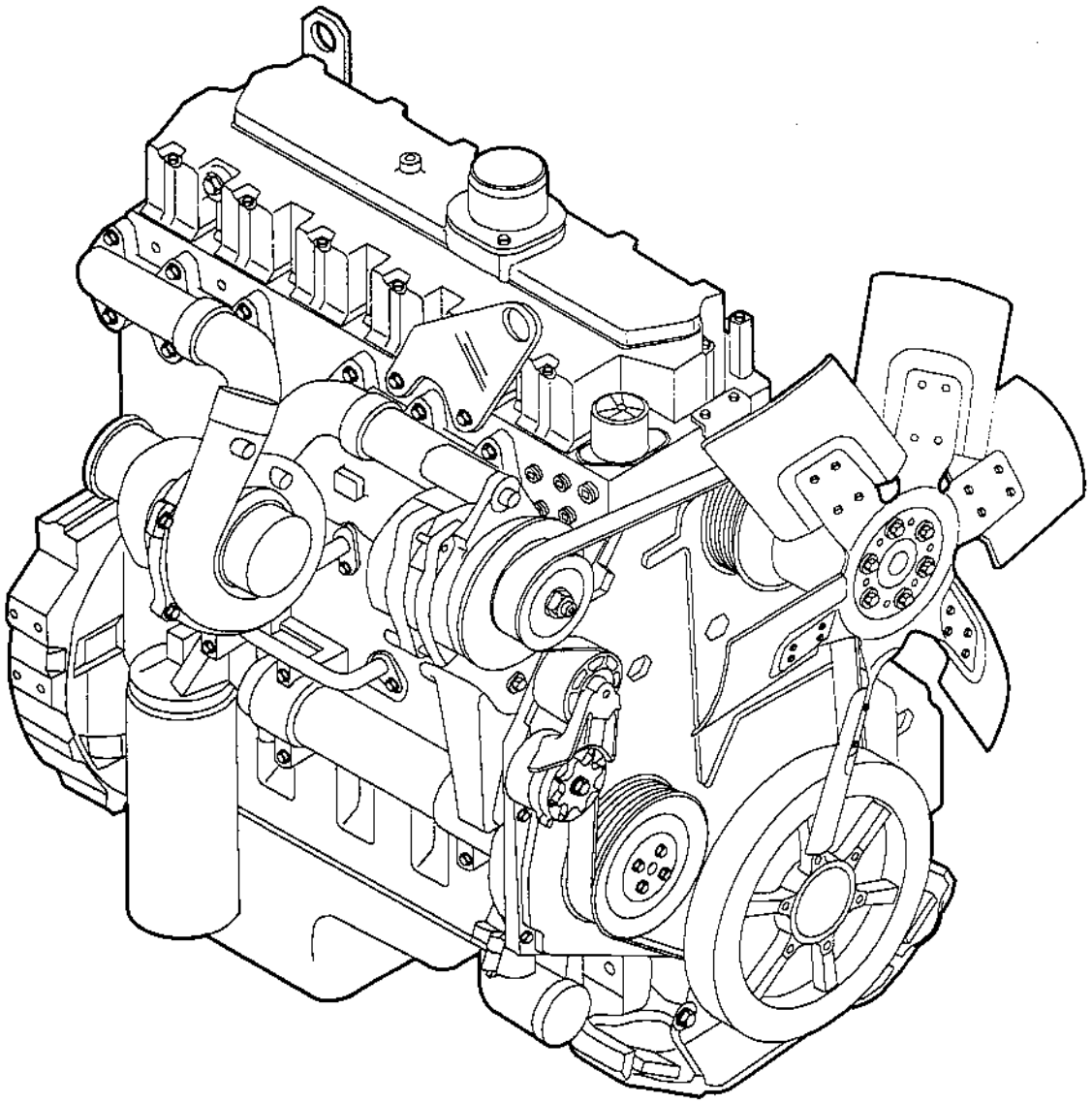
DETROIT DIESEL

Series 40E



Engine Operator's Guide

TP-6031

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.

ATTENTION!

This document is a guideline for qualified personnel. It is intended to be used by operators and contains preliminary recommendations of Detroit Diesel Corporation for the ancillary systems supporting the Detroit Diesel engines covered by this document. The equipment manufacturer is responsible for developing, designing, manufacturing and installing these systems, including component qualification. The equipment manufacturer is also responsible for furnishing equipment users complete service and safety information for these systems.

Detroit Diesel Corporation makes no representations or warranties regarding the information contained in this document and disclaims all liability or other responsibility for the design, manufacture or installation of these ancillary systems, or the preparation or distribution to equipment users of appropriate information regarding these systems.

The information contained in this document is subject to change without notice.

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1 SAFETY PRECAUTIONS

1.1 SAFETY

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

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

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

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

Whenever possible, it will benefit you to rely on an authorized Detroit Diesel service outlet for all your service needs from maintenance to major parts replacement. Authorized service outlets worldwide stock factory original parts and have the specialized equipment and experienced, trained personnel to provide prompt preventive maintenance and skilled engine repairs.

1.2 CAUTION SUMMARY

The following cautions must be observed by the operator of the vehicle in which this engine is installed or by the operator of the engine when used in applications without a vehicle.

Failure to read and heed these cautions and exercise reasonable care for personal safety and the safety of others when operating the vehicle or performing basic engine preventive maintenance may result in personal injury and engine and/or vehicle damage.

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

CAUTION:

Engine exhaust may be harmful to your health if inhaled. Please note this caution and remember:

- ❑ **Always start and operate the engine in a well–ventilated area.**
- ❑ **If in an enclosed area, vent the exhaust to the outside.**
- ❑ **Do not modify or tamper with the exhaust system.**

CAUTION:

When working near the engine, always remove loose items of clothing or jewelry that could get caught in a moving part of the engine and cause personal injury. Safety glasses and hearing protection must also be worn.

CAUTION:

To avoid personal injury (burns, eye injury) from the hot oil, do not operate the engine with rocker cover removed for any reason.

CAUTION:

The rotating fan, pulleys, and belts of an operating engine may pose certain hazards when servicing the engine. To avoid possible personal injury, follow these precautions:

- ❑ **Shut down the engine before performing basic preventive maintenance.**
- ❑ **If this is not possible or practical, keep hands, clothing, and tools away from the fan, pulleys, and belts while the engine is running.**
- ❑ **Avoid wearing loose clothing or jewelry which can get caught in the fan, pulleys, or belts. Do not place tools where they can fall into the fan system, becoming projectiles which may cause personal injury or property damage or both.**
- ❑ **Those with long hair should tie hair back or contain it in a hat to prevent possible entanglement with the fan, pulleys, or belts.**

CAUTION:

Personal injury and/or property damage may result from fire due to the leakage of flammable fluids such as lubricating oil. Contain and eliminate all leaks as they occur.

CAUTION:

Personal injury and/or engine damage may result from direct, physical contact with the vibration damper of an operating engine. This may occur if tools or other objects strike or become lodged behind the damper during operation. An object coming in contact with the damper of an operating engine may be thrown off with force, becoming a dangerous projectile which could cause personal injury, property damage, or both.

CAUTION:

Improper use of caustic chemicals may result in personal injury. If cleaning of an engine component should become necessary prior to replacement, follow the solvent manufacturer's usage, handling, and disposal instructions and observe all manufacturer cautions.

2. Observe the following cautions when using compressed air:

CAUTION:

To prevent possible personal injury when using compressed air, wear adequate eye protection (face plate or safety glasses) and do not exceed 40 psi (276 kPa) air pressure.

CAUTION:

Do not apply compressed air to any part of the body or clothing. Compressed air directed at the face or body may cause eye or hearing injury or other serious physical injury.

3. Observe the following cautions when using starting aids:

CAUTION:

Starting fluid used in capsules is highly flammable, toxic, and possesses sleep–inducing properties. Do not inhale vapors from starting fluid capsules.

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

CAUTION:

To avoid possible personal injury and/or engine damage from accidental engine start–up, always disconnect the battery before servicing the electrical system.

CAUTION:

Reversing battery polarity may result in personal injury caused by the sudden discharge of electrolyte from the battery vents and/or the sudden rupture of the battery case by explosion of internal hydrogen gas. Always establish the correct polarity before connecting cables to the battery or battery circuit.

CAUTION:

Do not touch battery terminals, alternator terminals, or wiring cables while the engine is operating. This can result in severe electrical shock, which may lead to personal injury.

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

CAUTION:

To avoid possible personal injury or injury to bystanders or damage to engine fuel system, service operations should be performed in a well–ventilated area that is kept free of bystanders.

CAUTION:

The addition of gasoline to diesel fuel will create a serious fire hazard. Do not mix gasoline with diesel fuel.

CAUTION:

When the temperature of diesel fuel is elevated, as occurs when the fuel is circulated through an operating engine, it may pose the following hazards that should be guarded against:

- ❑ **Heated liquid fuel may cause scalding if allowed to come in contact with the skin. Heated diesel fuel can form combustible vapor mixtures in the area around the fuel source.**
- ❑ **Whenever possible, it is recommended that the engine and fuel be given an opportunity to cool down to ambient temperature before performing service operations that could result in spillage of fuel from the engine or vehicle fuel system.**
- ❑ **When this is not possible, protective clothing and safety gear (insulated gloves, apron, face shield) should be worn when performing these operations.**
- ❑ **Engine or vehicle fuel system service operations should be performed in a well–ventilated area that is kept free of bystanders.**
- ❑ **Keep open flames, sparks, electrical resistance heating elements, or other potential ignition sources away and do not smoke during vehicle refueling or other service operations that could result in the escape of liquid or vaporized diesel fuel.**
- ❑ **Mop up or absorb spilled fuel immediately to avoid danger of possible slip and fall injury.**

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

CAUTION:

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

CAUTION:

Mop up or absorb spilled coolant immediately to avoid danger of possible slip and fall injury.

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

CAUTION:

To avoid personal injury (burns from the turbocharger or engine) or turbocharger damage, do not remove, attach, or tighten turbocharger air intake ducting while the engine is operating or operate the engine with the ducting removed.

CAUTION:

The rotating turbocharger impeller wheel may pose a hazard when the air inlet piping is removed. To avoid possible personal injury when an engine must be operated with the air inlet piping removed, do not start or run the engine without first installing the turbocharger air inlet shield (J 26554–A).

CAUTION:

To avoid personal injury when performing maintenance and repairs to turbocharged engines with air inlet piping disconnected, a turbocharger screen cover should be installed on the turbocharger air inlet.

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

CAUTION:

When the temperature of engine lubricating oil is elevated, as occurs when the oil is circulated through an operating engine, it may pose the following hazards that should be guarded against:

- ❑ **Heated oil may cause scalding if allowed to come in contact with the skin.**
- ❑ **Protective clothing and safety gear (insulated gloves, apron, face shield) should be worn when draining hot lubricating oil.**
- ❑ **Lubricating oil should be drained and replaced in a well–ventilated area that is kept free of bystanders.**
- ❑ **Keep open flames, sparks, electrical resistance heating elements, or other potential ignition sources away and do not smoke when draining or replacing lubricating oil.**

CAUTION:

Mop up or absorb spilled lubricating oil immediately to avoid danger of possible slip and fall injury.

2 GENERAL INFORMATION

2.1 FEATURES

The information in this manual will familiarize you with the Series 40E diesel engine features and provide sufficient information to enable you to perform services necessary for efficient operation.

The Series 40E diesel engines are a new family of inline six-cylinder, 4-cycle, water cooled, turbocharged, overhead valve, air-to-air intercooled with replaceable valve guides and valve seats for both intake and exhaust, offered by Detroit Diesel Corporation. The engine is fueled by a direct injection fuel system with electronic sensors and Hydraulically actuated Electronically controlled Unit Injectors (HEUI). The firing order is 1-5-3-6-2-4. The 530E has a displacement of 8.7 L (530 $in.^3$). The 466E has a displacement of 7.6 L (466 $in.^3$).

The crankcase has been designed to withstand the loads of diesel operation. It has cast water and oil passages. The crankcase also has replaceable wet-type cylinder sleeves. Every main bearing web has angled, drilled holes that are fitted with jet tubes that direct lube oil, under pressure, to the underside of each piston to help dissipate heat.

The crankshaft is forged steel with induction hardened journals and undercut fillets. It is supported on seven precision insert bearings. The camshaft is supported on four pre-reamed bushings and is gear driven from the crankshaft. The end thrust of the camshaft is controlled by a thrust flange located between the front camshaft journal and the cam gear.

The teepee style connecting rod is constructed of forged steel. They are attached to the crankshaft, one per journal. The pistons are cast aluminum alloy and are fitted with two compression rings and one oil ring. The piston pin is a free-floating type permitting the pin to move or float freely in the piston and connecting rod, and is held in place with pin retaining rings.

A gerotor-type lube oil pump is mounted to the front cover. The pump is driven directly by the crankshaft at engine speed. All models are equipped with an oil cooler. The oil cooler has a single spin-on oil filter. There is also a single spin-on coolant filter. The fuel system has a single spin-on fuel filter and pre-strainer assembly attached to the fuel filter header. With the exception of the air compressor, high pressure pump and turbocharger, there is no external piping.

There are two oil galleys in the crankcase. The unfiltered oil galley runs down the lower right-hand side of the crankcase, and the filtered oil galley runs above it. Unfiltered oil travels from the oil pump, back through the front cover assembly, through the high pressure oil relief valve and into the unfiltered oil galley. The high pressure oil relief controls unfiltered oil pressure at 552 kPa (80 lb/in.^{2}). There are two exit ports in the unfiltered oil galley. One exits to the front header of the oil cooler and one exits to the rear header of the oil cooler.

Depending upon the position of the oil thermostat, located in the rear oil cooler header, unfiltered oil can bypass the oil cooler core and go directly to the oil filter, or can flow through the oil cooler core and into the rear header and oil filter. The oil thermostat opens or closes by sensing the temperature of the unfiltered oil as it enters the rear header. Once the oil has passed the thermostat, unfiltered oil goes into the oil filter.

Clean engine oil flows out of the filter and goes back into the oil cooler header, then out the header and into the crankcase clean oil galley. The clean oil enters the crankcase, passes the main oil pressure regulating valve and is directed through various ports of the crankcase. The regulator valve keeps clean engine oil at minimum 345 kPa (50 lb/in.^{2}).

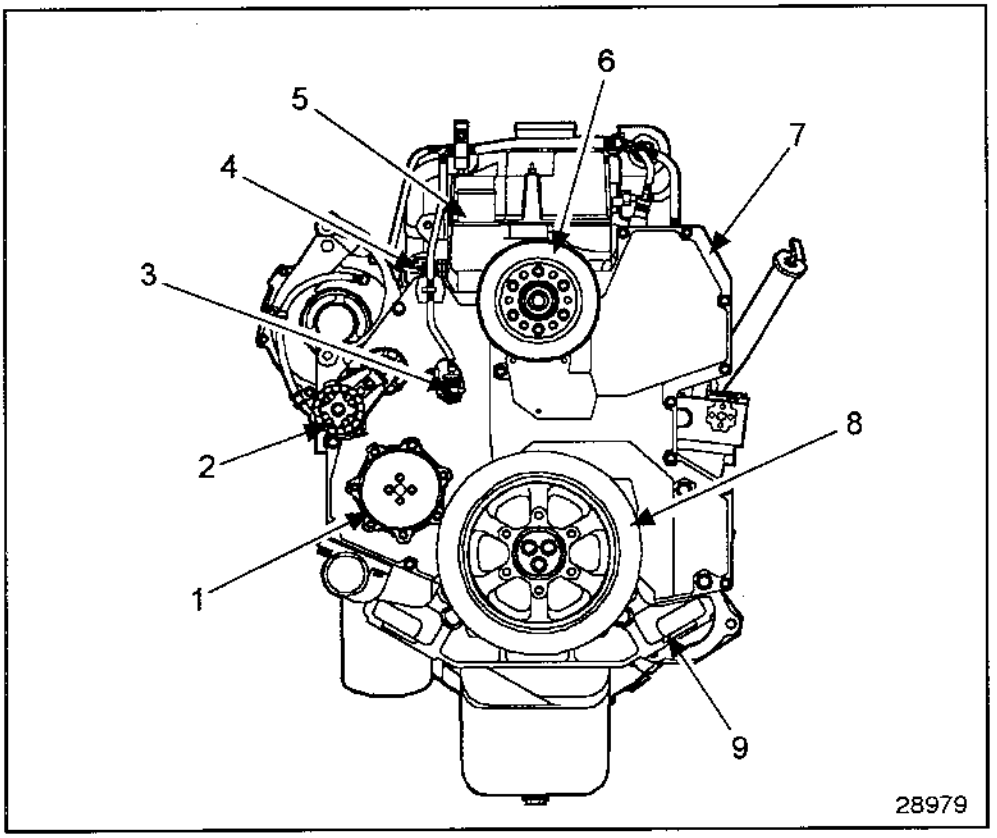
2.2 CHASSIS MOUNTED AIR–TO–AIR INTERCOOLER

The Series 40E engines may be equipped with a chassis–mounted air–to–air cooling system. The charge air cooler is mounted either in front of the radiator or side by side. Air from the turbocharger is pushed through a network of heat exchanger tubes prior to entering the valve cover/intake manifold. Outside air flowing over the tubes and fins serves to cool the charge air. The resulting cooler intake air is denser than uncooled air, allowing an improved fuel/air ratio in the cylinders during combustion. This results in improved emission control and power output. Detailed descriptions of the following systems can be found in the Series 40E Diesel Engine Service Manual.

- ❑ Fuel System
- ❑ Lubrication System
- ❑ Cooling System
- ❑ Air Induction and Exhaust Systems

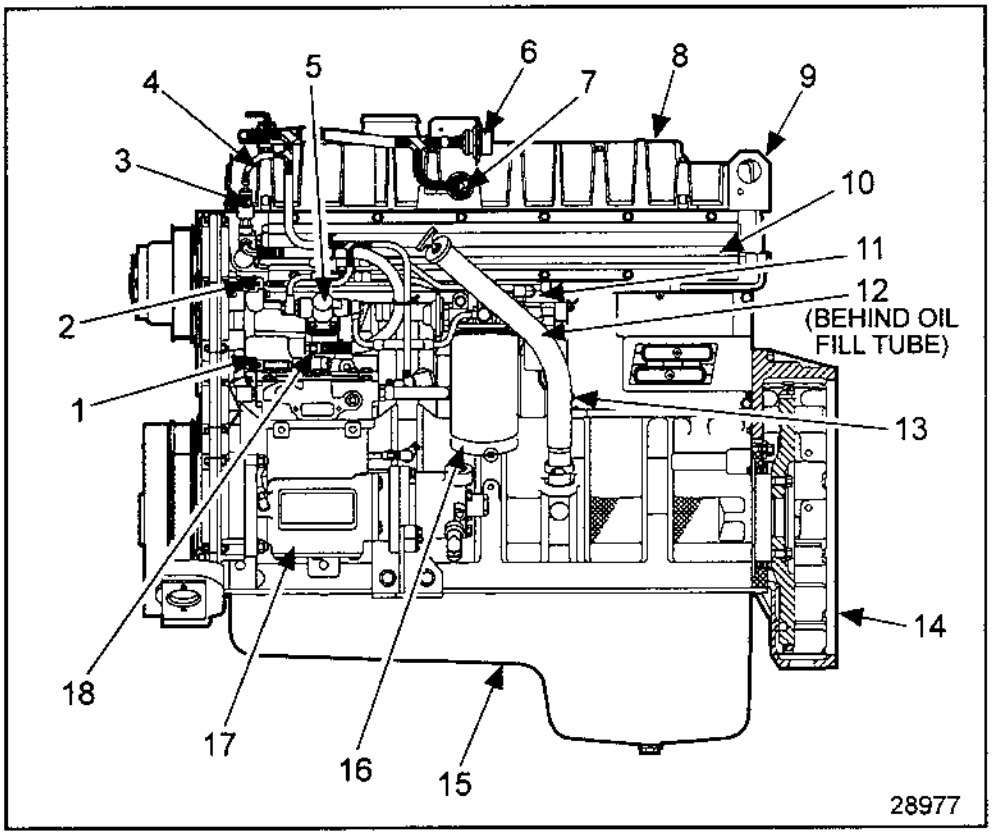
2.3 COMPONENT LOCATION

Major component locations on the Series 40E diesel engines are identified in the following figures. See Figure 2–1 for the front view of major components. See Figure 2–2 for the left side view. See Figure 2–3 for the right side view and see Figure 2–4 for the rear view.



