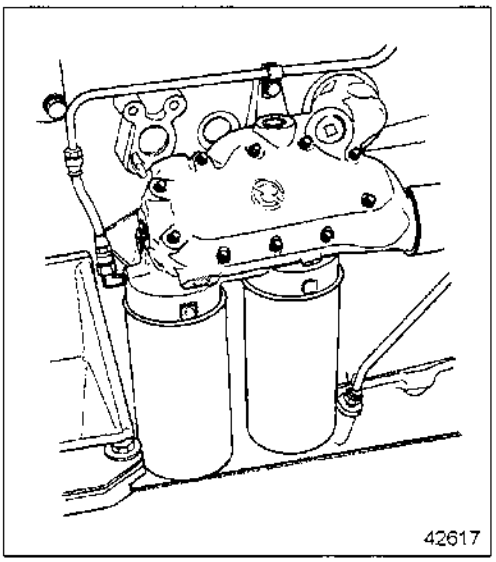


Figure 19 Lubricating Oil Filters

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.

CAUTION:

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

Item 9 – Water Pump and Coolant Inhibitor Element

Water Pump

Water Pump Drain Hole – The water pump drain hole should be inspected every 500 hours or 6 months to make sure it is open. A small chemical build-up or streaking at the drain hole may occur. **This is not an indication of a defective water pump or seal.** Remove the build-up with a mild detergent cleaner and a brush. If coolant does not leak from the drain hole under normal conditions, do not replace the water pump.

Coolant Inhibitor Element

If the cooling system is protected by a supplemental coolant additive (SCA) element, the coolant must be tested at required intervals and the element replaced, if required. See Figure 20.

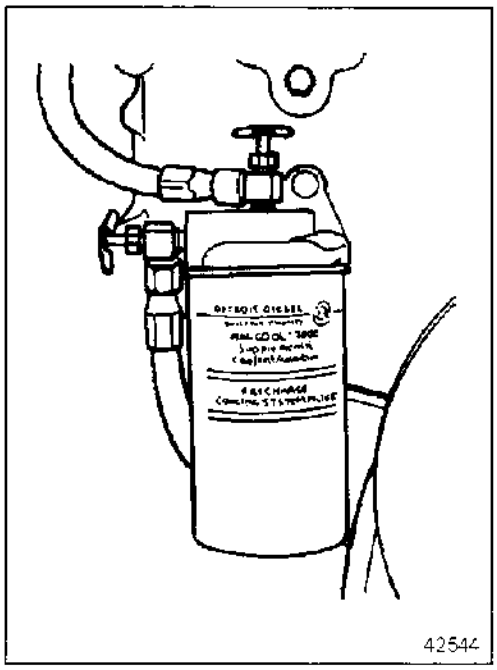


Figure 20 Coolant Inhibitor Element

Required test intervals are listed in Table 21. For SCA test procedures refer to the SCA Test Procedures in section E. How to Select Coolant in this guide. Refer to section SPECIFICATIONS for the coolant filter element required. The valves mounted on the filter adaptor head *must* be opened after the element is replaced.

Item 10 – Cranking Motor

For cranking motor (starter) information, contact an authorized Delco Remy® or Bosch® service center, depending on manufacturer.

Item 11 – Air System

Periodically inspect the air-to-air charge cooler for buildup of dirt, debris etc. and wash off. Check the charge cooler, ductwork and flexible connections for leaks and have repaired or replaced, as required.

Item 12 – Exhaust System

Have the exhaust manifold retaining bolts and other connections checked for tightness.

Item 13 – Engine (Steam Clean)

NOTICE:

Do not apply steam or solvent directly to the battery-charging alternator, starting motor, DDEC components, sensors or other electrical components, as damage to electrical equipment may result.

Steam clean the engine and engine compartment every 3000 hours or 24 months, whichever comes first.

Item 14 – Radiator

The exterior of the radiator core should be inspected every 1000 hours or 12 months, and cleaned, if necessary.

⚠ CAUTION:

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

Use a quality grease solvent, such as mineral spirits, and dry with compressed air. **Fuel oil, kerosene or gasoline should not be used.**

It may be necessary to clean the radiator more frequently if the engine is being operated in extremely dusty or dirty areas.

If the low coolant level sensor is installed in the top tank of the radiator, it should be tested for proper operation every 1000 hours or 12 months, whichever comes first. Authorized Detroit Diesel distributors are properly equipped to perform this service.

Item 15 – Oil Pressure

Under normal operation, oil pressure is noted each time the engine is started. In the event the equipment has warning lights rather than pressure indicators, the pressure should be checked and recorded every 1,000 hours or 12 months.

Item 16 – Battery-Charging Alternator

Bosch® T1 Alternator Service Requirements

The transistor regulator must be replaced every 1,000 hours or 12 months using DDC service kit part number 23524613 (includes regulator assembly and brushes). Front and rear bearings must be replaced every 2,000 hours or 24 months using kit part number 23524614 (includes bearings, seals and spacer ring). Authorized Bosch distributors have the parts, tools and trained personnel to perform these services.

General Service Requirements – Bosch® and Delco Remy® Alternators

Terminals should be checked for corrosion and loose connections and wiring inspected for damage and frayed insulation every 1,000 hours or 12 months. Have wiring repaired or replaced, as required.

Check torque on alternator mounting bolts and bracketing every 1,000 hours or 12 months. Retighten, if necessary.

Alternator Precautions

⚠ CAUTION:

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. Always establish correct polarity before connecting cables to the battery or battery circuit. 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.**

Precautions must be taken when working on or around the alternator. The diodes and transistors in the alternator circuit are very sensitive and can be easily destroyed.

1. Avoid grounding the output terminal. Grounding an alternator's output wire or terminal (which is always "hot," regardless of whether or not the engine is running) and accidentally reversing the battery polarity will result in equipment damage.
2. Do not reverse battery connections. This can also cause damage.
3. Never disconnect the battery while the alternator is operating. Disconnecting the battery can result in damage to the battery diodes. In applications which have two (2) sets of batteries, switching from one set to the other while the engine is running will momentarily disconnect the batteries. This can result in equipment damage.
4. If a booster battery is to be used, batteries must be connected correctly (negative to negative, positive to positive) to avoid equipment damage.
5. Never use a fast charger with the batteries connected or as a booster for battery output.

