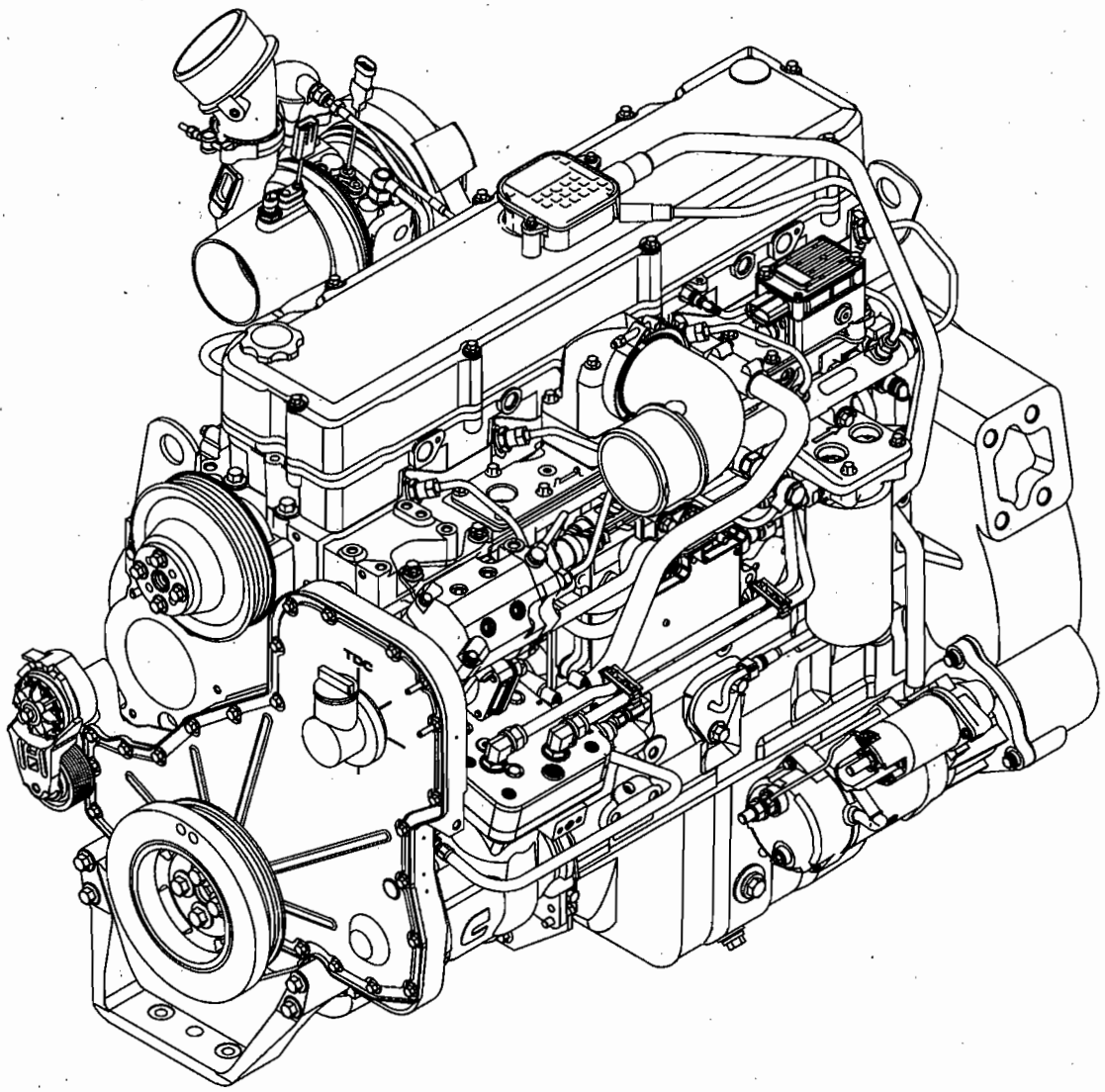
Troubleshooting and Repair Manual ISC, ISC^{e}, QSC8.3, ISL and QSL9 Engines



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General Safety Instructions

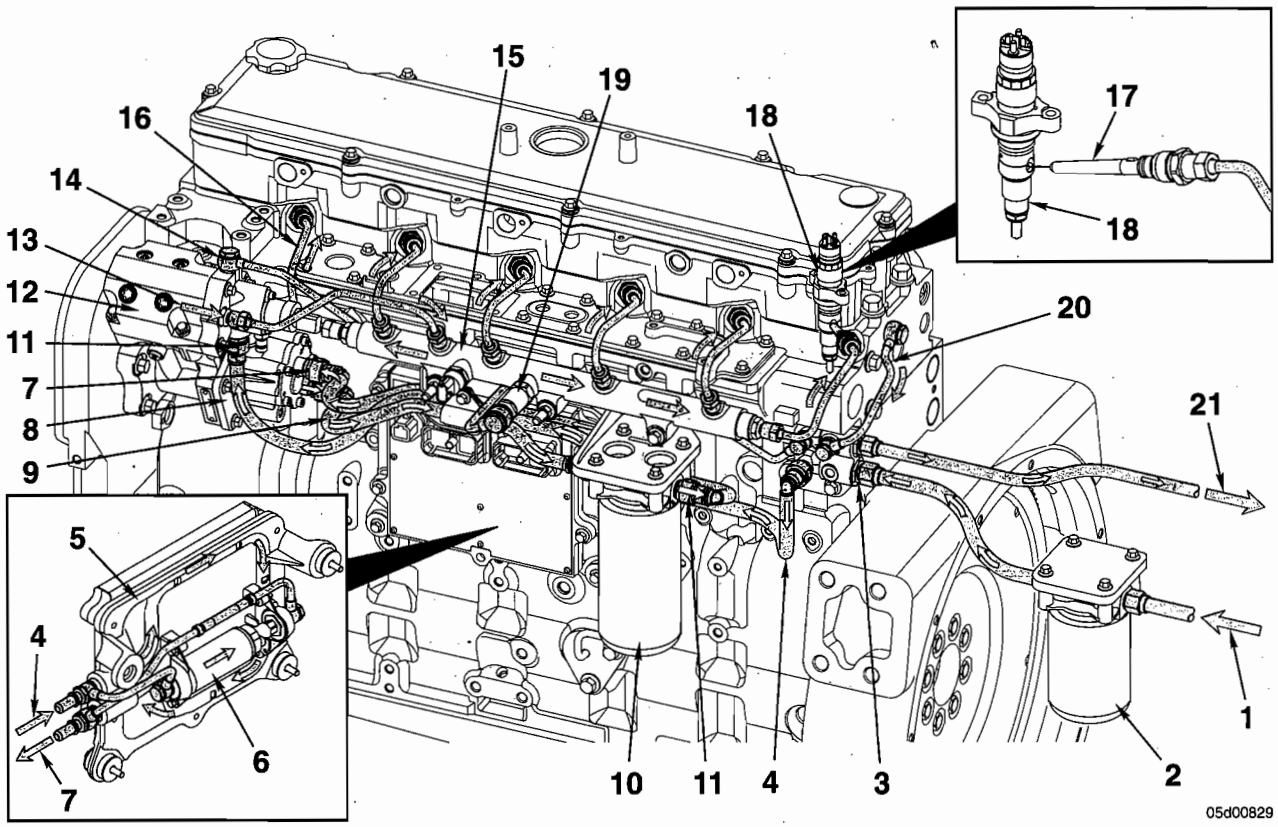
Important Safety Notice

⚠ WARNING ⚠

Improper practices, carelessness, or ignoring the warnings can cause burns, cuts, mutilation, asphyxiation or other personal injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do **Not** Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.
- **Always** use blocks or proper stands to support the product before performing any service work. Do **not** work on anything that is supported ONLY by lifting jacks or a hoist.
- Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do **not** check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use the tools before performing any service work. Use ONLY genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.
- Liquified petroleum gas is heavier than air and can accumulate near the floor, in sumps, and low-lying areas.
- Natural gas is lighter than air and can accumulate under hood and awnings.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect natural gas and liquified petroleum gas lines in a well ventilated area.
- Coolant is toxic. If **not** reused, dispose of in accordance with local environmental regulations.