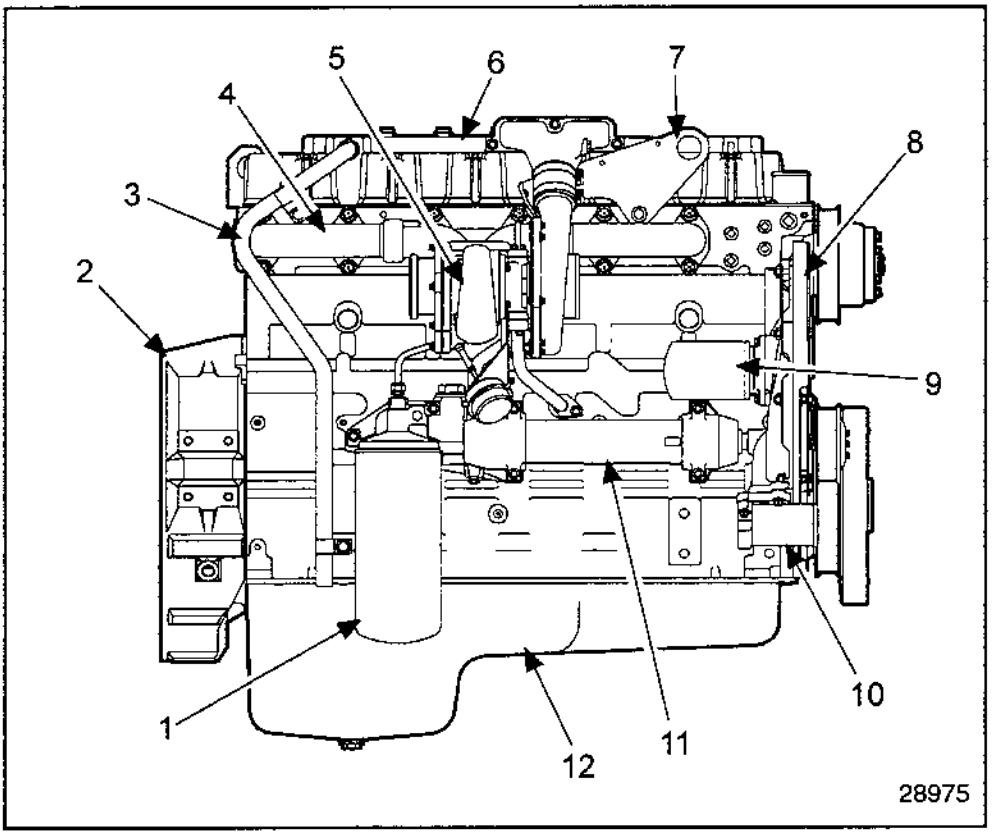
1. Water Pump Pulley
2. Auto Belt Tensioner
3. Timing Sensor
4. Coolant Sensor
5. Thermostat
6. Fan Pulley
7. Front Cover
8. Vibration Damper
9. Mounting Bracket

Figure 2–1 Major Component Location, Front View



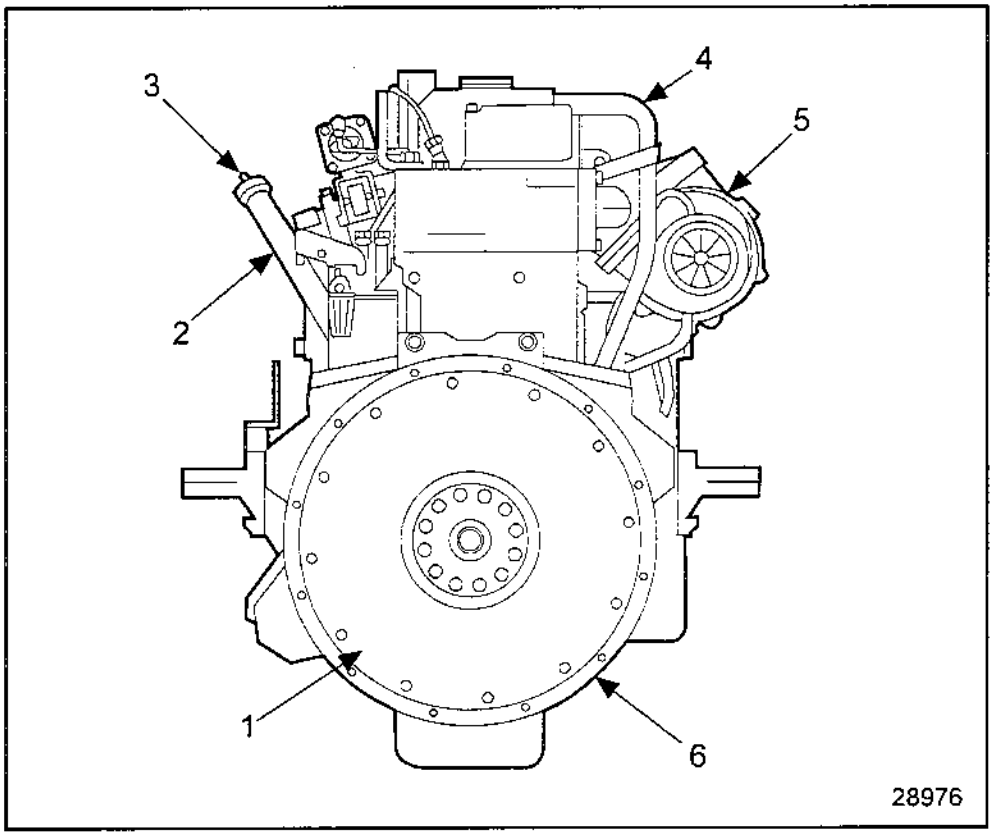
1. High Pressure Oil Pump
2. Oil Temperature Sensor
3. Injector Pressure Sensor
4. Wiring Harness
5. Fuel Supply Pump
6. 31–Pin Connector
7. Wiring Harness Connector
8. Valve Cover
9. Lifting Eye (2)
10. Supply Manifold
11. Fuel Filter Header
12. Fuel Strainer
13. Oil Fill Tube
14. Flywheel Housing
15. Oil Pan
16. Fuel Filter
17. Air Compressor (if equipped)
18. IPS Pressure Regulating Valve

Figure 2–2 Major Component Location, Left Side View



1. Oil Filter
2. Flywheel Housing
3. Road Draft Tube
4. Exhaust Manifold
5. Turbocharger
6. Valve Cover
7. Lifting Eye (2)
8. Alternator Bracket
9. Coolant Filter
10. Water Inlet
11. Oil Cooler
12. Oil Pan

Figure 2–3 Major Component Location, Right Side View



1. Flywheel
2. Oil Fill Tube
3. Oil Level Gage
4. Road Draft Tube
5. Turbocharger
6. Flywheel Housing

Figure 2–4 Major Component Location, Rear View

2.4 SERIES 40E ON–HIGHWAY DIESEL ENGINE

In compliance with the United States, Canadian and California regulations, the Series 40E diesel engine has been designed to operate, when properly maintained, within the permissible emission limits.

Because permissible smoke levels depend on proper engine operation the engine must be correctly maintained. This manual lists the schedule of maintenance operations required to assure optimum emission control and service from the engine.

As the owner, it is your responsibility to be certain that maintenance operations are performed at specified mileage or intervals. In addition to controlling required emission levels, proper maintenance pays off in improved vehicle performance and more economical operation.

Remember that maximum life and efficiency of equipment is assured if proper precautions are taken to keep dirt and other foreign particles out of the units. Be sure that oil, coolant, and fuel are always kept clean and that combustion air is always filtered. Always follow the specified maintenance schedule and maintenance procedures to reduce problems.

When new engine parts are required be sure to specify genuine Detroit Diesel service or Detroit Diesel ReMan parts to ensure the best results and high quality.

Throughout this manual use of terms left, right, front and rear must be understood to avoid confusion when following instructions. The left and right sides of the engine are described when facing the flywheel from the flywheel end of the engine. The front of the engine is the fan drive pulley end. The left is the high pressure lube oil pump side. The right is the oil cooler side.

2.5 IDENTIFICATION

We suggest you write the engine model serial number in the spaces provided for quick reference when parts or service are required.

2.5.1 Series 40E Diesel Engine Serial Numbers

Engine Serial Number _____
(Stamped on pad located on crankcase left side)

Engine Model _____
(Punched out on Emission Label on Valve Cover/Intake Manifold)

Turbocharger Serial Number_____

Turbocharger Part Number _____

2.5.2 Engine Identification

When in need of parts, always specify the engine model and serial number. The engine serial number is stamped on the crankcase pad located on the left side of the engine below the center of the cylinder head. See Figure 2-5. Engine exhaust emission labels are located on the top of the valve cover/intake manifold. See Figure 2-6. Engine emission labels designate the model and other pertinent information.

Other nameplate locations are on the turbocharger and starter. See Figure 2-7. See Figure 2-8. These nameplates, showing manufacturer and specifications, are important to assist operator or maintenance personnel in identifying equipment on the engine.

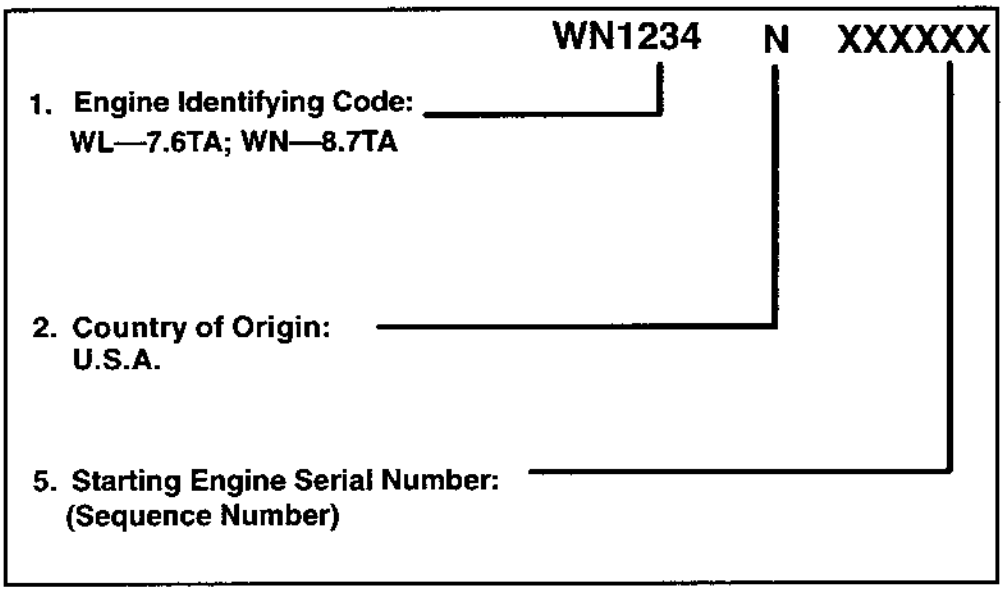


Figure 2–5 Serial Number Explanation

NOTE:

Exhaust Emission Label – More than one label may be present with each label having the same information in different languages. The labels, located on the valve cover/intake manifold of each engine, indicate the model year it is certified to meet governmental emission standards. For serial number and emission label location, see Figure 2–6.

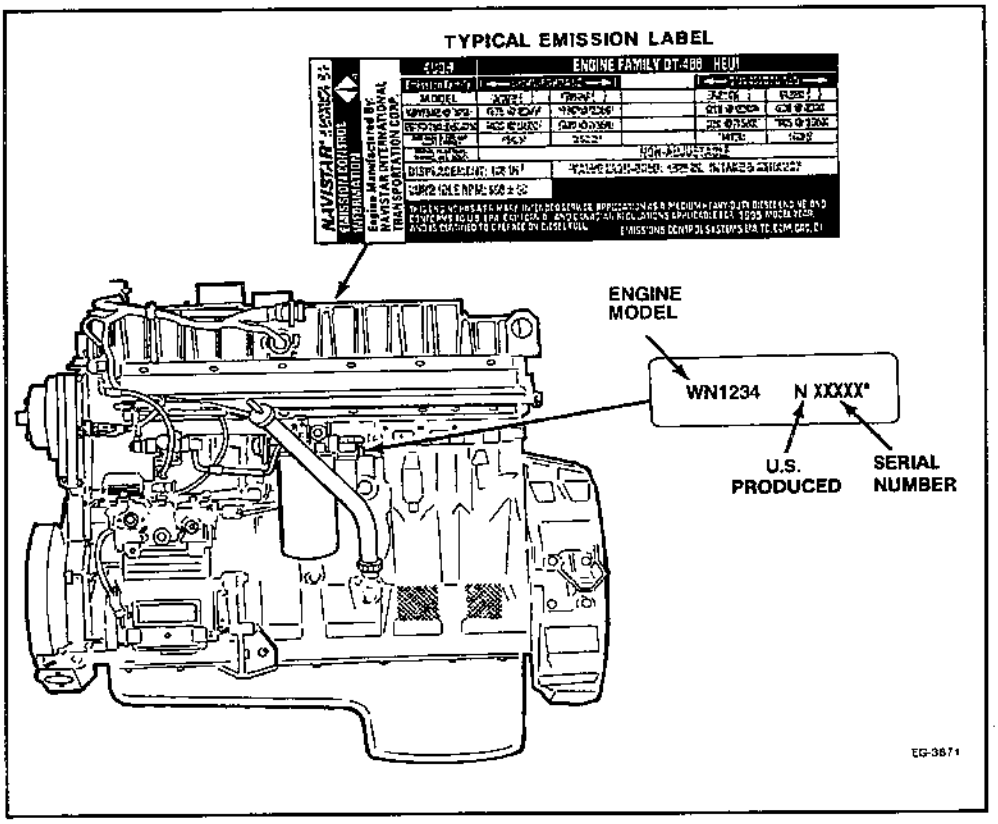
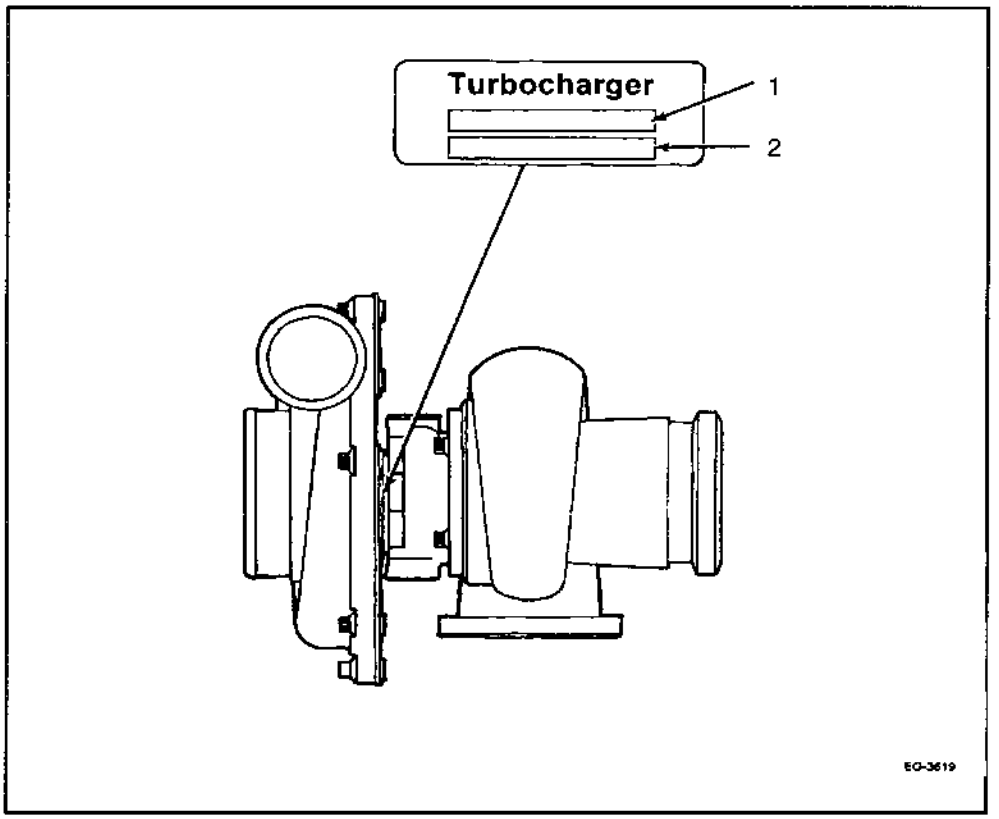


Figure 2–6 Serial Number and Emission Label Location

2.5.3 Turbocharger Identification

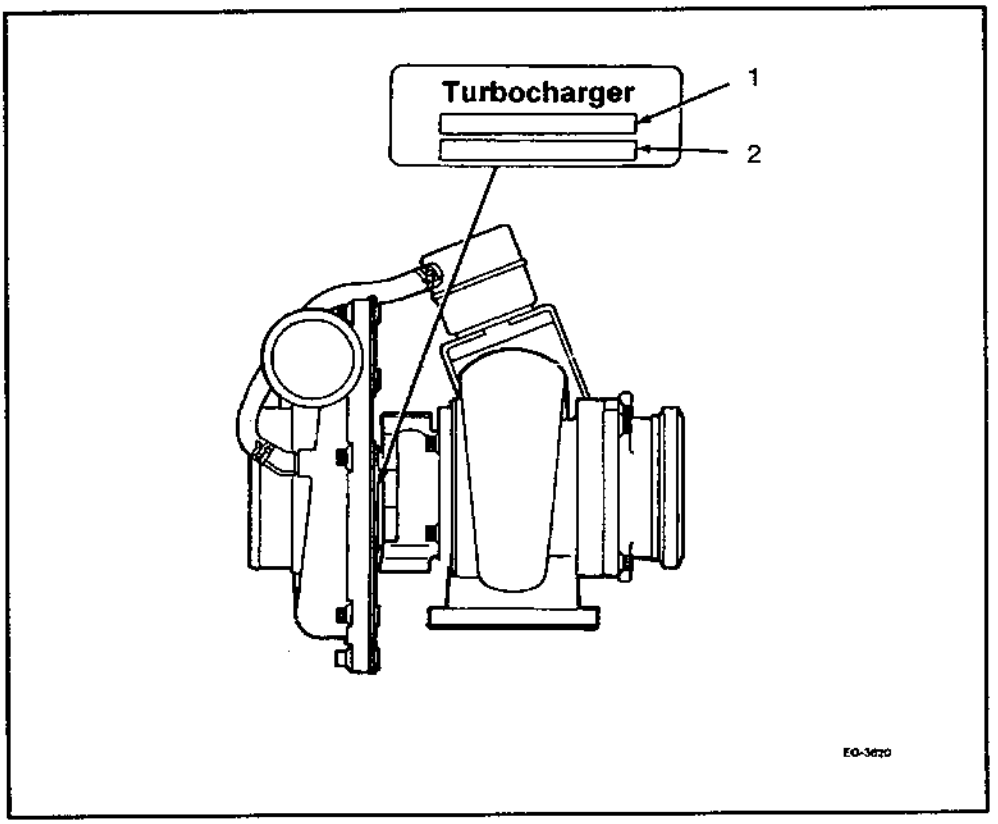
See Figure 2–7 for the location of the turbocharger identification plate for the non–wastegate version.



1. Detroit Diesel Part Number
2. Turbocharger Part Number

Figure 2–7 Turbocharger Identification (Non–Wastegate Version)

See Figure 2–8 for the location of the turbocharger identification plate for the wastegate version.



1. Detroit Diesel Part Number
2. Turbocharger Part Number

Figure 2–8 Turbocharger Identification (Wastegate Version)

3 DDC LIMITED WARRANTIES

3.1 LIMITED WARRANTY FOR INDUSTRIAL AND CONSTRUCTION APPLICATIONS

This limited warranty on new Series 40 engines used in industrial and construction applications follows.

3.1.1 Terms of Coverage

This limited warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 40 engines (referred to as Engine) and attached air compressor, starting motor, alternator and hydraulic pump (referred to as Accessories) manufactured or supplied by Detroit Diesel Corporation (referred to as DDC) which are used in industrial and construction applications operated in the United States or Canada. (In Canada, the reference is to Detroit Diesel or Canada Limited.)