For information on the alternator assembly, contact an authorized Delco Remy® or Bosch® distributor, depending on manufacturer.

Item 17– Engine and Generator Mounts

The engine and generator mounting bolts and the condition of the mounting pads should be checked every 1,000 hours or 12 months. Tighten and/or repair as necessary.

Item 18 – Crankcase Pressure

The crankcase pressure should be checked and recorded every 500 hours or 6 months.

Item 19– Fan Hub

If the fan bearing hub assembly has a grease fitting, use a hand grease gun to lubricate the bearings with one shot of quality lithium-base, multi-purpose grease every 500 hours or 6 months. Care should be taken not to overfill the bearing housing.

Item 20 – Thermostats and Seals

Inspect the thermostats every 1,000 hours or 12 months. Replace if the start-to-open 192 °F (89 °C) and full-open 210° F (99° C) temperatures are not met. Install thermostats with new seals.

Item 21 – Spark Plug Boot Assemblies

Spark plug boot assemblies should be inspected every 1,500 hours or 12 months and replaced if they show signs of wear or heat distress (cracking or hardening of silicone materials).

Item 22 – Spark Plugs

For efficient fuel combustion, spark plugs must be replaced every 1500 hours or 12 months and installed to the proper torque: 26 – 30 lb-ft (35 – 41 N·m).

Item 23 – Vibration Damper

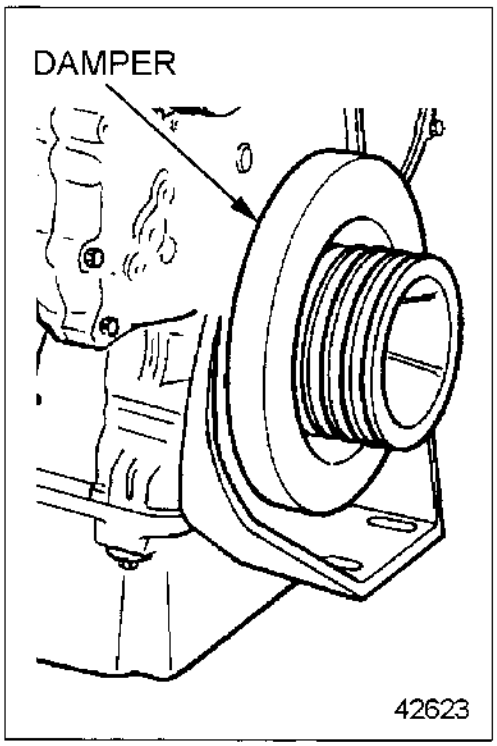


Figure 21 Viscous Vibration Damper

The viscous vibration damper should be inspected periodically and replaced if dented or leaking. See Figure 21.

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.

NOTICE:
Failure to replace a damaged vibration damper when required may result in severe engine damage.

Item 24 – Valve Lash

There is no scheduled interval for performing an engine tune-up. However, the valve lash *must* be measured and, if necessary, adjusted after the first 1,500 hours or 12 months of operation, whichever comes first.

Once the initial measurements/adjustments have been made, any adjustments beyond this point should be made only as required to maintain satisfactory engine performance. Authorized Detroit Diesel distributors have the trained technicians to perform this service.

Item 25 – Electrical System

Inspect the electrical system annually. Check wiring harnesses and sensors for cracks, rubbing, loose connections and corrosion. Check battery cables for broken insulation, rubbing/chafing and corroded or loose connections. Retighten, replace or reposition, as required.

Item 26 – PSV

The PSV (pulse width modulated stepper motor valve) should be inspected annually. Refer to the *Series 50 Service Manual* (6SE50) or the *Series 60 Service Manual* (6SE483) for procedure.

Item 27 – Fuel Mixer

Inspect the fuel mixer for moisture in the gas chamber every 3,000 hours or 24 months, whichever comes first. Drain, if necessary.

Welding Precaution

NOTICE:

Failure to isolate the DDEC system from high current flow can result in severe ECM (electronic control module) damage. To prevent damage to the ECM and other DDEC components, disconnect battery power and ground cables and the 5–pin power connector at the ECM before welding.

"HOW-TO" SECTION

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

NOTICE:

The manufacturer's warranty applicable to Series 50G/60G 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 Selections in North America

Lubricants formulated for use in natural gas-fueled engines must provide adequate engine lubrication, minimal thermal degradation, and good deposit control. No API (American Petroleum Institute) category currently exists for natural gas engine oils. Therefore, selection of the proper engine oil is limited to the lubricants which have demonstrated adequate performance in these engines. The lubricants identified by Detroit Diesel are listed in Table 33. Other lubricants may be selected by the customer, provided the oil supplier can demonstrate equivalent performance and durability with the oils identified. Detroit Diesel will not determine this equivalency.

B. When to Change Oil

Oil and Filter Change Intervals

⚠ CAUTION:

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

During engine operation, lubricating oil undergoes deterioration from combustion by-products and contamination. These intervals will vary in length, depending on fuel quality. The oil drain interval listed in Table 12 should be considered the **maximum** interval.

Application	Lube Oil and Filter Change Interval*
Standby Duty	250 Hours or 12 Months, whichever comes first
Continuous Duty	250 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 12 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur 16 ppm or Less)

Application	Lube Oil and Filter Change Interval*
Standby Duty	200 Hours or 6 Months, whichever comes first
Continuous Duty	200 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 13 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur Greater than 16 ppm, but Less than 24 ppm)

Application	Lube Oil and Filter Change Interval*
Standby Duty	150 Hours or 3 Months, whichever comes first
Continuous Duty	150 Hours or 3 Months, whichever comes first

* Change both full-flow filters when lube oil is changed.

Table 14 Recommended Engine Oil Drain/Filter Change Interval (Engine Using Fuel with Total Sulfur Greater than 24 ppm, but Less than 32 ppm)

NOTICE:

Operation with fuels having total sulfur greater than 32 ppm, on a mass basis, may result in engine damage, and is not recommended by Detroit Diesel Corporation.

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.

C. How to Replace the Lube Oil Filters

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. For filter part numbers, refer to the SPECIFICATIONS section of this guide.

