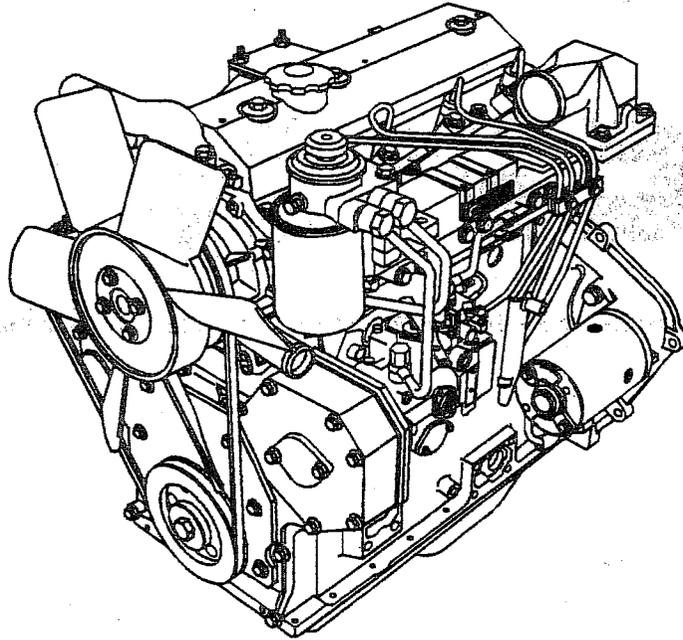




# Operation and Maintenance Manual B3.3 Series Engines



00900137

## Specifications

General Engine Data	Naturally Aspirated	Turbocharged
Engine Weight (Dry) Less Flywheel and Electronics	245 kg [540 lb]	255 kg [562 lb]
Compression Ratio	18	17
Bore	95 mm [3.74 in]	
Stroke	115 mm [4.528 in]	
Displacement	3.26 liters [199 in <sup>3</sup> ]	
Firing Order	1-2-4-3	
Valve Clearance:	Intake	0.35 mm [0.014 in]
	Exhaust	0.50 mm [0.020 in]
Rotation Viewed from the Front of the Engine	<b>Clockwise</b>	

Lubrication System	Naturally Aspirated	Turbocharged
Regulating Valve Opening Pressure	490 kPa [71 psi]	588 kPa [85 psi]
Lubricating Oil Capacity:	Total System 7.5 liters [8.0 qt]	8.0 liters [8.5 qt]
	Standard Oil Pan Only	7.0 liters [7.4 qt]
Lubricating Oil Pressure at Idle (Minimum Allowable)	69 kPa [10 psi]	
Lubricating Oil Pressure at Rated (Minimum Allowable)	245 kPa [35 psi]	
Oil Filter Differential Pressure to Open Bypass Valve	98 kPa [14 psi]	
Number of liters [qt] from Low to High	1.5 liters [1.6 qt]	

Cooling System	Naturally Aspirated	Turbocharged
Coolant Capacity (Engine Only)	4.5 liters [4.75 qt]	
Standard Modulating Thermostat Range:	Start	82° C [180° F]
	Fully Open	95° C [203° F]
Maximum Pressure Cap @ Sea Level	50 kPa [7 psi]	

Air Induction System	Naturally Aspirated	Turbocharged
Maximum Allowable Intake Restriction at Rated Speed and Load with Dirty Filter Element	762 mm H <sub>2</sub> O [30 in H <sub>2</sub> O]	762 mm H <sub>2</sub> O [30 in H <sub>2</sub> O]

Exhaust System	Naturally Aspirated	Turbocharged
Maximum Allowable Exhaust Restriction at Rated Speed and Load with Dirty Filter Element	75 mm Hg [3 in Hg]	

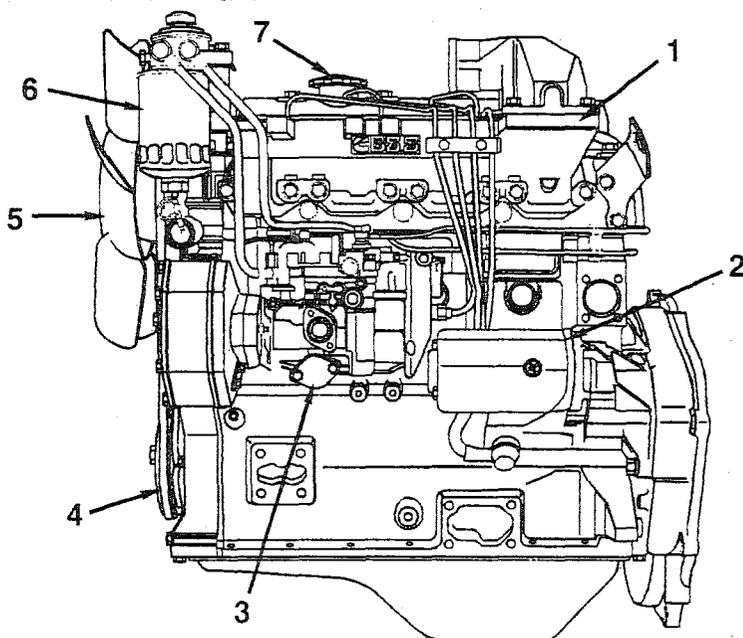
Fuel System	Naturally Aspirated	Turbocharged
Maximum Allowable Restriction to the Fuel Transfer Pump or Filter Head <b>Must Not Exceed</b>	75 mm Hg [3 in Hg]	
Maximum Allowable Return Line Restriction <b>Must Not Exceed</b>	190.5 mm Hg [7.5 in Hg]	
Inlet Pressure to the Injection Pump Range	0.00 kPa [0.00 psi] to 39.0 kPa [5.00 psi]	

<b>Electrical System</b>		<b>Naturally Aspirated and Turbocharged</b>
Minimum Recommended Battery Capacity with Light Accessories*:	12-VDC Starter	550 CCA
Minimum Recommended Battery Capacity with Heavy Accessories**:	12-VDC Starter	730 CCA
Maximum Allowable Resistance of the Starting Circuit:	12-VDC Starter	0.0012 ohms
*Typical light accessories include: Alternator, small steering pump, and disengaged clutch.		
**Typical heavy accessories include: Hydraulic pump and torque converter.		

## Engine Diagrams

### Engine Views

The following illustrations show the locations of the major external engine components, filters, and other service and maintenance points. Some external components will be at different locations for different engine models.

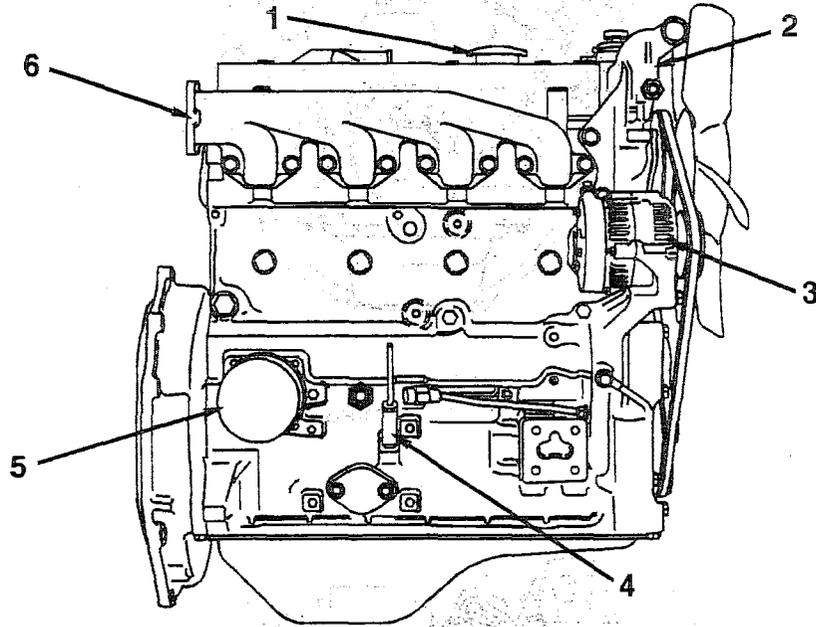


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Intake Side  
(Naturally Aspirated)

- 1. Intake Manifold
- 2. Starting Motor
- 3. Fuel Injection Pump
- 4. Crankshaft Pulley

- 5. Fan
- 6. Fuel Filter
- 7. Oil Fill Cap.

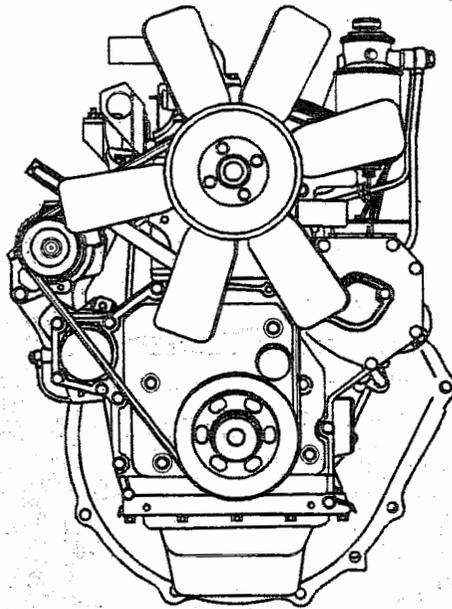


00900139

**Exhaust Side  
(Naturally Aspirated)**

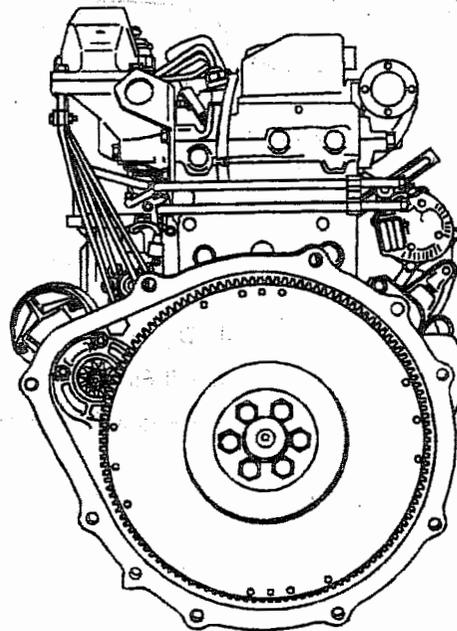
- 1. Oil Fill Cap
- 2. Thermostat Housing
- 3. Alternator

- 4. Dipstick
- 5. Oil Filter
- 6. Exhaust Manifold.



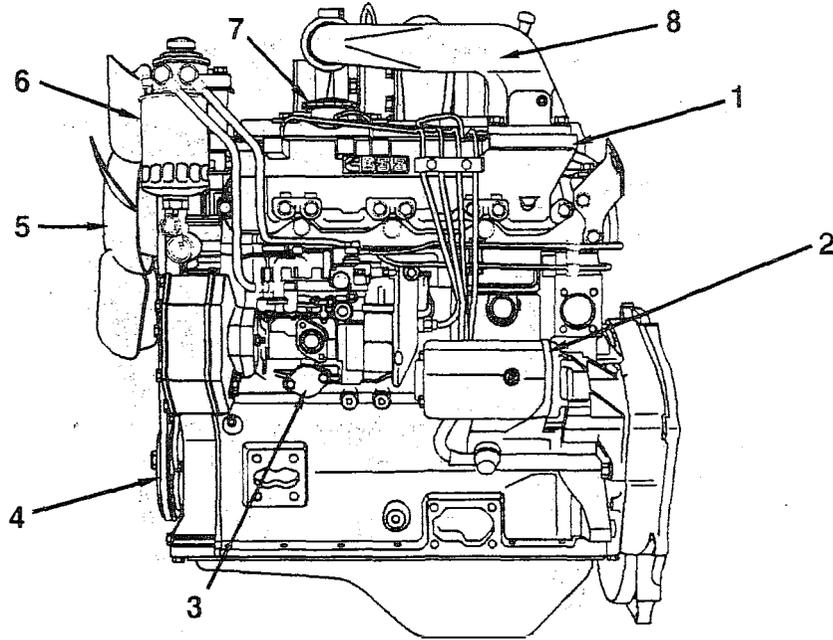
00900140

**Front View  
(Naturally Aspirated)**



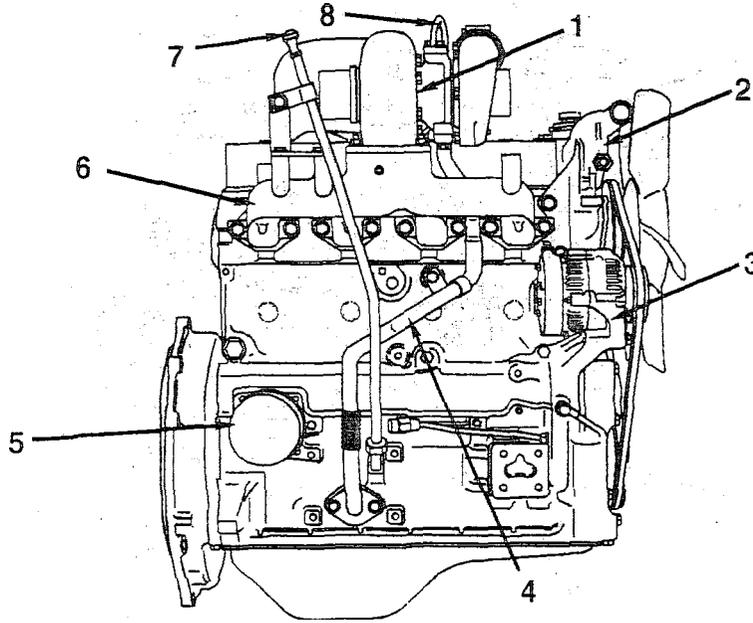
00900141

**Rear View  
(Naturally Aspirated)**



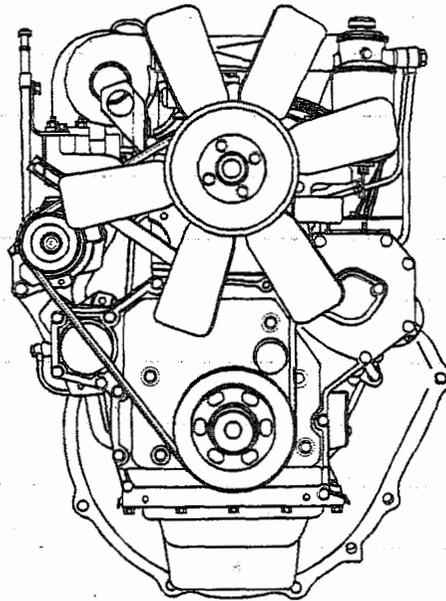
Left Side  
(Turbocharged)