3.1.1.1 Defects

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

3.1.1.2 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.

3.1.1.3 Warranty Period

The WARRANTY PERIOD begins on the date the Engine is delivered to the first retail purchaser or put in use prior to sale at retail, whichever date occurs first, and ends at the time limits shown below:

Item	Months*	Engine Hours*	Parts†	Labor†
Engine	0–12	No Limit	No Charge	No Charge
Optional Equipment	0–12	No Limit	No Charge	No Charge
‡ §Major Components	13–24	No Limit	No Charge	No Charge

* Warranty Limitations, whichever occurs first.

† Repair charge to be paid by owner.

‡ Major components include cylinder block casting, cylinder head casting, crankshaft, camshaft and connecting rod.

§ Upon expiration of the 12 month warranty coverage, but within 24 months of delivery date, the warranty continues to apply to the major components.

Table 3–1 Warranty Period, Industrial and Construction Applications

3.1.1.4 Service Supplies

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

3.1.1.5 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.

3.1.1.6 Mechanic's Travel Expenses

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

3.1.1.7 Engine Removal and Reinstallation

Reasonable labor costs for engine removal and reinstallation, when necessary to make a warranty repair, are covered by this warranty.

3.1.2 This Warranty Does Not Cover:

The following items are not covered by this warranty.

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

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

3.1.2.2 Non–DDC Supplied/Manufactured Components

DDC is not responsible for repair of components and/or assemblies which are manufactured or supplied by another manufacturer, such as power take–offs, intake and exhaust systems. Such items are covered by the equipment manufacturer.

3.1.2.3 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 and coolant meeting DDC recommended specifications. Performance of required maintenance and use of proper fuel, oil, lubricants and coolant are the responsibility of the owner. See the Operator's Guide for full details.

3.1.2.4 Incidental or Consequential Damages

DDC is not responsible for incidental or consequential costs or expenses which the owner may incur as a result of a malfunction or failure covered by this warranty, such as communication expenses, meals, lodging, overtime, towing, loss of use of the Engine or equipment ("downtime"), loss of time, inconvenience, cargo loss or damage, and other similar costs and expenses.

3.1.3 Other Limitations

The performance of REPAIRS is the exclusive Owner's remedy under this warranty. DDC does not authorize any person to assume or create for it any other obligation or liability in connection with the Engine or the Accessories.

This limited warranty is the only warranty applicable to the engine and accessories as used in industrial and construction applications. Detroit Diesel Corporation makes no other warranties express or implied, including any implied warranty of merchantability or fitness for a particular purpose. Detroit Diesel Corporation shall not be liable for any incidental or consequential damages as described above.

Some states do not allow the limitation of how long this warranty may last or the limitation or exclusion of incidental or consequential damages, so the above may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state.

3.2 LIMITED WARRANTY FOR PRIME POWER GENERATOR SETS

This limited warranty on new Series 40 engines used in prime power generator sets follows.

3.2.1 Terms of Coverage

This limited warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 40 engines (referred to as Engine) manufactured or supplied by Detroit Diesel Corporation (referred to as DDC) which are used in prime power generators, delivered and operated in the United States or Canada. (In Canada, the reference is to Detroit Diesel or Canada Limited.)

3.2.1.1 Defects

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

3.2.1.2 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.

3.2.1.3 Warranty Period

The WARRANTY PERIOD begins on the date of initial start-up or delivery of the Engine to the first retail customer and ends at the time or hour limits shown below.

Item	Months*	Engine Hours*	Parts†	Labor†
Engine	0–12	No Limit	No Charge	No Charge
‡ §Major Components	13–24	No Limit	No Charge	No Charge

* Warranty Limitations, whichever occurs first.

† Repair charge to be paid by owner.

‡ Major components include cylinder block casting, cylinder head casting, crankshaft, camshaft and connecting rod.

§ Upon expiration of the 12 month warranty coverage, but within 24 months of delivery date, the warranty continues to apply to the major components.

Table 3–2 Warranty Period, Prime Power Generator Sets

3.2.1.4 Service Supplies

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

3.2.1.5 Like Replacement Engine

Engine(s) used to replace an Engine still under warranty will assume the identity of the Engine being replaced and be entitled to the remaining warranty coverage.

3.2.1.6 Mechanic's Travel Expenses

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

3.2.2 This Warranty Does Not Cover:

The following items are not covered by this warranty.

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

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

3.2.2.2 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.

3.2.2.3 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.

3.2.2.4 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, 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. See the Operator's Guide for full details.

3.2.2.5 Incidental or Consequential Damages

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, or any other cost or expense resulting from a defect covered by this warranty.

3.2.3 Other Limitations

This limited warranty is the only warranty applicable to the engine as used in prime power generators. Detroit Diesel Corporation makes no other warranties express or implied, including any implied warranty of merchantability or fitness for a particular purpose. Detroit Diesel Corporation shall not be liable for any incidental or consequential damages as described above.

Some states do not allow the limitation of how long this warranty may last or the limitation or exclusion of incidental or consequential damages, so the above may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state.

3.3 LIMITED WARRANTY FOR STAND–BY POWER GENERATOR SETS

This limited warranty on new Series 40 engines used in stand–by power generator sets follows.

3.3.1 Terms of Coverage

This limited warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 40 engines (referred to as Engine) manufactured or supplied by Detroit Diesel Corporation (referred to as DDC) which are used in stand–by power generators, delivered and operated in the United States or Canada. (In Canada, the reference is to Detroit Diesel or Canada Limited. In countries outside the U.S. or Canada, the reference is to Detroit Diesel Overseas Distribution Corporation.)

3.3.1.1 Defects

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

3.3.1.2 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.

3.3.1.3 Warranty Period

The WARRANTY PERIOD begins on the date the Engine is delivered to the first retail customer and ends at the time or hour limits shown below.

Item	Months*	Engine Hours*	Parts†	Labor†
Engine	0–24	0–800	No Charge	No Charge

* Warranty Limitations, whichever occurs first.

† Repair charge to be paid by owner.

Table 3–3 Warranty Period, Stand–by Generator Sets

3.3.1.4 Service Supplies

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

3.3.1.5 Like Replacement Engine

Engine(s) used to replace an Engine still under warranty will assume the identity of the Engine being replaced and be entitled to the remaining warranty coverage.

3.3.1.6 Mechanic's Travel Expenses

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

3.3.2 This Warranty Does Not Cover:

The following items are not covered by this warranty.

3.3.2.1 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.

3.3.2.2 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.

3.3.2.3 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.

3.3.2.4 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, 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. See the Operator's Guide for full details.

3.3.2.5 Incidental or Consequential Damages

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, or any other cost or expense resulting from a defect covered by this warranty.

3.3.3 Other Limitations

This limited warranty is the only warranty applicable to the engine as used in stand-by generators. Detroit Diesel Corporation makes no other warranties express or implied, including any implied warranty of merchantability or fitness for a particular purpose. Detroit Diesel Corporation shall not be liable for any incidental or consequential damages as described above.

Some states do not allow the limitation of how long this warranty may last or the limitation or exclusion of incidental or consequential damages, so the above may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state.

3.4 LIMITED WARRANTY FOR ON–HIGHWAY APPLICATIONS

This limited warranty on new Series 40 engines used in on–highway vehicle applications follows.

3.4.1 Terms of Coverage

This limited warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 40 engines (referred to as Engine) and attached starting motor, air compressor and alternator (referred to as Accessories)) manufactured or supplied by Detroit Diesel Corporation (referred to as DDC) which are used in on–highway vehicle applications operated in the United States or Canada. (In Canada, the reference is to Detroit Diesel or Canada Limited.)

3.4.1.1 Defects

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

3.4.1.2 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 after taking the engine to the authorized service outlet. Repairs will be performed during normal business hours.

3.4.1.3 Warranty Period

The WARRANTY PERIOD begins on the date the Engine is delivered to the first retail purchaser or put in use prior to sale at retail, whichever date occurs first, and ends at the time or mileage/kilometer limits shown below:

Item	Months*	Miles or Kilometers*	Parts†	Labor†
Engine	0–24	0–100,000 miles 0–160,000 km	No Charge	No Charge
Accessories	0–12	0–50,000 miles 0–80,000 km	No Charge	No Charge

* Warranty Limitations, whichever occurs first.

† Repair charge to be paid by owner.

Table 3–4 Warranty Period, On–highway Vehicle Applications

3.4.1.4 Service Supplies

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

3.4.1.5 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.

3.4.1.6 Engine Removal and Reinstallation

Reasonable labor costs for engine removal and reinstallation, when necessary to make a warranty repair, are covered by this warranty.

3.4.2 This Warranty Does Not Cover:

The following items are not covered by this warranty.

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

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

3.4.2.2 Braking Devices

DDC is not responsible for repair of mechanical braking devices installed on the engine. Such devices are warranted by the brake manufacturer.

3.4.2.3 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 and coolant meeting DDC recommended specifications. Performance of required maintenance and use of proper fuel, oil, lubricants and coolant are the responsibility of the owner. See the Operator's Guide for full details.

3.4.2.4 Incidental or Consequential Damages

DDC is not responsible for incidental or consequential costs or expenses which the owner may incur as a result of a malfunction or failure covered by this warranty, such as communication expenses, meals, lodging, overtime, towing, loss of use of the Engine or vehicle ("downtime"), loss of time, inconvenience, cargo loss or damage, and other similar costs and expenses.

3.4.3 Other Limitations

The performance of REPAIRS is the exclusive Owner's remedy under this warranty. DDC does not authorize any person to assume or create for it other obligation or liability in connection with the Engine or the Accessories.

This limited warranty and the emissions warranty are the only warranties applicable to the engine and accessories as used in on-highway vehicle applications. Detroit Diesel Corporation makes no other warranties express or implied, including any implied warranty of merchantability or fitness for a particular purpose. Detroit Diesel Corporation shall not be liable for any incidental or consequential damages as described above.

Some states do not allow the limitation of how long this warranty may last or the limitation or exclusion of incidental or consequential damages, so the above may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state.

4 EMISSION CONTROL SYSTEMS

4.1 FEDERAL EMISSION SYSTEM WARRANTY

For California owners' emissions warranty, refer to section 4.2.

Detroit Diesel Corporation warrants that your new heavy-duty diesel engine was designed and built to conform to applicable U.S. Environmental Protection Agency regulations for a period of five (5) years or 160,000 km (100,000 miles) or 3,000 hours of operation, whichever occurs first, for medium-heavy duty diesel class engines.

The new model year, class of diesel engine, and emission application determination for your engine are identified on the emission control information label affixed to the top of the valve cover/intake manifold. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser.

Any emission control system parts which are proven defective during normal use will be repaired or replaced during the warranty period. The warranty repairs and service will be performed by any authorized Detroit Diesel distributor with no charge for parts or labor (including diagnosis).

As the vehicle owner you are responsible for all the required maintenance listed in your owner's manual. Detroit Diesel Corporation will not deny a emission warranty claim solely because you have no record of maintenance; however, a claim may be denied if your failure to perform maintenance resulted in the failure of a warranted part. Receipts covering regular maintenance should be retained in the event of questions and these receipts should be passed on to each subsequent owner of the vehicle.

It is recommended replacement parts used for maintenance or repairs be Detroit Diesel parts to maintain the quality originally designed into your emission certified vehicle/engine. The use of non-Detroit Diesel parts does not invalidate the warranty on other components unless the use of such parts causes damage to warranted parts.

Detroit Diesel Corporation wishes to assure the emission control systems warranty is being properly administered. If you believe you have not received the service entitled to under this warranty you should contact the nearest Detroit Diesel Regional Office for assistance. Refer to section 4.5 for the address and phone number of each Regional Office. If additional assistance or information is needed, contact:

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

Please note that the Emission Warranty does not cover:

- ❑ Systems and parts that were not first installed on the new vehicle or engine as original equipment by Detroit Diesel.
- ❑ Part malfunctions caused by abuse, misuse, improper adjustment, modification, alteration, tampering, disconnection, improper or inadequate maintenance, or use of non-recommended fuels and lubricating oils.
- ❑ Accident caused damage, acts of nature or other events beyond Detroit Diesel's control.
- ❑ Replacement of expendable items made in connection with scheduled maintenance.
- ❑ Parts requiring replacement at inspection or adjustment maintenance intervals for reasons other than being defective.
- ❑ Parts which are not Detroit Diesel parts.
- ❑ Loss of time, inconvenience, loss of use of vehicle/engine or commercial loss
- ❑ Vehicles with altered or disconnected odometer or hourmeter where the mileage or hours cannot be determined.
- ❑ Vehicles registered and normally operated outside the United States.
- ❑ Non-defective parts replaced by other than Detroit Diesel dealers.

4.2 CALIFORNIA EMISSION SYSTEM WARRANTY

The California Air Resources Board will explain the emission control system warranty on your vehicle. In California, new motor vehicles must be designed, built and equipped to meet the State's stringent anti-smog standards. Detroit Diesel Corporation must warrant the emission control system on your vehicle for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your vehicle engine.

Your emission control system may include parts such as the fuel injection system or catalytic converter. Also included may be hoses, belts, connectors and other emission-related assemblies. Where a warrantable condition exists, Detroit Diesel will repair your vehicle at no cost to you including diagnosis, parts and labor. For five (5) years or 160,000 km (100,000 miles) or 3,000 hours of engine operation, whichever occurs first, if an emission-related part on your vehicle is defective, the part will be repaired or replaced by Detroit Diesel. This is your emission system defects warranty.

As the vehicle owner, you are responsible for the performance of all the required maintenance listed in the owner's manual. Detroit Diesel Corporation recommends that you retain all receipts covering maintenance on your truck, but cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance. You are responsible for presenting your vehicle to a Detroit Diesel service outlet as soon as a problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

As the vehicle owner, you should also be aware that Detroit Diesel may deny you warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

If you have any questions regarding your warranty rights and responsibilities, you should contact:

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

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

4.3 DETROIT DIESEL EMISSION WARRANTY COVERAGE

Detroit Diesel Corporation warrants that your new vehicle and heavy-duty diesel engine, certified for sale and registered in California, were designed and built to conform to applicable California Air Resources Board regulations for the above stated warranty period. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser. The engine model year and emissions application for your engine are identified on the emission control information label affixed to the top of the valve cover/intake manifold. This warranty is based on the heavy-duty engine model year stated on the label, not the model year of the vehicle. Your maintenance records and receipts covering the required maintenance should be passed on to each subsequent owner of the vehicle.

Any emission control system parts which are defective during normal use will be repaired or replaced during the warranty period. The warranty repairs and service will be performed by any authorized Detroit Diesel service outlet with no charge for parts or labor (including diagnosis). In an emergency where a Detroit Diesel dealer is not reasonably available, repairs may be performed at any available service establishment or by the owner using any replacement part. A part not being available within 30 days or a repair not completed within 30 days also constitutes an emergency. Detroit Diesel will reimburse you for such repairs (including diagnosis), not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the

geographically appropriate hourly labor rate. Replaced parts and paid invoices must be presented to a Detroit Diesel service outlet as a condition of reimbursement for such emergency repairs.

It is recommended that replacement parts used for maintenance or repairs be Detroit Diesel parts to maintain the quality originally designed into your emission certified engine. You may elect to use other than Detroit Diesel parts and service for maintenance, replacement or repair without invalidating this warranty. However, the costs of such parts and services will not be covered under the warranty except in the case of an emergency as noted above. If such parts are used the owner should ensure that these parts are equivalent in design and durability to Detroit Diesel parts.

The use of non–Detroit Diesel parts does not invalidate the warranty on other components unless the use of such parts causes damage to warranted parts.

Detroit Diesel wishes to ensure the emission control systems warranty is being properly administered. If you believe you have not received the service to which you are entitled under this warranty, contact the nearest Detroit Diesel Corporation Regional Office for assistance. The address and phone number of each Regional Office follows. If further questions of warranty rights and responsibilities remain, other contacts can be made. Refer to section 4.2.

New vehicle/engines certified for sale and registered in California have the following items that are covered by the emission warranty when the items were first installed on the new engine as original equipment by Detroit Diesel:

- ❑ Fuel injection system
- ❑ Air induction system
  - ❑ Turbocharger system (includes exhaust manifold)
  - ❑ Intake manifold
- ❑ Positive crankcase ventilation system (if applicable)
  - ❑ CDR (PCV) valve
  - ❑ Oil fill cap

- ❑ Diesel particulate control system (if applicable)
  - ❑ Catalytic converter or trap
- ❑ Miscellaneous items used in above systems
  - ❑ Hoses, clamps, fittings and tubing
  - ❑ Pulleys, belts and idlers
  - ❑ Vacuum, temperature and time sensitive valves and switches

4.4 EMISSION WARRANTY EXCLUSIONS

Please note that the Emission Warranty statement does not cover the following:

- ❑ Part malfunctions caused by abuse, misuse, improper adjustment (unless done by a Detroit Diesel dealer during warranty work), modification, alteration, tampering, disconnection, improper or inadequate maintenance or use of non-recommended fuels and lubricating oils.
- ❑ Accident caused damage, acts of nature or other events beyond Detroit Diesel's control.
- ❑ Replacement of parts beyond their first required maintenance point.
- ❑ Parts which are not Detroit Diesel parts.
- ❑ Loss of time, inconvenience, loss of use of vehicle/engine or commercial loss.
- ❑ Vehicles with altered or disconnected odometer or hourmeter where the mileage or hours cannot be determined.
- ❑ Vehicles registered and normally operated outside the United States.
- ❑ Non-defective parts replaced by other than Detroit Diesel dealers.

4.5 CUSTOMER ASSISTANCE

When contacting the regional or home office, please keep in mind that ultimately your problem will be resolved at the distributorship or dealership, utilizing their facilities, equipment, and personnel. Regional Offices are listed in Table 4–1.

Regional Offices	Regional Offices
EASTERN REGION **Long Branch, New Jersey** 187 Monmouth Park Highway West Long Branch, NJ 07764 Phone: (732) 222–1888 Fax: (732) 222–3411	**LATIN AMERICAN REGION** **Miami, Florida** 2277 N.W. 14th Street Miami, FL 33125–0068 Phone: (305) 637–1555 Fax: (305) 637–1580
SOUTHEASTERN REGION **Jacksonville, Florida** 5111 Bowden Road Jacksonville, FL 32216 Phone: (904) 448–8833 Fax: (904) 448–2444	**WESTERN REGION** **Downey, California** 10645 Studebaker Road Downey, CA 90241 Phone: (562) 929–7016 Fax: (562) 864–0502
CENTRAL REGION **Detroit, Michigan** 13400 Outer Drive, West Detroit, MI 48239–4001 Phone: (313) 592–5990 Fax: (313) 592–5887	**CANADIAN REGION** **London, Ontario** Detroit Diesel of Canada Ltd. 150 Dufferin Ave., Suite 701 London, ON N6A 5N6 Phone: (519) 661–0149 Fax: (519) 661–0171
SOUTHWESTERN REGION **Dallas, Texas** 2711 LBJ Freeway Suite 1036 Dallas, TX 75234 Phone: (972) 247–4313 Fax: (972) 247–4316	**MEXICO** **Detroit Diesel–Allison de Mexico, S.A.** Av Santa Rosa 58 Col. Ampliacion Norte San Juan Ixtacala, Tlanepantla C.P. 54160, Edo de Mexico Phone: (525) 333–1800 Fax: (525) 333–1870

Regional Offices	Regional Offices
ASIAN REGION **Singapore** **No. 1 Benoi Place** Singapore 629923 Phone: (65) 865–1910 Fax: (65) 861–1618	**EUROPE, MIDDLE EAST, AFRICA (EMA) REGION** **The Netherlands** Ridderpoort 9 2980 GD Ridderkerk The Netherlands Phone: (31) 180–410388 Fax: (31) 180–462062
PACIFIC REGION **Detroit Diesel–Allison** **Australia** 488 Blackshaws Road Altona North, Victoria 3025 Australia Phone: (61) 3–9243–9292 Fax: (61) 3–9243–9271	

Table 4–1 Regional Offices

5 GAGES

5.1 WATER TEMPERATURE GAGE

NOTE:
After the engine starts and at frequent intervals while the engine is operating, all gages should be observed for proper readings. This manual describes the gages in general terms as gage type may vary with vehicle application.