Replace Spin-On Type Oil Filter

Replace spin-on type filters as follows:

1. Place a suitable container under the engine oil pan, remove drain plug and drain the lubricating oil. Replace the drain plug and tighten securely.
2. Remove spin-on filters using tool J 29917 or equivalent and a 1/2-in. drive socket wrench and extension.

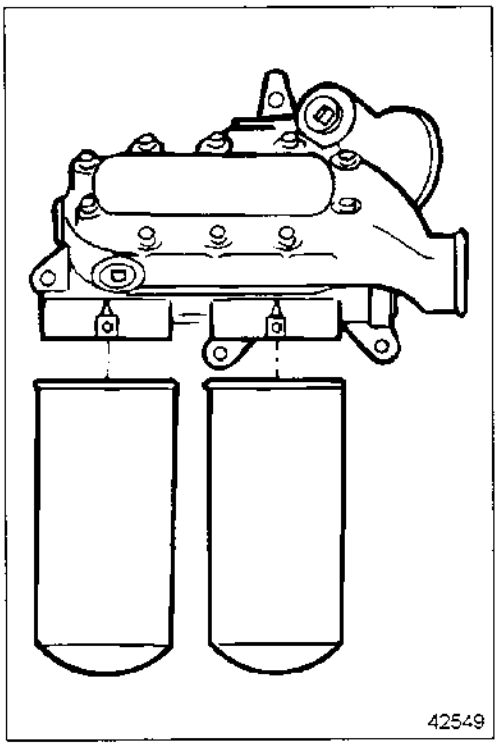


Figure 22 Spin-On Oil Filters

3. Dispose of used oil and filters in an environmentally responsible manner, according to federal (EPA) and/or state recommendations.

4. Clean the filter gasket-contact surface of the adaptor head with a clean, lint-free cloth.
5. Fill the new filters with clean lubricating oil and lightly coat the filter gaskets with the same oil.

NOTICE:

Do not overtighten filters. Overtightening may crack or distort the filter adaptor.

6. Start the new filters on the adaptor head and tighten by hand until the gaskets touch the mounting adaptor head. **Tighten filters an additional two-thirds turn by hand, or as indicated on the filter.**
7. Add oil as required to bring the level to the "Full" mark on the dipstick.

NOTICE:

If the engine 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. Coolant dilution of lubricating oil can result in serious engine damage.

8. Start the engine and check for leaks. After correcting any leaks, stop the engine and allow the oil to drain back to the crankcase (approximately 20 minutes). Add oil as required to bring the level to the "Full" mark on the dipstick.

D. How to Select Fuel

Fuel Composition

The characteristics listed in Table 15 and Table 16 identify the minimum quality level recommended by Detroit Diesel for use in natural gas-fueled engines.

NOTICE:

Operation with fuels having total sulfur greater than 32 ppm, on a mass basis, may result in engine damage, and is not recommended by Detroit Diesel Corporation.

Users of this recommended specification are advised to review SAE J 1616, " Compressed Natural Gas Vehicle Fuel Recommended Practice," for additional information.

Property	Limit	ASTM Test Method
Hydrocarbon	**Mole Percent**	
Methane	88% Min.	
Ethane	6% Max.	D 1945
Propane	1.7% Max.	
C4 and Higher	0.3% Max.	
Other Gaseous Species	**Mole Percent**	
Hydrogen	0.1% Max.	D 2650
Carbon Dioxide + Nitrogen + Oxygen	5.0% Max.	D 1945
Oxygen	0.5% Max.	D 1945
Carbon Monoxide	0.1% Max.	D 2650
Other Species		
Methanol	0% Mass Max.	No Test Method
Sulfur, Total	0.05 Grains / 100 SCF Max. (16 PPM Mass Max.)	No Test Method ASTM D 5504
Performance Related Properties		
Motor Octane Number	115 Min.	D 2623 (See Footnote 1)
Wobbe Number	1290 – 1380 BTU/SCF	D 3588 (See Footnote 1)
Contaminants	(See Footnote 2)	–
Pressure Water Dew Point Temperature, Max.	(See Footnote 3)	D 1142
Pressure Hydrocarbon Dew Point Temperature, Max.	Below which will form 1% condensate (See Footnote 3)	D 1142
Odorant	(See Footnote 4)	–

Table 15 Compressed Natural Gas Minimum Quality Requirements

Footnotes to Table 15.

1. Test Method D 2623 was obsoleted by ASTM in 1991. Wobbe Index (WI), also known as Wobbe Number, is a measure of fuel energy flow rate through a fixed orifice under given inlet conditions. Numerically, WI = (dry, higher heating value) / (specific gravity).
2. The compressed natural gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fuel station equipment being fueled.
3. The water and hydrocarbon dew point at fuel storage container pressure shall be at least 10° F below the 99.0% winter design temperature listed in Chapter 24, Table 1, "Climactic Conditions for the United States," in *American Society of Heating, Refrigerating and Air Conditioning Engineer's Handbook*, 1989 fundamentals volume. Testing for water and hydrocarbon vapor shall be in accordance with ASTM D 1142, utilizing the Bureau of Mines apparatus.
4. The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of 1% by volume.

Property	Limit Mole Percent	ASTM Test Method
Methane	98% Min.	D 1945
Heavy Hydrocarbon (C4 and higher)	0.5% Max.	
Inert Gas	2% Max.	

Table 16 Liquefied Natural Gas Minimum Quality Requirements

E. How to Select Coolant

Definitions

This section covers selection of the required coolant for Series 50G/60G engines. To help ensure complete understanding of the information, the definitions of the following terms are provided:

Antifreeze — Ethylene glycol or propylene glycol containing a corrosion inhibitor package and which meets an appropriate heavy-duty specification (i.e., TMC RP-329 for ethylene glycol or TMC RP-330 for propylene glycol).

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 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 coolant.

OAT — Organic Acid Technology. An inhibitor system based on nitrite and organic acid inhibitors, instead of traditional North American inhibitor formulations.

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

Approved Coolants

NOTICE:

Required specifications for water, ethylene glycol, propylene glycol, inhibitor packages and inhibitor concentration are included in this section. To avoid possible engine damage from inadequate or overconcentrated coolant, this information should be read thoroughly before the coolant is replaced.

The approved and preferred coolants for Series 50G/60G engines are listed in Table 17. Once installed, these coolants should be maintained according to the procedures discussed under Maintenance in this section.