- |                        |                        |
|------------------------|------------------------|
| 1. Intake Manifold     | 5. Cooling Fan         |
| 2. Starting Motor      | 6. Fuel Filter         |
| 3. Fuel Injection Pump | 7. Oil Fill Cap        |
| 4. Crankshaft Pulley   | 8. Air Crossover Tube. |



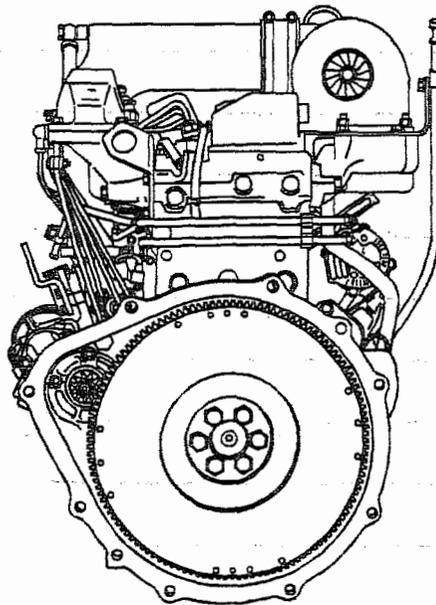
Right Side  
(Turbocharged)

- |                                |                                  |
|--------------------------------|----------------------------------|
| 1. Turbocharger                | 5. Oil Filter                    |
| 2. Thermostat Housing          | 6. Exhaust Manifold              |
| 3. Alternator                  | 7. Dipstick                      |
| 4. Turbocharger Oil Drain Tube | 8. Turbocharger Oil Supply Tube. |



00900144

**Front View  
(Turbocharged)**



00900145

**Rear View  
(Turbocharged)**

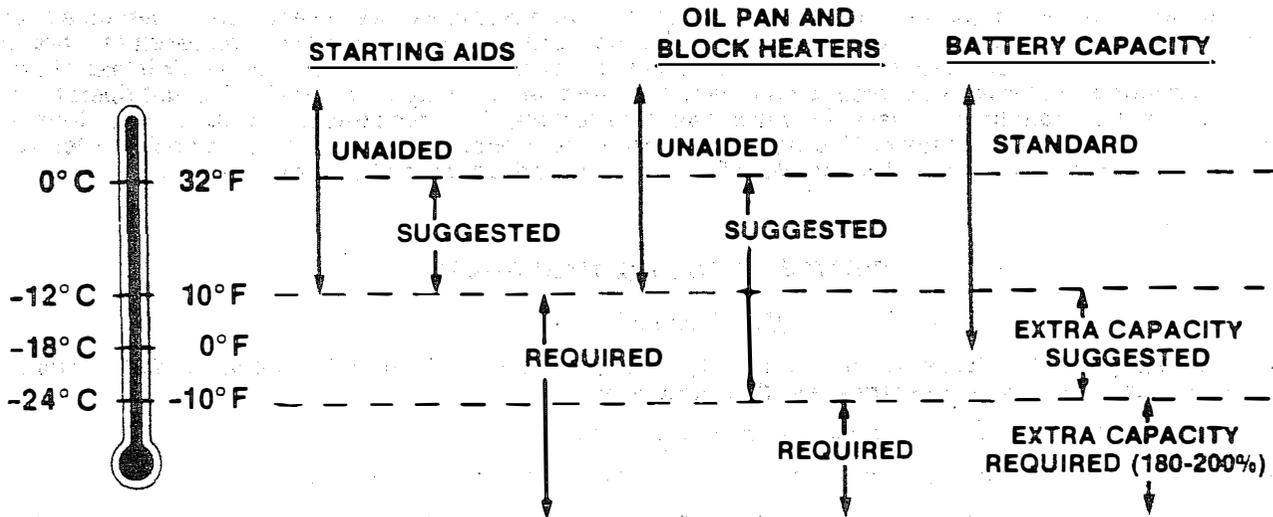
## Cold Weather Operation

### Starting Aid Requirements

Use the following chart as a reference for required cold weather starting aids:

Operation in ambient temperatures below 0°C [32°F] can require special consideration be given to engine starting.

At temperatures below 0°C [32°F], operate the engine at **moderate** speeds for 5 minutes before full loads are applied.



## Cold Weather Starting

### Using Starting Fluid With Mechanical or Electrical Metering Equipment

- Disengage the driven unit, or if equipped, put the transmission in neutral.
- Activate the switch to open the fuel pump shutoff valve.
- While cranking the engine, inject metered amounts of starting fluid.
- Engine oil pressure **must** be indicated on the gauge within 30 seconds after starting.

### Using Starting Fluid Without Metering Equipment

#### ▲ WARNING ▲

Never use starting fluid near an open flame or with a preheater or flame thrower equipment. This combination can cause an explosion.

#### ▲ WARNING ▲

Do not breathe starting fluid fumes. Starting fluid fumes can be harmful to your health.

#### ▲ CAUTION ▲

Do not use excessive amounts of starting fluid when starting an engine. Using too much starting fluid will cause engine damage.

- Spray starting fluid into the air cleaner intake while another person cranks the engine.

#### ▲ WARNING ▲

Do not use volatile cold starting aids in underground mine or tunnel operations because of the potential for an explosion. Check with the local U.S. Bureau of Mines inspector for instructions.

## Starting Procedure - After Extended Shutdown or Oil Change

Complete the following steps after each oil change, or after the engine has been shut off for more than 30 days to make sure the engine receives the correct oil flow through the lubricating oil system:

- Disconnect the electrical wire from the fuel pump solenoid valve.
- Rotate the crankshaft, using the starting motor, until oil pressure appears on the gauge, or the warning light goes out.
- Connect the electrical wire to the fuel pump solenoid valve.
- Start the engine; refer to Normal Starting Procedures in this section.
- Refer to Fuel Supply Lines - Vent, Section 5, for instructions on how to vent the fuel system.

## Operating the Engine

- Do **not** operate the engine at full throttle below peak torque engine speed (1100 to 1600 rpm, depending on engine rating) for extended periods (more than 1 minute) of time.
- Allow the engine to idle 3 to 5 minutes before shutting it off after a full-load operation.
- Monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil System Specifications or Cooling System Specifications, Section V, for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature does **not** meet the specifications.

### CAUTION

**Continuous operation with low coolant temperature (below 60°C [140°F]) or high coolant temperature (above 100°C [212°F]) can damage the engine.**

- If overheating starts to occur, reduce the power output of the engine by releasing the throttle pressure or shifting the transmission to a lower gear, or both, until the temperature returns to normal operating range. If the engine temperature does **not** return to normal, shut off the engine, and refer to Troubleshooting Symptoms, Section TS, or contact a Cummins Authorized Repair Location.
- Most failures give an early warning. Look and listen for changes in performance, sound, or engine appearance that can indicate service or engine repair is needed. Some changes to look for are as follows:

- |  |                                    |
|--|------------------------------------|
| — Engine misfires  | — Excessive smoke                  |
| — Vibration  | — Loss of power                    |
| — Unusual engine noises  | — An increase in oil consumption   |
| — Fuel, oil, or coolant leaks                                    | — An increase in fuel consumption. |
| — Sudden changes in engine operating temperature or oil pressure |                                    |

## Engine Operating Range

### ⚠ CAUTION ⚠

Cummins engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed (rpm). This is consistent with recommended driving practices for good fuel economy. Excessive full-throttle operation below peak torque rpm (peak torque rpm varies from 1100 rpm to 1600 rpm, depending upon rated engine speed) will shorten engine life to overhaul, can cause serious engine damage, and is considered engine abuse.

### ⚠ CAUTION ⚠

Operation of the engine below peak torque rpm can occur during gear shifting because of the difference in ratios between any two transmission gears, but engine operation must not be sustained more than 1 minute at full throttle below peak torque rpm.

### ⚠ CAUTION ⚠

Operating the engine beyond high-idle speed can cause severe engine damage. When descending a steep grade, use a combination of transmission gears and engine or service brakes to control the vehicle and engine speed.

## Engine Shutdown

- Allow the engine to idle 3 to 5 minutes after a full-load operation before shutting it off. This allows the engine to cool gradually and uniformly.
- Turn the ignition keyswitch to the OFF position.

# Section 2 - Maintenance Guidelines

## Section Contents

	Page
General Information .....	2-1
Maintenance Record Form .....	2-3
Maintenance Schedule .....	2-1
Page References for Maintenance Instructions .....	2-2

Approved by: [Signature]

## General Information

Cummins Engine Company, Inc. recommends that the engine be maintained according to the Maintenance Schedule in this section.

If the engine is operating in ambient temperatures consistently below -18°C [0°F] or above 38°C [100°F], perform maintenance at shorter intervals. Shorter maintenance intervals are also required if the engine is operated in a dusty environment or if frequent stops are made. See a Cummins Authorized Repair Location for recommended intervals.

Use the chart provided at the end of this section to record maintenance.

If the engine is equipped with a component or an accessory **not** manufactured by Cummins Engine Company, Inc., refer to the component manufacturer's maintenance recommendations.

## Maintenance Schedule

Daily or Refueling	Every 250 Hours or 3 Months	Every 500 Hours or 6 Months	Every 1000 Hours or 1 Year	Every 2000 Hours or 2 Years
<ul style="list-style-type: none"> <li>● Fuel-Water Separator - Drain</li> </ul>	<ul style="list-style-type: none"> <li>● Lubricating Oil - Change/Replace<sup>(1)</sup></li> </ul>	<ul style="list-style-type: none"> <li>● Fuel Filter - Change</li> </ul>	<ul style="list-style-type: none"> <li>● Drive Belt Tension - Measure</li> </ul>	<ul style="list-style-type: none"> <li>● Cooling System - Flush</li> </ul>
<ul style="list-style-type: none"> <li>● Engine Oil Level - Check</li> </ul>	<ul style="list-style-type: none"> <li>● Lubricating Filter - Change/Replace</li> </ul>	<ul style="list-style-type: none"> <li>● Fuel Supply Lines - Vent</li> </ul>	<ul style="list-style-type: none"> <li>● Drive Belt - Check</li> </ul>	<ul style="list-style-type: none"> <li>● Valve Lash Clearance - Adjust<sup>(2)</sup></li> </ul>
<ul style="list-style-type: none"> <li>● Coolant Level - Check</li> </ul>	<ul style="list-style-type: none"> <li>● Valve Lash Clearance - Adjust<sup>(2)</sup></li> </ul>	<ul style="list-style-type: none"> <li>● Injection Pump - Vent</li> </ul>		
<ul style="list-style-type: none"> <li>● Drive Belt - Inspect</li> </ul>	<ul style="list-style-type: none"> <li>● Air Intake System - Inspect</li> </ul>	<ul style="list-style-type: none"> <li>● Cooling System - Check<sup>(3)</sup></li> </ul>		
<ul style="list-style-type: none"> <li>● Cooling Fan - Inspect</li> </ul>	<ul style="list-style-type: none"> <li>● Air Cleaner Restriction - Check</li> </ul>			

1. Oil change interval for naturally aspirated engine is every 500 hours or 6 months.
2. Initial valve lash clearance adjustment; subsequent adjustments must be performed at 2000-hour or 2-year intervals, whichever comes first.
3. Must use a heavy-duty year-around antifreeze that meets the chemical composition of GM6038M. The change interval is 2000 hours or 2 years, whichever comes first.

## Page References for Maintenance Instructions

For your convenience, listed below are the page numbers which contain specific instructions for performing the maintenance checks listed in the maintenance schedule.

### Daily or Refueling

- Drive Belt - Inspect ..... 3-3
- Coolant Level - Check ..... 3-2
- Engine Oil Level - Check ..... 3-2
- Cooling Fan - Inspect ..... 3-3
- Fuel-Water Separator (If Equipped) - Drain ..... 3-2

### Every 250 Hours or 3 Months

- Air Intake System - Inspect ..... 4-7
- Air Cleaner Restriction - Check ..... 4-7
- Lubricating Oil - Change ..... 4-2
- Lubricating Oil Filters - Change ..... 4-2
- Valve Lash Clearance - Adjust (first time **only**, thereafter every 2000 hours or 2 years) ..... 4-5

### Every 500 Hours or 6 Months

- Cooling System - Check ..... 5-4
- Injection Pump - Vent ..... 5-4
- Fuel Filter - Change ..... 5-2
- Fuel Supply Lines - Vent ..... 5-2

### Every 1000 Hours or 12 Months

- Drive Belt - Check ..... 6-2
- Drive Belt Tension - Measure ..... 6-2

### Every 2000 Hours or 2 Years

- Cooling System - Flush ..... 7-2
- Valve Lash Clearance - Adjust ..... 7-5

## Section 3 - Maintenance Procedures at Daily Interval

### Section Contents

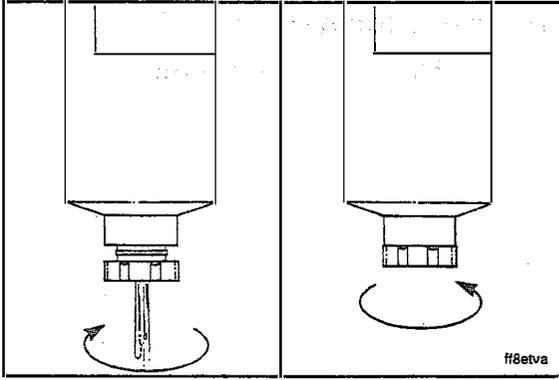
	Page
Coolant Level .....	3-2
Check .....	3-2
Cooling Fan .....	3-3
Inspect .....	3-3
Daily Maintenance Procedures - General Information .....	3-1
Drive Belt .....	3-3
Inspect .....	3-3
Engine Oil Level .....	3-2
Check .....	3-2
Fuel-Water Separator (If Equipped) .....	3-2
Drain .....	3-2

## Daily Maintenance Procedures - General Information

Preventative maintenance begins with day-to-day awareness of the condition of the engine and its systems.

Before starting the engine, check the oil and coolant levels. Look for:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine appearance.



### Fuel-Water Separator (If Equipped)

#### Drain



Drain the water and sediment from the separator daily.



Shut off the engine. Use your hand to open the drain valve. Turn the valve **counterclockwise** 4 complete turns until the valve drops down 1". Drain the filter sump of water until clear fuel is visible.

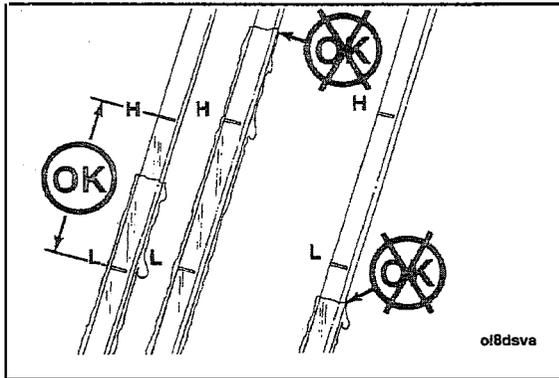


**CAUTION**

Do not overtighten the valve. Overtightening can damage the threads.