The temperature gage indicates the temperature of the coolant in the cooling system. The gage operates only when the ignition switch is turned to the ON position. Normal engine operating temperature is between 180 - 206°F (82 - 97°C). See Figure 5–1. If the indicator suddenly rises, the engine should be stopped and the cause of overheating determined.

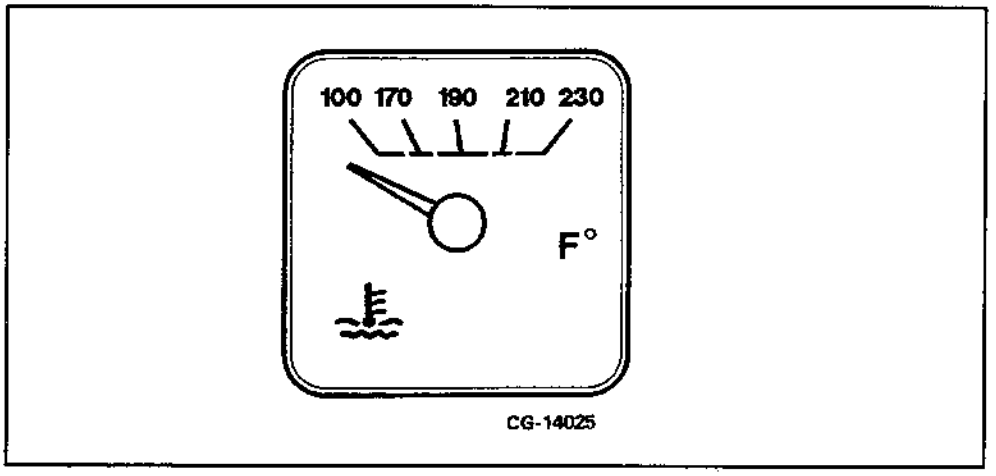


Figure 5–1 Water Temperature Gage

NOTICE:
Operation of engine above 230°F (110°C) may cause internal damage.

5.2 OIL PRESSURE GAGE

The engine oil pressure gage indicates operating oil pressure of the engine. For oil pressure gage, see Figure 5–2. Lube Oil Pressure specifications are listed in Table 5–1.

NOTICE:

If the gage fluctuates or drops to 344 kPa (50 lb/in²) or less at 2000 r/min (underload), stop the engine immediately and correct the cause.

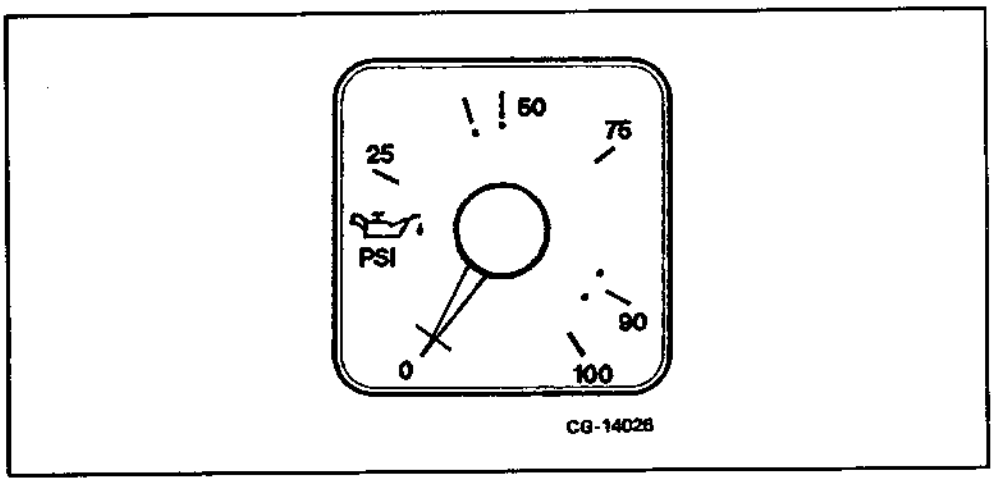


Figure 5–2 Oil Pressure Gage

At Low Idle (700 r/min Non–adjustable)	At High Idle†
137 kPa (20 lb/in²) minimum*	344 kPa (50 lb/in²) minimum*

* Engine at normal operating temperature with SAE 15W–40 oil.

† Refer to Section 6, 7.6L engine high idle r/min listed in Table 7–1 and 8.7L engine high idle r/min listed in Table 7–2.

Table 5–1 Lube Oil Pressure Specifications

5.3 AIR CLEANER RESTRICTION INDICATOR

The amount of air cleaner restriction may be detected by either an air cleaner restriction indicator or a vacuum gage that reads in inches of water.

The vehicle is equipped with either an air cleaner mounted restriction indicator or a dash mounted restriction indicator. See Figure 5–3. Each functions identically, however the dash mounted version has the reset button mounted on the face of the gage.

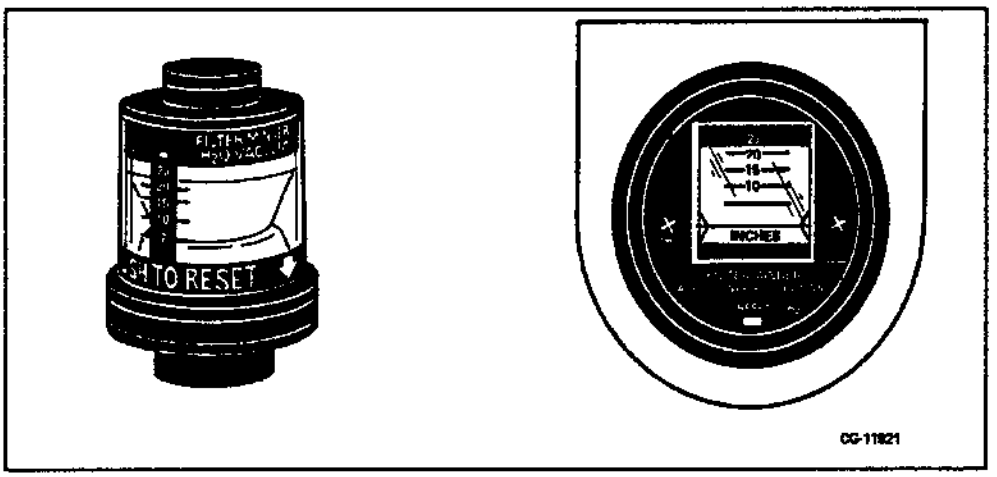


Figure 5–3 Air Cleaner Mounted Restriction Indicator and Dash Mounted Restriction Gage

The air restriction indicator indicates how much engine air cleaner filter capacity has been used and how much filter capacity remains. It measures maximum restriction of the filter element when the engine is operated at full load and locks at that point.

The vacuum gage and/or indicator should be tested periodically to insure proper indication. This can be accomplished with a master gage.

NOTE:
When the yellow indicator in the gage reaches the maximum restriction (red zone), air cleaner service is required. It is not necessary that the engine be shut down.

When the filter element reaches maximum allowable restriction, the yellow indicator reaches the top of the window and automatically locks in this position. See Figure 5–4. The indicator remains fully exposed even after engine shutdown. The filter element must be properly serviced at this time to prevent low power complaints or engine damage.

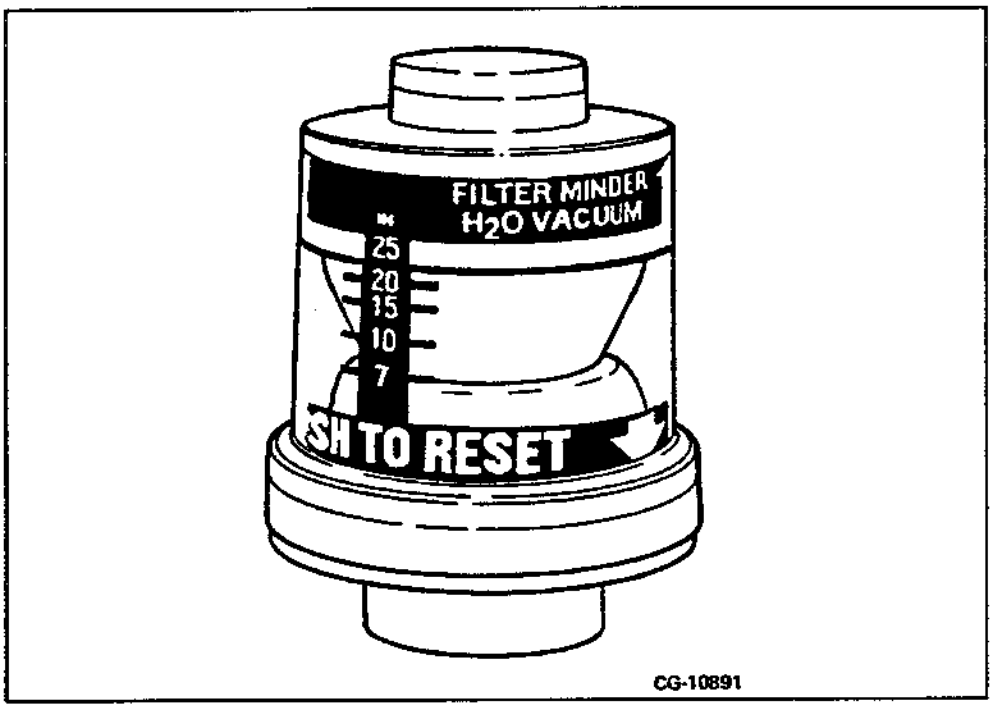


Figure 5–4 Maximum Restriction

NOTE:
After starting the engine, the indicator may be seen in the lower part of the window. This is normal and should not be mistaken as a signal for element service. See Figure 5–5.

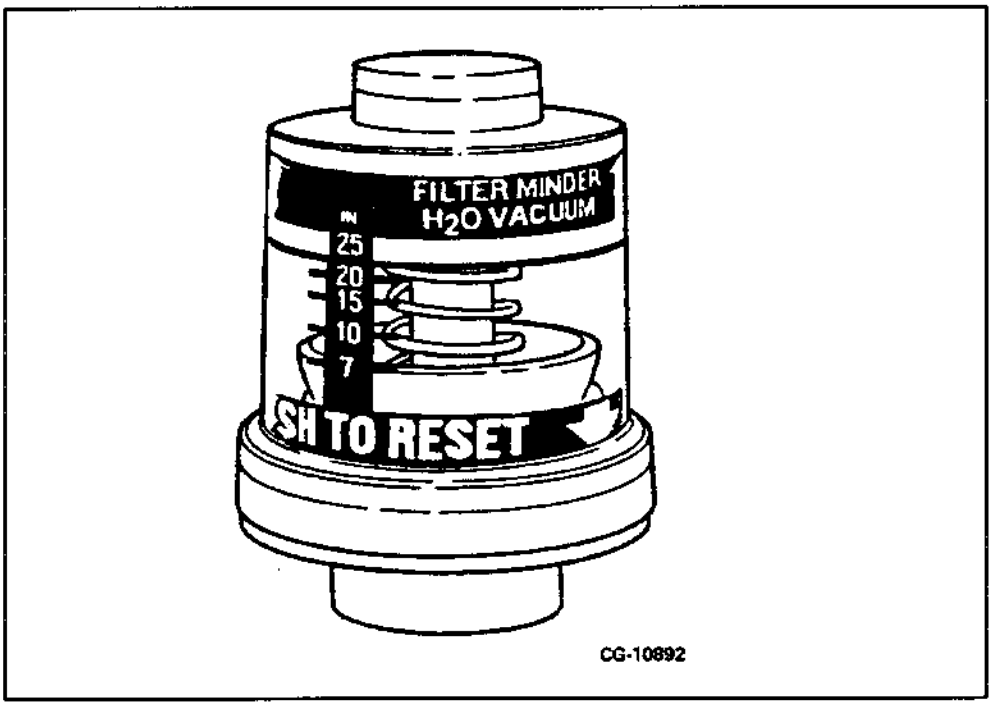


Figure 5–5 Normal Clean Filter

The initial restriction with a new air filter element will vary with air cleaner design and installation.

After servicing the filter element, reset the yellow indicator by pushing the reset button and releasing it. The yellow indicator will drop below the window so the air restriction gage can be reused.

5.3.1 Air Restriction Indicator Test

Check the indicator periodically to be sure it is operating. To test the air restriction indicator, hook an accurate vacuum gage (calibrated in inches of water) or a water manometer to the indicator. The pop–up gage should lock in the service position at 6.2 kPa (25 in. H_2O) for turbocharged engines. The gage should read the same as the master vacuum gage.

6 BEFORE STARTING THE ENGINE

6.1 BEFORE STARTING THE ENGINE

Before starting the engine, the operator should fully understand the use and function of all controls, instruments and equipment.

This engine has been given pre-delivery and delivery service by your DDC dealer and is ready for operation.

CAUTION:

Do not use volatile starting aids such as ether, propane or gasoline in the engine air intake system. Glow plugs will ignite vapors. Explosion hazard can cause personal injury and severe engine damage.

Perform the following checks before starting the engine:

1. Check the cooling system level and fill if necessary. Refer to section 7.4 of this manual.
2. Check that the engine crankcase is filled to the proper oil level and with the proper grade of oil for the prevailing temperature. See Figure 6–1. Refer to section 7.9.2.

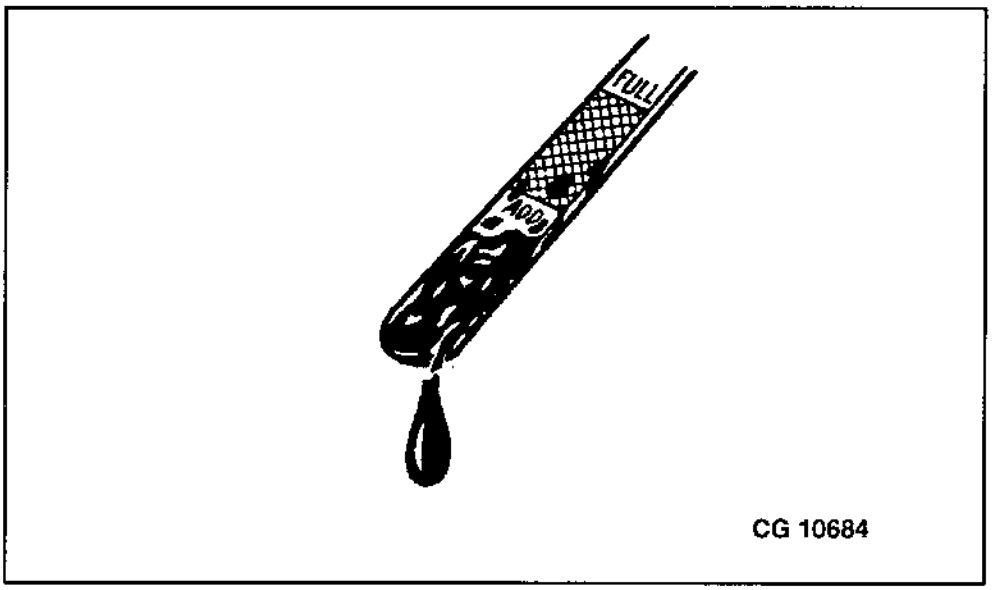


Figure 6–1 Checking Oil Level

3. Fill the tank with the recommended fuel. Refer to section 7.2. Check that all fuel connections are tight.
4. Check air cleaner and piping for tightness and proper installation of filter element. Inspect the air cleaner restriction indicator (if equipped). If the yellow indicator is locked in the raised position, service the air cleaner.
5. Ensure all electrical connections are tight.
6. Check belt for proper tension.
7. Check condition of automatic belt tensioner.

NOTE:
Starting procedure may vary slightly depending upon accessory package.

6.2 ENGINE DIAGNOSTIC BUTTON

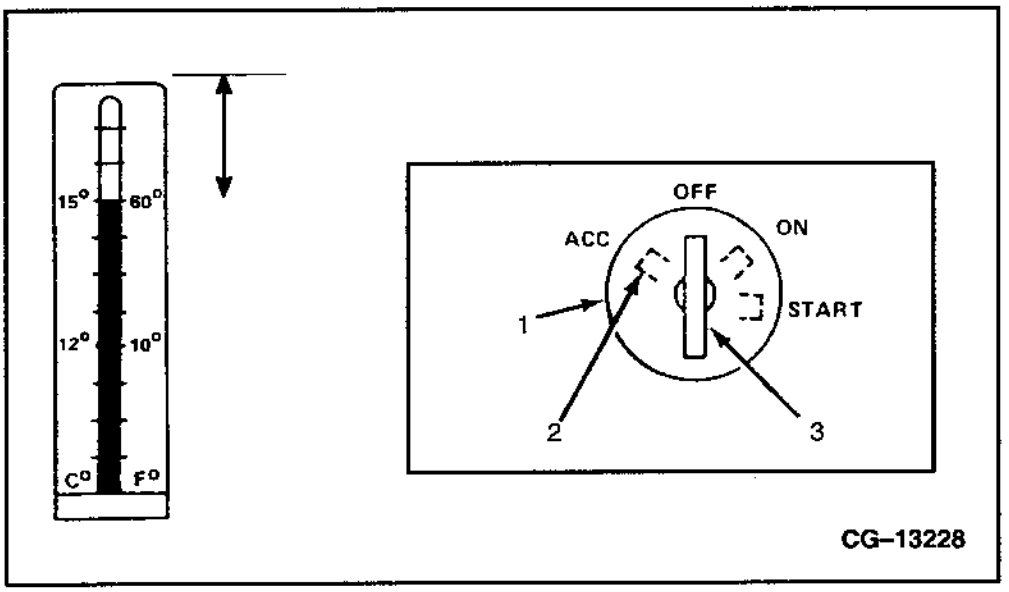
The engine diagnostic button, located on the vehicle dashboard, is used to read faults detected by the Electronic Control Module (ECM). The ECM will flash the Check Engine Light to warn of problems with the engine, oil, or water and it indicates which faults have been detected.

Depress and hold the engine diagnostic button. Turn the ignition switch to ON and release the engine diagnostic button. DO NOT START THE ENGINE. The ECM will begin the self test to check the output circuits. If a fault is detected, the Check Engine Light will flash repeatedly, signaling the action fault code. Refer to STI (Self Test Input) Button – Flash Codes in the Troubleshooting Manual.

6.3 STARTING THE ENGINE

To start the engine:

1. Set parking brake, place transmission control lever into the neutral position.
2. Depress the clutch pedal, if equipped. Do not depress the accelerator pedal.
3. Turn the key clockwise to ON position. See Figure 6-2.



1. Key Switch
2. Key Positions
3. Key

Figure 6–2 Starting the Engine

4. Continue to turn key to START position. (If the vehicle has pushbutton starting, press and hold the starter button.)
5. Engage starter and crank engine.
6. As soon as the engine starts, release the key (or starter button, if applicable). The key switch will return to the ON position and the engine will continue to run.

NOTE:
If the engine starts, then stops, repeat engine starting procedure. If more than three attempts are required, investigate for causes of no–start.

NOTICE:

If the engine fails to start within 30 seconds, release the starter switch and wait 2-3 minutes to allow the starter motor to cool. Repeat above procedure. If after three attempts the engine does not start, investigate and determine the cause for the engine not starting. Starter motor damage may result if starting attempts are continued.

7. Low idle speed is 700 r/min (non-adjustable). Extended idling periods should be avoided. Refer to section 6.7. Check all gages during warm-up.:

NOTICE:

Do not increase the engine speed until the oil pressure gage indicates normal. Shut down the engine if oil pressure does not register on the gage within 20–30 seconds after start.

8. Within seconds after starting engine, oil pressure should exceed 137 kPa (20 lb/in.^{2}) minimum.
9. If oil pressure does not meet these minimum limits, stop engine, locate and correct the problem.

CAUTION:

Do not use volatile starting aids, such as ether propane or gasoline in the engine air intake system. Explosion hazard can cause severe engine damage and personal injury.

10. After the engine has reached an operating temperature, the oil pressure should be 276 kPa (40 lb/in.^{2}) minimum. If oil pressure does not meet this minimum, stop the engine, locate and correct the problem.

6.3.1 Emergency Starting

Perform the following steps for emergency starting:

CAUTION:

Emergency starting procedures must be performed exactly as outlined. Otherwise, injury to the face, eyes, body, limbs and respiratory system could result from fire or acid due to battery explosion. Property damage could also occur.