Coolant Fill Option	Product
Ethylene Glycol & Water + Corrosion Inhibitors [1]	DDC *Power Cool*
Commercial Equivalent of DDC *Power Cool*	Fully Formulated TMC RP-329 Type A Antifreeze & Water
Propylene Glycol & Water + Corrosion Inhibitors [1]	DDC *Power Cool* Plus
Ethylene Glycol & Water + OAT Inhibitors	DDC *Power Cool* Plus
Water Only + Corrosion Inhibitors [2]	Water + DDC *Power Cool* 3000
Water Only + OAT Inhibitors [2]	Water + DDC *Power Cool* Plus 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 17 Initial Fill Coolant Options

Ethylene Glycol & Water Plus SCA Inhibitor or Propylene Glycol & Water Plus SCA 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 for use, while the concentrated coolant must be mixed with water prior to use.

Detroit Diesel *Power Cool* engine coolant (part number 23512138) is the preferred ethylene glycol coolant. If other commercial brands of ethylene glycol are used, they must be equivalent to the *Power Cool* (see following paragraph). Detroit Diesel does not market a propylene glycol coolant. If a propylene glycol coolant is used, it must also meet the requirements listed in the following paragraph.

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

Fully formulated antifreeze does not require a dosage of SCA (supplemental coolant additive) 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 listed in Table 20 and fill the cooling system.

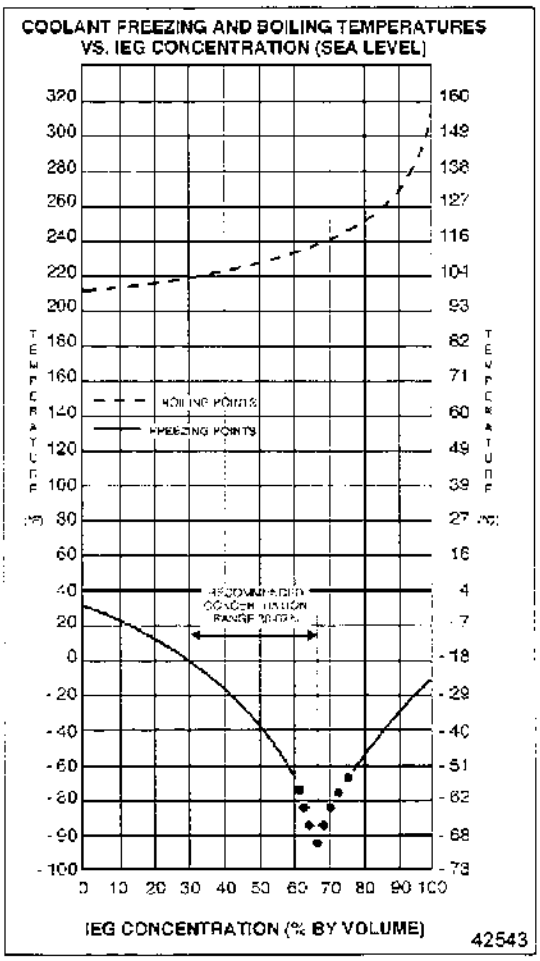


Figure 23 Coolant Freezing and Boiling Temperatures Versus Inhibited Ethylene Glycol (IEG) Concentration (Sea Level)

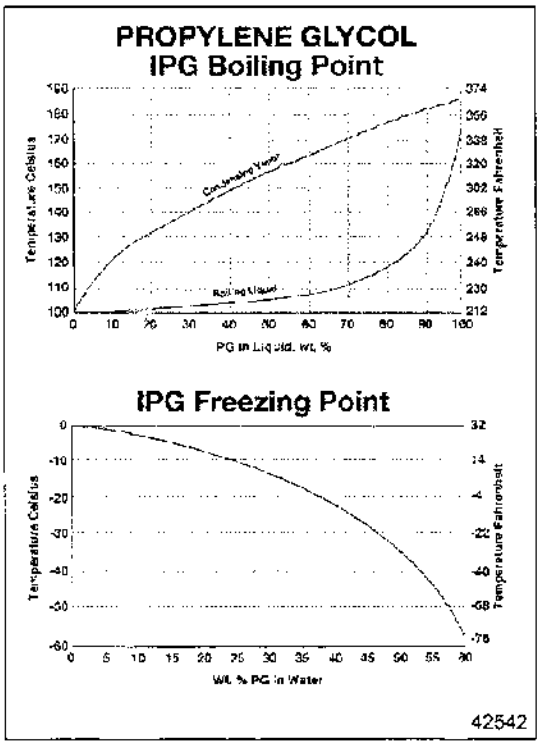


Figure 24 Coolant Freezing and Boiling Temperatures Versus Inhibited Propylene Glycol (IPG) Concentration (Sea Level)

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 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.*

See Figure 23 for ethylene glycol-base coolant concentration versus freezing and boiling temperatures.

See Figure 24 for propylene glycol-base coolant concentration versus freezing and boiling temperatures.

Always verify that the freeze point and nitrite concentration of the antifreeze/water mixture are correct by using a *Power Trac*® 3–Way Coolant Test Strip. If chemical analysis is used, elements in the coolant must fall within the limits listed in Table 18.

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 18 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 TMC 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.*

Ethylene Glycol/Water + OAT Inhibitor or Propylene Glycol/Water + OAT Inhibitor — Ethylene glycol and propylene glycol are also available with a OAT (Organic Acid Technology) corrosion package. These coolants require less maintenance over the useful life of the engine. OAT coolants, maintained as detailed in the **Maintenance** section of this guide, may be operated up to four (4) years or 10,000 operating hours, whichever comes first. Refer to the Maintenance section in this guide. The cooling system should either be equipped with a "blank" coolant filter, or the coolant filter and piping may be omitted from the system.

OAT fully formulated antifreezes are available as concentrated and pre-mixed. Concentrated antifreezes should be mixed 50% (50% antifreeze, 50% water).

OAT coolants should not be mixed with conventional coolants. If they 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 IEG coolant, not as an OAT (Organic Acid Technology) coolant.