Cummins Common Rail Fuel System

1. Fuel from supply tank
2. Fuel filter and water separator
3. OEM fuel supply connection
4. Fuel supply to ECM mounted fuel lift pump
5. ECM cooling plate
6. ECM mounted fuel lift pump
7. Fuel outlet from ECM mounted fuel lift pump
8. Fuel gear pump
9. Fuel from gear pump to fuel filter
10. Primary fuel filter
11. Fuel inlet to fuel pump actuator
12. High-pressure fuel pump
13. Fuel outlet from high-pressure pump
14. High-pressure pump drain flow connection
15. Fuel rail
16. High-pressure injector supply lines
17. High-pressure fuel connector
18. Fuel injector
19. Fuel pressure relief valve
20. Fuel injector drain flow line
21. Fuel return to supply tanks

Fuel in Coolant

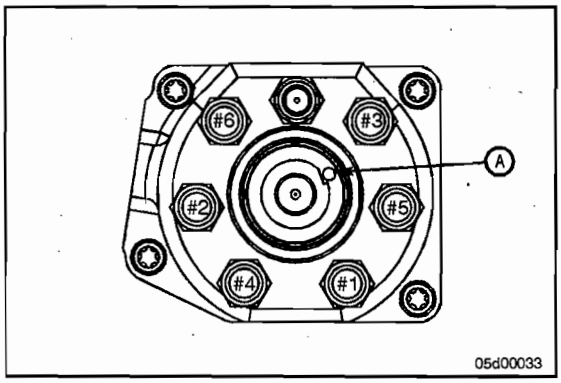
This is symptom tree T091.

Cause	Correction
Bulk coolant supply is contaminated	Check the bulk coolant supply. Drain the coolant and replace with noncontaminated coolant. Replace the coolant filters. Refer to Procedure 008-018.
OK ▼	
Cylinder head is cracked or porous	Remove intake and exhaust manifolds. Check for evidence of coolant leak. If necessary, operate engine at low idle. Pressure-test the cylinder head. Refer to Procedure 002-004.

Engine Vibration Excessive (Continued)

Cause	Correction
Flywheel or flexplate capscrews are loose or broken	Check the flywheel or flexplate and the mounting capscrews. Refer to Procedure 016-005.
OK ➡ Flywheel housing is **not** aligned correctly	Check the flywheel housing alignment. Refer to Procedure 016-006.
OK ➡ Power take-off (PTO) is damaged	Check the PTO for damage and correct installation. Refer to the OEM service manual.
OK ➡ Internal engine damage	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to Procedure 007-083.

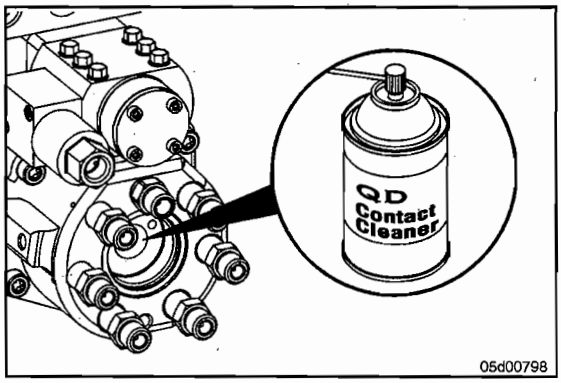
NOTES



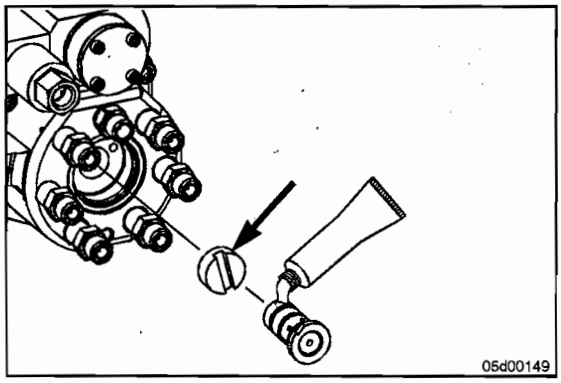
Clean and Inspect for Reuse

Check the position of the notch on the rotor. It **must** line up with the alignment mark (A) on the outside of the distributor (when the engine is barred to TDC for the number 1 cylinder). If the alignment is correct, the rotor is properly timed to the engine.

If a mechanical problem exists, indicated by misalignment of the rotor, the entire fuel pump will have to be replaced; refer to Procedure 005-016.

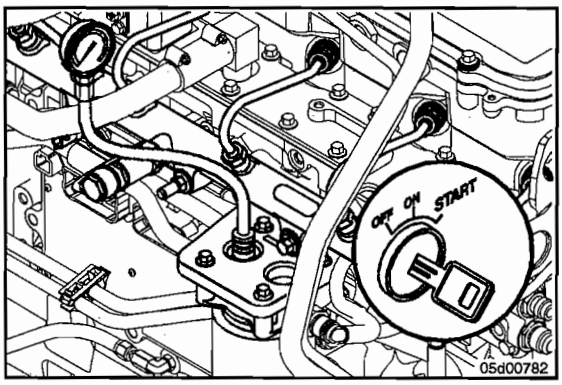


Clean the rotor bore with QD contact cleaner, Part Number 3824510.



Install

Use Lubriplate™ 105, or equivalent, between the drive coupling and the rotor to prevent it from falling off during assembly.

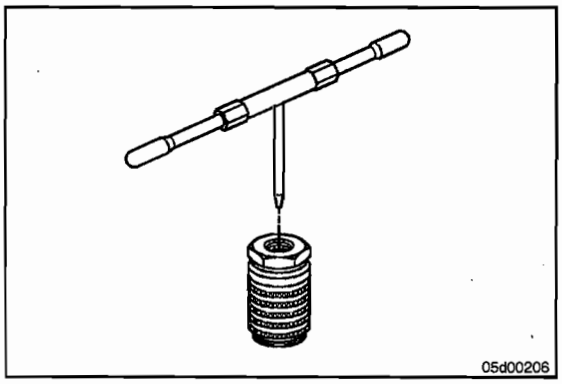


Measuring gear pump pressure with the engine cranking (useful if engine will **not** start).

1. Install a pressure gauge at the on engine fuel filter head (M10 x 1.5 Compucheck® fitting, Part Number 3824842).
2. Monitor the gear pump pressure while the engine is cranking.

Gear Pump Pressure at Cranking (minimum) 69 kPa [10 psi]

If the gear pump pressure is lower than 69 kPa [10 psi] during cranking, make sure that the engine cranking speed is at least 150 rpm. Make sure that the lift pump pressure during cranking is at least 35 kPa [5 psi]. Refer to Procedure 005–045.