1. Prevent shorting of the system by removing metal rings or watches and not allowing metal tools to contact the positive terminal of battery.
2. Place the transmission in NEUTRAL and set the parking brake.
3. Shut off the lights, heater, air conditioner and any other electrical loads in both vehicles.
4. Eye protection should be worn if available. If not available, shield eyes when near the batteries.
5. Vehicle bodies or bumpers must not be in contact.
6. Connect one end of the first jumper cable to the positive (+) terminal of the dead battery and then the other end to the positive (+) terminal of the booster battery.

CAUTION:

Do not attach the other end to the negative (–) battery terminal. A spark could occur and cause explosion of the gases normally present around the battery. Injury to personnel and equipment can occur.

7. Connect one end of the second jumper cable to the negative (–) terminal of the booster battery and the other end to an engine bolt head or good metallic contact spot on the engine of the vehicle to be started.
8. Reverse the above procedure when removing the jumper cables.

6.4 OPERATING INSTRUCTIONS

Prevent overspeeding of the engine when going down long and steep grades. The governor has no control over engine speed when it is being pushed by the loaded vehicle. Operate in a gear that will permit an engine speed not in excess of high idle r/min. Operating the engine beyond high idle speed can cause severe damage.

6.5 COLD WEATHER OPERATION

In order to operate the engine in temperatures of 0°C (32°F) or lower, observe the following instructions:

1. Ensure the battery is of sufficient size and is fully charged. Check that all other electrical equipment is in optimum condition.
2. Use permanent-type antifreeze solution to protect against damage by freezing.
3. At the end of each daily operation, drain water from the water separator, if equipped. Allow the engine to cool; then, fill the fuel tank to prevent condensation.
4. Use proper cold weather lubricating oil, and be sure the crankcase contains a sufficient amount.
5. At temperatures of –20°C (–4°F) and below, it is recommended that you use a crankcase mounted coolant heater to improve cold starting.
6. If operating in arctic temperatures of –29°C (–20°F) or lower, consult your dealer for information about special cold weather equipment and precautions.

6.6 HOT WEATHER OPERATION

For hot weather operation, follow these instructions.

1. Ensure the battery has the proper amount of electrolyte, if not a maintenance-free battery.
2. Keep the cooling system filled with clean permanent antifreeze solution to protect against damage by overheating.
3. At the end of each daily operation, drain water from the water separator, if equipped. Allow the engine to cool; then, fill the fuel tank to prevent condensation.
4. Keep the external surfaces of the engine, radiator and accessories clean to avoid dirt buildup.

6.7 EXTENDED IDLING PERIODS

Extended idling periods should be avoided. If necessary, use optional electronic fast idle feature. Diesel engine efficiency is improved when cylinder temperature remains high.

If cylinder temperatures are too low, the following may occur:

1. Unburned fuel, which has the dark colored appearance of lubricating oil, may seep from the exhaust manifold gaskets and vehicle exhaust system connections. This seepage is commonly called exhaust "slobber".
2. Cylinder temperature will be too low to allow complete combustion and unburned fuel will wash lubricating oil from the cylinder sleeves. Unburned fuel will be carried into the lubricating oil causing the viscosity of the oil to change. This is known as fuel dilution.
3. Fuel injector tips will form carbon and cause nozzle plugging.
4. Carbon deposits will form on the turbine wheel of the turbocharger causing reduced turbocharger efficiency.

A Cold Ambient Protection (CAP) system has been added to the vehicle's ECM. This software aids in engine warm-up and maintaining the engine heat during extended idling periods.

After five minutes of idle time and the intake air temperature below 0°C (32°F), the CAP slowly ramps up the engine idle speed to 900 r/min for engines equipped with automatic

transmissions, or 1400 r/min on engines equipped with manual transmissions. The engine speed will increase or decrease to a r/min that will maintain a coolant temperature of 71°C (160°F).

NOTE:
The lower CAP r/min limit for engines equipped with automatic transmissions minimizes the possibility of vehicle lurch should the operator place the shift lever in gear without first applying the service brakes to lower the idle speed to 700 r/min.

The cycle described in the paragraph above will continue until one or a combination of any of the following occurs:

- ❑ Engine load is greater than 25%.
- ❑ Brake pedal is applied or brake switch fault is detected.
- ❑ Clutch pedal is depressed or clutch pedal switch fault is detected (manual transmission).
- ❑ Shift selector is moved from neutral to forward or reverse range (automatic transmissions).
- ❑ PTO switch, also used for electronic hand throttle, is turned on.
- ❑ Accelerator pedal is depressed or accelerator pedal sensor fault is detected.
- ❑ Timed idle shutdown is enabled.
- ❑ Coolant Temperature Sensor (CTS) fault is detected.
- ❑ Intake Air Temperature (ambient temperature) sensor fault is detected.

6.8 ENGINE SHUTDOWN

Idle the engine for three to five minutes before shutting down. This few minutes idling allows the lubricating oil and water to carry heat away from the iron masses. The larger the engine, the greater the need for this idling period.

This idling period helps prevent heat damage to seals or O-rings of an engine. The idling period should be increased for larger engines.

6.9 SHUTDOWN WARNING LIGHT AND BUZZER

Vehicles may be equipped with an automatic engine shutdown system to stop the engine in the event of high coolant temperature or low engine oil pressure. A Stop Engine Light and Alarm buzzer and light on the instrument panel will indicate high coolant temperature or low oil pressure. If the temperature or pressure continues to change beyond the warning point to a predetermined level, the engine will automatically shut down.

Most systems are equipped with an override feature that will allow the engine to be restarted so that the vehicle can be moved. The engine should be run no longer than absolutely necessary. A decal located in front of the operator provides instructions on how the override should be operated.

6.10 PARKING

Remember the following when parking:.

CAUTION:

When parking your diesel vehicle, do not leave the transmission in gear. Use a parking brake when parking on a grade. Block the wheels or turn them to the curb.

Failure to follow these procedures could result in an unattended vehicle moving, resulting in personal injury or property damage.

6.11 ROAD OPERATION

To receive satisfactory engine performance with maximum fuel economy and service life, the following general engine guidelines should be followed.

Start the vehicle in motion by utilizing the highest gear speed in the transmission that will enable the engine to easily start the load without slipping the clutch. Accelerate smoothly and evenly to engine rated speed. Rapid acceleration will result in high fuel consumption with no increase in performance.

Engine speed should not be permitted to drop below peak torque when pulling at full throttle to avoid lugging conditions. When approaching a hill, depress the accelerator smoothly to start the upgrade at full power, then shift down as needed to maintain maximum vehicle speed.

6.12 DOWNHILL OPERATION

Prevent overspeeding of the engine when going down long and steep grades.

NOTICE:

Operating the engine beyond high idle speed can cause severe damage.

Operate in a gear that will permit an engine speed not in excess of high idle r/min.

6.13 IDLE SPEEDS

Low idle speed for the Series 40E engine is 700 r/min (non–adjustable).

CAUTION:

Provide proper ventilation when operating the engine in a closed area to remove deadly exhaust fumes. Breathing exhaust fumes may be fatal.

Extended idling periods should be avoided. If necessary, use the electronic fast idle feature. Diesel engine efficiency is improved when the cylinder temperature remains high.

7 ENGINE SPECIFICATIONS

7.1 SERIES 40E SPECIFICATION TABLES

The specifications for the 40E, 7.6L engine models are listed in Table 7–1.

Engine Models: Series 40E, 7.6L	Specifications
Number of Cylinders	6
Configuration	Inline
Bore	109.2 mm (4.301 in.)
Stroke	135.9 mm (5.350 in.)
Displacement	7.6L (466 $in.^3$)
Compression Ratio Standard Torque Engines High Torque Engines	 16.4:1 15.9:1
Firing Order	1–5–3–6–2–4
Valve Tappet Clearance (hot or cold) Intake Exhaust	 0.635 mm (0.025 in.) 0.635 mm (0.025 in.)
Engine Lube Oil Pressure (operating temperature with SAE 15W–40 oil) Low Idle (700 r/min, non–adjustable) High Idle	 137 kPa (20 lb/in^2) min. 276 kPa (40 lb/in^2) min.
Idle Speed No Load (r/min)	700 (non–adjustable)
Thermostat Opening Temperature	81°C (177°F)
Crankcase Capacity (without oil filter)	22.7L (24 quarts)
Crankcase Capacity (with oil filter)	26.4L (28 quarts)

Table 7–1 Series 40E (7.6L) Engine Specifications

The specifications for the 40E, 8.7L engines are listed in Table 7–2.

Engine Models: Series 40E, 8.7L	**Specifications**
Number of Cylinders	6
Configuration	Inline
Bore	114.3 mm (4.590 in.)
Stroke	135.9 mm (5.350 in.)
Displacement	8.7L (530 $in.^3$)
Compression Ratio Standard Torque Aluminum Piston High Torque Steel Top	 16.6:1 16.3:1
Firing Order	1–5–3–6–2–4
Valve Tappet Clearance (hot or cold) Intake Exhaust	 0.635 mm (0.025 in.) 0.635 mm (0.025 in.)
Engine Lube Oil Pressure (operating temperature with SAE 15W–40 oil) Low Idle (700 r/min, non–adjustable) High Idle	 137 kPa (20 lb/in^2) min. 276 kPa (40 lb/in^2) min.
Idle Speed No Load (r/min)	700 (non–adjustable)
Thermostat Opening Temperature	82 – 85°C (180 – 185°F)
Crankcase Capacity (without oil filter)	22.7L (24 quarts)
Crankcase Capacity (with oil filter)	26.4L (28 quarts)

Table 7–2 Series 40E (8.7L) Engine Specifications

7.2 FUEL REQUIREMENTS

This fuel information will help the operator obtain maximum performance for the least amount of cost when using a 40E engine. The specifications are broad enough to permit the use of low cost fuels yet are restrictive enough to prevent use of low quality fuels which could lead to frequent engine overhauls.

7.3 FUEL SYSTEM

The fuel system is direct injection with electronic sensors and hydraulically actuated electronically controlled unit injectors (HEUI), fuel strainer, filter and fuel lines.

7.3.1 Recommended Fuel for Diesels

Use only Grade No. 1–D or Grade No. 2–D diesel fuels. Specifications for these fuels are listed in ASTM D975 or Federal Specification VV–F–800. Choose the proper fuel grade as listed in Table 7–3.

NOTE:
Do not use fuels sold only as heating or furnace oil.

Expected Temperature	Preferred Fuel Grade
Above +20°F (–7°C)	Grade No. 2–D
Below +20°F (–7°C)	Grade No. 1–D

Table 7–3 Preferred Fuel Grades

NOTE:
If grade No. 1–D is not available, use a winterized or climatized Grade No. 2–D fuel, made by blending No. 1–D with No. 2–D fuel to match the temperature conditions in your area.

If your engine suddenly becomes noisy after a fuel fill, you possibly received substandard fuel with a low cetane rating. Whenever feasible, buy diesel fuel from a reputable supplier who sells a large amount of diesel fuel.

7.3.1.1 Sulfur Content

Diesel fuels with a maximum sulfur content of 0.05 percent are required by U.S. EPA Emission Standards. Know your fuel sulfur content. (Ask your supplier, or have fuel analyzed.) If fuel contains more than 0.5 percent sulfur, reduce the oil-change interval as follows:

NOTE:
These intervals are based on the use of lubricants with minimum 6 Total Base Number (TBN) per ASTM D975.

Sulfur Content, Percent	Oil Change Interval
Below 0.5	Normal (every 8,000 miles, 13,000 km, 2300 hr, 2 months)
0.5 to 1.0	3/4 Normal (every 6,000 miles, 9.750 km, 1725 hr, 6 weeks)
Above 1.0	1/2 Normal (every 4,000 miles, 6,500 km, 1150 hr or 1 month)

Table 7–4 Sulfur Content

NOTE:
It is not necessary to reduce filter change intervals when oil change intervals are reduced to accommodate fuels with more than 0.5% sulfur content.

7.3.1.2 Advisory

Detroit Diesel Corporation DOES NOT recommend or in any way advocate the blending of used engine oil with diesel fuel in any application equipped with a 40E diesel engine.

NOTICE:

Blending used engine oil with diesel fuel in on–highway vehicles constitutes the use of fuels NOT recommended for the engine and will significantly increase exhaust emissions of your vehicle. It is also likely that using such blends will increase the rate of internal engine wear.

Any malfunctions or failure of the vehicle to meet Federal, California or any other State emissions standards due to non–recommended fuel usage, is not covered by the emission control system warranty.

CAUTION:

Do not mix gasoline, gasohol and/or alcohol with diesel fuel. This practice creates an extreme fire hazard, and under certain conditions, an explosive hazard which could result in serious injury or death.

Detroit Diesel Corporation DOES NOT recommend the blending of gasoline or alcohol with diesel fuel due to the hazards of fire or explosion and the detrimental effects on engine performance.

7.3.2 Hazards of Fire and Explosion

Only two percent volume gasoline mixed with diesel fuel will create a flammable, explosive mixture in the fuel tank vapor space, that will pose an extreme fire or explosion hazard during refueling or engine operation. See Figure 7–1.

Figure 7–1 Do Not Mix Diesel Fuel and Gasoline

7.3.3 Engine Performance Problems

Lower fuel viscosity could reduce engine power and fuel economy, and increases the possibility of excessive fuel system wear or failure.

NOTICE:
A lower cetane number could cause hard starting and slower warm–up. It can also increase engine noise and exhaust emissions, leading to engine damage or failure.

Lower cetane number could cause hard starting and slower warm–up, and could increase engine noise and exhaust emissions.

7.4 COOLING SYSTEM REQUIREMENTS

The following are required for the cooling system:

- ❑ An antifreeze concentration greater than 68% has a higher freezing point than 68% antifreeze. This will adversely affect freeze protection and heat transfer rates which may result in restriction of engine coolant passages, causing overheating and subsequent engine damage.
- ❑ Use coolant which has an ethylene glycol base. Propylene glycol has been approved as an alternative antifreeze substitute. Your diesel engine warranty may be adversely affected if any other substitute coolant is used.
- ❑ Coolant made with methoxy propanol is not recommended for use with the series 40E engines. These types of coolant can damage engine internal seals and coolant hoses and create a potential fire hazard due to lower flash points than ethylene glycol.

NOTE:
DO NOT add propylene glycol antifreeze to any Detroit Diesel engine cooling system containing ethylene glycol antifreeze or vice versa.

7.4.1 Ethylene Glycol Antifreeze

For cooling system capacities, refer to the vehicle operator's manual. Detroit Diesel ethylene glycol antifreeze may be added in 45% – 55% concentration for protection below -20°F (-29°C). Concentrations above 60% and not over 68% are acceptable only for very cold climates where freeze protection of -55 to -78°F (-48 to -61°C) respectively are required.

7.4.2 Propylene Glycol Antifreeze

Blends of propylene glycol antifreeze and water containing 50 to 55% antifreeze concentrate are recommended for normal applications. These correspond to freeze points of -26 to -40°F (-32 to 40°C) respectively. Concentrations above 60% and not over 68% are acceptable only for very cold climates where freeze protection of -55 to -78°F (-48 to -61°C), respectively, are required. Antifreeze part numbers are listed in Table 7–5.

Capacity	Antifreeze Part Number
Gallon	2JJ 996723A
55–Gallon Drum	2JJ 996900C

Table 7–5 Antifreeze Part Numbers

7.5 COOLING SYSTEM SPECIFICATIONS

Approved cooling system conditioner and filter part numbers are listed in Table 7–6. For Cooling system maintenance schedules, refer to section 8.2.

7.5.1 Maintaining Required Conditioner Concentration

All cooling system conditioners, including those in antifreeze solutions, become depleted through normal operation. If conditioners in antifreeze are allowed to become depleted, the antifreeze becomes corrosive. The antifreeze solution then attacks the metal surface of the cooling system causing leaks and deposit build up, which reduces heat transfer. To maintain an acceptable conditioner concentration, additional chemicals must be supplied to the cooling system.

Detroit Diesel Cooling Conditioner, recommended for use in the Series 40E diesel engines, is a complete inhibitor system. It is a phosphate–molybdate and nitrate based formulation which provides corrosion protection, prevents cylinder pitting, controls pH, neutralizes acids and contains additives which prevent the formulation of mineral deposits.

Approved cooling system conditioner part numbers are listed in Table 7–6.

Quantity	DDC P/N	DDC P/N	DCA–4
Pint	DCA60L	–	–
5.0 gallon	DCA75L	–	–
5.5 gallon	DCA65L	–	–
55–gal	DCA880L	–	–
Spin–on Filter	–	1 820 358 C1	0.0
Spin–on Filter	–	1 822 313 C1	4.0
Spin–on Filter	–	1 820 361 C1	15.0

Table 7–6 Detroit Diesel Cooling Conditioner and Coolant Filter Part Numbers

7.5.2 Coolant Filter and Conditioner

Series 40E diesel engines are equipped with a coolant filter and should be serviced as listed in Table 7–1 (7.6L) and as listed in Table 7–2 (8.7L). For cooling system capacity, refer to vehicle operator's manual.

Engines in high hour and low mileage applications, such as refuse packers and transit mixers that operate frequently at low engine speeds and engine temperatures, are best maintained according to hour intervals rather than mileage intervals.

Anytime make–up coolant is added to the cooling system, liquid Detroit Diesel Cooling System Conditioner should be added at a minimum rate of 227 ml (8 ounces) (2.5 units) per one gallon of make–up coolant. After adding conditioner, operate engine until it is warmed up enough to circulate the conditioner through the cooling system.

7.5.3 Coolant Testing for Conditioner Concentration

When the cooling system is maintained as recommended, the conditioner concentration should be satisfactory. A Coolant Test Kit, P/N: CC2601 is available to determine the chemical concentration level.

A good reading indicates that the conditioner contained in the coolant is sufficient to insure cooling system protection. Test kit measurements are in units per gallon, listed in Table 7–7.

Recommended level is 1.5 to 3.0 units per gallon. It is recommended that the conditioner concentration be checked with the test kit at a minimum of every four (4) months, every time the filter is changed or any time there is a large loss of coolant.

NOTE:
It is vital that the change intervals listed in Table 7–7, for filter and conditioner, be followed precisely.

NOTICE:
Conditioner should only be added to a clean cooling system because it will loosen deposits that could cause radiator plugging. Therefore, a field application's cooling system must be drained and chemically flushed with cooling system cleaner prior to bringing the application's conditioner concentration up to recommended levels.

Total Cooling System Capacity (Qts)	900 Engine Hours* Service w/Coolant Filter:	3800 Engine Hours† and after any complete drain, service with proper coolant filter/conditioner	Extra DCA–4 Units Required per Gal
30–41	1 820 361 C1	Drain and flush with cooling system cleaner, P/N: 995 007 R2	0.9–1.4
42–55	1 820 361 C1	Drain and flush with cooling system cleaner, P/N: 995 007 R2	1.5–1.8
56–67	1 820 361 C1	Drain and flush with cooling system cleaner, P/N: 995 007 R2	1.8–2.0
68–76	1 820 361 C1	Drain and flush with cooling system cleaner, P/N: 995 007 R2	2.0
77–85	1 820 361 C1	Drain and flush with cooling system cleaner, P/N: 995 007 R2	2.0

* 24,000 miles (3862 km)

† 100,000 miles (161,000 km) or 2 years, whichever comes first

Table 7–7 Conditioner Concentration Maintenance Schedule

7.6 ENGINE LUBRICATION REQUIREMENTS

Information on oil is contained in this section. Crankcase oil specifications are listed in Table 7–1 (7.6L engine) and listed in Table 7–2 (8.7L engine).

7.6.1 Oil Quality

Oil quality is described by API (American Petroleum Institute) engine service categories. API categories are defined by oil performance (deposits and wear) measured in standardized engine tests. The API "S" category (SJ) describe oils for spark ignition (gasoline) engines, while "C" categories (CD,CE,CG4) describe oils for diesel engines. Oils with both "S" and "C" categories (such as CG4/SH) are suitable for both spark ignition and diesel engines. Sometimes the "S" and "C" categories are reversed (such as SJ/CG4).

Use oil meeting API category CG–4. API oil can be recognized by the Identification Symbol displayed on the container. Detroit Diesel Premium 15W–40 meets this requirement. CG–4/SJ,

CF–4 and CF–4/SH oils can be used when CG–4 oil is not available. CD engine oils, such as 5W–30 and 10W–30, should only be used when the CF oils are not available in viscosity grades that are required for low temperature engine operation.