Detroit Diesel markets a OAT-inhibited ethylene glycol coolant, DDC *Power Cool* Plus, which contains all the required additives. If a non-DDC OAT antifreeze is used, it must conform to TMC 338 specification. *Do not add extender to new OAT antifreeze or coolant.*

Water Only + SCA or Water Only + OAT Inhibitor — In warm climates a coolant based on water with corrosion inhibitors is approved for use. Water-only systems need to be treated with the proper dosage of corrosion inhibitors. Detroit Diesel-approved SCAs or OAT corrosion inhibitors *must* be added to the water to provide required corrosion and cavitation erosion protection. OAT inhibitors such as *Power Cool* Plus 6000 are available for water-only systems. Inhibitor should be mixed at 7.5% – 10% by volume with water. For a list of *Power Cool* products, refer to section SPECIFICATIONS in this guide. Traditional SCA (*Power Cool* 3000) can also be used to protect the engine. *Power Cool* 3000 concentration limits are listed in Table 19.

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 19 *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. This is 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, reverse osmosis-purified, 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 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 20.

	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 20 Satisfactory Water Limits – Make-Up Only

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:

1. **All antifreezes and coolants containing phosphate** should be avoided. Drop out, overheating and water pump seal failures can result from the use of coolant or inhibitor packages based on phosphate.
2. **Automotive type coolants** generally contain high levels of phosphate and silicate, offer no liner pitting protection, and are *not suitable* for use in Detroit Diesel engines.
3. **Methyl alcohol-based antifreeze** must not be used because of its effect on the non-metallic components of the cooling system and its low boiling point.
4. **Methoxy propanol-based antifreeze** must not be used because it is not compatible with the fluoroelastomer seals found in the cooling system.
5. **Glycol-based 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.

Additives Not Recommended

The following additives are *not recommended* for use in Series 50G/60G engines:

1. **Soluble oil additives** are not approved for use in Detroit Diesel engine cooling systems. A small amount of oil adversely affects 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.
2. **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 chromium-inhibited coolant

must be chemically cleaned with *Power Cool* dry chemical cooling system cleaner/conditioner listed in Table 46 (or equivalent sulfamic acid/sodium carbonate cleaner) and flushed.

Maintenance

Coolant Inhibitor Test Intervals

— The coolant inhibitor level should be checked at the intervals listed in Table 21.

Service Application	Inhibitor Test Interval
Stand-By Duty Generator Engine	200 Hours or Yearly, whichever comes first
Continuous Duty Generator Engine	

Table 21 Required Coolant Inhibitor Test Intervals

⚠ CAUTION:

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

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

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.
- ☐ 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 22 with a *Power Trac* 3–Way Test Strip.

Coolant	Interval [1]	Action
Antifreeze / Water + SCA Inhibitor (DDC *Power Cool*)	500 Hours or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	2 Years or 4,000 Hours*	Drain and clean system. Replace with new coolant.
Ethylene Glycol / Water + SCA Inhibitor or Propylene Glycol / Water + SCA Inhibitor	500 Hours or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	2 Years or 4,000 Hours*	Drain and clean system. Replace with new coolant.
Ethylene Glycol / Water + OAT Inhibitor or Propylene Glycol / Water + OAT Inhibitor	5,000 Hours	Add *Power Cool* Plus Extender
	4 Years or 10,000 Hours*	Drain and clean system. Replace with new coolant.
Water Only + SCA Inhibitor	500 Hours or 3 Months*	Test nitrite concentration with test strip. Add SCA or dilute coolant as needed.
	2 Years or 4,000 Hours	Drain and clean system. Replace with new coolant.
Water Only + OAT Coolant	5,000 Hours	Add *Power Cool* Plus Extender
	4 Years or 10,000 Hours	Clean and drain. Replace with new coolant.

[1] Maintenance interval based on application. Drain interval dependent on proper maintenance.

NOTE: Nitrite levels *must* be within the ranges listed in Table 18.

Table 22 Coolant Maintenance Intervals

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 Series 50G/60G 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 maintenance interval 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 listed in Table 47. Cavitation/corrosion is indicated on the strip by the level of nitrite concentration. Freeze/boil over protection is determined by glycol concentration.

For best results make the test while the coolant is between 50° – 140° F (10.0° – 60° C). Wait at least 60, but not longer than 75, seconds before reading the nitrite level. Use the test strips as follows:

⚠ CAUTION:

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

1. With the engine shut down and cool to the touch, remove the radiator pressure cap *slowly*. 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 listed in Table 47 in the **Specifications** section. To verify coolant acceptability, submit a sample for coolant analysis every three (3) years, or 6,000 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 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.

⚠ CAUTION:

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 listed in Table 46 in the **Specifications** section.

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, testing has determined that a OAT coolant extender package should be added to the coolant at two (2) years or 5,000 hours, whichever comes first. The proper maintenance dosages for all OAT coolants are listed in Table 22 , 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 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

***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 (i.e., water) at initial fill and at maintenance intervals. **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

⚠ CAUTION:

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

1. Always maintain the engine coolant to meet Detroit Diesel specifications.
2. Only use water that meets the specifications listed in Table 20. 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 3,200 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 or coolants with phosphates.
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. Coolant Life:

    ☐ 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 for the life of the engine until overhaul. 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 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 listed in Table 47.

    ☐ OAT Coolant. A properly maintained OAT coolant may be operated four (4) years, 10,000 hours 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 two (2) years or 5,000 hours, whichever comes first. Use 1 pint of extender for every 20 gallons of coolant.

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

11. 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

F. How to Drain and Flush the Cooling System

⚠ CAUTION:

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

1. With the engine cool, drain the previous solution from the engine and radiator. Dispose of the coolant in an environmentally friendly manner, according to state and/or federal (EPA) recommendations.
2. Refill the cooling system with clean, soft water and a good cooling system cleaning compound, such as those listed in Table 46 in the **Specifications** section. If the engine is warm, fill slowly to prevent the rapid cooling and distortion of the metal castings.
3. Start the engine and operate it for fifteen minutes to circulate the solution thoroughly.
4. Stop the engine and allow it to cool.
5. With the engine cool, drain the cooling system completely.
6. Refill the cooling system with clean, soft water and operate it for fifteen minutes.
7. Stop the engine and allow it to cool.
8. With the engine cool, drain the cleaner residue from the cooling system.
9. Refill the system with the required coolant. Refer to section E. How to Select Coolant.
10. Entrapped air must be purged after filling the cooling system. To do this, allow the engine to warm up without the pressure cap installed. Increase engine speed above 1000 RPM and add coolant as required. Install the pressure cap after the coolant level has stabilized at the bottom of the radiator filler neck.