SERVICE TOOLS FOR LOW PRESSURE SYSTEM TESTING

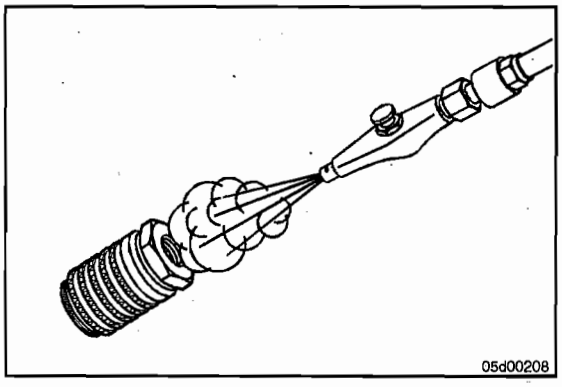
Construction of 0.043–inch Orificed Diagnostic Fuel Line

This tool is available as a service tool, Part Number 3164621.

A 0.043–inch orifice diagnostic fuel line is used in procedures to create rated flow through the low-pressure fuel system without the need to operate the engine under load.

Tap a female quick-connect, Part Number 3376859.

Tap size: 8–36 national fine (U.S.)



⚠ WARNING ⚠

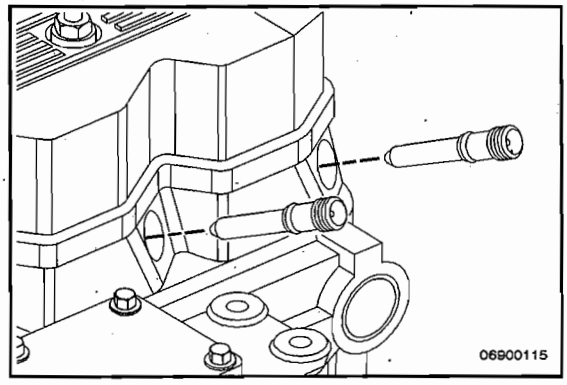
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

Clean the female quick-connect with compressed air.

Install

CAPS Fuel System

Before installing the injector supply lines, make sure that the fuel connector is fully and properly seated against the injector. Refer to Procedure 006–052.



Install the fuel lines in the reverse order of removal.

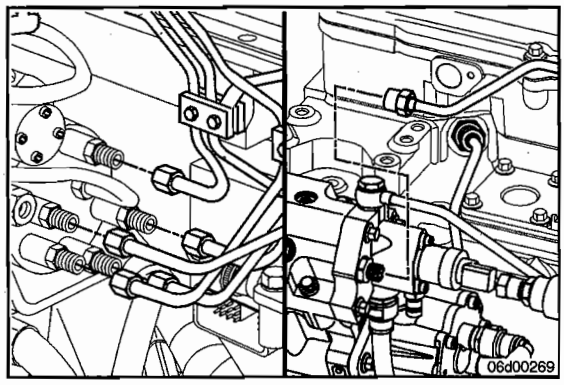
Check the fuel pump connection.

Torque Value: 24 N•m [18 ft-lb]

Check the cylinder head connection.

Torque Value: 38 N•m [28 ft-lb]

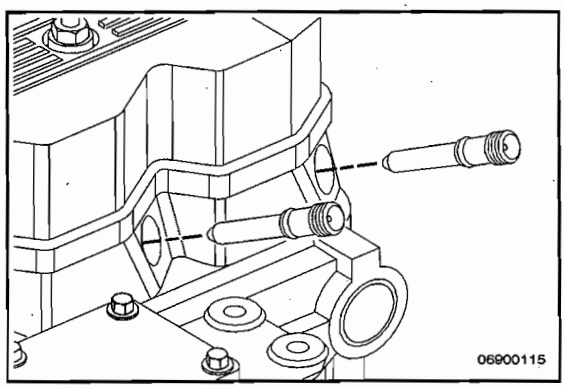
Operate the engine and check for leaks.



Cummins Common Rail Fuel System

Before installing the injector supply lines, make sure that the fuel connector is fully and properly seated against the injector. Refer to Procedure 006–052.

For Cummins Common Rail Fuel Systems, be certain that the high-pressure connector retaining nut is tightened. Refer to Procedure 006–052.



Install the fuel lines in the reverse order of removal.

Check the fuel pump connection.

Torque Value: 38 N•m [28 ft-lb]

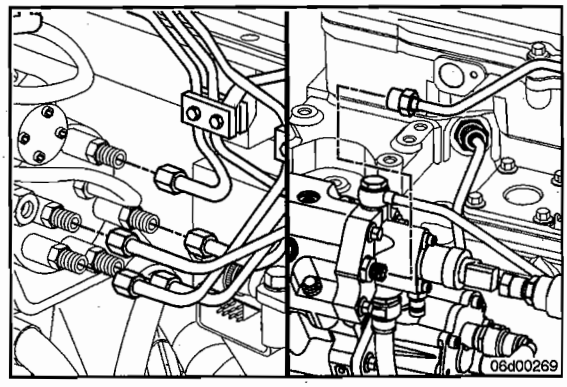
Check the cylinder head connection.

Torque Value: 38 N•m [28 ft-lb]

Check thr fuel rail connection.

Torque Value: 38 N•m [28 ft-lb]

Operate the engine and check for leaks.

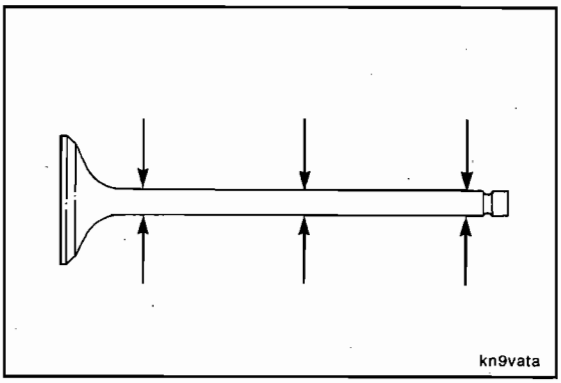


Inspect for abnormal wear on the heads and stems.

Measure the valve stem diameter.

Valve Stem Diameter		
mm		in
7.96	MIN	0.313
7.98	MAX	0.314

Replace any valve found outside of these dimensions.

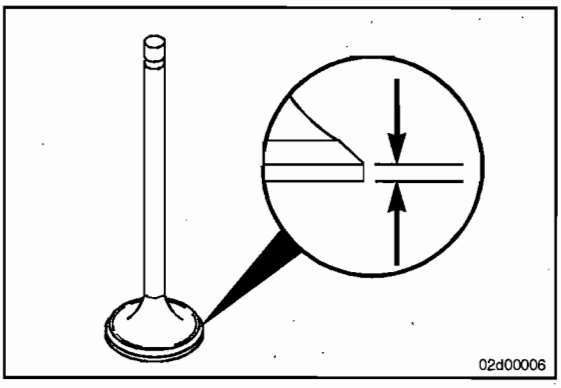


Check the valve stem tip for flatness.

Inspect for bent valves.

Measure the rim thickness. If the valve thickness is **not** within the limits, a new valve **must** be used.