NOTICE:

Do not use oils specifically marketed by suppliers for stationary, marine or railroad diesel engines or for stationary natural gas engines, even though they are marked API category CD. Such oils can cause excessive valve train wear and combustion chamber deposits.

NOTE:
Such oils are sold only in drums and in bulk quantities.

7.6.2 Oil Viscosity

Oil viscosity (thickness) is described by SAE (Society of Automotive Engineers) Viscosity Grade. Colder temperatures require lower viscosity oils to ensure good flow during starting, while hotter temperatures require higher viscosity oils for satisfactory lubrication. Based upon the temperature range you expect before your next oil change, use the chart and the notes below to choose the proper viscosity grade. Using other viscosity grades or using viscosity grades at temperatures outside the recommended ranges could cause engine damage. See Figure 7–2 for preferred SAE viscosity grades.

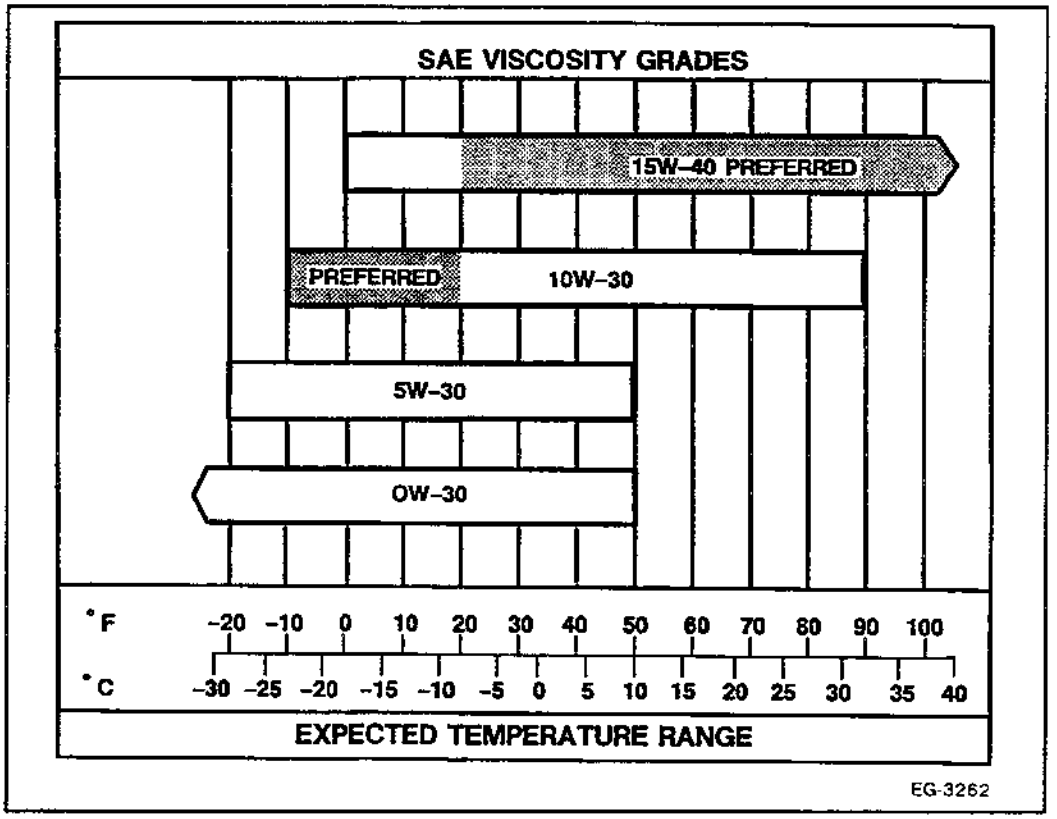


Figure 7–2 Preferred Viscosity Grades

NOTE:
Alternate oil grades are:

10W	–235°to 105°C (–105° to 505°F)
20W–20	–125° to 215°C (105° to 705°F)

Some increase in oil consumption may be expected when SAE 0W–30, 5W–30, 10W and 10W–30 oils are used. Check oil level more frequently.

7.6.3 Oil Change Interval

Refer to section 8.4.8 for the recommended oil change interval for your engine. Use of oils exceeding the required quality level, synthetic oils or other oils claiming longer service intervals does not justify extending oil change intervals beyond those recommended.

For Series 40E diesel engines, the recommended oil change intervals are based on the U.S. EPA Emission Standards with a

maximum sulfur content of 0.05 percent. Know your fuel sulfur content. (Ask your supplier, or have the fuel analyzed.) Sulfur content and oil change interval adjustments are listed in Table 7–8.

NOTE:
These intervals are based on the use of lubricants with minimum 6 Total Base Number (TBN) per ASTM D975.

Sulfur Content, Percent	Oil Change Interval
Below 0.5	Normal
0.5 to 1.0	3/4 Normal
Above 1.0	1/2 Normal

Table 7–8 Fuel Sulfur Content

NOTE:
It is NOT necessary to reduce filter change intervals when oil change intervals are reduced to accommodate fuels with more than 0.5% sulfur content.

7.7 ENERGY CONSERVING OILS

Oils marketed as *Energy Conserving* are intended to improve fuel economy in passenger car engines. Some of these oils contain friction modifier chemical additives. One additive, molybdenum dithiophosphate, has been implicated in copper corrosion problems in some heavy duty diesel engines.

Therefore, until further information is available, do not use an Energy Conserving oil containing molybdenum dithiophosphate in any Series 40E engine. In addition, some Energy Conserving oils meet only API category SH for spark ignition engines, and do not meet the oil quality requirements for diesel engines.

7.8 IDENTIFICATION SYMBOL

An oil container symbol system has been developed to help you choose the proper oil. The top portion of the symbol shows the oil quality, such as API Service CG-4/SJ in the example. The symbol may show additional categories, such as API Service CD/SH or CE. The center portion will show the SAE viscosity grade, such as SAE 15W-40 in the example. If the lower portion shows Energy Conserving or Energy Conserving II, be sure the upper and center portions show correct API service category and proper SAE viscosity grade recommended for your engine. See Figure 7-3.

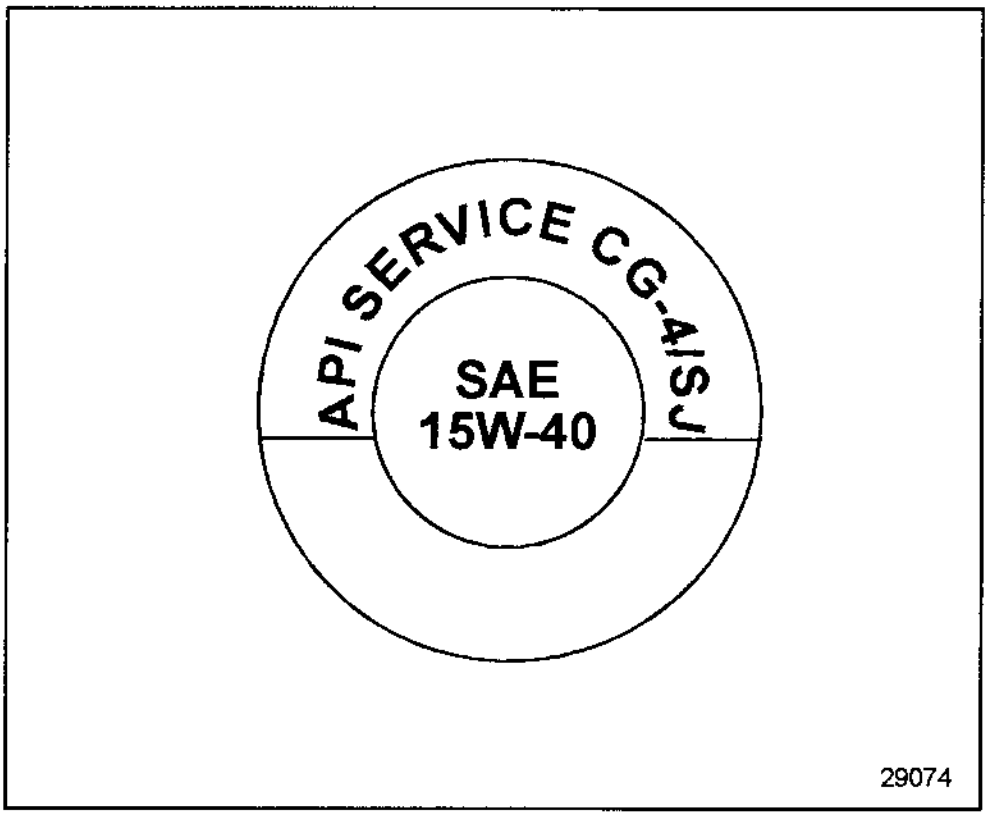


Figure 7-3 Identification Symbol

7.9 CRANKCASE OIL SPECIFICATIONS

For specific information on most commercial oil brand names, write for the booklet entitled:

Lubricating Oil Data Book For Heavy-duty Automotive and Industrial Engines

Engine Manufacturers Association
401 North Michigan Avenue
Chicago, Illinois 60611-4267

If any questions on ordering, call: 1-312-644-6610 ext. 3626

7.9.1 Series 40E Diesel Engine Crankcase Refill Capacities

Series 40E diesel engine crankcase refill capacities with rear sump oil pan follow:

- ☐ 24 quarts (22.7 L) without filter change
- ☐ 28 quarts (26.4 L) with filter change

NOTE:
The filter change intervals are based on the use of lubricants with a minimum 6 Total Base Number (TBN) per ASTM D975.

7.9.2 Checking Engine Oil Level

Check engine oil level daily.

NOTICE:
Never check the oil level with the engine running or immediately after engine shutdown as an inaccurate reading will be obtained.

Keep oil level as near the high level mark as possible. Never operate an engine with oil level below low level mark.
Do not overfill!

8 MAINTENANCE

8.1 MAINTENANCE OVERVIEW

For effective emission control and low operating cost, it is important that maintenance operations listed on the following pages be performed at the specified periods of mileage intervals indicated.

Service intervals are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

As the owner, you are responsible for the performance of all scheduled maintenance. The required maintenance operations may be performed by the owner or a service establishment of the owner's choosing. Any replacement parts used for required maintenance services or repairs should be genuine Detroit Diesel parts or equivalent in quality and performance to genuine DDC parts. Use of inferior replacement parts hinders operations of the engine and emissions control system.

Receipts covering the performance of regular maintenance should be retained in the event questions arise concerning maintenance. The receipts should be transferred to each subsequent owner of the engine (vehicle).

8.2 DAILY MAINTENANCE

The following items need to be inspected, serviced corrected or replaced on a daily basis, as necessary.

- ❑ Check oil level. Refer to section 8.4.1.
- ❑ Check coolant level. Refer to section 8.4.2.
- ❑ Drain water separator (fuel system). Refer to section 8.4.3.
- ❑ Inspect air–to–air intercooler. Refer to section 8.4.4.
- ❑ Inspect for external leakage. Refer to section 8.4.5.
- ❑ Inspect air restriction indicator; service air cleaner elements as required. Refer to section 8.4.6.
- ❑ Inspect belt. Refer to section 8.4.7.

8.3 MAINTENANCE OF ENGINES

Service intervals are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

8.3.1 Every 12,000 Miles (19,300 km), 450 Hours or 6 Months Interval Maintenance

Every 12,000 miles (19,300 km), 450 hours or 6 months, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Change engine oil and filter. If fuel contains more than 0.05% sulfur, reduce oil change intervals. Refer to section 8.4.8.
- ❑ Check coolant SCA concentration. Refer to section 8.4.9.
- ❑ Inspect air intake piping and clamps. Refer to section 8.4.10.

8.3.2 Every 24,000 Miles (38,600 km), 900 Hours or 12 Months Interval Maintenance

Every 24,000 miles (38,600 km), 900 hours or 12 months, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Change engine oil and filter. If fuel contains more than 0.05% sulfur, reduce oil change intervals. Refer to section 8.4.8.
- ❑ Check coolant SCA concentration. Refer to section 8.4.9.
- ❑ Inspect air intake piping and clamps. Refer to section 8.4.10.
- ❑ Measure air intake restriction. Refer to section 8.4.11. Refer to Troubleshooting Manual or Service Manual.

- ❑ Change fuel filters according to transfer pump minimum specifications. Refer to section 8.4.12.
- ❑ Change coolant filter. Refer to section 8.4.13.

8.3.3 Every 100,000 Miles (161,000 km), 3800 Hours or 24 Months Interval Maintenance

Every 100,000 miles (161,000 km), 3800 hours or 24 months, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Change engine oil and filter. If fuel contains more than 0.05% sulfur, reduce oil change intervals. Refer to section 8.4.8.
- ❑ Check coolant SCA concentration. Refer to section 8.4.9.
- ❑ Inspect air intake piping and clamps. Refer to section 8.4.10.
- ❑ Measure air intake restriction. Refer to section 8.4.11. Refer to Troubleshooting Manual or Service Manual.
- ❑ Change fuel filters according to transfer pump minimum specifications. Refer to section 8.4.12.
- ❑ Change coolant filter. Refer to section 8.4.13.
- ❑ Service cooling system for the 7.6L engine. Refer to cooling system specifications. Refer to section 8.4.14.
- ❑ Inspect vibration damper. Refer to section 8.4.15. Refer to Troubleshooting Manual or Service Manual.
- ❑ Pressurize induction system. Refer to section 8.4.16. Refer to Troubleshooting Manual or Service Manual.

8.3.4 Every 120,000 Miles (193,100 km) or 5000 Hours Interval Maintenance.

Every 120,000 miles (193,100 km), or 5000 hours, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Adjust valve lash. Refer to section 8.4.17. Refer to Troubleshooting Manual or Service Manual.

8.3.5 Every 180,000–200,000 Miles (290,000–322,000 km), or 6,700 to 7,500 Hours Interval Maintenance

Every 180,000 to 200,000 miles (299,000 to 322,000 km), or 6,700 to 7,500 hours, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Service cooling system for the 8.7L engine. Refer to cooling system specifications. Refer to section 8.4.14.
- ❑ Measure crankcase pressure. Refer to section 8.4.18.
- ❑ Inspect turbocharger. Refer to section 8.4.19.

8.3.6 Annual Interval Maintenance

Annually, the following components must be inspected, serviced, corrected or replaced as necessary.

- ❑ Inspect electrical system. Refer to section 8.4.20.

8.4 MAINTENANCE OPERATIONS

Service intervals are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

8.4.1 Oil Level

Check oil level daily.

Check the oil level by removing the oil level gage from the oil fill tube and observe. Ensure the oil level is at the FULL mark on the oil level gage. See Figure 8–1. If the oil level is below FULL, fill with the proper grade of oil for the temperature. Refer to section 7.6. Do not overfill past the FULL mark.

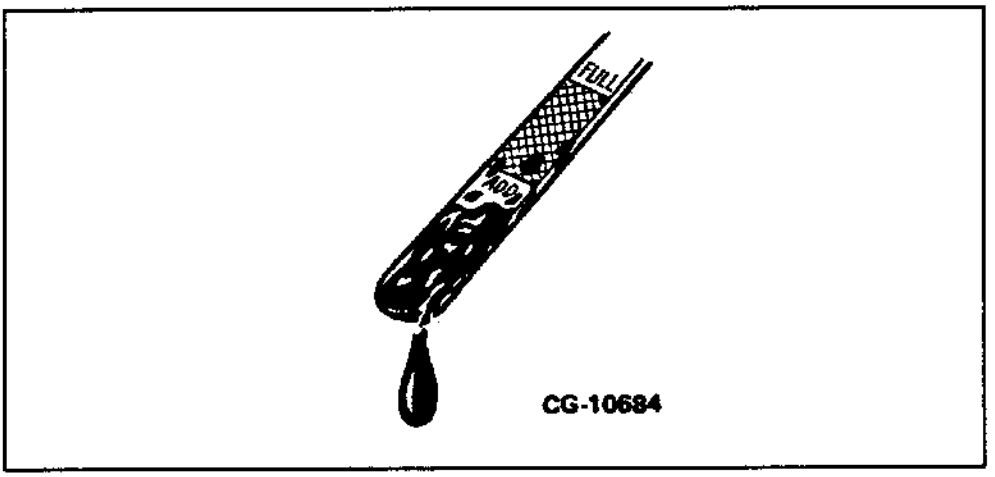


Figure 8–1 Checking Oil Level

8.4.2 Coolant Level

Check coolant level daily.

1. Observe the level of coolant in the deaeration tank. If the coolant level is not visible in the sight gage, refer to section 7.4 for proper requirements and specifications.
2. Refer to section 8.4.14 for the filling procedure.

8.4.3 Water Separator (Fuel System)

Check water separator, (fuel system) daily. Drain water from the fuel system as follows:

1. Loosen valve on bottom of water separator and allow water to drain out.
2. Tighten drain valve.

8.4.4 Air–to–Air Intercooler

Inspect Air–to–Air Intercooler daily.

1. With the engine off, visually inspect the air–to–air intercooler core assembly for debris and clogging of external fins. See Figure 8–2
2. Prior to engine operation, remove any debris blocking the core.

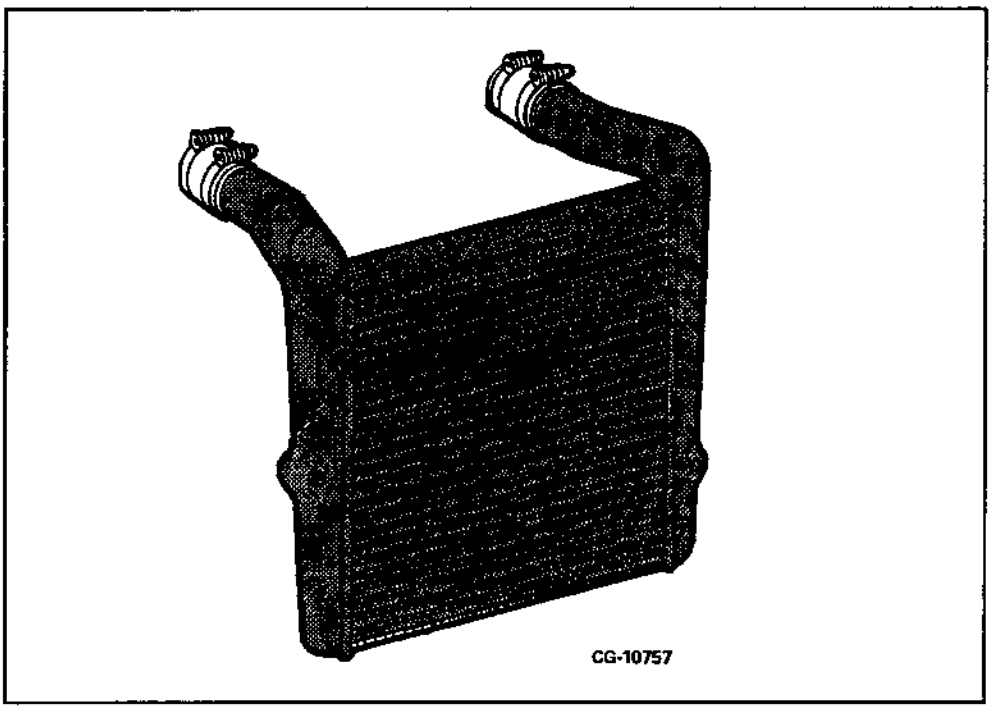


Figure 8–2 Chassis Mounted Air–to–Air Intercooler

8.4.5 External Leakage

Inspect for external leakage daily. Visually inspect for leakage as follows:

- ❑ Hoses (for cracking and loose clamps)
- ❑ Water stains
- ❑ Oil stains
- ❑ Wetness at water pump

8.4.6 Air Restriction Indicator

Inspect Air Cleaner Restriction Indicator daily. Refer to section 4 for inspection procedure.

Service the air cleaner as follows:

1. Remove dirty air cleaner element and discard.
2. Clean any accumulation of dirt from the air cleaner housing. Do not use shop air for this cleaning.
3. Visually inspect air cleaner housing for damage or distortion that could allow unfiltered air to enter the engine. Correct as required.
4. Install a new air cleaner element.
5. Reset the indicator by pushing the reset button and releasing it. The yellow indicator will drop below the window so the gage can be reused.