NOTICE:

If the engine overheats and the coolant level is satisfactory, the cooling system may require cleaning with a descaling solvent and backflushing. Authorized Detroit Diesel service outlets are properly equipped to perform these services.

In addition to the cleaning procedure, other components of the cooling system should be checked periodically to keep the engine operating at peak efficiency.

Hoses. Cooling system hoses should be inspected and any hose that shows obvious signs of damage or feels abnormally soft or hard should be replaced. Damaged clamps should also be replaced. All external leaks should be corrected as soon as detected.

NOTE:

If Detroit Diesel ***Power Cool*** antifreeze/coolant (or equivalent fully formulated, precharged antifreeze) is used, a precharge element is not required. Coolant inhibitor levels *must* be checked at the intervals listed in Table 21.

G. When to Service the Dry Type Air Cleaner

Replace dry type air cleaner elements when the maximum allowable air cleaner restriction (20 inches of water or 5.0 kPa) has been reached or annually, whichever comes first. Some air cleaners are equipped with a restriction indicator which aids in determining the servicing interval.

Cleaning and/or reusing dry paper type air cleaner elements is not recommended unless the cleaning method used removes clogging without damaging the element. Inspection and cleaning of elements *must* be done in accordance with the air cleaner manufacturer's recommendations, if any.

BASIC TROUBLESHOOTING

This section covers basic troubleshooting of engine operation or performance malfunctions and their probable causes. Hard starting symptoms are listed in Table 23. Objectionable exhaust symptoms are listed in Table 24. Abnormal engine operation symptoms are listed in Table 25. Abnormal operating condition symptoms are listed in Table 26. Abnormal coolant temperature symptoms are listed in Table 27.

For detailed troubleshooting information, refer to publication *Series 50G/60G Troubleshooting Guide,* 6SE482, available from authorized Detroit Diesel distributors.

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			
Out of fuel			X
Loose fuel connections			X
Cracked fuel lines			X
Obstructed fuel filters/lines			X
DDEC Malfunction			X
Installation/operation of fuel check valve or shutoff valve			X
Low Compression			
Worn intake and exhaust valves			X
Worn piston rings/liners			X
Leaking cylinder head gasket			X
Improper intake or exhaust valve adjustments			X

Table 23 Hard Starting Symptoms and Probable Causes

Probable Causes	Blue Smoke
Lubricating oil not burned in cylinder (being burned in exhaust manifold or turbocharger)	X
Faulty oil control rings	X
Excessive installation angle	X
Excessive oil in crankcase	X
Clogged breather filter	X
Turbocharger failure	X
Worn or faulty valve stem seals	X

Table 24 Objectionable Exhaust Symptoms and Probable Causes

Probable Causes	Rough Running or Frequent Stalling	Low Power	Deton-ation	Back Fire
Fuel quality	X	X	X	
Misfiring cylinder	X	X	X	
Insufficient fuel	X	X		
Low compression	X	X		X
DDEC malfunction	X	X	X	X
High air inlet restriction/exhaust back pressure		X		
Engine application		X		
High manifold temperature		X	X	
High altitude operation		X		
Incorrect engine gear train timing	X	X	X	X
High coolant temperature			X	
Oil picked up by inlet airstream			X	
Fuel system malfunction	X	X	X	X
Turbocharger malfunction		X		

Table 25 Abnormal Engine Operation Symptoms and Probable Causes

Probable Causes	High Lube Oil Consumption	Low Oil Pressure
Loose connections	X	
Cracked lines	X	
Damaged gaskets or seal rings	X	
Lube oil loss to closed crankcase breather system *	X	
Lube oil loss at dipstick tube *	X	
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	
Faulty oil pressure gage		X
Faulty electrical components (for gage)		X
Plugged oil orifice or obstructed oil line		X
Low oil level		X
Improper engine oil viscosity		X
Faulty oil pressure regulator valve		X
Worn crankshaft, 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

* Indicates high crankcase pressure

Table 26 Abnormal Operating Condition Symptoms and Probable Causes

Probable Causes	Above Normal Coolant Temp.	Below Normal Coolant Temp.
Restricted cooling system passages	X	
Restricted radiator core passages	X	
Slipping fan drive belts	X	
Faulty temperature-controlled fan	X	
Obstruction in front of radiator or intercooler	X	
Low coolant level	X	
Damaged hoses	X	
Faulty thermostats	X	
Faulty water pump	X	
Faulty radiator pressure cap	X	
Air in coolant	X	
Thermostats not fully closed		X
Leakage around thermostat seals		X
Faulty temperature-controlled fan		X

Table 27 Abnormal Coolant Temperature Symptoms and Probable Causes

ENGINE STORAGE

Preparing Engine for 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 other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

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. Operate the engine for two (2) minutes at 1200 rpm and no load. **Do not drain 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 DDC's recommendations. Refer to section E. How to Select Coolant.

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.

CAUTION:

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

6. Clean the exterior of the engine (except electrical parts) with fuel oil and dry with compressed air.

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.

7. Seal all engine openings. The material used must be waterproof, vaporproof 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 (natural gas), and lubricating 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 45 – 50 N·m (33 – 37 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 sediment from the fuel filters and remove the elements. Install new elements.
7. Service the air cleaner.
8. **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.
9. Apply a non-friction rust preventive compound to all exposed engine parts. If 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.

10. Drain the engine cooling system.
11. Drain the preservative oil from the engine crankcase. Reinstall and torque the 3/4" – 14 square, magnetic drain plug to 45 – 50 N·m (33 – 37 lb-ft).
12. 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.
13. Insert heavy paper strips between the pulleys and drive belts to prevent sticking.
14. Seal all engine openings, including the exhaust outlet, with moisture-resistant tape. Use cardboard, plywood or metal covers where practical.

15. 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.
16. 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 (if installed) 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. Reconnect the engine fuel system to the CNG supply. Open the fuel shutoff valve(s).

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 E. 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. **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 section Preparations for Starting the Engine the First Time..