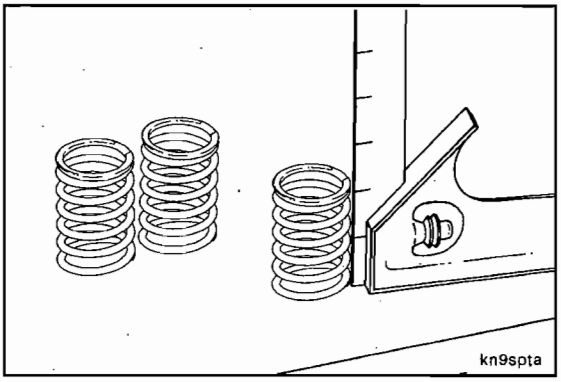
Valve Rim Thickness Limit			
	mm		in
Exhaust	1.83	MIN	0.072
Intake	2.20	MIN	0.087



Inspect the valve springs.

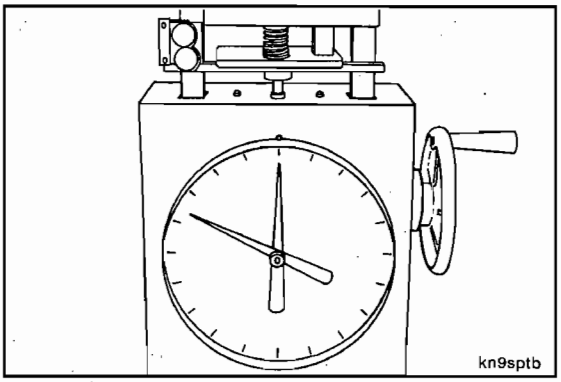
Measure the valve spring.

Approximate Free Length 59.18 mm [2.330 in]



A load of 906 to 1007 N [204 to 226 lb] is required to compress the spring to a height of 30.6 mm [1.20 in]. Use spring compressor tool, Part Number 3944711, to measure spring force.

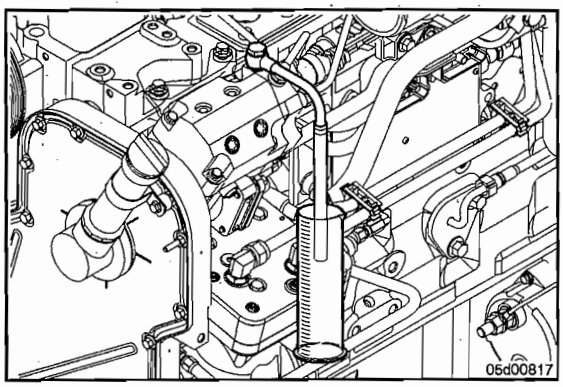
Replace the valve spring if the load required to compress the spring is outside of the specification.



Alternate Test Setup

If the drain manifold is **not** easily accessed, a M14 banjo may be attached at the pump head drain port with a fuel hose that is routed to the collection container.

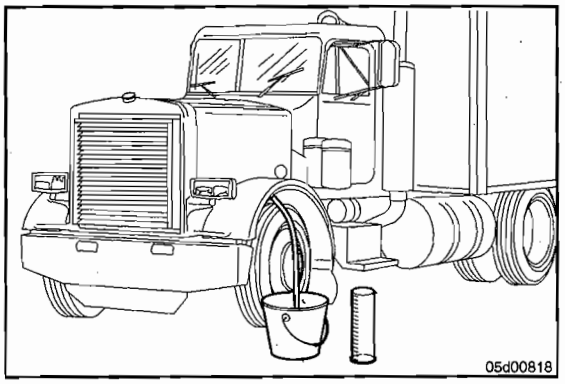
NOTE: In this setup a bolt, nut, and washers are needed to prevent drain flow from flowing backwards and leaking from the unused drain line.



⚠ CAUTION ⚠

The high-pressure leakage test in the INSITE™ electronic service tool will cause the engine to operate at elevated pressures while the engine idles. The engine noise will change when this test is being performed due to the higher fuel injection pressures. Safety glasses should be worn while working near the running engine. Fuel lines should not be adjusted while performing this test.

Close the engine cover(s) while performing these tests.



Test (Engine Will Not Start)

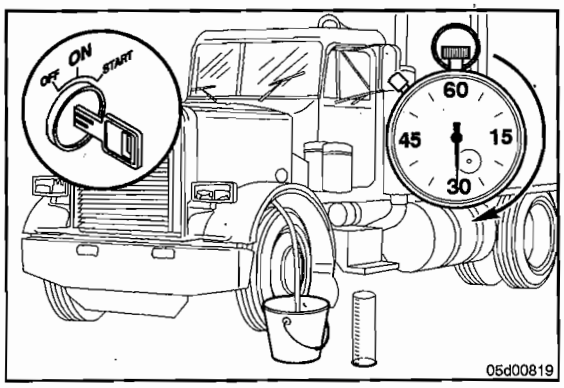
Turn the keyswitch ON and allow the lift pump to complete its cycle. Afterward the cycle is completed, begin cranking the engine until fuel exits the drain line.

When fuel begins to exit the drain line, route the drain flow to a graduated cylinder and continue cranking for 30 seconds.

Maximum Volume of Fuel During Cranking

cc	**seconds**
200	30

If 200 cc pump head drain flow is collected in less than 30 seconds of cranking, the pump head has failed and **must** be replaced.



Test (Engine Will Start)

If the engine will start, perform the high-pressure leakage test using Cummins INSITE™ electronic service tool.

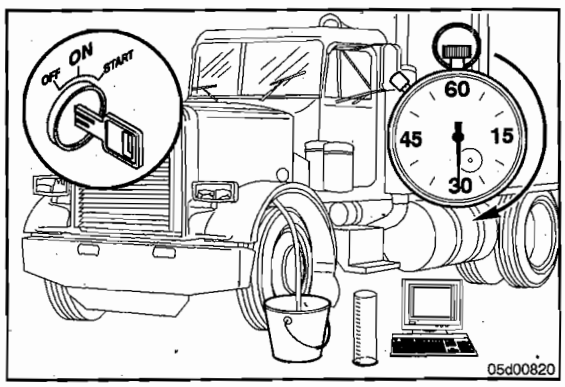
Connect the INSITE™ electronic service tool.

Start the engine and allow the engine to idle with fuel flowing into a collection device.

Begin the high-pressure leakage test using INSITE™.

Measure the time necessary to collect 300 cc (1 liter) of fuel pump head drain flow while performing the high-pressure leakage test.

Use a graduated cylinder that is marked in cubic centimeters for this measurement.



Fuel in the Lubricating Oil

This is symptom tree T092.

Cause	Correction
Bulk oil supply is contaminated	Check the bulk oil supply. Drain the oil and replace with noncontaminated oil. Replace the oil filters. Refer to Procedures 007-037 and 007-013.
OK ⬇	
Engine idle time is excessive	Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes). Shut off the engine rather than idle for long periods. If idle time is necessary, raise the idle speed.
OK ⬇	
Injector hold-down clamp capscrews are loose	Tighten capscrews to specification. Refer to Procedure 006-026.
OK ⬇	
Injector o-rings are damaged or missing	Remove and check the injectors. Replace the injector o-rings. Refer to Procedure 006-026.
OK ⬇	
Injector sealing washer is **not** correct	Remove the injectors and verify the injector sealing washer thickness. Refer to Procedure 006-026.
OK ⬇	
Injector is malfunctioning	Perform the automated cylinder performance test. Replace injectors as necessary. Refer to Procedure 014-008 and Procedure 006–026.
OK ⬇	
Cylinder head is cracked or porous	Pressure-test the cylinder head. Refer to Procedure 002-004.
OK ⬇	
Fuel pump is malfunctioning	Check the fuel pump. Refer to Procedure005-025.

Engine Will Not Shut Off

This is symptom tree T081.