8.4.7 Belt

Inspect belt daily. Check belt for worn, grease coated, oil soaked and missing material. Replace as necessary. Install new belt as follows:

NOTE:
When installing belt, place it around the inside edge of the belt tensioner.

1. Place belt around pulleys.

2. Attach breaker bar to square hole of belt tensioner. See Figure 8–3.
3. Pull breaker bar counterclockwise. Install belt over tensioner pulley. Then, release pulley in a clockwise direction. Belt tensioner is automatically adjusted. Remove breaker bar.

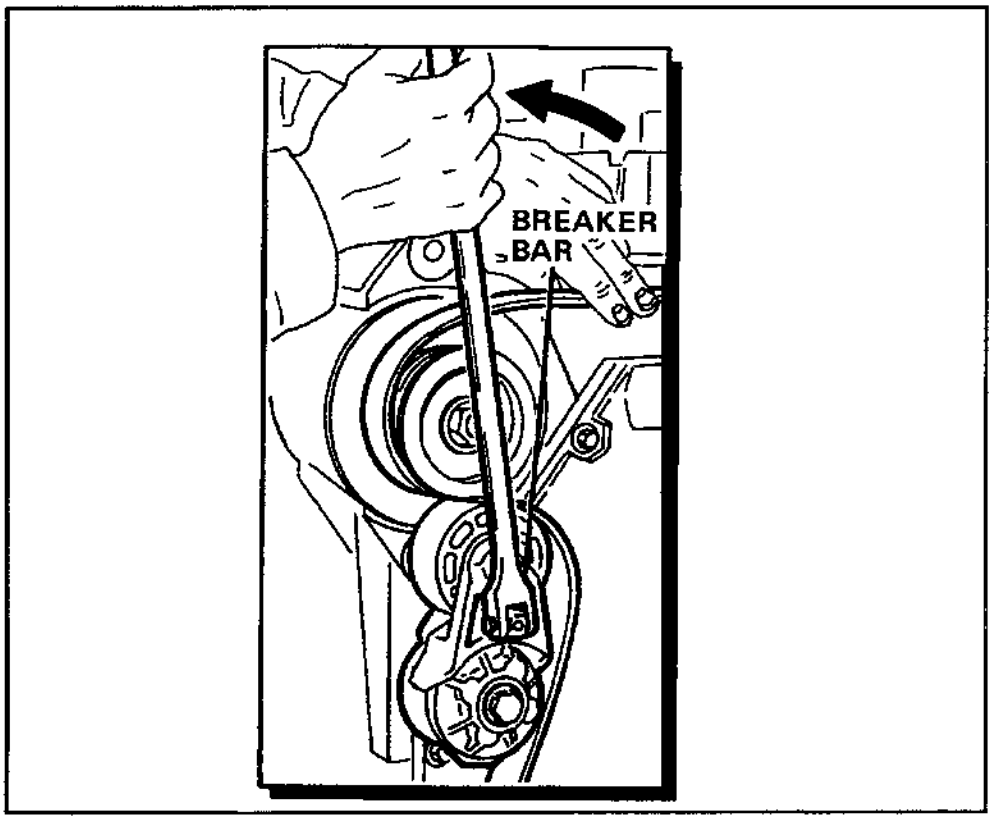


Figure 8–3 Setting Belt Tensioner

8.4.8 Engine Oil and Oil Filter

Change engine oil and oil filter as follows. If fuel contains more than 0.05% sulfur, reduce the oil change intervals as listed in Table 8–1.

Sulfur Content, Percent	Oil Change Interval
Below 0.5	Normal
0.5 to 1.0	3/4 Normal
Above 1.0	1/2 Normal

Table 8–1 Fuel Sulfur Content

1. Run engine until operating temperature is reached; then shut down.
2. Drain oil pan and reinstall drain plug, using a new gasket if required.
3. Install new oil filter, P/N: 1 819 452 C1, as follows:

NOTICE:
Do not overtighten filter. A damaged filter may fracture or leak.

   a. Remove old oil filter and discard. See Figure 8–4
   b. Lubricate new oil filter gasket with clean engine oil.
   c. Install new oil filter and hand-tighten one full turn after the gasket first contacts the filter header.

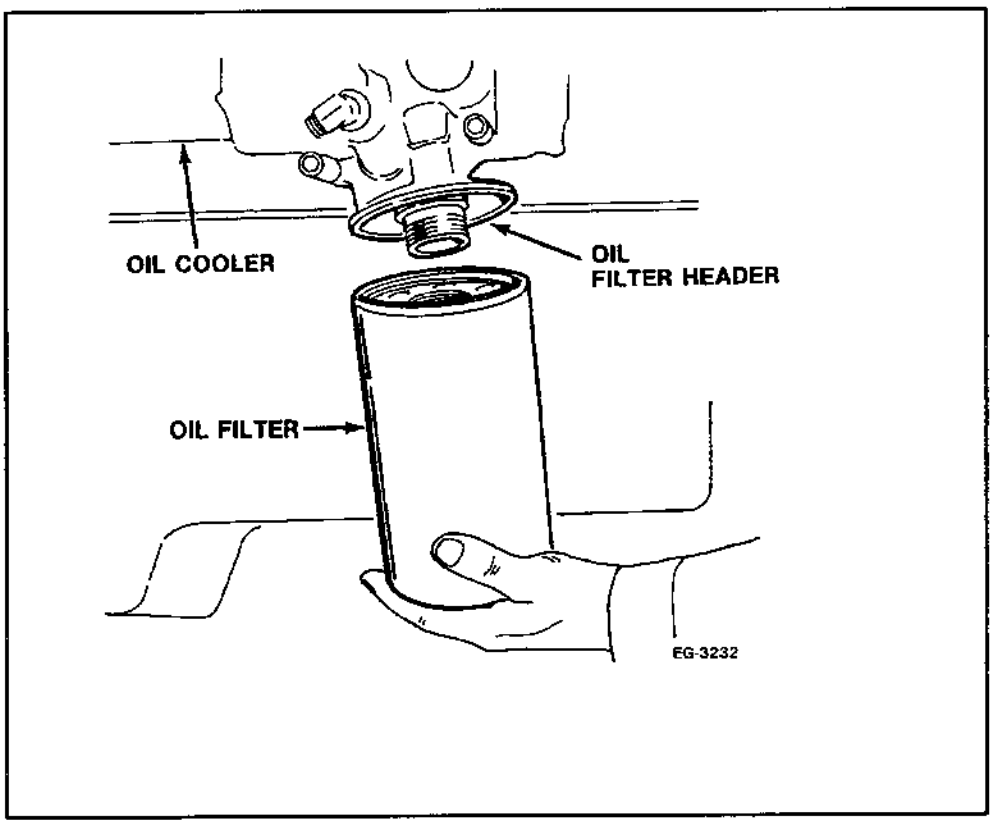


Figure 8–4 Oil Filter

4. Fill engine to specified capacity with the appropriate oil type. Refer to section 6.
5. Start engine and run at low idle r/min. Check lube oil pressure gage reading. If there is no gage reading, shut engine off immediately. Check for oil filter leaks. Lube oil pressure gage reference is a minimum of 137 kPa (20 psi) @ 700 r/min. Let engine run until operating temperature is reached. Check for leaks.
6. Shut engine down. Wait 15 minutes.
7. Recheck oil level and add oil if needed, bringing oil level to FULL mark on the gage.
8. Do not overfill past FULL mark.

8.4.9 Coolant

Check coolant SCA concentration.

Every six months, check the coolant concentration level in the coolant. Refer to section 7.4 for further information.

8.4.10 Air Intake Piping

Inspect air intake piping every six months. See Figure 8–5.

1. Check for loose hoses and clamps.
2. Check for ruptured hoses.
3. Check air cleaner housing for cracks.
4. Check air–to–air intercooler for holes or damage.

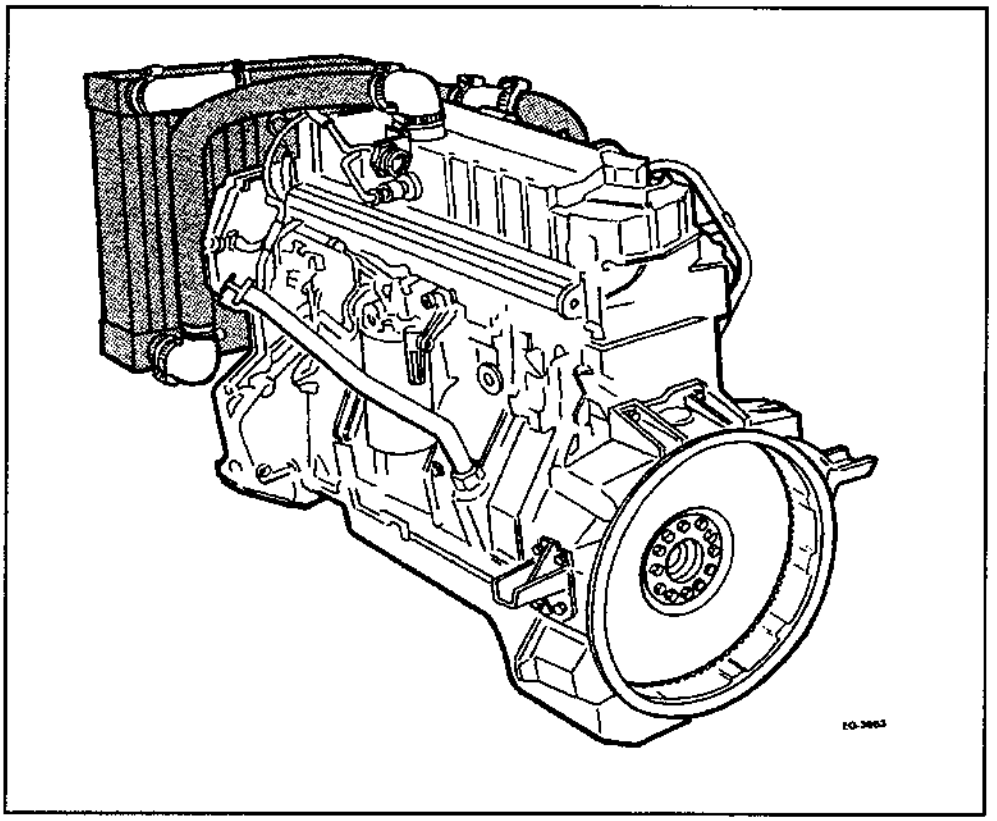


Figure 8–5 Air Intake Piping

8.4.11 Air Intake Restriction

Measure air intake restriction every 12 months or 900 hours.

NOTE:
The air cleaner is to be serviced only when the restriction reaches the maximum allowable limit. The restriction can be measured by the service indicator.

NOTE:
Often a low power and poor fuel economy complaint is simply due to a dirty air cleaner. As the air cleaner accumulates dirt, restrictions to airflow increases. If the service indicator is locked at maximum restriction, replace the air cleaner elements.

1. Refer to section 4 for gage and indicator operation.
2. Inspect the elements for damaged gaskets or dents in the elements. If they exhibit either, they should be repaired.
3. If low power is still experienced after replacing the air cleaner, see your DDC dealer.

8.4.11.1 Optional Dual Element Cleaner

The dual element air cleaner provides a large primary (outer) filter element and optional small secondary (inner) filter element. The secondary element should be used in dusty environments such as dump and mixer applications. See Figure 8–6.

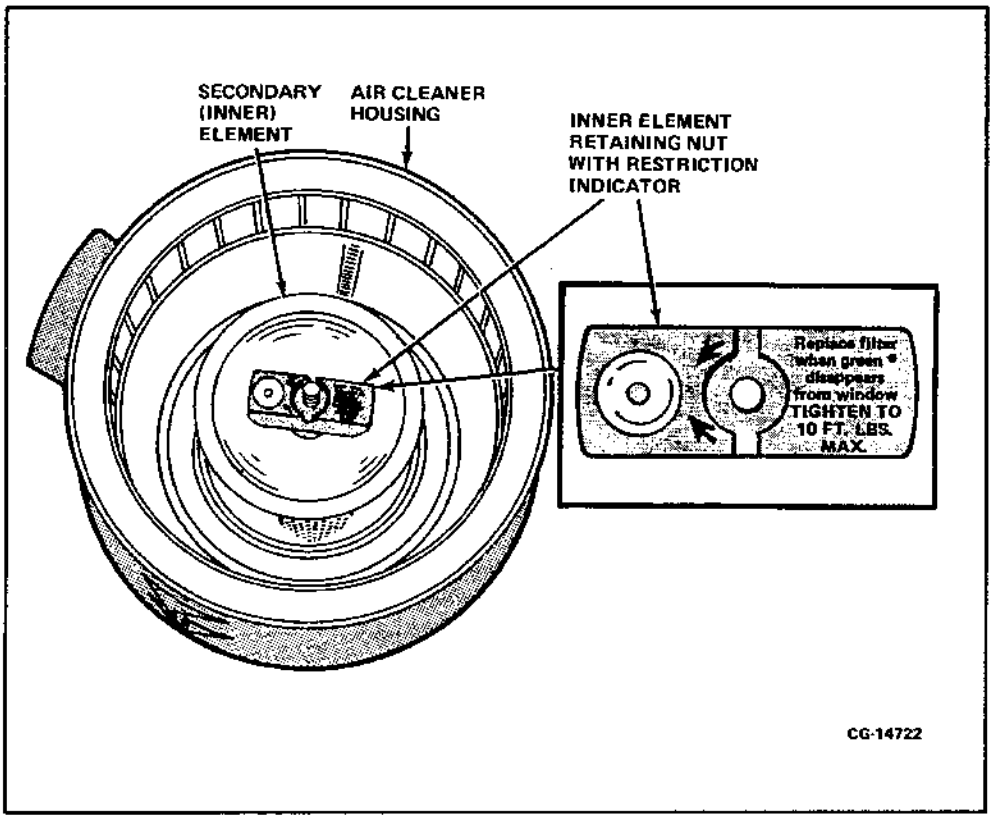


Figure 8–6 Top View of Dual Element Air Cleaner with Retaining Nut Indicator

The current dual element air cleaner restriction indicator assembly is located between the primary and the secondary element in the bottom of the air cleaner housing. This arrangement allows only the primary element to be sensed by the restriction indicator or dash mounted vacuum gage. The inner element is not recorded on the restriction indicator or dash mounted vacuum gage.

A separate inner element indicator senses restriction of that element. Dependent upon the manufacturer, either a rectangular wing nut with a built–in indicator is used or an element with an indicator located on the inner element end cap. See Figure 8–7. When all green disappears on the wing nut indicator, replace the inner element. When the green dot disappears from the indicator built into the inner element end cap, replace the inner element.

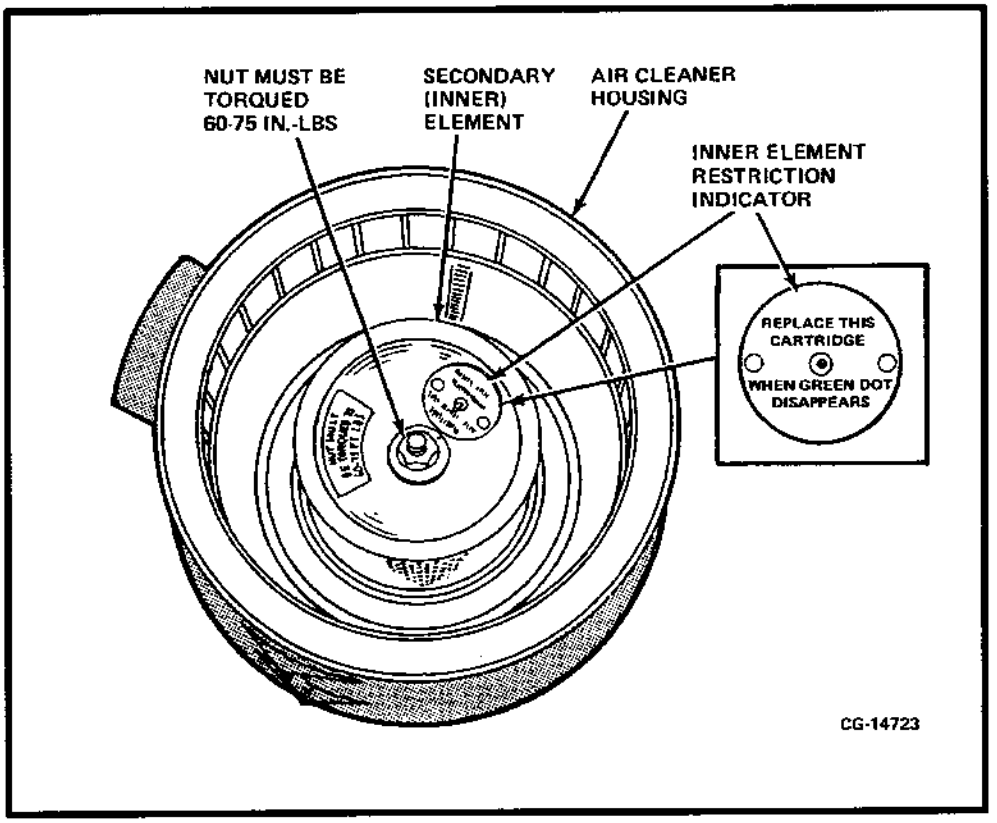


Figure 8–7 Top View of Dual Element Air Cleaner with Indicator in End Cap

8.4.12 Fuel Filter and Strainer Assembly

Change fuel filter and strainer assembly every 12 months. Fuel with more than average impurities may require changing the filter and strainer assembly at shorter intervals. See Figure 8–8. Use the following procedure:

1. Using an appropriate filter wrench/strap, loosen and remove the fuel filter from the header and discard.

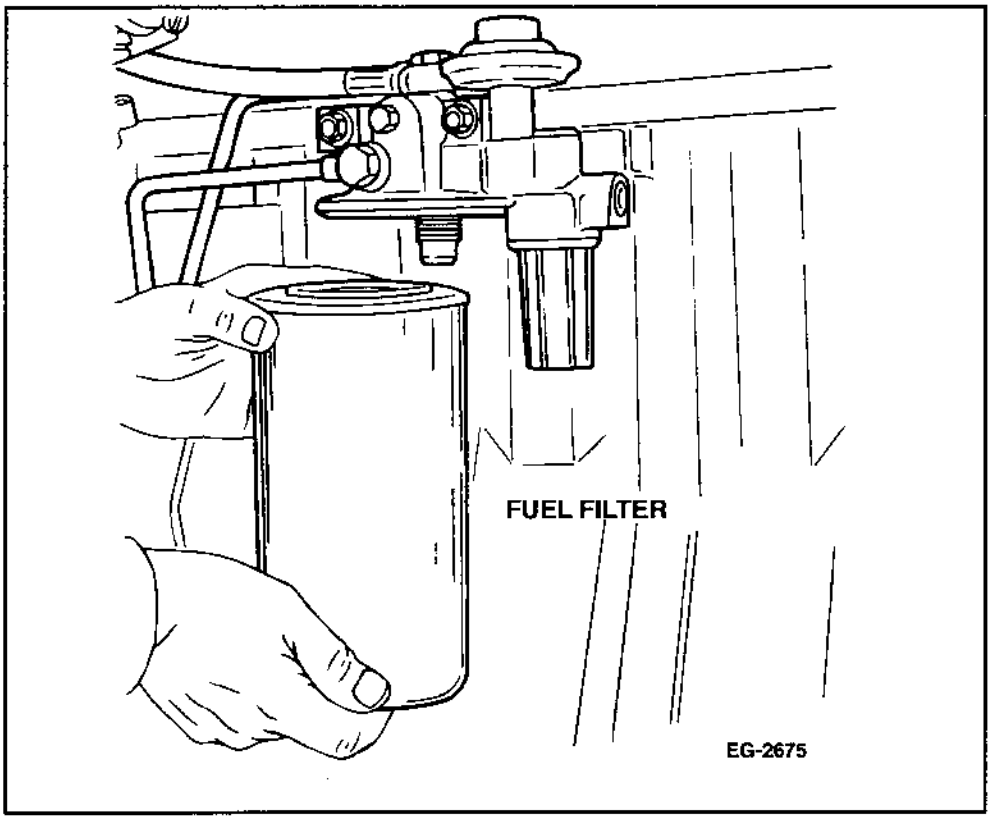


Figure 8–8 Removing Fuel Filter

2. Remove the primary fuel filter/strainer assembly as follows:
   a. Remove plastic strainer cover from filter strainer assembly using a 1-1/8 in. or 29 mm (12 point) socket. See Figure 8–9.
   b. Clean or replace strainer after inspection. Reinstall strainer and cover to header assembly.