⚠ CAUTION:

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

- ☐ **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.**

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

NOTE:
Before subjecting the engine to a load or high speed, allow it to reach normal operating temperature. Then monitor the DDEC Diagnostic Data Link (DDL) for trouble codes.

SERVICE PUBLICATIONS

Series 50G/60G Publications

The service manuals covering Detroit Diesel Series 50G and Series 60G engines and various reference works which may be of interest to the owner/operator are listed in Table 28.

To purchase a copy of any of these publications, contact an authorize Detroit Diesel distributor in the U.S. or Canada. Check the Yellow Pages under "Engine, Diesel" or refer to the Distributor and Dealer Directory listed below for the distributor or service outlet nearest you.

Description	Form No.
Series 50 Engine Service Manual	6SE50
Series 60 Engine Service Manual	6SE483
DDEC III/IV Single ECM Troubleshooting Guide	6SE497
Series 50G/60G Generator Set Engine Application and Installation Manual	7SA820
Series 50G/60G Troubleshooting Guide	6SE482
U.S. and Canada Distributor/Dealer Directory	6SE280
International Distributor/Dealer Directory	6SE281
Series 50/60 Service Outlet Directory	6SA336
Coolant Requirements for Engine Cooling Systems	7SE298
Technician's Guide – Used Lubricating Oil Analysis	7SE398
Technician's Guide – Turbocharger	7SE374
Technician's Guide – Cooling System	7SE390

Table 28 Service Publications

DETROIT DIESEL CUSTOMER ASSISTANCE

U.S. and Canada 1–800–445–1980

If you require 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 warranties. *YOU MAY BE RESPONSIBLE FOR REPAIR EXPENSES.*

Before calling Customer Assistance, please do the following:

- ☐ Check coolant level
- ☐ Check for fuel supply
- ☐ Check DDEC fuses
- ☐ Check for fuel leaks
- ☐ Make sure the manual shutoff valves in the fuel supply system are open.
- ☐ Check the oil level on the dipstick
- ☐ Check diagnostic codes against those listed in Table 1, Table 2, and Table 3.

If you call, have the following information available:

- ☐ Engine serial number
- ☐ Generator make and model
- ☐ Engine hours
- ☐ Generator set owner/company name

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:

- ☐ Service by trained personnel.
- ☐ Sales team to help determine your specific power requirements.
- ☐ In many areas, emergency service 24 hours a day.
- ☐ Complete parts support, including reliabilt® remanufactured 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 a service agreement.

Step Two

When it appears that your problem cannot be readily resolved at the distributor level without additional assistance, contact the Detroit Diesel Regional Product Support Manager 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:

- ☐ Series 50 Engine model* 604_ _ _ _ _.
- ☐ Series 50 Engine serial number* 04R0 _ _ _ _ _ _.
- ☐ Series 60 Engine model* 606 _ _ _ _ _ _.
- ☐ Series 60 Engine serial number* 06R0_ _ _ _ _ _.
- ☐ Type and make of generator.
- ☐ Engine delivery date and accumulated hours of operation.
- ☐ Nature of problem.
- ☐ Chronological summary of engine's history.
- ☐ Name and location of authorized service outlet, if known.

***Important:** Your engine model number and serial number should be written on the lines provided. They

will identify your engine and all service parts, plus provide warranty and extended coverage information. For the location of the engine model and serial numbers, refer to section ENGINE MODEL AND SERIAL NUMBER DESIGNATION.

Step Three

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

Vice President, Customer Assurance
Detroit Diesel Corporation
13400 Outer Drive, West
Detroit, MI 48239–4001
Phone: 313–592–7357
FAX: 313–592–7888

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.

See Figure 25 for the Detroit Diesel NAFTA off-highway regions. The addresses and phone/fax numbers for Detroit Diesel North American off-highway regional offices are listed in Table 29. The addresses and phone/fax numbers for Detroit international off-highway regional offices are listed in Table 30.

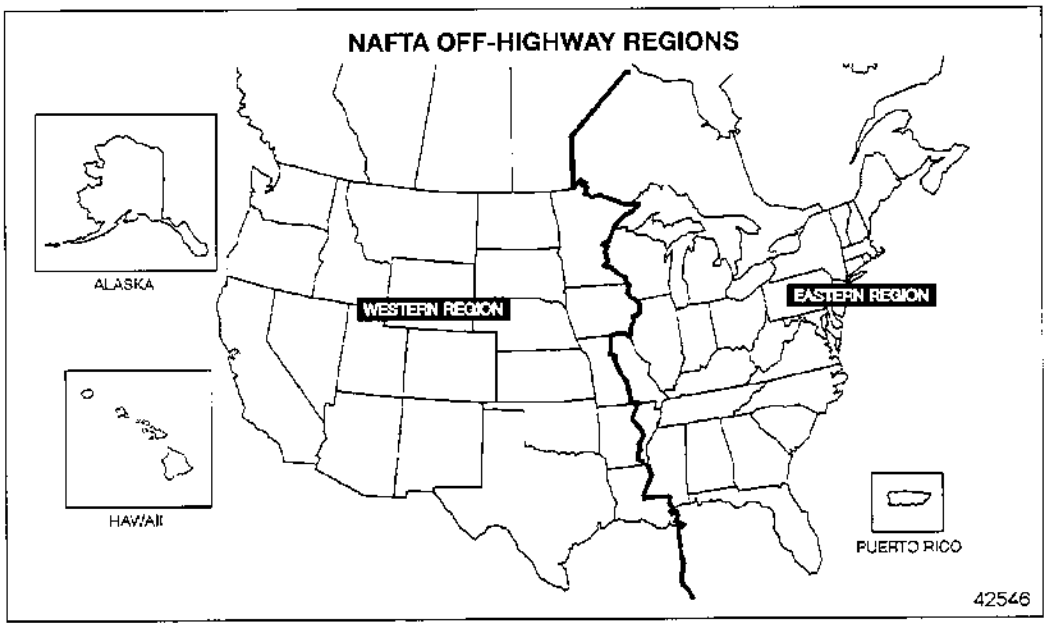


Figure 25 Detroit Diesel NAFTA Off-Highway Regions

DDC NAFTA OFF-HIGHWAY REGIONAL OFFICE LOCATIONS	
EASTERN REGION (Off-Highway) **Jacksonville, Florida** 5111 Bowden Road Jacksonville, FL 32216 Phone: 904-448-1011 Fax: 904-448-2444	**WESTERN REGION (Off-Highway)** **Dallas, Texas** 2711 LBJ Freeway Suite 1036 Dallas, TX 75234 Phone: 972-247-4313 Fax: 972-247-4316