Cause	Correction
Keyswitch circuit is malfunctioning	Check the vehicle, equipment, or vessel keyswitch circuit. Refer to Procedure 019-064 in Troubleshooting and Repair Manual, CM850 Electronic Control System, ISC and ISL Engines, Bulletin 4021416, or Procedure 019–064 in Troubleshooting and Repair Manual, ISC, QSC8.3 and ISL Engines, Bulletin 3666271.
OK ➡ Starting aid is malfunctioning	Check for correct operation of cold-starting aid. Refer to Procedures 005-008 and 010-029.
OK ➡ Turbocharger oil seal is leaking	Check the turbocharger compressor and turbine seals. Refer to Procedures 010-033.
OK ➡ Engine is running on fumes drawn into the air intake	Check the air intake ducts. Locate and isolate the source of the fumes. Repair as necessary. Refer to the OEM service manual.
OK ➡ Electronic control module (ECM) is malfunctioning	Replace the ECM. Refer to Procedure 019-031 in Troubleshooting and Repair Manual, CM850 Electronic Control System, ISC and ISL Engines, Bulletin 4021416, or Procedure 019–031 in Troubleshooting and Repair Manual, ISC, QSC8.3 and ISL Engines, Bulletin 3666271.

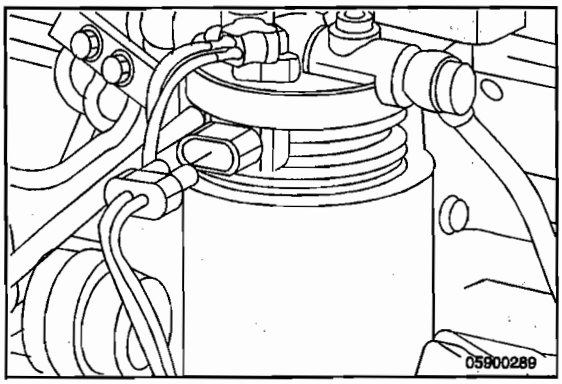
Engine Fuel Heater, Electric (005-008)

Initial Check

The fuel heater is an optional device installed on the fuel filter head. It is held on the filter head by the threaded filter spud.

NOTE: The fuel heater is **not** controlled by the electronic control module (ECM). A bimetallic switch on the filter head acts as a thermostat. The fuel heater will turn on at approximately 1°C [34°F] and turn off at approximately 18°C [65°F].

The switch should register as an open circuit above 18°C [65°F] and register as a closed circuit below 1°C [34°F].

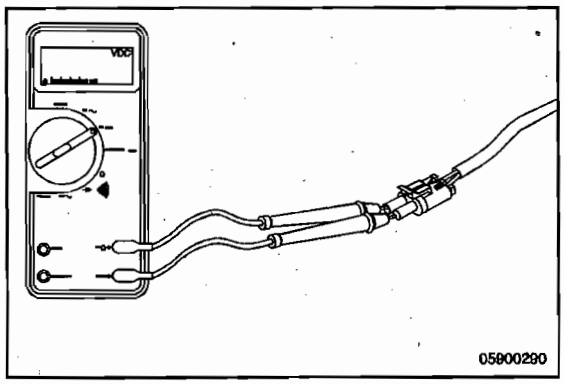


Remove the 2-pin connector from the fuel heater.

Check for proper voltage to the fuel heater.

NOTE: Minimum voltage is 12 VDC with keyswitch ON (separate 24 volt heaters are used on vehicles with 24 volts charging systems).

If the voltage is **not** within specifications, refer to the OEM troubleshooting and repair manual.



Preparatory Steps

⚠ WARNING ⚠

Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.

⚠ WARNING ⚠

Drain the fuel-water separator into a container, and dispose of contents in accordance with local environmental regulations.

Disconnect the OEM power supply connector from the fuel heater.

Disconnect the engine harness connector from the water-in-fuel sensor.

Drain a small quantity of fuel from the filter water drain to reduce fuel spillage during filter removal.

Remove the spin-on fuel filter. Refer to Procedure 006–015.

Section i - Introduction

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Alternator Overcharging

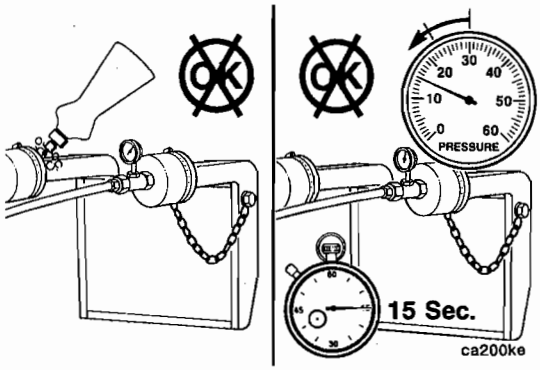
This is symptom tree T014.

Cause	Correction
Battery cell is damaged (open circuit)	Check the condition of the batteries. Replace the batteries, if necessary. Refer to the OEM service manual.
OK ⬇	
Voltage regulator is malfunctioning	Check the voltage regulator. Replace the voltage regulator, if necessary. Refer to the OEM service manual.

STEP 7C: Inspect the charge air cooler.

Condition:
- Refer to Procedure 010-027.

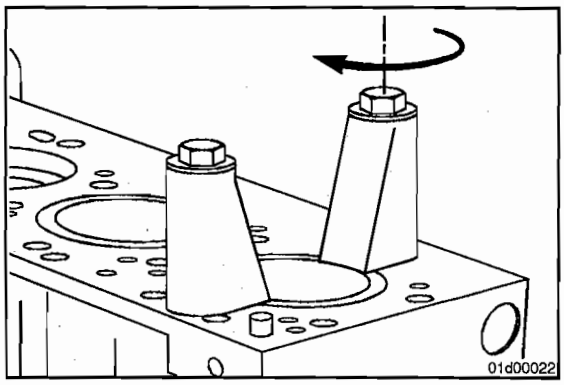
Action	Specifications/Repair	Next Step
Inspect the charge air cooler for cracks, holes, or damage. Refer to Procedure 010-027.	Is the charge air cooler free of cracks or damage? **YES**	7D
	Is the charge air cooler free of cracks or damage? **NO** **Repair:** Repair the charge air cooler assembly.	Repair complete



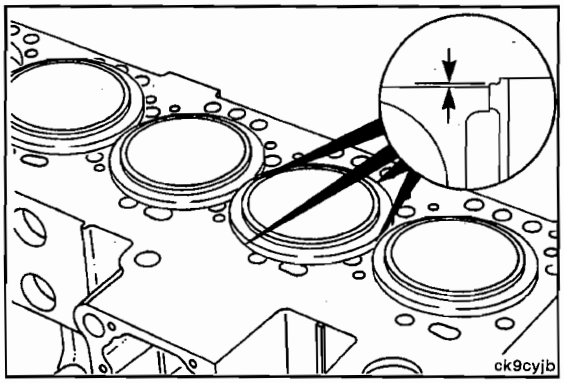
NOTE: If the liner protrusion varies more than 0.025 mm [0.0010 in] for 180 degrees:

- Install and tighten the liner clamps again.