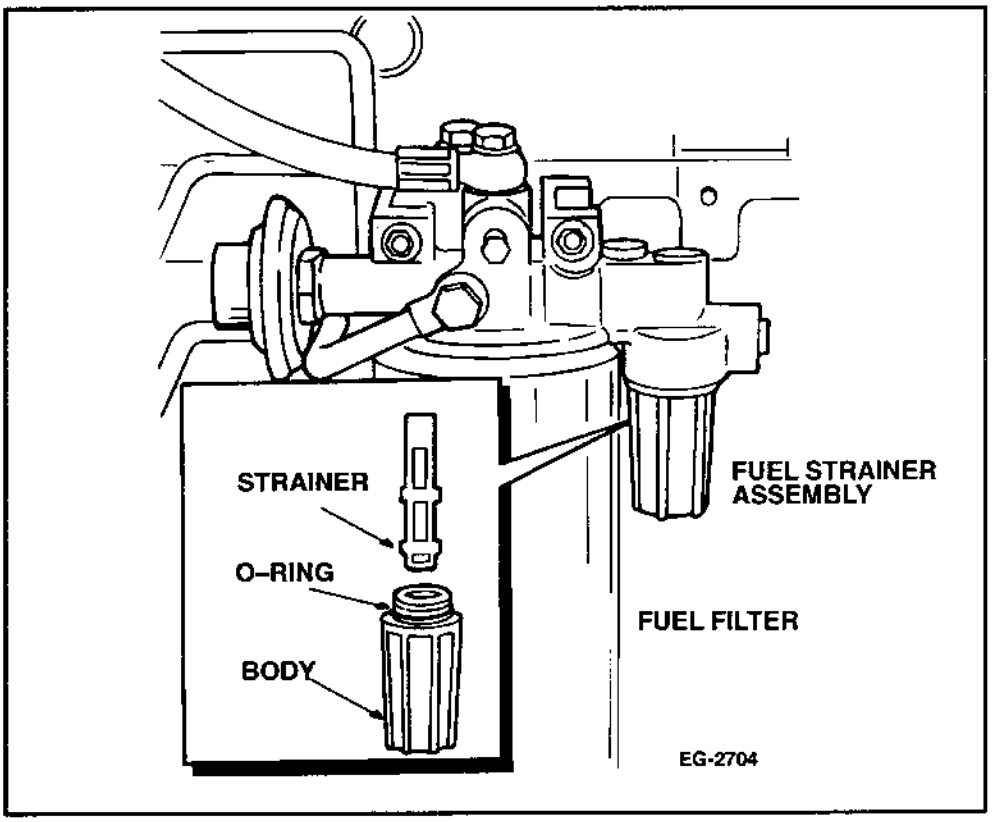


Figure 8–9 Removing Strainer Assembly

NOTE:
Install strainer with open end toward filter header.

3. Install a new fuel filter, P/N: 1 820 479 C1 (6 inch) or P/N: 1 809 789 C1 (8 inch), as follows:
   a. Lubricate fuel filter gasket with clean diesel fuel.
   b. Tighten until gasket touches fuel filter header.
   c. Tighten by hand an additional 1/2 turn.

NOTE:
Do not add fuel to new fuel filter.

4. Bleed air from the fuel system as follows. See Figure 8–10.

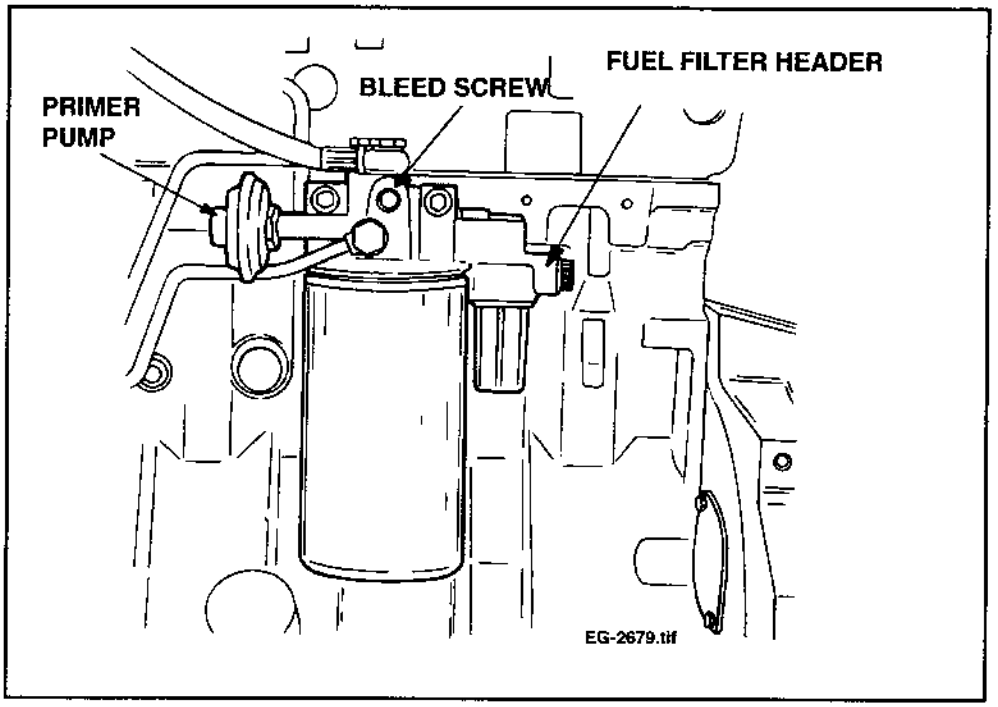


Figure 8–10 Bleeding Air from Fuel System

a. Loosen bleed screw at fuel filter header.

b. Operate priming pump until pump action provides solid fuel at bleed screw. Close bleed screw.

c. Crank engine for 15 seconds.

d. Start engine and operate until engine runs smoothly.

8.4.13 Change Coolant Filter

Change coolant filter every 12 months using the following procedure.

1. Remove deaeration tank pressure cap and remove coolant filter using a filter wrench/strap. The filter is located on the right hand side rear of the front cover. See Figure 8–11.

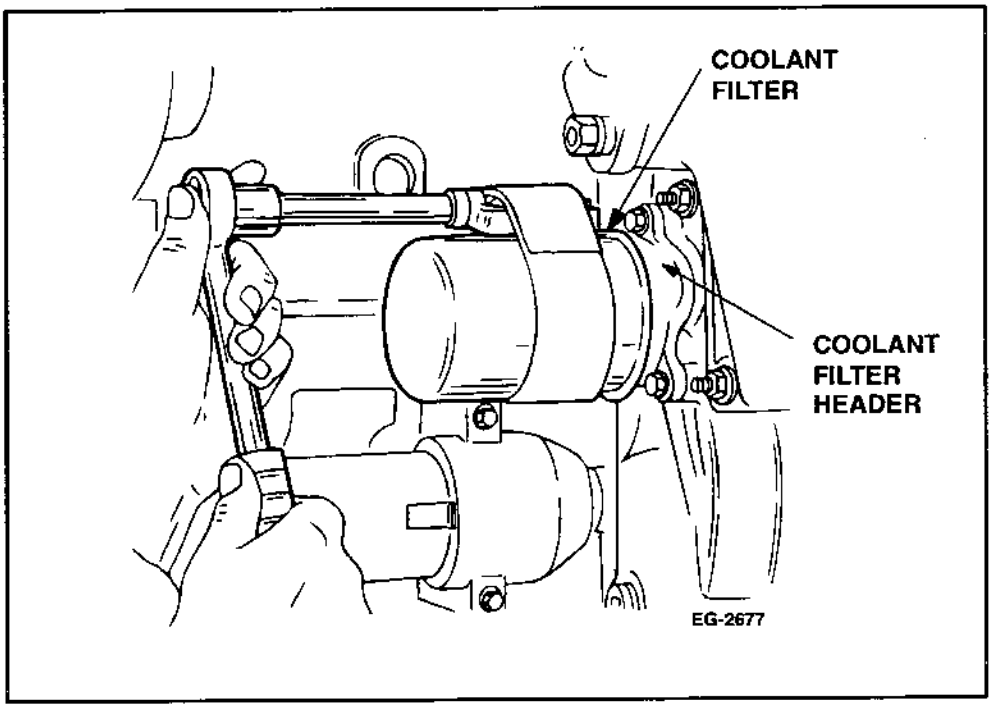


Figure 8–11 Removing Strainer Assembly

NOTE:
Coolant filter header is equipped with two check valves to stop flow of coolant when filter is removed.

2. Apply a thin coat of coolant to filter gasket and install onto filter header.
3. Tighten until gasket touches the coolant filter header. Tighten by hand an additional one full turn.

8.4.14 Service Cooling System

Service cooling system every 100,000 miles (161,000 km) for the 7.6L engine, and every 180,000 miles (290,000 km) for the 8.7L engine.

CAUTION:

Allow engine to cool before performing next operation. Steam could cause injury.

Drain and fill the cooling system as follows:

1. The engine must be level. This will permit all water to drain from the cooling system.
2. Allow the engine to cool. Remove deaeration tank pressure cap; open radiator drain. Wrap a heavy cloth around the cap and push down. Loosen cap slowly to the first notch position. Pause to allow steam and pressure to escape. Continue top turn the cap to the left and remove.
3. Remove crankcase coolant drain plug and oil cooler drain plug from the rear of the cooler. After the system has been thoroughly drained, close all drains.
4. Slowly fill the cooling system until the coolant reaches the bottom of the filler opening. Install deaeration tank cap.
5. Set the parking brake and start the engine.
6. Allow the engine to operate until the engine reaches its normal operating temperature. Watch for overheating.
7. After the engine reaches its normal operating temperature, shut off engine. Carefully remove tank cap and add sufficient coolant to fill system. Reinstall tank cap.

Clean the cooling system as follows.

1. Drain the system completely.
2. Flush the cooling system with water. If the system is dirty or rusty, use the dealer recommended cooling system cleaner following the procedures in this guide. Refer to section 8.4.14.1.
3. Refill the system with water, conditioner, antifreeze and coolant as specified in this guide. Refer to section 6.4.

NOTICE:

If coolant is extremely low and the engine is very hot, let the engine cool for approximately 15 minutes before adding coolant. Then, with the engine running, add coolant slowly. Adding cold water to a hot engine may crack the cylinder head or crankcase. Never use water alone!

8.4.14.1 Cleaning the Cooling System

The cooling system should be drained and thoroughly flushed. Refer to section 8.4.14.

Unless the cooling system is treated with a corrosion preventative, rust and scale will eventually clog up passages in the radiator and water jackets. This condition is aggravated in some localities by formation of insoluble salts from the water used.

DDC cleaning solutions are available which have proven very successful in removing accumulation or rust, scale, sludge and grease. They should be used according to the recommendation on the container.

NOTE:
Do not use chemical mixtures to stop radiator leaks except in an emergency. Never use such solutions instead of needed radiator repair.

8.4.14.2 Radiator Fins

Check the radiator fins periodically to make sure they are free of bugs, leaves and other debris, and that they are not bent or damaged. Clogged or damaged fins prohibit the flow of outside air to the radiator and hamper efficient cooling system operation.

8.4.14.3 Coolant Hoses

Only coolants with an ethylene glycol or a propylene glycol base are recommended for use in the Series 40E cooling systems. Other base coolants may damage rubber hoses, especially those made of silicone rubber. Type of rubber can usually be determined by color. Silicone hoses are made in COLOR while other rubber hoses are BLACK.

NOTICE:

Coolant made with methoxy propanol is not recommended for use with Detroit Diesel Corporation engines. These types of coolant can damage engine internal seals and coolant hoses, and create a potential fire hazard due to lower flash points than ethylene glycol.

NOTE:
Avoid mixing propylene glycol antifreeze and ethylene glycol antifreeze in any diesel engine cooling system. This mixing of antifreeze solutions does not allow an accurate coolant solution reading for freeze protection.

The cooling system will most likely be filled with ethylene glycol coolant. It is recommended that an ethylene glycol coolant be added to the system when required.

8.4.14.4 Thermostat

Your new engine is equipped at the factory with a high temperature thermostat.

NOTE:
Ethylene glycol antifreeze must be used with high temperature thermostats.

8.4.15 Vibration Damper

Inspect vibration damper every 24 months.

1. At the appropriate inspection interval, have the vibration damper inspected by your DDC dealer for deterioration of rubber.
2. Refer to the appropriate service manuals for the inspection procedures.

8.4.16 Induction System

Pressurize induction system every 24 months.

1. At the appropriate inspection interval, your DDC dealer should pressure test the air induction system.
2. Refer to the appropriate troubleshooting manuals for the inspection procedures.

8.4.17 Valve Lash

Adjust valve lash every 120,000 miles (193,100 km).

1. At the appropriate inspection interval, have the valve lash adjusted by your DDC dealer.
2. Refer to the appropriate service manuals for the inspection procedures.

8.4.18 Crankcase Pressure

Measure crankcase pressure every 200,000 miles (290,000 km).

1. At the appropriate interval, have the crankcase pressure checked by your DDC dealer.
2. Refer to the appropriate service manuals for the inspection procedures.

8.4.19 Turbocharger

Inspect turbocharger every 180,000 miles (290,000 km).

1. Clean, then remove the turbocharger compressor inlet connections.
2. Visually inspect the compressor wheel for:
   a. Dirt.
   b. Wheel rub.
   c. Wheel blade damage (bent or broken tips).
3. Check by hand for the following conditions:
   a. Excessive radial or end play.
   b. Free wheel spin.
4. Consult your DDC dealer if there is any doubt as to the condition of the turbocharger.

8.4.20 Electrical System

Inspect the electrical system annually.

1. Check the wiring harness for cracks, rubbing and loose connections.
2. Check sensors for loose connections, corrosion or cracks.
3. Check battery cables for
   a. Broken insulation.
   b. Rubbing/chafing.
   c. Corroded or loose connections.

9 ENGINE STORAGE

9.1 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, transmission and 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.

9.2 TEMPORARY STORAGE (30 DAYS OR LESS)

To protect an engine for a temporary period of time, proceed as follows:

1. Drain the engine crankcase.
2. Fill the crankcase to the proper level with the recommended viscosity and grade of oil.
3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for two minutes at 1200 r/min and no load. Do not drain the fuel system or the crankcase after this run.
4. Check the air cleaner and service it, if necessary.
5. If freezing weather is expected during the storage period, check the antifreeze content of the coolant for required freeze and inhibitor protection. Add antifreeze solution to the cooling system in accordance with the manufacturer's recommendations.

NOTE:
If an antifreeze solution is not required during storage, flush the cooling system with a good rust inhibitor to prevent rusting of the outside diameter of the cylinder liners.

CAUTION:

To prevent possible personal injury when using compressed air, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.

6. Clean the exterior of the engine, except electrical components, with fuel oil. Dry with compressed air.
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 oil, lubricating oil and transmission oil levels.

9.3 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. Drain the engine crankcase; install and tighten the 3/4 in. – 14 square, magnetic oil drain plug to 45–50 N·m (33–37 lb·ft) torque. Install new lubricating oil filters.
5. Fill the crankcase to the proper level with Tectyl® 930A preservative lubricating oil or an equivalent 30–weight preservative lubricating oil meeting Mil–L–21260C, Grade 2 specification.

6. Drain the fuel tank. Refill with enough clean No. 1 diesel fuel or pure kerosene to permit the engine to operate for about ten minutes. If draining the fuel tank is not convenient, use a separate, portable supply of recommended fuel.

NOTE:
If an engine in a vehicle is stored where condensation of water in the fuel tank may be a problem, additives containing Methyl Carbitol or Butyl Cellusolve may be added to the fuel. Follow manufacturer's instructions for treatment. Where biological contamination of fuel may be a problem, add a biocide such as Biobor® JF, or equivalent to the fuel. (Biobor® is a registered trademark of United States Borax and Chemical Corporation.) When using a biocide, follow the manufacturer's concentration recommendations, and observe all cautions and warnings.

7. Drain the fuel system and remove the fuel filters. Dispose of used filters in an environmentally responsible manner, according to state and federal (EPA) recommendations. Fill new filters with No. 1 diesel fuel or pure kerosene, and install on the engine. Bleed air from the fuel system. Refer to section 8.4.12.
8. Operate the engine for five minutes to circulate the clean fuel oil throughout the engine. Be sure the engine fuel system is full. Disconnect the fuel return line and the inlet line at the primary filter and securely plug both to retain the fuel in the engine.
9. Service the air cleaner.
10. Transmission – Follow the manufacturer's recommendations for prolonged storage.
11. Power Take-Off (if equipped) – Follow the manufacturer's recommendations for prolonged storage.

NOTICE:

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

12. Turbocharger – Since turbocharger bearings are pressure lubricated through the external oil line leading from the oil filter adapter while the engine is operating, no further attention is required. However, the turbocharger air inlet and turbine outlet connections should be sealed off with moisture-resistant tape.
13. 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.

14. Drain the engine cooling system.
15. Drain the preservative oil from the engine crankcase. Install and tighten the 3/4 in.-14 square, magnetic drain plug to 45–50 N·m (33–37 lb·ft) torque.
16. Remove and clean the battery and battery cables with a baking soda and 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 dry place, never below 0°C or 32°F. Keep the battery fully charged and check the level and specific gravity of the electrolyte regularly.

17. Insert heavy paper strips between the pulleys and drive belts to prevent sticking.
18. Seal all engine openings including the exhaust outlet, with moisture-resistant tape. Use cardboard plywood or metal covers where practical.
19. Clean and dry the exterior painted surfaces of the engine and spray with a suitable liquid automobile body wax, a synthetic resin varnish, or a rust preventive compound.
20. Protect the engine with a good weather-resistant tarpaulin and store it under cover, preferably in a dry building that can be heated during the winter months.

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.

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

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.

9.4 RESTORE TO SERVICE

To prepare an engine for service after it has been in extended storage (more than 30 days) follow this procedure:

1. Remove the covers and tape from all of the openings of the engine., fuel tank and electrical equipment. Do not overlook the exhaust outlet.
2. Remove the plugs from the inlet and outlet fuel lines and reconnect the lines to their proper positions.
3. Wash the exterior of the engine with fuel oil to remove the rust preventive. Do not wash electrical components.
4. Remove the rust preventive from the flywheel.
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 ensure all bearings and rocker shafts are lubricated.
7. Fill the fuel tank with the required fuel.
8. Close all drain cocks and fill the engine cooling system with clean, soft water and required inhibitors. If the engine is to be exposed to freezing temperatures, install genuine Detroit Diesel Power Cool® antifreeze or an equivalent ethylene glycol-base or propylene glycol-base antifreeze solution that provides required freeze, boil over, and inhibitor protection.
9. Install and connect the battery. Ensure the average specific gravity of the battery is 1.260 or higher. Charge the battery if necessary.
10. Service the air cleaner, if required.
11. Transmission - Follow the manufacturer's recommendations covering the return of the transmission to service.
12. Power Take-Off (if equipped) - Follow the manufacturer's recommendations covering the return of the power take-off to service.

13. Turbocharger – Remove the covers from the turbocharger air inlet and turbine outlet connections. Reconnect piping as required. Pre-lube the turbocharger. Refer to the lubricating procedure in the service manual.

14. After all preparations are completed, start the engine. The small amount of rust preventive compound that remains in the fuel system will cause smoky exhaust for a few minutes.

NOTE:
Before subjecting the engine to a load or high speed, allow it to reach normal operating temperature.

10 EMISSION MAINTENANCE SERVICE RECORD

10.1 SERVICE RECORD

The service record, listed in Table 10–1, provides space for recording the dates and mileage (odometer readings) when the required emission control maintenance operations were performed.

To prove proper maintenance of the vehicle engine records, work orders and receipts should be retained showing that scheduled maintenance has been performed. Failure to maintain such records may affect your warranty coverage.

Date	Service Month	Service Hours	km (miles)	Item Serviced

Date	Service Month	Service Hours	km (miles)	Item Serviced

Date	Service Month	Service Hours	km (miles)	Item Serviced

Table 10–1 Emission Maintenance Record

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