Push the valve up and turn the valve **clockwise** to close the drain valve.

**NOTE:** If more than 2 oz. is drained, refilling of the filter is required to prevent hard starting. Refer to Low Pressure Lines and Fuel Filter(s) Venting in Section 5.



### Engine Oil Level

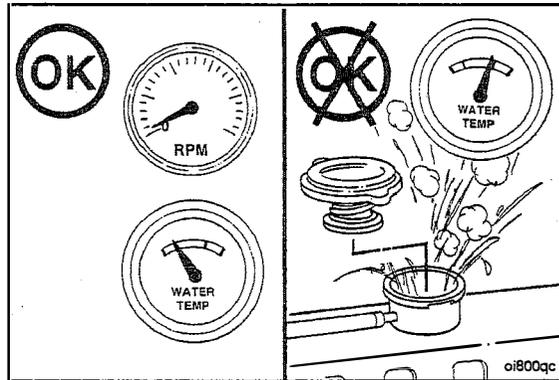
#### Check

Never operate the engine with the oil level below the L (Low) mark or above the H (High) mark. Wait at least 15 minutes after shutting off the engine to check the oil. This allows time for the oil to drain to the oil pan.

**NOTE:** The vehicle **must** be level when checking the oil level to make sure the measurement is correct.

Low Mark To High Mark

Oil Capacity 1.5 liters [1.6 U.S.qt]



### Coolant Level

#### Check



**WARNING**

Do not remove the radiator cap from a hot engine. Wait until the temperature is below 50°C [120°F] before removing the pressure cap. Failure to do so can result in personal injury from heated coolant spray or steam. Remove the filler cap slowly to relieve coolant system pressure.

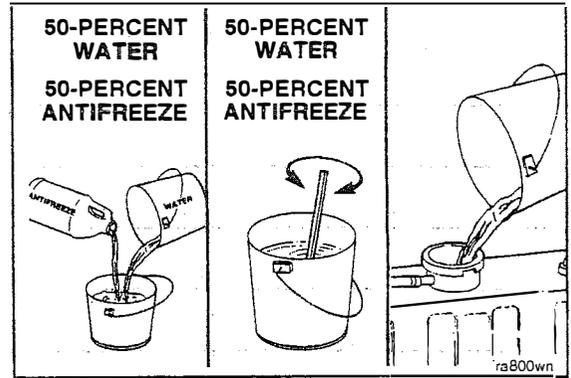
**NOTE:** Never use a sealing additive to stop leaks in the coolant system. This can result in coolant system plugging and inadequate coolant flow causing the engine to overheat.

The coolant level **must** be checked daily.

**CAUTION**

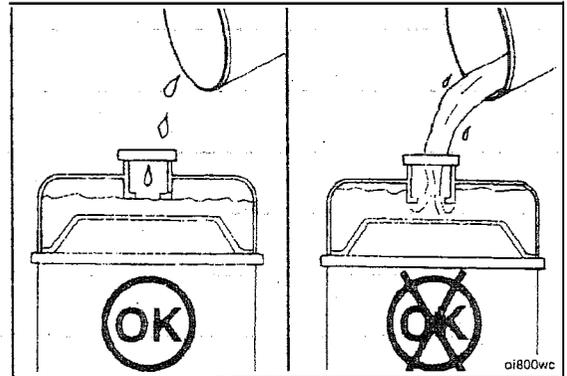
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [120°F] before adding coolant.

**NOTE:** On applications that use a coolant recovery system, check to make sure the coolant is at the appropriate level on the coolant recovery tank depending on engine temperature.



Fill the cooling system with coolant to the bottom of the fill neck in the radiator fill or expansion tank.

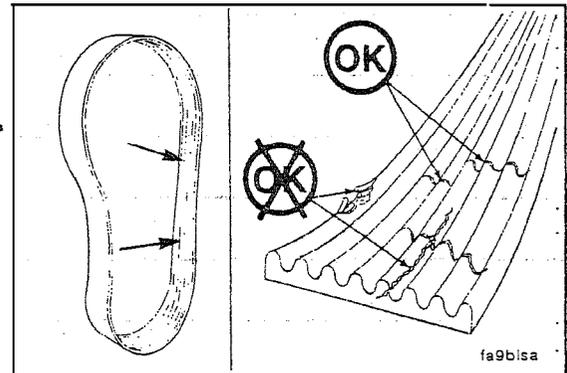
**NOTE:** Some radiators have two fill necks, both of which must be filled when the cooling system is drained.



## Drive Belt

### Inspect

Visually inspect the belt. Check the belt for intersecting cracks. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are **not** acceptable. Replace the belt if it is frayed or has pieces of material missing.



## Cooling Fan

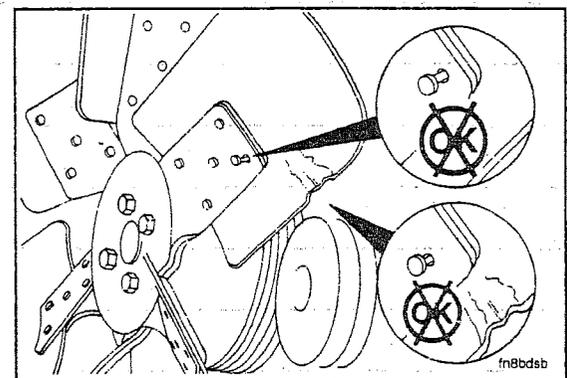
### Inspect

**WARNING**

Personal injury can result from a fan blade failure. Never pull or pry on the fan. This can damage the fan blade(s) and cause fan failure.

**NOTE:** Rotate the crankshaft by using the engine barring gear.

A visual inspection of the cooling fan is required daily. Check for cracks, loose rivets, and bent or loose blades. Check the fan to make sure it is securely mounted. Tighten the capscrews if necessary. Replace any fan that is damaged.



# Maintenance Procedures at 250 Hours or 3 Months

## Section Contents

	Page
<b>Air Cleaner Restriction</b> .....	4-7
Check .....	4-7
<b>Air Intake System</b> .....	4-7
Inspect .....	4-7
<b>Lubricating Oil and Filter</b> .....	4-2
Drain .....	4-2
Install .....	4-3
Remove .....	4-3
<b>Lubricating Oil and Filter Change Interval</b> .....	4-1
<b>Maintenance Procedures - General Information</b> .....	4-1
<b>Valve Lash Clearance</b> .....	4-5
Adjust .....	4-5

## **Maintenance Procedures - General Information**

All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Initial valve lash adjustment is to be performed at 250 hours or 3 months. Subsequent adjustments are to be performed every 2000 hours or 2 years, whichever comes first.

### **Lubricating Oil and Filter Change Interval**

The oil change interval for turbocharged engines is every 3 months or 250 hours.

The oil change interval for naturally aspirated engines is every 6 months or 500 hours.

## Lubricating Oil and Filter

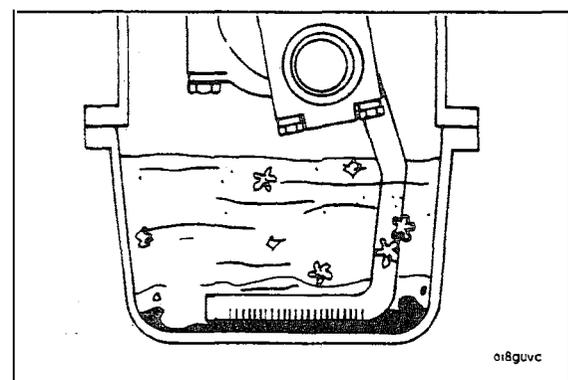
### Drain

#### ⚠ CAUTION ⚠

Avoid prolonged and repeated skin contact with used engine oils. Such prolonged and repeated contact can cause skin disorders or other bodily injury.

- Avoid excessive contact - wash thoroughly after contact.
- Keep out of reach of children.

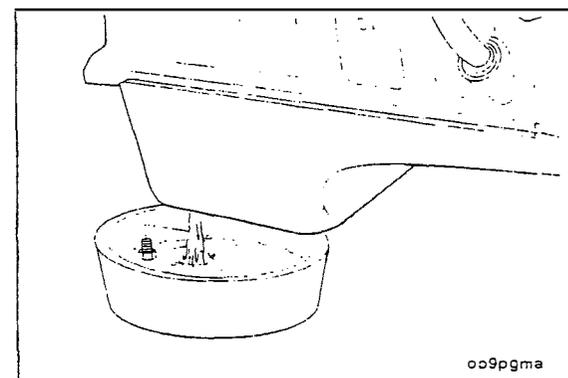
**PROTECT THE ENVIRONMENT:** Handling and disposal of used engine oil is subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for receipt of used oil. If in doubt, contact state and local environmental authorities or the Environmental Protection Agency for guidance as to proper handling and disposal of used engine oil.



**NOTE:** If the engine is in service, the oil drain interval of 250 hours or 3 months **must** be observed.

Change the oil and filters to remove the contaminants suspended in the oil.

**NOTE:** Drain the oil **only** when it is hot and the contaminants are in suspension.



#### ⚠ CAUTION ⚠

Hot oil can cause personal injury.

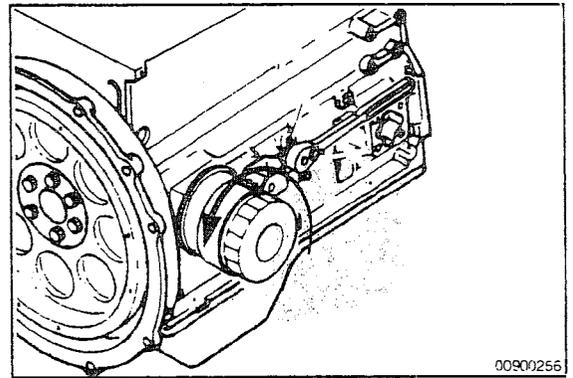
Operate the engine until the water temperature reaches 60°C [140°F]. Shut the engine off. Remove the oil drain plug.

**NOTE:** Use a container that can hold at least 20 liters [15 qt] of oil.

**Remove**

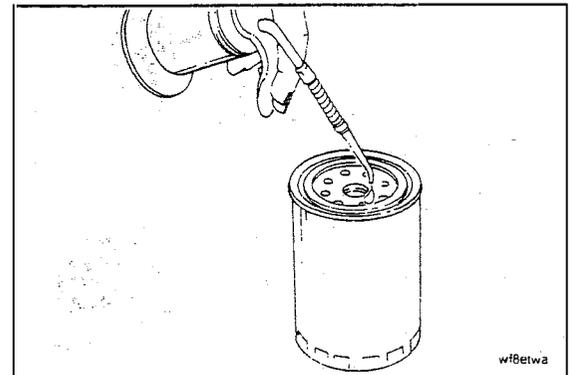
Clean the area around the lubricating oil filter head. Remove the filter. Clean the gasket surface of the filter head.

**NOTE:** The o-ring can stick on the filter head. Make sure it is removed before installing the new filter.



**Install**

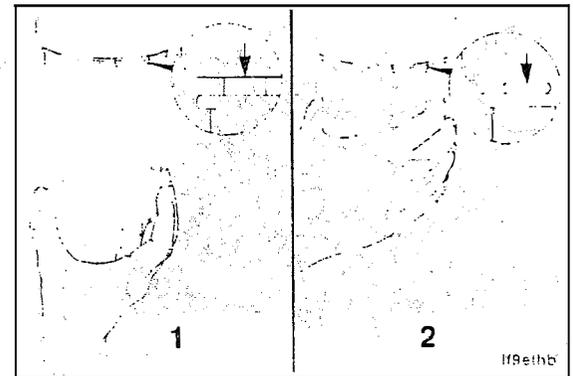
Apply a light film of lubricating oil to the gasket sealing surface before installing the filters.



**CAUTION**

**Mechanical overtightening can distort the threads or damage the filter element seal.**

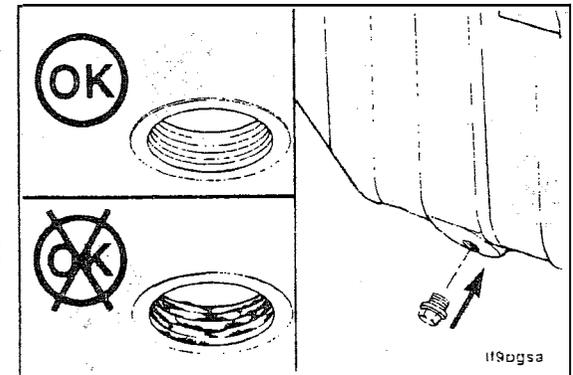
Install the filter as specified by the filter manufacturer.



Check and clean the oil drain plug threads and sealing surface.

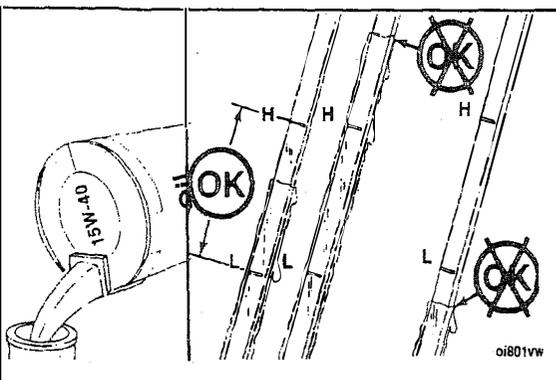
Install the oil drain plug.

**Torque Value:** 50 N•m [37 ft-lb]





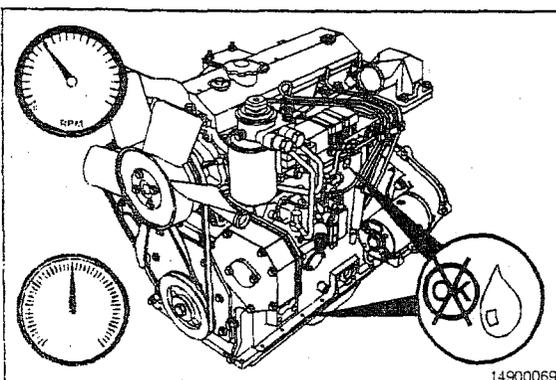
**NOTE:** Use a high-quality 15W-40 multiviscosity lubricating oil, such as Cummins Premium Blue™, or its equivalent, in Cummins engines. Choose the correct lubricating oil for your operating climate as outlined in section V.