Torque Value: 68 N•m [50 ft-lb]

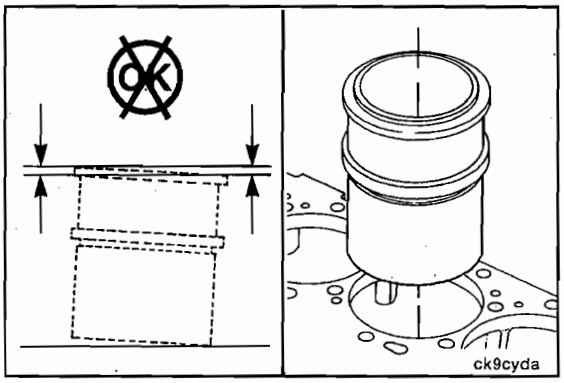


- Measure the liner protrusion again.

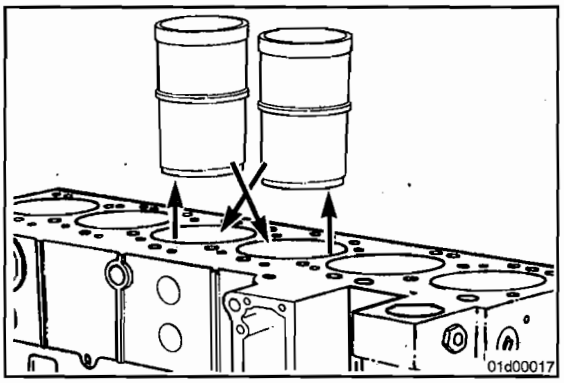


NOTE: If the protrusion still varies more than 0.025 mm [0.0010 in]:

- Remove the liner
- Inspect the liner sealing edge for burrs, dirt, or damage
- Replace the liner if it is damaged
- Install the liner again
- Measure the liner protrusion.



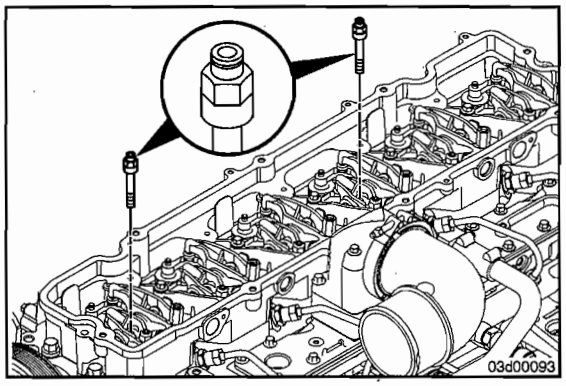
Service Tip: If the out-of-limit condition is minimal, tolerance stack-up may allow the protrusion limits to be obtained by installing other new liners in the out-of-limit bore.



Install the engine brake oil supply capscrews on intake rocker levers 1 and 4.

Torque Value:

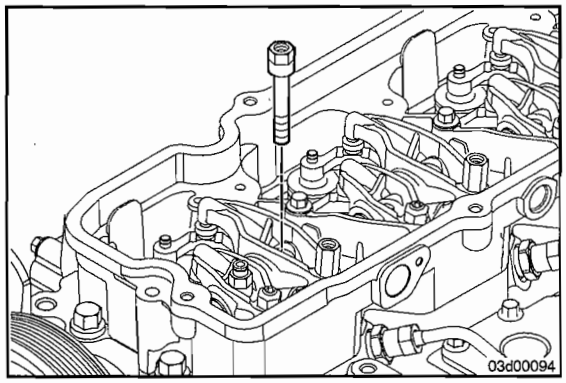
Without CM850 Control Module		65 N•m	[48 ft-lb]
With CM850 Control Module	Step 1	34 N•m	[25 ft-lb]
	2	Rotate 60 degrees	



Install the exhaust rocker levers on all exhaust levers.

Torque Value:

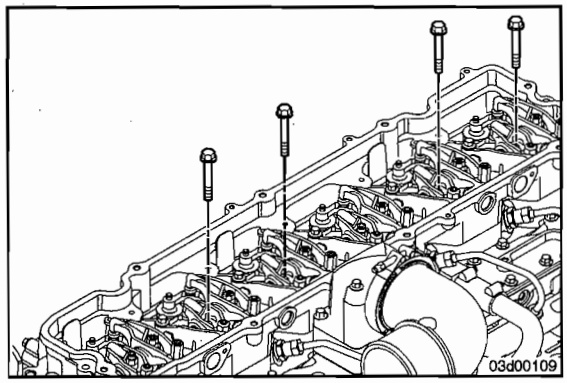
Without CM850 Control Module		65 N•m	[48 ft-lb]
With CM850 Control Module	Step 1	34 N•m	[25 ft-lb]
	2	Rotate 60 degrees	



Install the pedestal capscrews in cylinders 2, 3, 5, and 6 intake rocker pedestals.

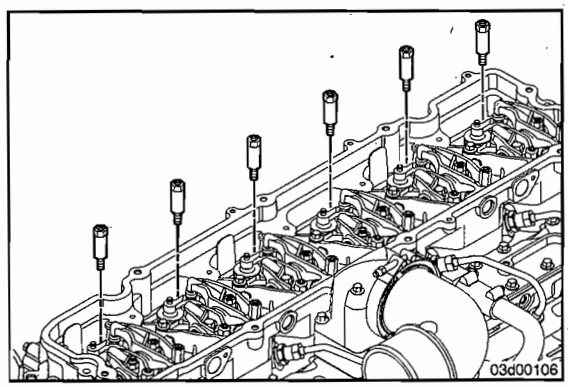
Torque Value:

Without CM850 Control Module		65 N•m	[48 ft-lb]
With CM850 Control Module	Step 1	34 N•m	[25 ft-lb]
	2	Rotate 60 degrees	



Install the six threaded spacers into the cylinder head.

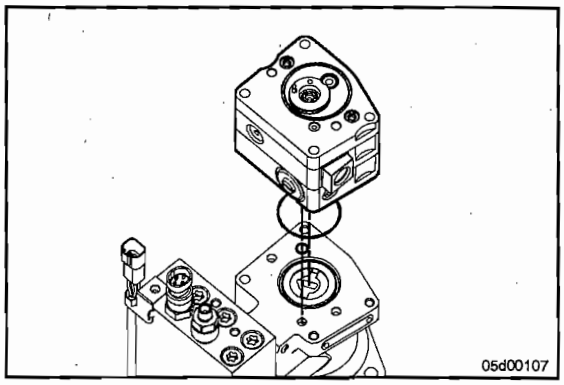
Torque Value: 65 N•m [48 ft-lb]



Remove

Remove the gear pump module.

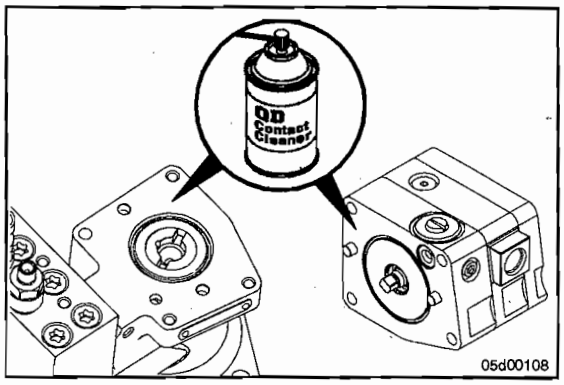
NOTE: Do **not** remove the two capscrews. The gear pump will slide off the dowel pins once the distributor is removed.



Clean and Inspect for Reuse

Clean the mounting surfaces of the gear pump and cam housing.