Table 29 DDC NAFTA Off-Highway Regional Offices

DDC INTERNATIONAL REGIONAL OFFICE LOCATIONS	
ASIAN REGION (Off-Highway) **Singapore** No. 16 Benoi Crescent Singapore 629979 Phone: (65) 861-5922 Fax: (65) 865-1618	**EUROPE, MIDDLE EAST, AFRICA (EMA) REGION (Off-Highway)** **The Netherlands** Ridderpoort 9 2984 BG Ridderkerk The Netherlands Phone: (31) 1804-63388 Fax: (31) 1804-62062
PACIFIC REGION (Off-Highway) **Australia** 12 Dalgetty Road Beaumaris, Victoria 3193 Australia Phone: (61) 3-9589-0484 Fax: (61) 3-9589-6858	**LATIN AMERICAN REGION (Off-Highway)** **Miami, Florida** 2277 N.W. 14th Street Miami, FL 33125-0068 Phone: 305-637-1555 Fax: 305-637-1580
MEXICO (Off-Highway) Detroit Diesel Allison de Mexico Av. Santa Rosa 58 Col. Ampliacion Norte San Juan Ixtacala, Tlanepantla C.P. 54160, Edo de Mexico Phone: 525-333-1802 525-333-1870	**SOUTH AMERICAN REGION (Off-Highway)** Calle 80 No. 8-14 Of. #101 P.O. Box 53382 Bogota, Colombia Phone: (57) 1-211-4480 Fax: (57) 1-211-4053

Table 30 DDC International Off-Highway Regional Offices

WARRANTY INFORMATION

LIMITED WARRANTY ON NEW DETROIT DIESEL SERIES 50G AND SERIES 60G NATURAL GAS-FUELED ENGINES USED IN GENERATOR SET APPLICATIONS

TERMS OF COVERAGE

Uses

This warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 50G® and Series 60G® Natural Gas-Fueled Engines (referred to as Engine) manufactured by Detroit Diesel Corporation and/or supplied by Detroit Diesel Corporation, Detroit Diesel of Canada Limited, or Detroit Diesel Overseas Distribution Corporation (all which are collectively referred to as DDC) for use in prime or continuous power generators or in standby generators.

Defects

This warranty covers Engine REPAIRS to correct any malfunction occurring during the WARRANTY PERIOD resulting from defects in material or workmanship.

Repairs

To obtain warranty repairs, you must request the needed repairs within the WARRANTY PERIOD from an authorized DDC service outlet. Only new genuine parts or remanufactured parts or components supplied or approved by DDC will be used. DDC may, at its discretion, replace rather than repair components. A reasonable time must be allowed to perform the warranty repair. Repairs will be performed during normal business hours.

Warranty Period

The WARRANTY PERIOD begins on the date of initial start-up or delivery of the Engine to the first retail purchaser and ends at the time or hour limits in the continuous duty WARRANTY PERIOD chart in Table 31 or in the standby duty WARRANTY PERIOD chart in Table 32.

WARRANTY PERIOD				
Item	Warranty Limitations (Whichever Occurs First)		Repair Charges to Be Paid by Owner	
	Months	Engine Hours	Parts	Labor
Engine	0 – 12	No Limit	No Charge	No Charge
Upon expiration of the 12 month warranty coverage, but within 12,000 hours of use, the warranty continues to apply as follows:				
Block, Crankshaft and Connecting Rods (assemblies)	13 – 36	0 – 12,000	No Charge	100% of Service Outlet's Normal Charge

Table 31 Warranty Period Chart – Continuous Duty Power Generator Sets

WARRANTY PERIOD				
Item	Warranty Limitations (Whichever Occurs First)		Repair Charges to Be Paid by Owner	
	Months	Engine Hours	Parts	Labor
Engine	0 – 12	0 – 400	No Charge	No Charge

Table 32 Warranty Period Chart – Standby Duty Power Generator Sets

Service Supplies

The cost of service supplies such as coolant, oil and filters which are not reusable due to needed warranty repairs is covered by this warranty.

Like Replacement Engine

Engine(s) supplied by DDC as a replacement for an engine still under warranty will assume the identity of the Engine being replaced and be entitled to the remaining warranty coverage.

Mechanic's Travel Expenses

DDC will pay reasonable travel expenses for the repairing mechanic to travel to and from the repair site.

THIS WARRANTY DOES NOT COVER:

Repairs Due to Accidents, Misuse, Alteration, Storage Damage, Negligence or Certain Modifications

Repairs due to an accident, misuse, alteration, misapplication, storage damage, negligence or modification exceeding DDC specifications are not covered by this warranty.

Engine Removal and Reinstallation

Labor costs to gain access or replace the Engine, including removal and reinstallation of items/materials or components in which the Engine is installed are not covered by this warranty.

Non-DDC Supplied/Manufactured Components

DDC is not responsible for repair of components and/or assemblies such as exhaust and intake systems and fuel storage tanks which are manufactured or supplied by another manufacturer. Such items are covered by the equipment manufacturer.

Maintenance

DDC is not responsible for the cost of maintenance or repairs due to lack of performance of required maintenance services or the failure to use fuel, oil, lubricants, coolant, cooling air and ventilation meeting DDC-recommended specifications. Performance of the required maintenance and use of proper fuel, oil, lubricants, cooling air and ventilation are the responsibility of the owner. Refer to section LUBRICATION AND PREVENTIVE MAINTENANCE INTERVALS in this guide for details.

Incidental or Consequential Damage

This warranty does not cover any economic loss, including without limitation communication expenses, meals, lodging, loss of use of the Engine, loss of time, inconvenience, overtime, transportation of the Engine or any other cost or expense resulting from a defect covered by this warranty.

DETROIT DIESEL
CORPORATION

13400 OuterDrive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
FAX: 313-592-7288

TP-5830

6SE551 0211 As technical advances occur, specifications wil change. Printed in USA.