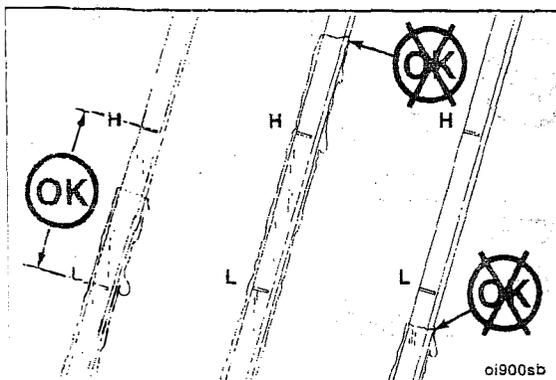
Fill the engine with clean oil to the proper level.

	<b>B3.3</b>	<b>BT3.3</b>
Pan Capacity	7.0 liters [8.0 qt]	7.0 liters [8.0 qt]
Total System Capacity	7.5 liters [8.0 qt]	8.0 liters [8.5 qt]

**NOTE:** Capacities assume standard pan. Total system assumes standard pan plus filter.



Operate the engine at idle to inspect for leaks at the filters and the drain plug.



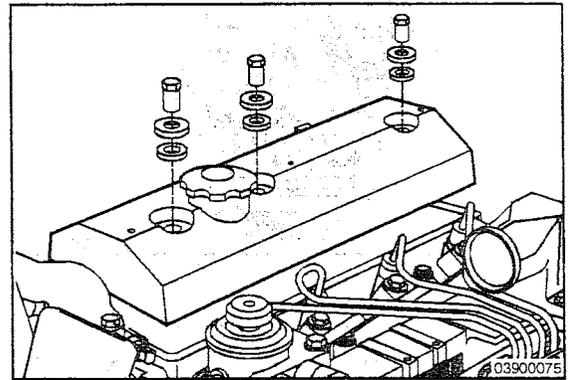
Stop the engine. Wait approximately 15 minutes to let the oil drain from the upper parts of the engine. Check the oil level again.

Add oil as necessary to bring the oil level to the H (high) mark on the dipstick.

## Valve Lash Clearance

### Adjust

Remove the cylinder head cover.



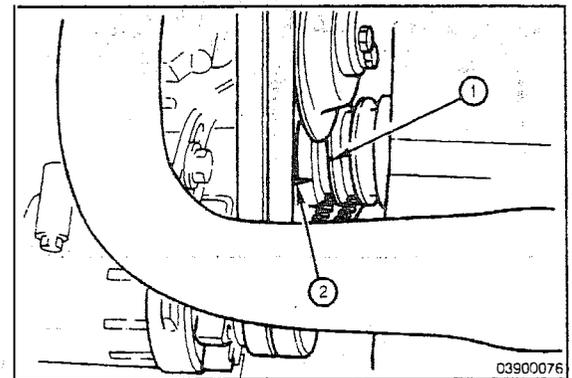
### ▲ WARNING ▲

**Do not use the fan to rotate the engine.**

Rotate the crankshaft in the normal direction using the crankshaft pulley mounting capscrews or the alternator pulley mounting nut.

While watching the movement of the intake valve of the No. 4 cylinder, bring the No.1 cylinder into compression top dead center position.

Align the TOP engraved mark on the crankshaft pulley (1) with pointer (2).



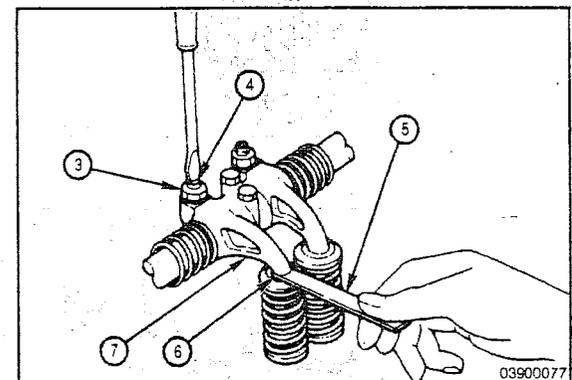
### NOTE:

- The engraved mark on the crankshaft pulley will read "1.4 TOP."
- The No. 4 intake valve will start to open when the No. 1 cylinder comes near compression top dead center.

Loosen the locknut (3) on the adjustment screw (4).

Insert the feeler gauge (5) between the valve stem (6) and the rocker arm (7).

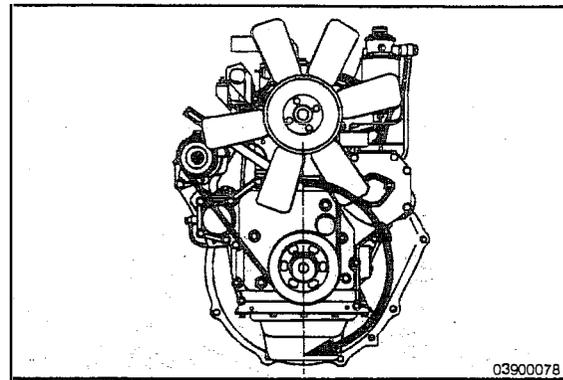
Adjust the clearance with the adjustment screw until slight drag is felt on the feeler gauge.



Valve Clearance (Engine Hot or Cold)	
Intake Valve	Exhaust Valve
0.35 mm	0.50 mm
0.014 in	0.020 in

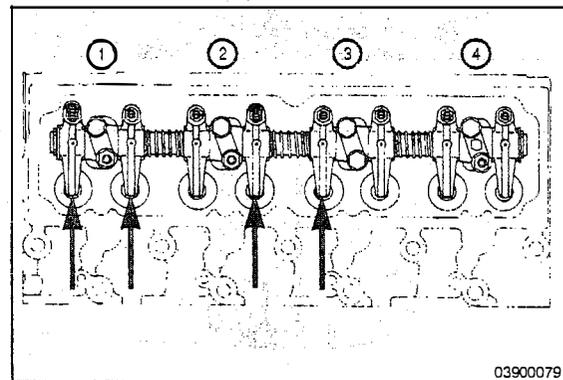


**NOTE:** Adjust intake and exhaust clearances in the following firing order by rotating the crankshaft 180 degrees in the normal direction: 1-2-4-3.



Adjust the valve clearances for **intake** valves No. 1 and No. 3.

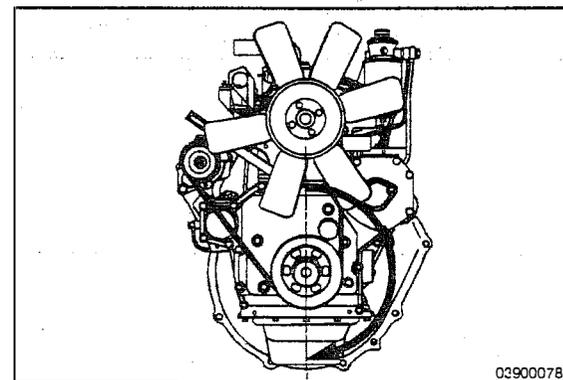
Adjust the valve clearances for **exhaust** valves No. 1 and No. 2.



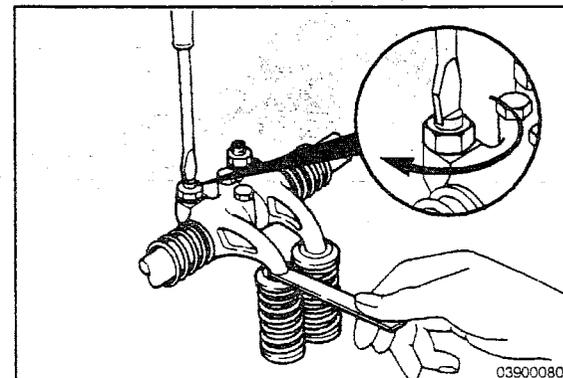
Rotate the crankshaft in the normal direction one revolution.

Adjust the valve clearances for **intake** valves No. 2 and No. 4.

Adjust the valve clearances for **exhaust** valves No. 3 and No. 4.



Tighten the locknut to secure the adjustment screw.



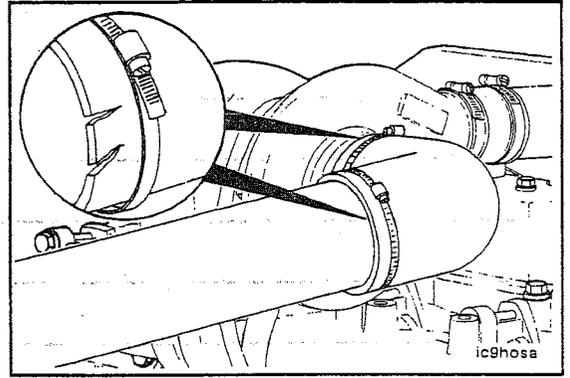
Locknut Torque Value		
N•m		ft-lb
39	MIN	29
49	MAX	36

## Air Intake System

### Inspect

Inspect the intake piping for cracked hoses, loose clamps, or punctures that can allow dirt and debris to enter the engine.

Tighten or replace parts as necessary to make sure the air intake system does **not** leak.

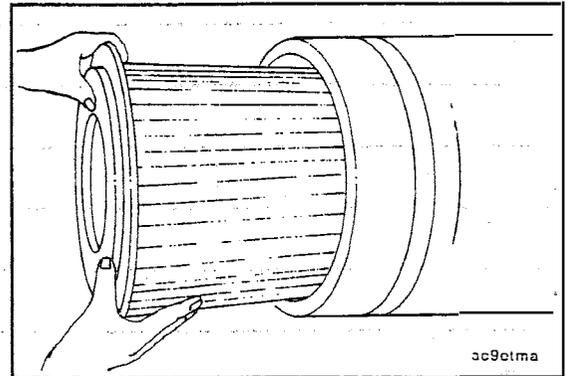


## Air Cleaner Restriction

### Check

Maximum intake air restriction is 762 mm H<sub>2</sub>O [30 in H<sub>2</sub>O] for turbocharged and naturally aspirated engines.

Turbocharged engines **must** be operated at rated rpm and full load to check maximum intake air restriction. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations.

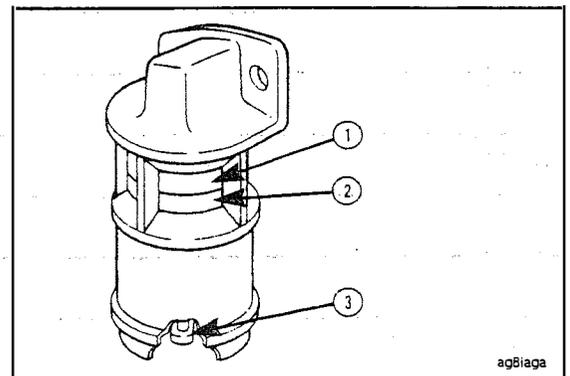


**NOTE:** Follow the manufacturer's instructions when cleaning or replacing the air cleaner element.

Check the air cleaner service indicator, if equipped. Change the filter element when the red indicator flag (2) is at the raised position in the window (1).

After the air cleaner has been serviced, push the button (3) to reset the service indicator.

**NOTE:** **Never** operate the engine without an air cleaner. Intake air **must** be filtered to prevent dirt and debris from entering the engine and causing premature wear.



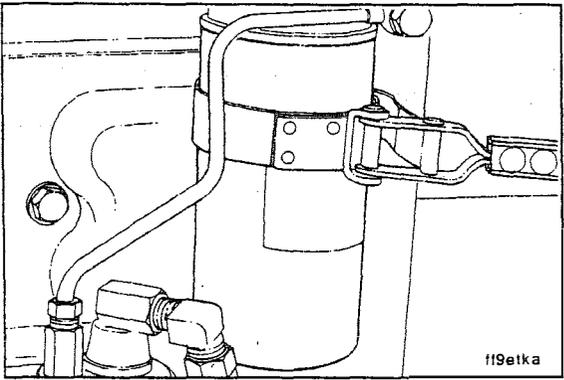
# Maintenance Procedures at 500 Hours or 6 Months

## Section Contents

	Page
<b>Cooling System</b> .....	5-4
Check .....	5-4
<b>Fuel Filter</b> .....	5-2
Install .....	5-2
Remove .....	5-2
<b>Fuel Supply Lines</b> .....	5-2
Vent .....	5-2
General Information .....	5-2
High Pressure Fuel Line(s) .....	5-3
Low Pressure Fuel Line(s) .....	5-3
<b>General Information</b> .....	5-1
<b>Injection Pump</b> .....	5-4
Vent .....	5-4

## General Information

All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval, except for valve lash adjustment.



### Fuel Filter

#### Remove

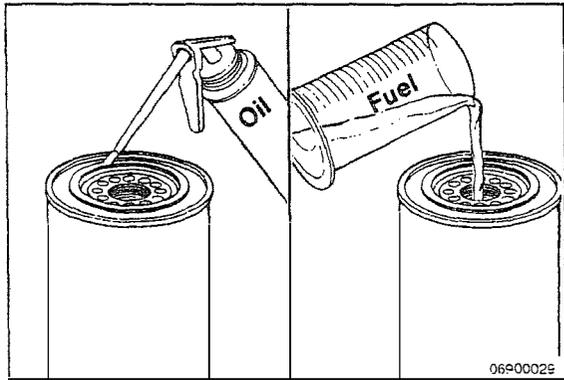


**NOTE:** Close any OEM fuel valves (if equipped) to prevent fuel from draining or siphoning.

Clean the area around the fuel filter head. Remove the filters. Clean the gasket surface of the filter head.



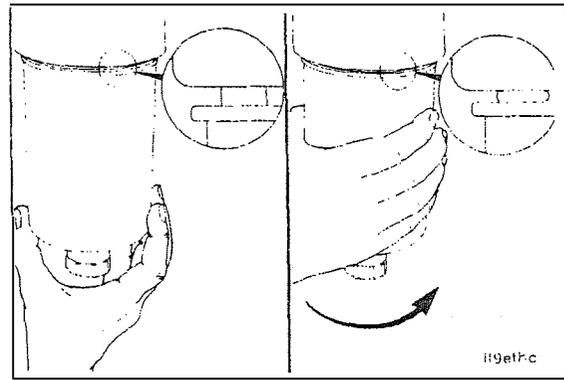
Replace the o-ring.



#### Install

Fill the new filter(s) with clean fuel, and lubricate the o-ring seal with clean lubricating oil.

- Fuel-water separator - used in single-filter applications.



### CAUTION

Mechanical overtightening will distort the threads, filter element seal or filter can.

Install the filter as specified by the filter manufacturer.

## Fuel Supply Lines

### Vent

#### General Information

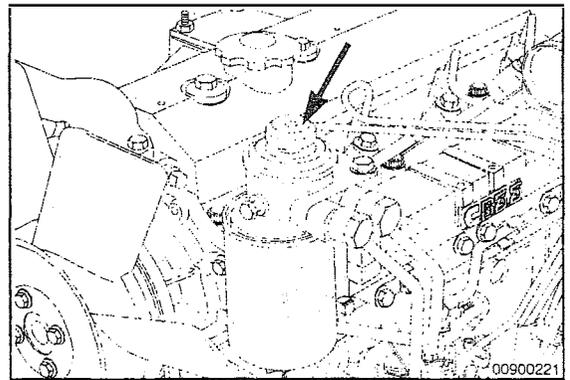
Controlled venting is provided at the injection pump through the fuel drain manifold. Small amounts of air introduced by changing the filters or injection pump supply line will be vented automatically if the fuel filter is changed in accordance with the instructions. **No** manual bleeding of fuel lines is required.