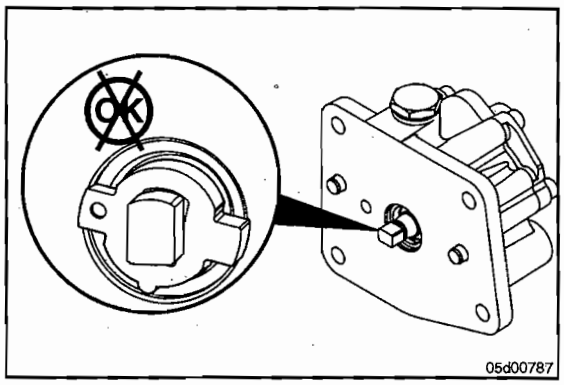
Use QD contact cleaner, Part Number 3824510.



Inspect the drive coupling and shaft ends for excessive wear.

A polished surface is acceptable.

Replace the coupling if wear is visible.



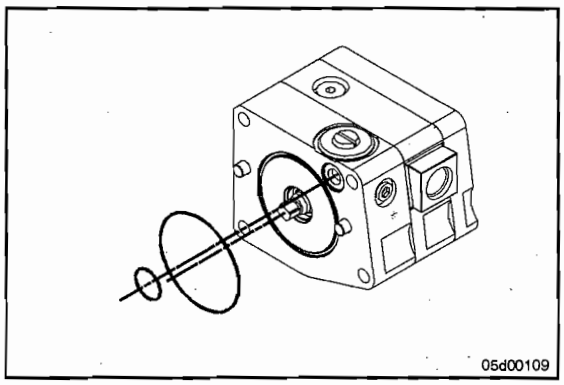
Install

⚠ CAUTION ⚠

The larger o-rings on either end of the gear pump differ in size. The longer o-ring goes to the side facing the cam housing.

Install new o-rings.

Apply Lubriplate™ 105, or equivalent, to the o-rings to keep them from falling out during assembly.



Finishing Steps

Install the 3/4–inch pipe plug into the end of the oil filter head.

Torque Value: 45 N•m [33 ft-lb]

Install the lubricating oil filter head. Refer to Procedure 007–015.

Install the lubricating oil filter. Refer to Procedure 007–013.

Lubricating Oil Filter Head (007-015)

Preparatory Steps

⚠ WARNING ⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

⚠ WARNING ⚠

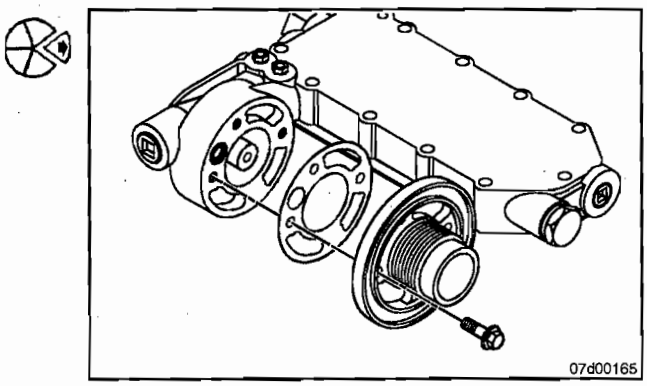
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Drain the coolant. Refer to Procedure 008–018.

Remove the lubricating oil cooler. Refer to Procedure 007–003.

Remove

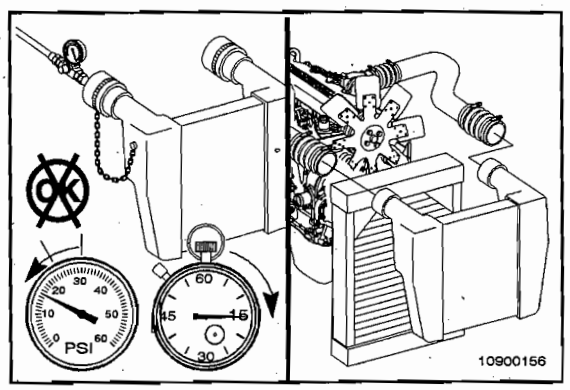
Remove the lubricating oil filter head capscrews, filter head, and gasket.



If the pressure drop is greater than 48 kPa [7 psi] in 15 seconds, the charge air cooler **must** be replaced.

Refer to the equipment manufacturer's service manual for replacement instructions.

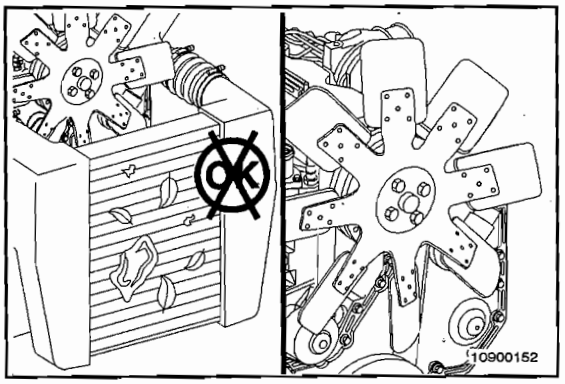
NOTE: Charge air coolers are **not** designed to be 100-percent leak-free. If the pressure drop is less than 48 kPa [7 psi] in 15 seconds, then the charge air cooler does **not** need to be replaced.



Temperature Differential Test

Inspect the charge air cooler fins for obstructions to air flow. Remove obstructions such as a winterfront or debris. Manually lock shutters in the OPEN position, if equipped.

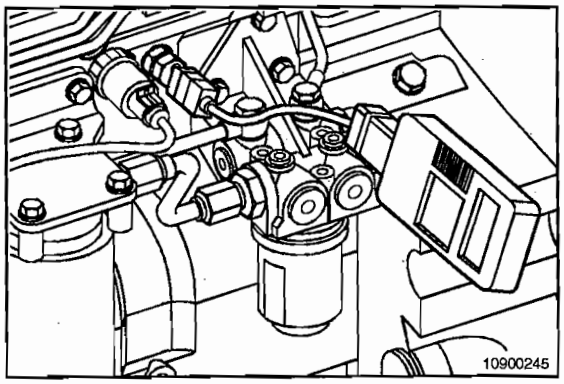
Lock the fan drive in the ON mode to prevent erratic test results. This can be done by installing a jumper wire across the temperature switch.



Install fluke digital thermometer, Part Number 3822666, into the intake manifold at the 1/8-inch NPT tap near the air horn connection with the intake manifold.

Another alternative is to use the monitor mode on the INSITE™ service tool.

Install another thermocouple at the air cleaner inlet to measure ambient air temperature.

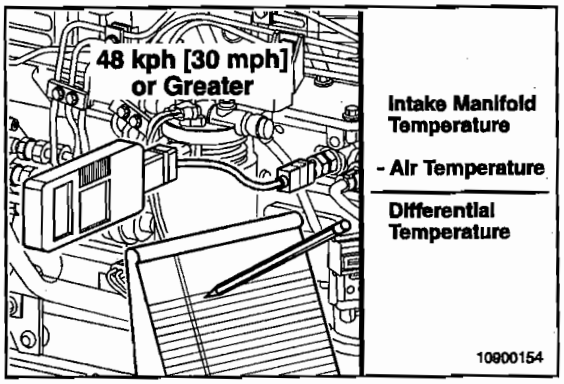


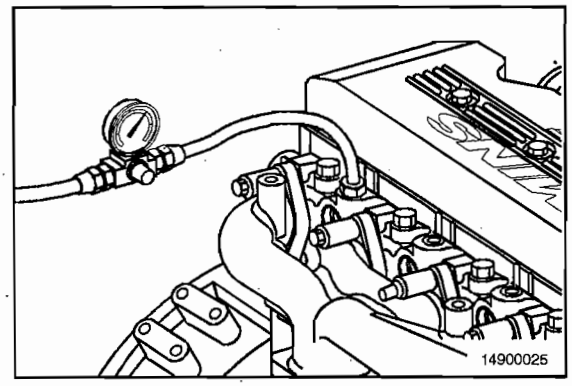
Perform a road test with the engine at peak power and a vehicle speed of 48 kph [30 mph] or greater.