**NOTE:** Manual bleeding is required if:

- The fuel filter is **not** filled prior to installation.
- The injection pump is replaced.
- High-pressure fuel line connections are loosened or lines replaced.
- Engine is initially started or started after an extended period of no engine operation.
- Vehicle fuel tank has run empty.

### Low Pressure Fuel Line(s)

The low pressure fuel lines are bled by pumping the hand lever on the filter head.

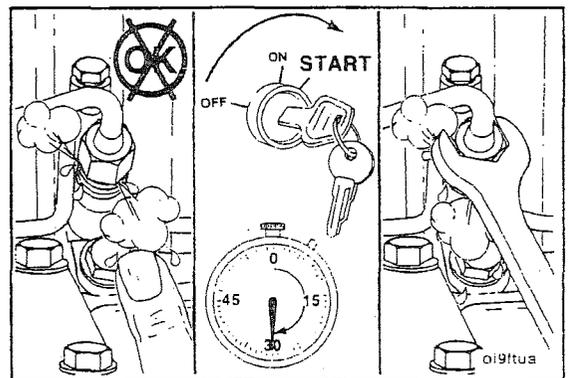


### High Pressure Fuel Line(s)

**▲ WARNING ▲**

The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious bodily harm.

Venting is accomplished by loosening one or more fittings at the injectors and cranking the engine to allow entrapped air to bleed from the lines.



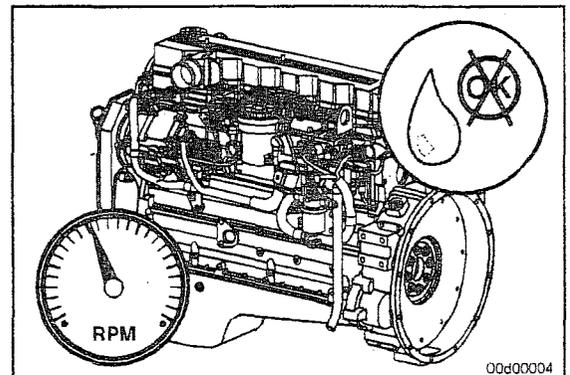
### Retighten Line Fittings

**▲ WARNING ▲**

Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

Tighten the line fittings and check for leaks.

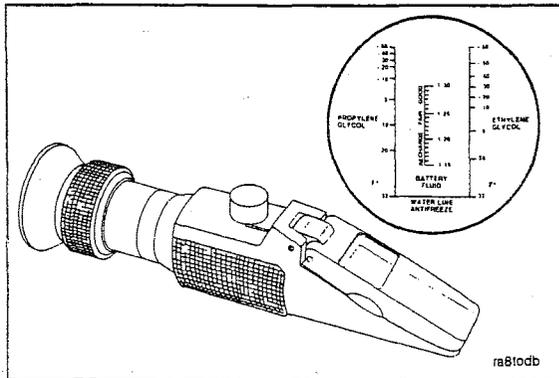
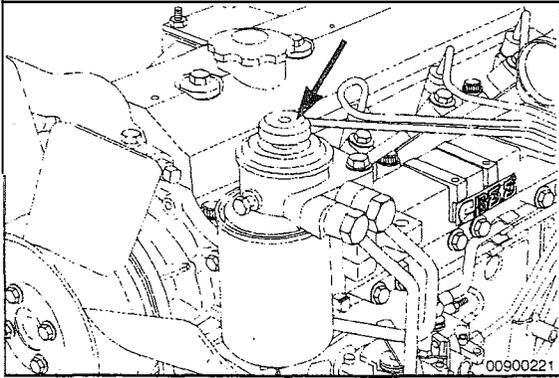
**Torque Value:** 22 N•m [16 ft-lb]



## Injection Pump

### Vent

Air/fuel can be pumped from this location with the hand lever on the filter head.



## Cooling System

### Check

Check the antifreeze concentration. Use a mixture of 50-percent water and 50-percent ethyleneglycol-base anti-freeze to protect the engine to  $-37^{\circ}\text{C}$  [ $-34^{\circ}\text{F}$ ] year-around.

---

**Antifreeze is essential in any climate.**

---

It broadens the operating temperature range by lowering the coolant freezing point and raising its boiling point.

The corrosion inhibitors also protect the cooling system components from corrosion and provide longer component life.

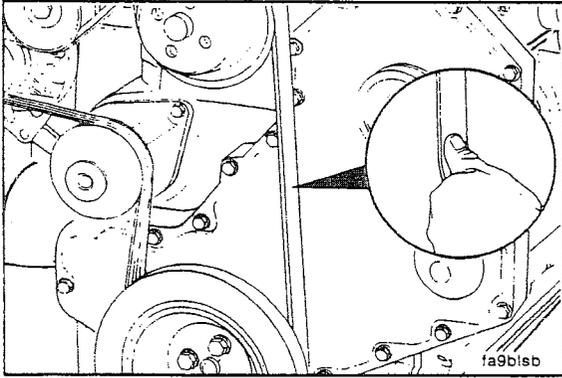
# Maintenance Procedures at 1000 Hours or 1 Year

## Section Contents

	Page
Drive Belt .....	6-2
Check .....	6-2
Drive Belt Tension .....	6-2
Measure .....	6-2
General Information .....	6-1

## General Information

All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval, except for valve lash adjustment.



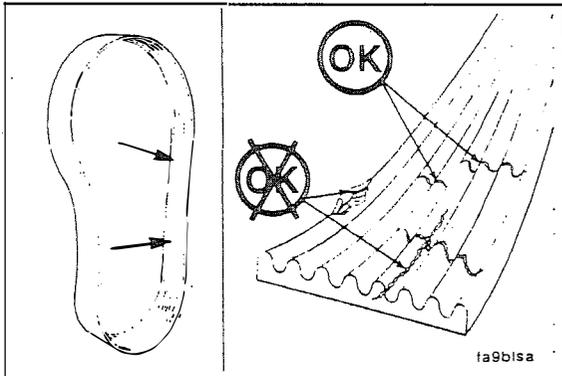
## Drive Belt Tension

### Measure

Measure the belt deflection at the longest span of the belt.

**Maximum Deflection with 6kg [13.2 lb] of Force:**

10.00 mm [0.39 in]



## Drive Belt

### Check



Visually inspect the belt. Check the belt for intersecting cracks. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are **not** acceptable. Replace the belt if it is frayed or has pieces of material missing.

Belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the belts.

# Maintenance Procedures at 2000 Hours or 2 Years

## Section Contents

	Page
<b>Cooling System</b> .....	7-2
Drain .....	7-2
Fill .....	7-4
Flush .....	7-3
<b>General Information</b> .....	7-1
<b>Valve Lash Clearance</b> .....	7-5
Adjust .....	7-5

## **General Information**

All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

## Cooling System

### Drain

#### ⚠ CAUTION ⚠

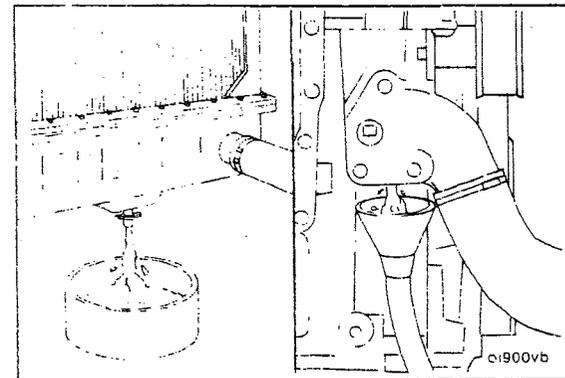
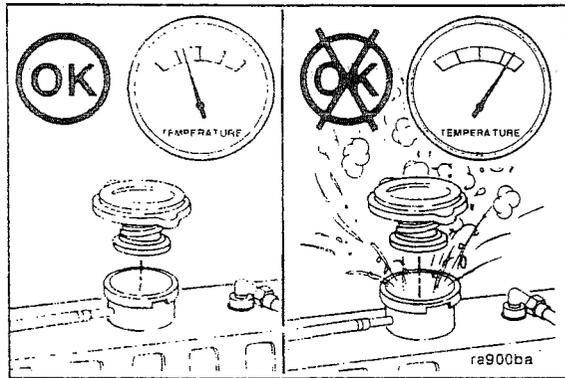
Avoid prolonged and repeated skin contact with used antifreeze. Such prolonged, repeated contact can cause skin disorders or other bodily injury.

- Avoid excessive contact - wash thoroughly after contact.
- Keep out of reach of children.

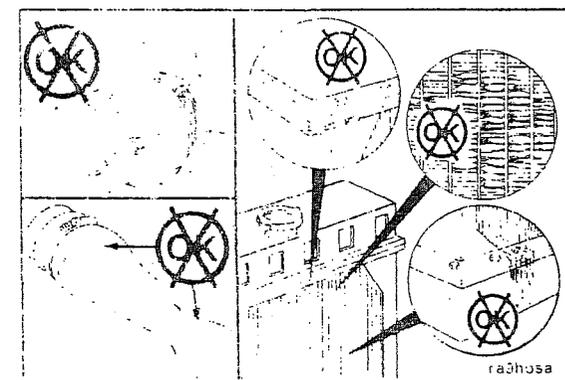
Protect the environment: Handling and disposing of used antifreeze can be subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for the receipt of used antifreeze. If in doubt, contact local authorities or the EPA for guidance as to proper handling of used antifreeze.

#### ⚠ CAUTION ⚠

Wait until the temperature is below 50°C [120°F] before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.



Drain the cooling system by opening the drain valve on the radiator and removing the plug in the bottom of the water inlet. A drain pan with a capacity of 20 liters [5 gal] will be adequate in most applications.



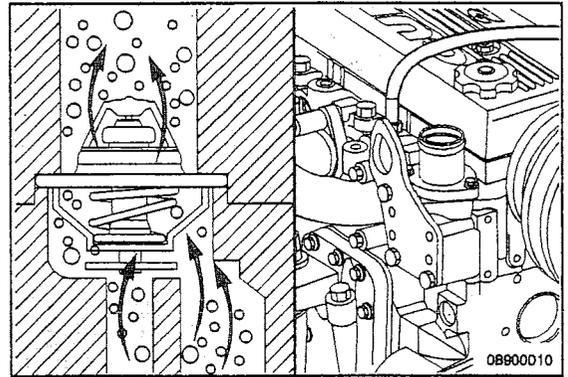
Check for damaged hoses and loose or damaged hose clamps. Replace as required. Check the radiator for leaks, damage, and buildup of dirt. Clean and repair as required.

## Flush



During filling, air must be vented from the engine coolant passages. The air vents through the "jiggle pin" openings to the top radiator hose and out the fill opening. Additional venting is provided for engines equipped with an aftercooler. Open the petcock during filling.

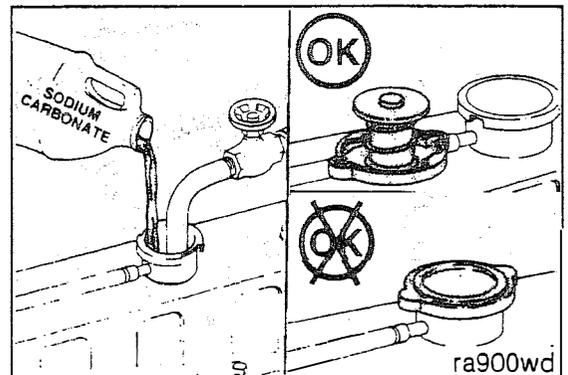
**NOTE:** Adequate venting is provided for a fill rate of 10 liters/minute [2.6 gal/min].



**NOTE:** Do **not** install the radiator cap. The engine is to be operated without the cap for this process.

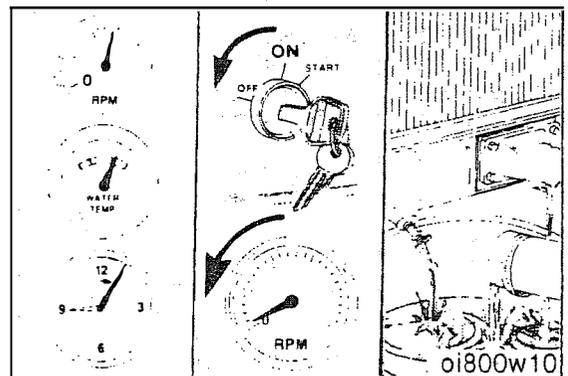
Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

**NOTE:** Use 0.5 kg [1.0 lb] of sodium carbonate for every 23 liters [6 gal] of water.



Operate the engine for 5 minutes with the coolant temperature above 82°C [180°F].

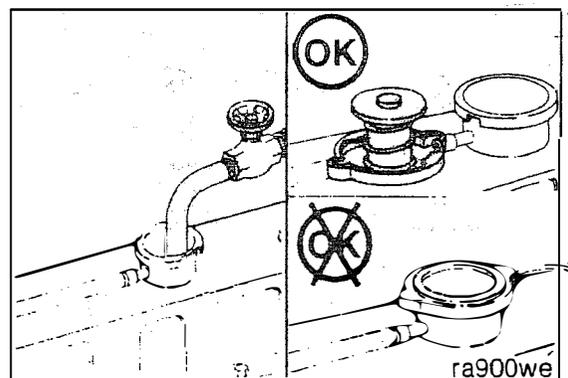
Shut the engine off, and drain the cooling system.

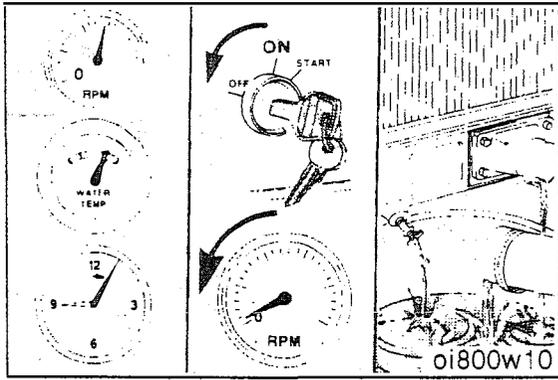


Fill the cooling system with clean water.

**NOTE:** Be sure to vent the engine and aftercooler for complete filling.

**NOTE:** Do **not** install the radiator cap or the new coolant filter.

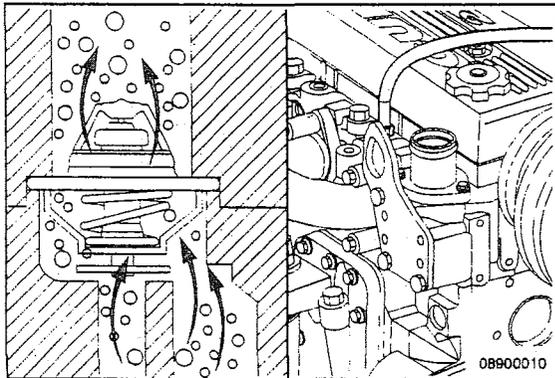




Operate the engine for 5 minutes with the coolant temperature above 82°C [180°F].

Shut the engine off, and drain the cooling system.

**NOTE:** If the water being drained is still dirty, the system must be flushed again until the water is clean.

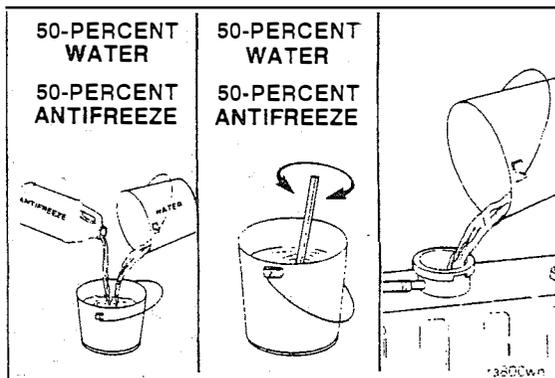


### Fill



The system must be filled properly to prevent air locks. During filling, air must be vented from the engine coolant passages.

The system has a design fill rate of 10 liters/minute [2.8 gal/min].

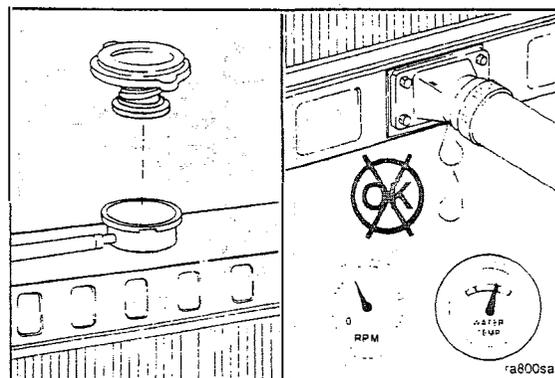


Never use water alone for coolant. Damage from corrosion can be the result of using water alone for coolant.

Use a mixture of 50-percent water and 50-percent ethylene glycol antifreeze to fill the cooling system.

**Coolant Capacity (Engine Only):**

4.50 liters [1.19 U.S.gal]



Before removing the pressure cap, wait until the coolant temperature is below 50°C [120°F]. Failure to do so can cause personal injury from heated coolant spray.

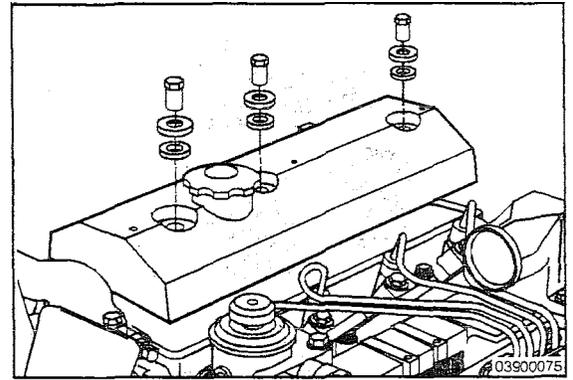
Install the pressure cap. Operate the engine until it reaches a temperature of 82°C [180°F], and check for coolant leaks.

Check the coolant level again to make sure the system is full of coolant, or that the coolant level has risen to the hot level in the recovery bottle on the system, if so equipped.

## Valve Lash Clearance

### Adjust

Remove the cylinder head cover.



### ▲ WARNING ▲

**Do not use the fan to rotate the engine.**

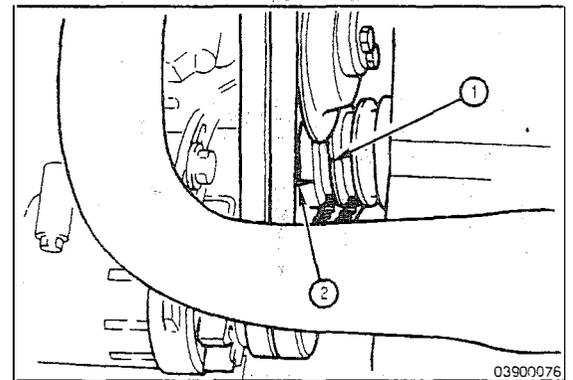
Rotate the crankshaft in the normal direction using the crankshaft pulley mounting capscrews or the alternator pulley mounting nut.

While watching the movement of the intake valve of the No. 4 cylinder, bring the No.1 cylinder into compression top dead center position.

Align the TOP engraved mark on the crankshaft pulley (1) with pointer (2).

#### NOTE:

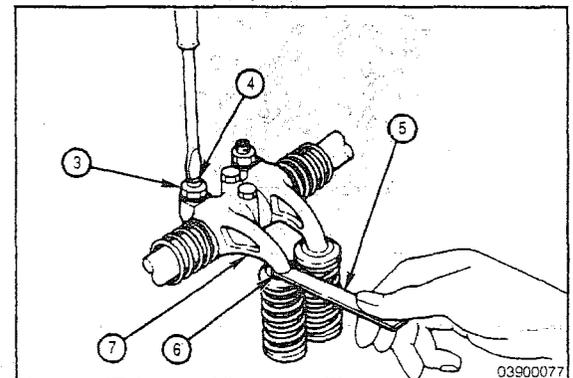
- The engraved mark on the crankshaft pulley will read "1.4 TOP."
- The No. 4 intake valve will start to open when the No. 1 cylinder comes near compression top dead center.



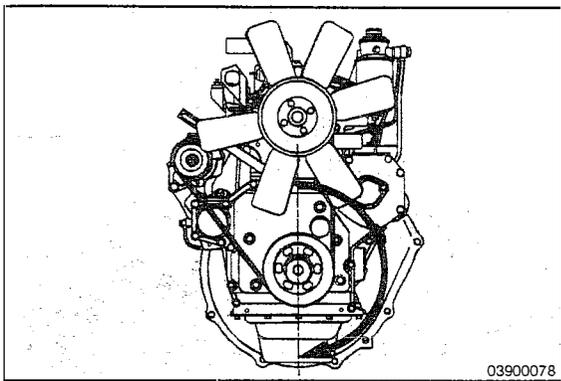
Loosen the locknut (3) on the adjustment screw (4).

Insert the feeler gauge (5) between the valve stem (6) and the rocker arm (7).

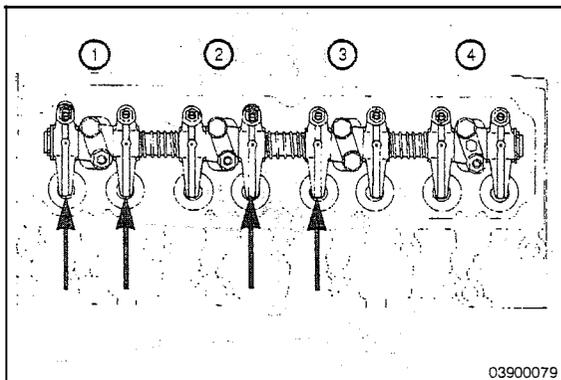
Adjust the clearance with the adjustment screw until slight drag is felt on the feeler gauge.



Valve Clearance (Engine Hot or Cold)	
Intake Valve	Exhaust Valve
0.35 mm	0.50 mm
0.014 in	0.020 in

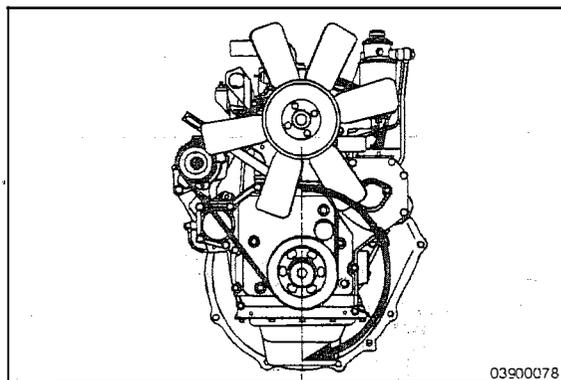


**NOTE:** Adjust intake and exhaust clearances in the following firing order by rotating the crankshaft 180 degrees in the normal direction: 1-2-4-3.



Adjust the valve clearances for **intake** valves No. 1 and No. 3.

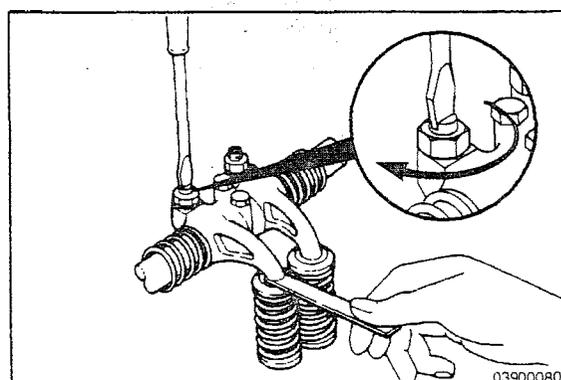
Adjust the valve clearances for **exhaust** valves No. 1 and No. 2.



Rotate the crankshaft in the normal direction one revolution.

Adjust the valve clearances for **intake** valves No. 2 and No. 4.

Adjust the valve clearances for **exhaust** valves No. 3 and No. 4.



Tighten the locknut to secure the adjustment screw.



Locknut Torque Value		
N•m		ft-lb
39	MIN	29
49	MAX	36

## Section D - System Diagrams

### Section Contents

	Page
Flow Diagram, Air Intake System .....	D-8
Flow Diagram, Cooling System .....	D-7
Flow Diagram, Exhaust System .....	D-9
Flow Diagram, Fuel System .....	D-2
Flow Diagram, Lubricating Oil System .....	D-5
System Diagrams - General Information .....	D-1

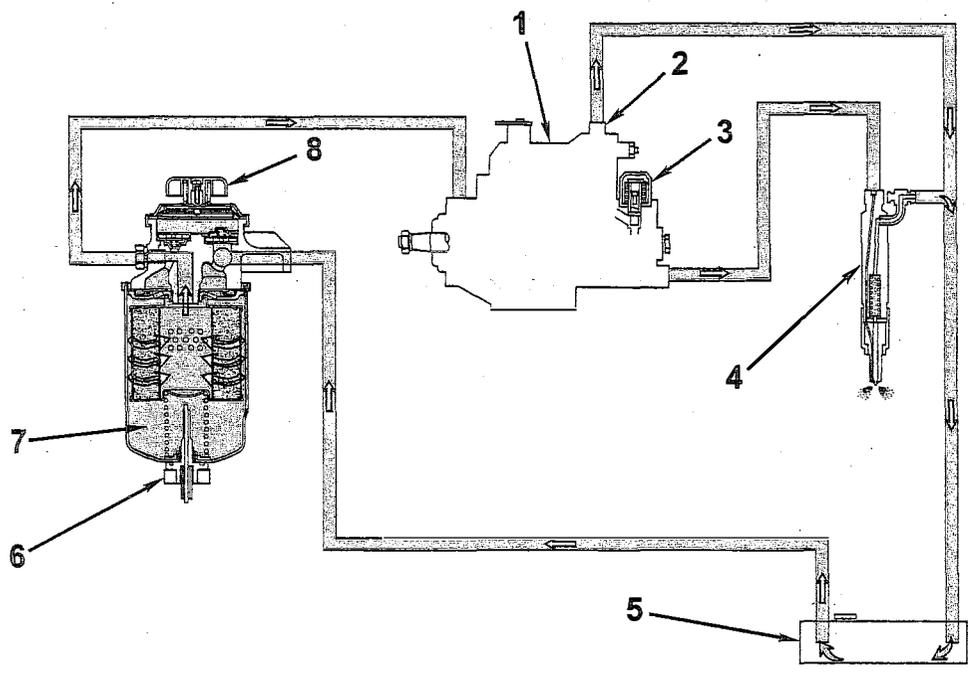
## **System Diagrams - General Information**

The following drawings show the flow through the engine systems. Although parts can change between different applications and installations, the flow remains the same. The systems shown are:

- Fuel System
- Lubricating Oil System
- Coolant System
- Intake Air System
- Exhaust System.

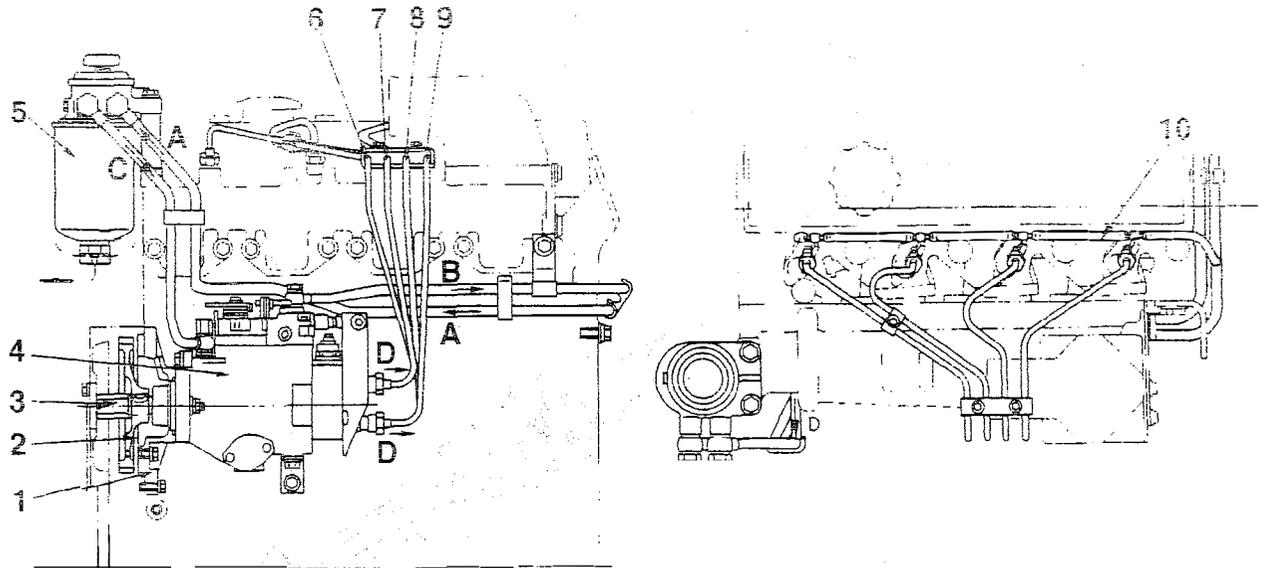
Knowledge of the engine systems can help in troubleshooting, service, and general maintenance of the engine.