Record the intake manifold temperature and the ambient air temperature.

Calculate the differential temperature:

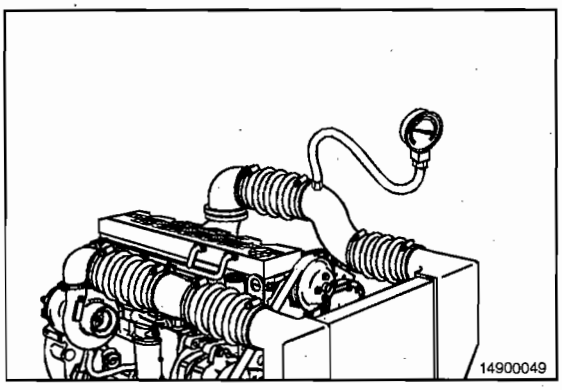
- Intake Manifold Temperature minus Ambient Air Temperature equals Differential Temperature
- Maximum Differential Temperature equals 28°C [50°F].





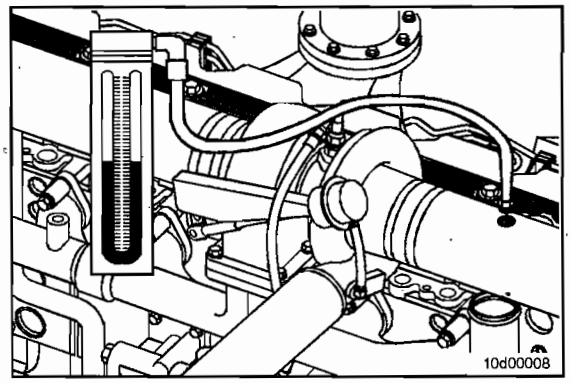
Measure the coolant pressure at a coolant tap on the exhaust side of the cylinder head.

Minimum Gauge Capacity 415 kPa [60 psi]



Measure the intake manifold pressure (turbocharger boost). Install a pressure gauge, Part Number ST-1273, in the location shown. Refer to Procedure 010–057.

Minimum Gauge Capacity 1905 mm Hg [75 in Hg]

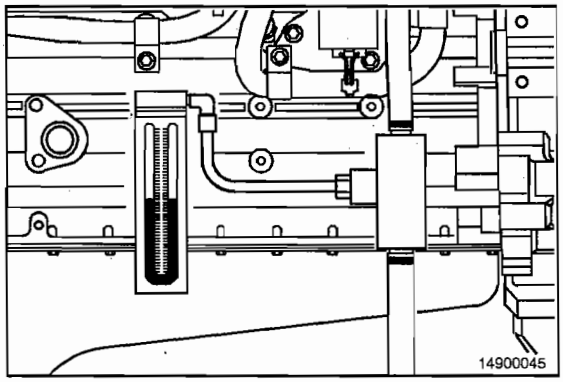


Connect a water manometer, Part Number ST-1111-3, to the turbocharger air inlet pipe to test air restriction. Refer to Procedure 010–031.

NOTE: The manometer connection **must** be installed at a 90-degree angle to the airflow in a straight section of pipe, one pipe diameter before the turbocharger, and be between the turbocharger and the air filter.

NOTE: A vacuum gauge, Part Number ST-434, can be used in place of the water manometer.

Minimum Gauge Capacity 760 mm H_2O [30 in H_2O]



Measure the blowby by installing blowby checking tool, Part Number 3822566, in the crankcase breather vent. Connect the blowby tool to a water manometer.

NOTE: Excessive blowby indicates a turbocharger malfunction or an engine internal components malfunction, allowing combustion gases to enter the crankcase.

Minimum Gauge Capacity 1270 mm H_2O [50 in H_2O]

Engine Brake Housing Spacer (020-007)

Preparatory Steps

Remove the rocker lever cover. Refer to Procedure 003–011.

Remove the engine brake assemblies. Refer to Procedure 020–004.

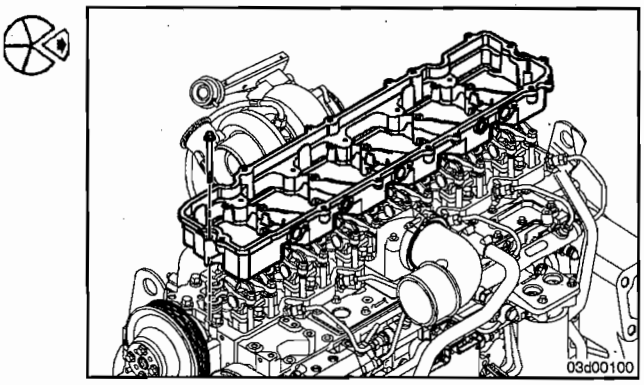
Remove

⚠ CAUTION ⚠

Do not damage the mounting surface of the spacer when removing it from the cylinder head, or oil leaks can result when the spacer is installed.

Remove the engine brake spacer 5 mounting capscrews.

Carefully remove the engine brake spacer from the cylinder head.



Clean and Inspect for Reuse

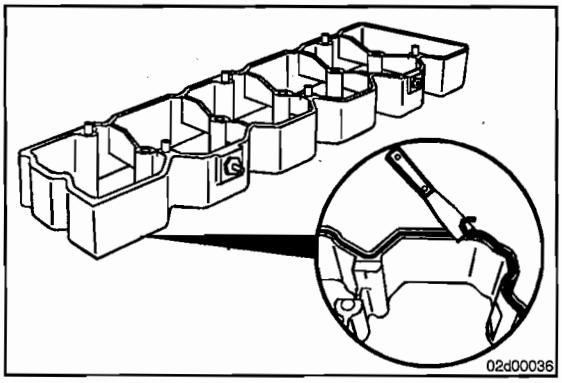
⚠ CAUTION ⚠

Be sure to remove all RTV from the groove in the mounting surface spacer, or oil leaks can result after installation.

Carefully clean the RTV from the mounting surface of the spacer.

Clean all RTV from the top of cylinder head where the spacer is mounted.

Inspect the engine brake spacer for cracks or any other damage, especially on the cylinder head mounting surface.



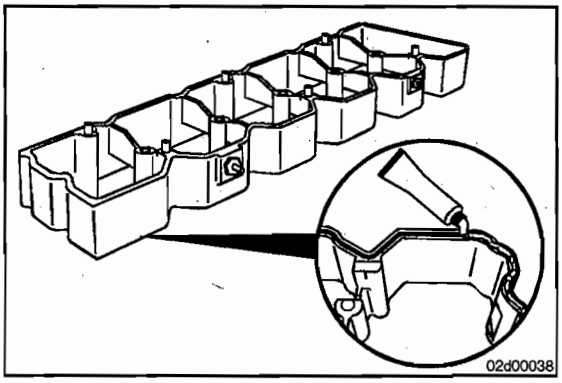
Install

⚠ CAUTION ⚠

To minimize the possibility of oil leaks, allow the RTV to cure for at minimum 1 hour prior operating the engine.

NOTE: Once the RTV has been applied, make sure to install the spacer within 15 minutes.

Apply a continuous bead of RTV in the groove around the brake spacer.



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