### Flow Diagram, Fuel System



00900149

- |                           |                               |
|---------------------------|-------------------------------|
| 1. Fuel Injection Pump    | 5. Fuel Tank                  |
| 2. Overflow Valve         | 6. Water in Fuel Sensor (WIF) |
| 3. Fuel Shut-off Solenoid | 7. Fuel Filter                |
| 4. Fuel Injection Nozzle  | 8. Hand Priming Pump.         |



00900150

### Fuel Injection Pump

1. Pump Holder
2. Fuel Injection Pump Drive Gear  
(number of teeth: 52)
3. Drive Shaft
4. Fuel Injection Pump (Body)
5. Fuel Filter
6. Fuel Injection Pipe (No. 1)
7. Fuel Injection Pipe (No. 2)
8. Fuel Injection Pipe (No. 3)
9. Fuel Injection Pipe (No. 4)
10. Spill Tube.

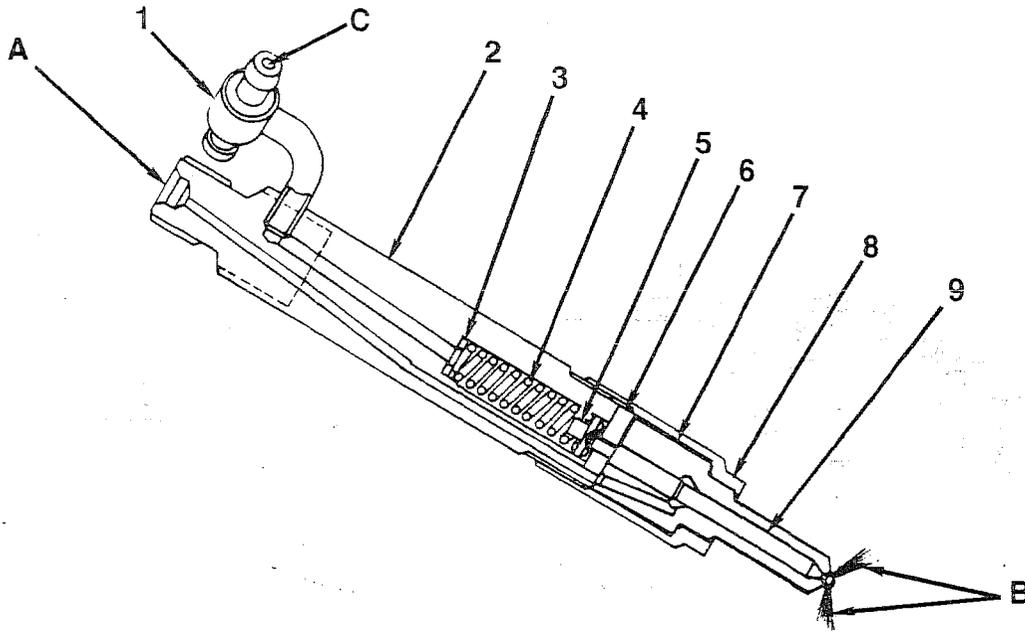
- A. Fuel Inlet (from Fuel Tank)  
B. To Fuel Tank  
C. To Fuel Injection Pump  
D. To Fuel Injection Nozzle.

#### Fuel Injection Pump

- Maker: Zexel
- Type: VE
- Lubrication Method: Forced Lubrication with Fuel.

#### Governor

- Type: Mechanical, All-speed Type.



00900151

**Fuel Injection Nozzle**

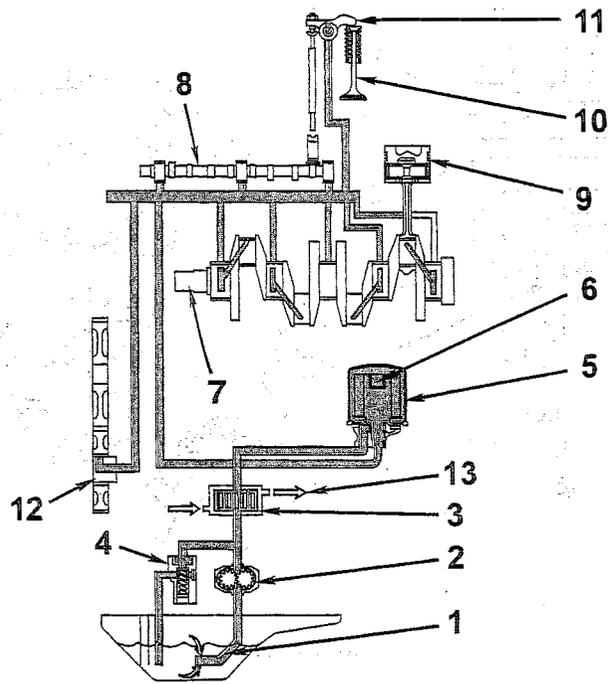
1. Fuel Drain Line Connector
2. Nozzle Holder
3. Adjusting Shim
4. Nozzle Spring
5. Spring Seat
6. Intermediate Plate
7. Nozzle Body
8. Retaining Nut
9. Needle.

- A. Fuel Inlet (from injection pump)
- B. Fuel Injection (to cylinder)
- C. Fuel Return (to fuel tank).

**Fuel Injection Nozzle**

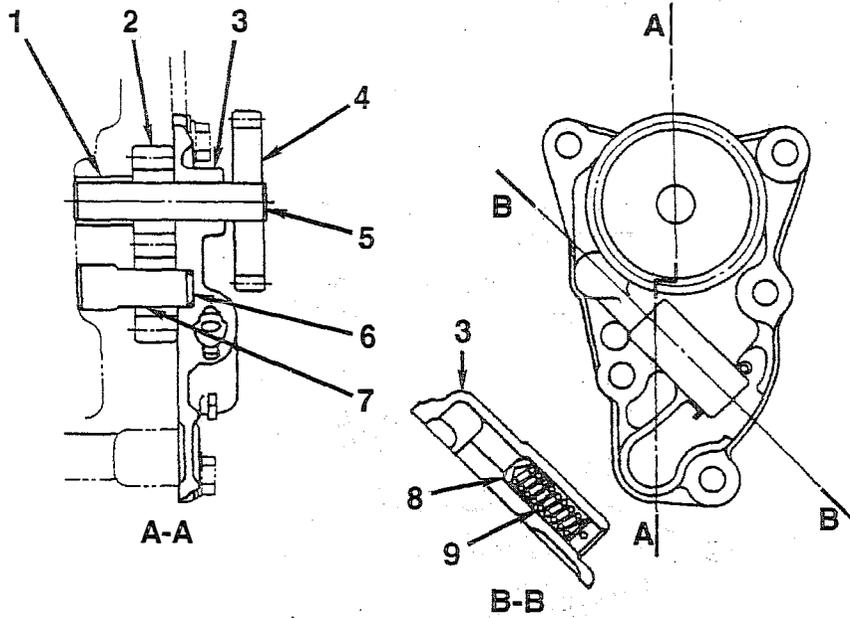
- Maker: Zexel
- Injection Pressure: 82,737 kPa [12,000 psi]
- Adjustment of Injection Pressure: By Shim.

### Flow Diagram, Lubricating Oil System



00900146

- |                          |                              |
|--------------------------|------------------------------|
| 1. Oil Strainer          | 8. Camshaft                  |
| 2. Oil Pump              | 9. Piston                    |
| 3. Oil Cooler (Optional) | 10. Intake and Exhaust Valve |
| 4. Regulator Valve       | 11. Rocker Arm               |
| 5. Oil Filter            | 12. Timing Gear              |
| 6. Safety Valve          | 13. Cooling Water.           |
| 7. Crankshaft            |                              |



00900148

Oil Pump

1. Bushing
2. Gear Drive (number of teeth: 7)
3. Pump Cover
4. Oil Pump Drive Gear  
(number of teeth: 22)
5. Driveshaft
6. Drivenshaft
7. Driven Gear (number of teeth: 7)

8. Regulator Valve
9. Valve Spring.

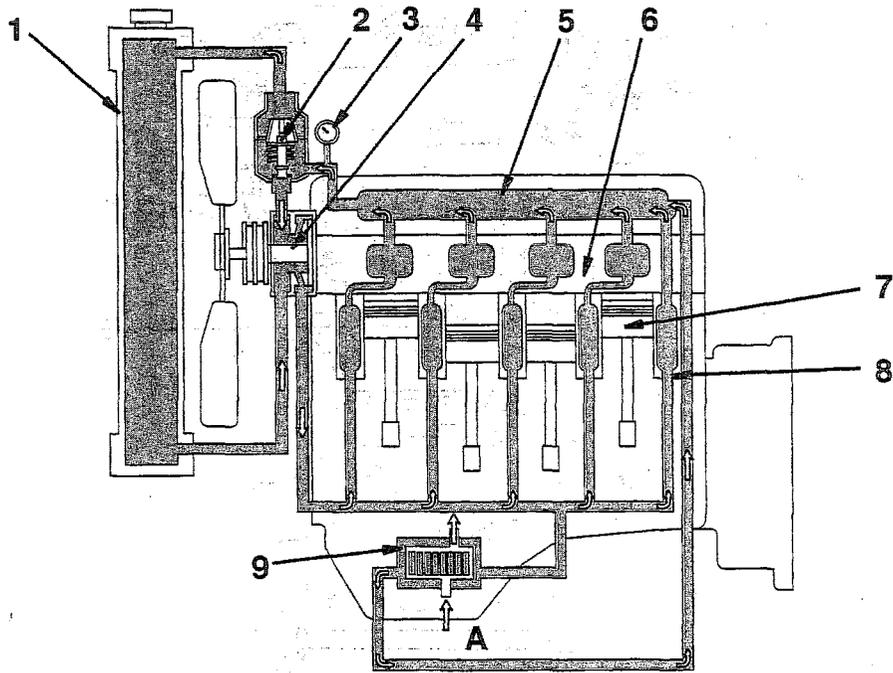
**Oil Pump**

- Type: Gear Type
- Pump Speed: Engine Speed x 1.182.

**Regulator Valve**

- Set Pressure: 588 ± 50 kPa [85 ± 7 psi].

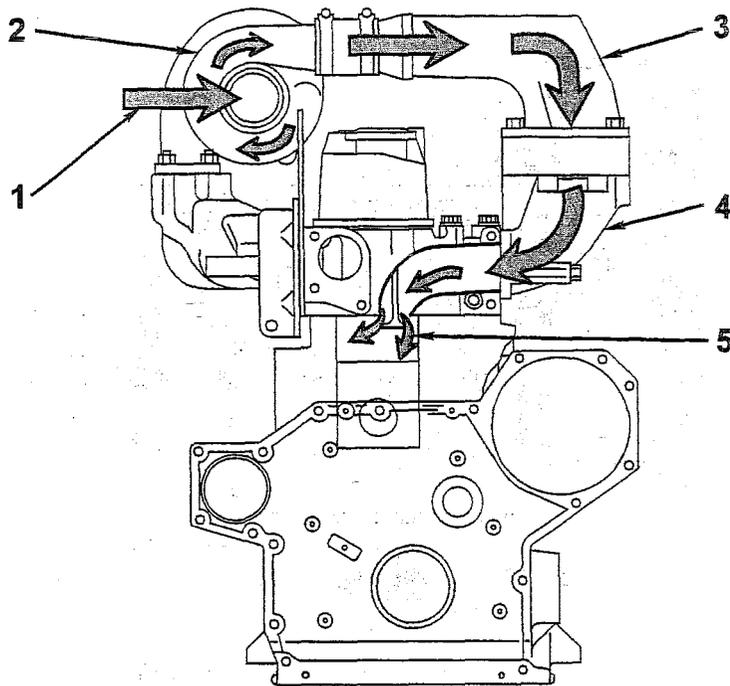
### Flow Diagram, Cooling System



00900147

- |                            |                           |
|----------------------------|---------------------------|
| 1. Radiator                | 6. Cylinder Head          |
| 2. Thermostat              | 7. Piston                 |
| 3. Water Temperature Gauge | 8. Cylinder Block         |
| 4. Water Pump              | 9. Oil Cooler (optional). |
| 5. Water Manifold          | A. From Oil Pump (oil).   |

### Flow Diagram, Air Intake System

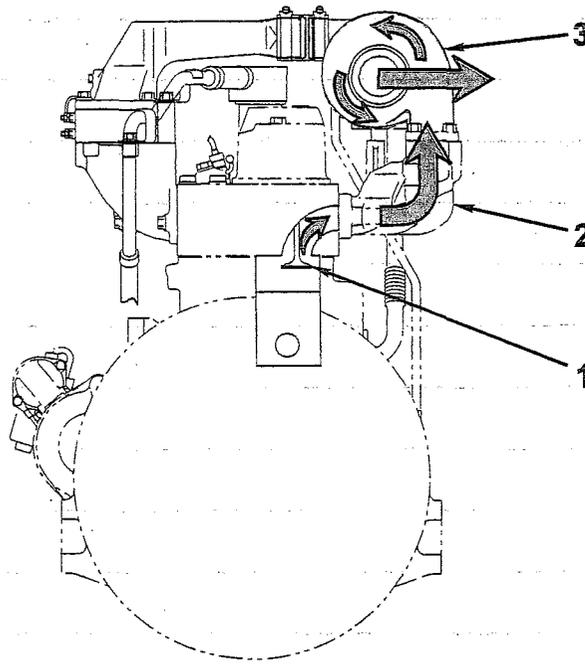


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- 1. Filtered Air
- 2. Turbocharger Compressor
- 3. Air Crossover Tube

- 4. Intake Manifold
- 5. Intake Valve Port.

### Flow Diagram, Exhaust System



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1. Exhaust Valve Port
2. Exhaust Manifold
3. Turbocharger Turbine.

# Section L - Service Literature

## Section Contents

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## Additional Service Literature

The following publications can be purchased by filling in and mailing the Service Literature Order Form:

Bulletin No.	Title of Publication
3666418	Troubleshooting and Repair Manual, B3.3 Series Engines
3810326	4B Series Standard Repair Times

## Service Literature Ordering Location

Region	Ordering Location
United States and Canada	Cummins Distributors or Cummins Engine Co., Inc. Publishing Services CMC 95030 Box 3005 Columbus, IN 47202-3005
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Obtain current price information from your local Cummins Distributor or (for U.S.A.) by calling Cummins Toll Free Number 1-800-DIESELS (1-800-343-7357).

## Literature Order Form

Use this form for prompt handling of your literature order.

Item	Bulletin Number	Title of Publication	Quantity	U.S. Price Each	Amount
1				\$	\$
2					
3					
4					
5					
6					
<b>Order Total</b>					\$

Contact your Cummins distributor for prices and availability.

For problems with literature orders, contact 1-800-DIESELS (1-800-343-7357) (for U.S.A. and Canada).

Prices subject to change without notice.

Mail the Literature Order Form along with your ship-to address to your nearest Cummins distributor.

<b>FROM:</b>		
Name:		
Street Address:		
City:	State:	Zip Code:
Country:		

<b>SHIP TO: (Name and address where literature is to be shipped)</b>		
Name:		
Street Address:		
City:	State:	Zip Code:
Country:		

## Specifications

General Engine Data	Naturally Aspirated	Turbocharged
Engine Weight (Dry) Less Flywheel and Electronics	245 kg [540 lb]	255 kg [562 lb]
Compression Ratio	18	17
Bore	95 mm [3.74 in]	
Stroke	115 mm [4.528 in]	
Displacement	3.26 liters [199 in <sup>3</sup> ]	
Firing Order	1-2-4-3	
Valve Clearance:	Intake	0.35 mm [0.014 in]
	Exhaust	0.50 mm [0.020 in]
Rotation Viewed from the Front of the Engine	<b>Clockwise</b>	

Lubrication System	Naturally Aspirated	Turbocharged
Regulating Valve Opening Pressure	490 kPa [71 psi]	588 kPa [85 psi]
Lubricating Oil Capacity:	Total System	8.0 liters [8.5 qt]
	Standard Oil Pan Only	7.0 liters [7.4 qt]
Lubricating Oil Pressure at Idle (Minimum Allowable)	69 kPa [10 psi]	
Lubricating Oil Pressure at Rated (Minimum Allowable)	245 kPa [35 psi]	
Oil Filter Differential Pressure to Open Bypass Valve	98 kPa [14 psi]	
Number of liters [qt] from Low to High	1.5 liters [1.6 qt]	

Cooling System	Naturally Aspirated	Turbocharged
Coolant Capacity (Engine Only)	4.5 liters [4.75 qt]	
Standard Modulating Thermostat Range:	Start	82° C [180° F]
	Fully Open	95° C [203° F]
Maximum Pressure Cap @ Sea Level	50 kPa [7 psi]	

Air Induction System	Naturally Aspirated	Turbocharged
Maximum Allowable Intake Restriction at Rated Speed and Load with Dirty Filter Element	762 mm H <sub>2</sub> O [30 in H <sub>2</sub> O]	762 mm H <sub>2</sub> O [30 in H <sub>2</sub> O]

Exhaust System	Naturally Aspirated	Turbocharged
Maximum Allowable Exhaust Restriction at Rated Speed and Load with Dirty Filter Element	75 mm Hg [3 in Hg]	

Fuel System	Naturally Aspirated	Turbocharged
Maximum Allowable Restriction to the Fuel Transfer Pump or Filter Head <b>Must Not Exceed</b>	75 mm Hg [3 in Hg]	
Maximum Allowable Return Line Restriction <b>Must Not Exceed</b>	190.5 mm Hg [7.5 in Hg]	
Inlet Pressure to the Injection Pump Range	0.00 kPa [0.00 psi] to 39.0 kPa [5.00 psi]	

Electrical System		Naturally Aspirated and Turbocharged
Minimum Recommended Battery Capacity with Light Accessories*:	12-VDC Starter	550 CCA
Minimum Recommended Battery Capacity with Heavy Accessories**:	12-VDC Starter	730 CCA
Maximum Allowable Resistance of the Starting Circuit:	12-VDC Starter	0.0012 ohms
*Typical light accessories include: Alternator, small steering pump, and disengaged clutch.		
**Typical heavy accessories include: Hydraulic pump and torque converter.		

## Fuel Recommendations and Specifications

### ▲ WARNING ▲

Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.

### ▲ CAUTION ▲

Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

Use ASTM No. 2D fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 are often needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

At operating temperatures below 0°C [32°F], use a blend of No. 1D and No. 2D fuels, also known as "winterized" No. 2D.

**NOTE:** Fuel economy will be less if No. 1D fuel is used.

Use low-sulfur content fuel having a cloud point that is at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel fuel.

The viscosity of the fuel **must** be kept above 2.0 centistokes to provide adequate fuel system lubrication at 40°C [104°F].

For a more detailed description of fuel properties, refer to Fuel For Cummins Engines, Bulletin No. 3379001.

The following chart lists acceptable alternate fuels for the B3.3 engine.

Acceptable Alternate Fuels - Component Wear/Durability	
Fuel Type	Bosch <sup>3</sup>
No. 1D Diesel	OK
No. 2 Fuel Oil	OK
No. 1K Kerosene	NOT OK
No. 2K Kerosene	NOT OK
Jet-A	NOT OK
Jet A-1	NOT OK
JP-5	NOT OK
JP-8	NOT OK
Jet-B	NOT OK
JP-4	NOT OK
Cite	NOT OK

**NOTE:** Any adjustment to compensate for reduced performance with a fuel system using alternate fuel is not warrantable.

**NOTE:** Wear on any midrange fuel pump component attributed to the lack of lubrication in the fuel is **not** a warrantable repair.

## Lubricating Oil Recommendations and Specifications

### General Information

#### Oil Performance Recommendations

Using quality engine lubricating oils, along with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability.

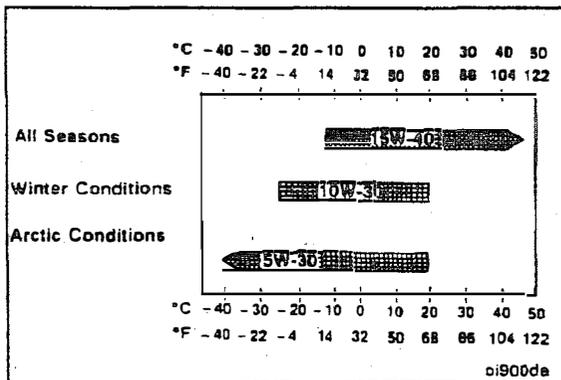
Cummins Engine Company, Inc. recommends the use of a high-quality SAE 15W-40 heavy-duty engine oil (such as Cummins Premium Blue®), which meets the American Petroleum Institute (API) performance classification CH4/SG.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control. The sulfated ash **must not** exceed 1.85 mass percent.

#### Oil Viscosity Recommendations

The use of multiviscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While 15W-40 oil is recommended for most climates, refer to the accompanying table for oil viscosity recommendations for extreme climates.



**NOTE:** Limited use of low-viscosity oils, such as 10W-30, can be used for easier starting and providing sufficient oil flow at ambient temperatures below -5°C [23°F]. However, continuous use of low viscosity oils can decrease engine life because of wear. Refer to the accompanying chart.

### New Engine Break-In Oils

Do not use special "break-in" lubricating oils for new or rebuilt Cummins engines. Use the same type of oil during the "break-in" as that which is used in normal operation.

### Recommended Oil Change Intervals

**NOTE:** The oil change interval for naturally aspirated engines is every 6 months or 500 hours.

**NOTE:** The oil change interval for turbocharged engines is every 3 months or 250 hours.

## Artic Operation

If an engine is operated in ambient temperatures consistently below -23°C [-10°F] and there are no provisions to keep the engine warm when it is **not** in operation, use a synthetic CH4/SG engine oil with adequate low-temperature properties, such as 5W-30.

The oil supplier **must** be responsible for meeting the performance service specifications.

### ⚠ CAUTION ⚠

**The use of a synthetic-base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.**

Additional information regarding lubricating oil availability throughout the world is available in the E.M.A. Lubricating Oils Data Book for Heavy-Duty Automotive and Industrial Engines. The data book can be ordered from the engine Manufacturers Association, One Illinois Center, 111 East Wacker Drive, Chicago, IL U.S.A. 60601. The telephone number is: (312) 644-6610.

## Coolant Recommendations and Specifications

Heavy-duty diesel engines require a balanced coolant mixture of water and antifreeze. Drain and replace the mixture every 2 years or 6000 hours of operation (whichever occurs first) to eliminate buildup of harmful chemicals.

- **Antifreeze is essential in any climate.** It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do **not** use more than 50-percent antifreeze in the mixture unless additional freeze protection is required. **Never** use more than 68-percent antifreeze under any condition.
- Use soft water in the coolant mixture. Contaminants in hard water neutralize the corrosion inhibitor components. Water **must not** exceed 300-ppm hardness or contain more than 100 ppm of either chloride or sulfate.
- **Specifications - Use low-silicate antifreeze that meets ASTM4985 test (GM6038M spec.) criteria.**

**Concentration - Antifreeze must be used in any climate for both freeze and boiling point protection. Cummins recommends a 50-percent concentration level (40-percent to 60-percent range) of ethylene glycol or propylene glycol in most climates.** Antifreeze at 68-percent concentration provides the maximum freeze protection and **must** never be exceeded under any condition. Antifreeze protection decreases above 68 percent.

### Ethylene Glycol

40% = -23°C [-10°F]  
50% = -37°C [-34°F]  
60% = -54°C [-65°F]  
68% = -71°C [-90°F]

### Propylene Glycol

40% = -21°C [-6°F]  
50% = -33°C [-27°F]  
60% = -49°C [-56°F]  
68% = -63°C [-82°F]

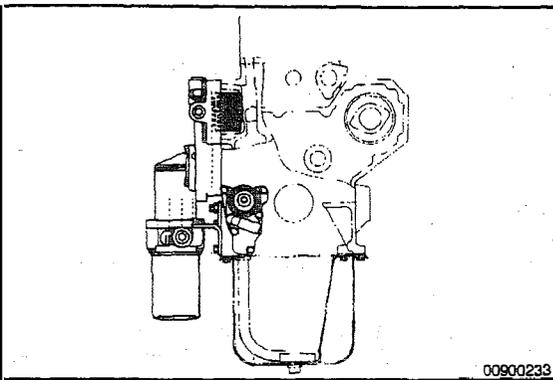
**Concentration Testing - Antifreeze concentration must be checked using a refractometer (such as Fleetguard® Part No. CC2800).** "Floating ball" types of density testers or hydrometers are **not** accurate enough for use with heavy-duty diesel cooling systems.

## Filter Selection

### Oil Filters

Standard four-cylinder applications:

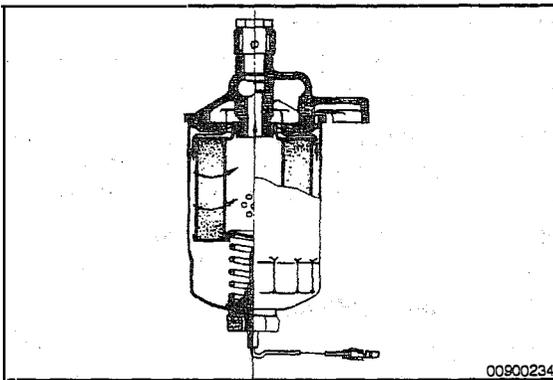
Part No. LF 3855



### Fuel Filters

Fuel-water separator used in single-filter applications:

Part No. C6003117460



## Sealants

Use the sealants listed below or sealants containing equivalent properties.

<b>Description</b>	<b>Sealing Method</b>
1. Pipe Plugs	Precoated teflon or pipe sealer.
2. Cup Plugs	Loctite 277 or 11,264.
3. O-Rings	No sealant required.
4. Rear Camshaft Expansion Plug	Precoated or Loctite 59,241 liquid teflon.
5. Turbocharger Drain in Block	Loctite 277 or 11,264.
6. Oil Pan at T-Joint	Silicone Sealant (P/N 3823494)
7. Front Cover	Silicone Sealant (P/N 3823494)

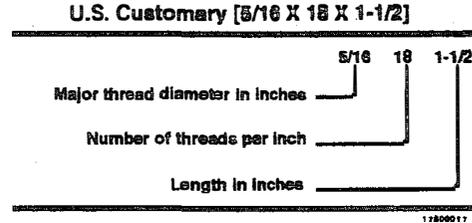
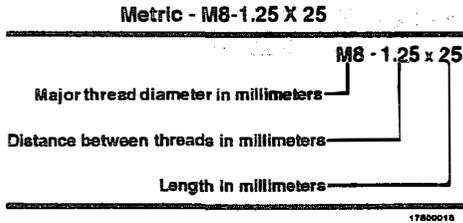
## Capscrew Markings and Torque Values



When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:



### NOTES:

1. Always use the torque values listed in the following tables when specific torque values are not available.
2. Do not use the torque values in place of those specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.
4. When the ft-lb value is less than 15, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

### Capscrew Markings and Torque Values - Metric

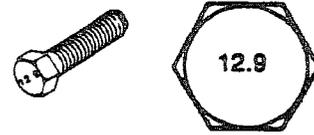
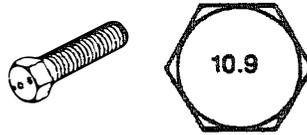
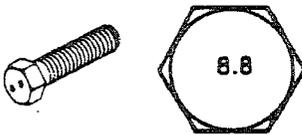
#### Commercial Steel Class

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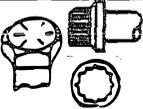
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#### Capscrew Head Markings



Body Size	Torque		Torque				Torque					
	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
Diam.	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	12	9	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	25	18	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	60	45	30	25	70	50	30	25
12	80	60	55	40	105	75	55	40	125	95	55	40
14	125	90	90	65	165	122	90	65	195	145	90	65
16	180	130	140	100	240	175	140	100	290	210	140	100
18	230	170	180	135	320	240	180	135	400	290	180	135

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5	8
Capscrew Head Markings These are all SAE Grade 5 (3 line)		
		
	<b>Capscrew Torque - Grade 5 Capscrew</b>	<b>Capscrew Torque - Grade 8 Capscrew</b>

Capscrew Body Size	Cast Iron		Aluminum		Cast Iron		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	8	6
- 28	12	9	9	7	18	13	9	7
5/16 - 18	20	15	16	12	30	22	16	12
- 24	23	17	19	14	33	24	19	14
3/8 - 16	40	30	25	20	55	40	25	20
- 24	40	30	35	25	60	45	35	25
7/16 - 14	60	45	45	35	90	65	45	35
- 20	65	50	55	40	95	70	55	40
1/2 - 13	95	70	75	55	130	95	75	55
- 20	100	75	80	60	150	110	80	60
9/16 - 12	135	100	110	80	190	140	110	80
- 18	150	110	115	85	210	155	115	85
5/8 - 11	180	135	150	110	255	190	150	110
- 18	210	155	160	120	290	215	180	120
3/4 - 10	325	240	255	190	460	340	255	190
- 16	365	270	285	210	515	380	285	210
7/8 - 9	490	360	380	280	745	550	380	280
- 14	530	390	420	310	825	610	420	310
1 - 8	720	530	570	420	1100	820	570	420
- 14	800	590	650	480	1200	890	650	480