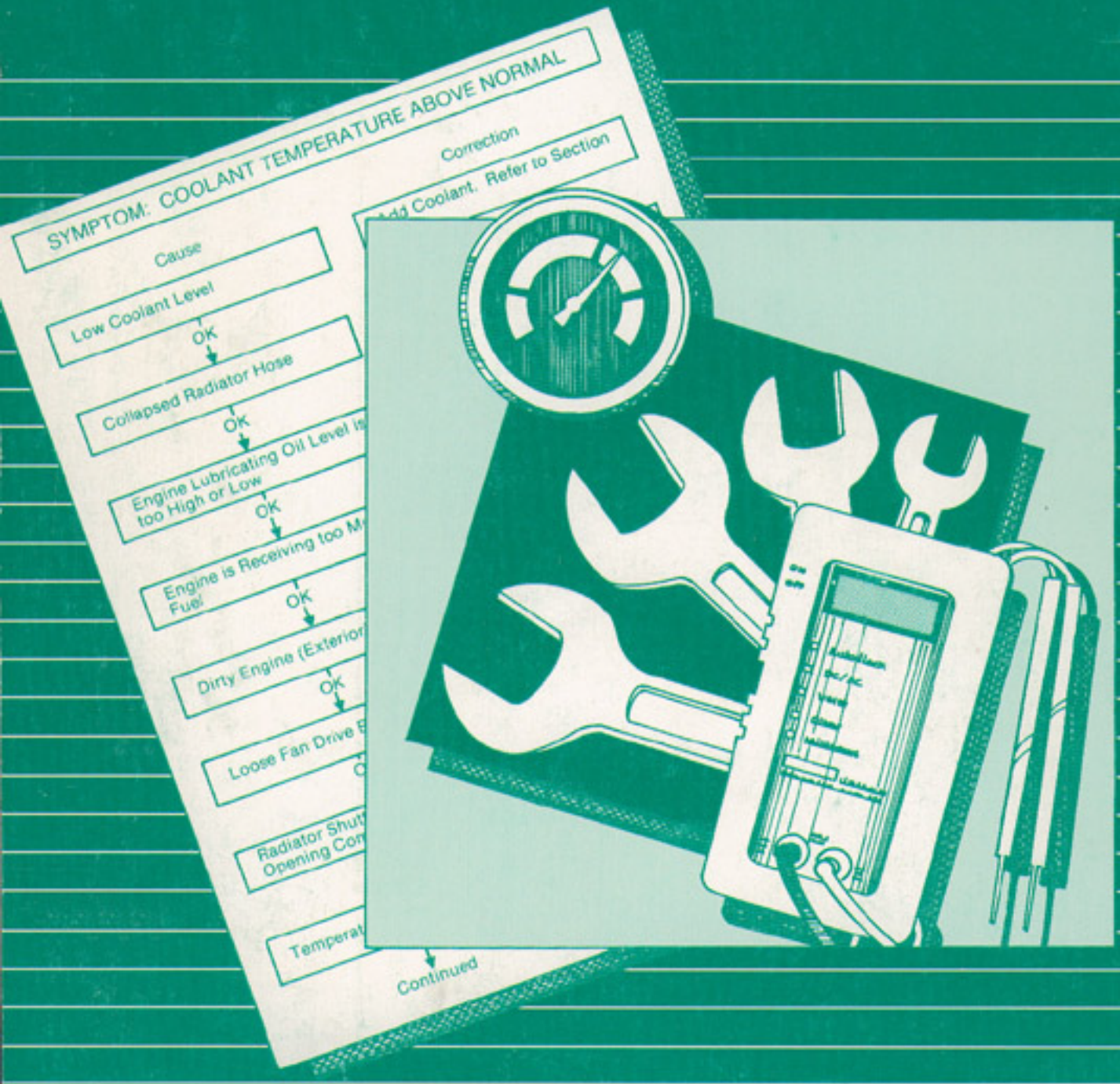
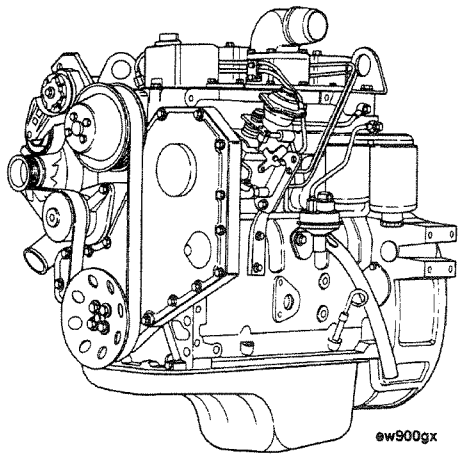
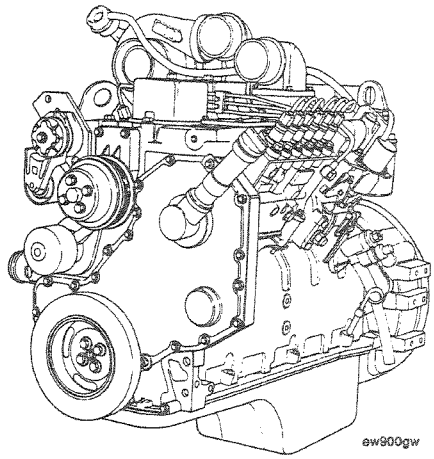
Troubleshooting and Repair Manual B Series Engines 1991 and 1994 Certification Levels



Troubleshooting and Repair Manual B Series Engines



Four Cylinder



Six Cylinder

Bulletin 3666087
Printed 11/93

Foreword

This manual provides instructions for troubleshooting and repairing the B Series Engine in the chassis. Component and assembly rebuild procedures are provided in the B Series Engine Shop Manual. Refer to Page i-2 in the Introduction for instructions on how to use this manual. The procedures given in this manual are applicable for the B Series engines produced in 1991 and newer. Refer to Bulletin No. 3810207 to find the procedures applicable to B Series engines introduced prior to 1991.

The manual is organized to guide a service technician through the logical steps of identifying and correcting problems related to the engine.

This manual does **not** cover vehicle or equipment problems. Consult the vehicle or equipment manufacturer for repair procedures.

A series of specific service manuals (Shop, Specifications, Alternative Repair, and so on.) are available and can be ordered by filling out and mailing the Literature Order Form located in the Service Literature Section L.

The repair procedures used in this manual are recommended by Cummins Engine Co., Inc. Some service procedures require the use of special service tools. Use the correct tools as described.

Reporting of errors, omissions, and recommendations for improving this publication by the user is encouraged. Please use the postage paid, self-addressed Literature Survey Form in the back of this manual for communicating your comments.

The specifications and rebuild information in this manual is based on the information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make any changes at any time without obligation. If differences are found between your engine and the information in this manual, contact a Cummins Authorized Repair Location, a Cummins Division Office, or the factory.

The latest technology and the highest quality components are used to manufacture Cummins engines. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:

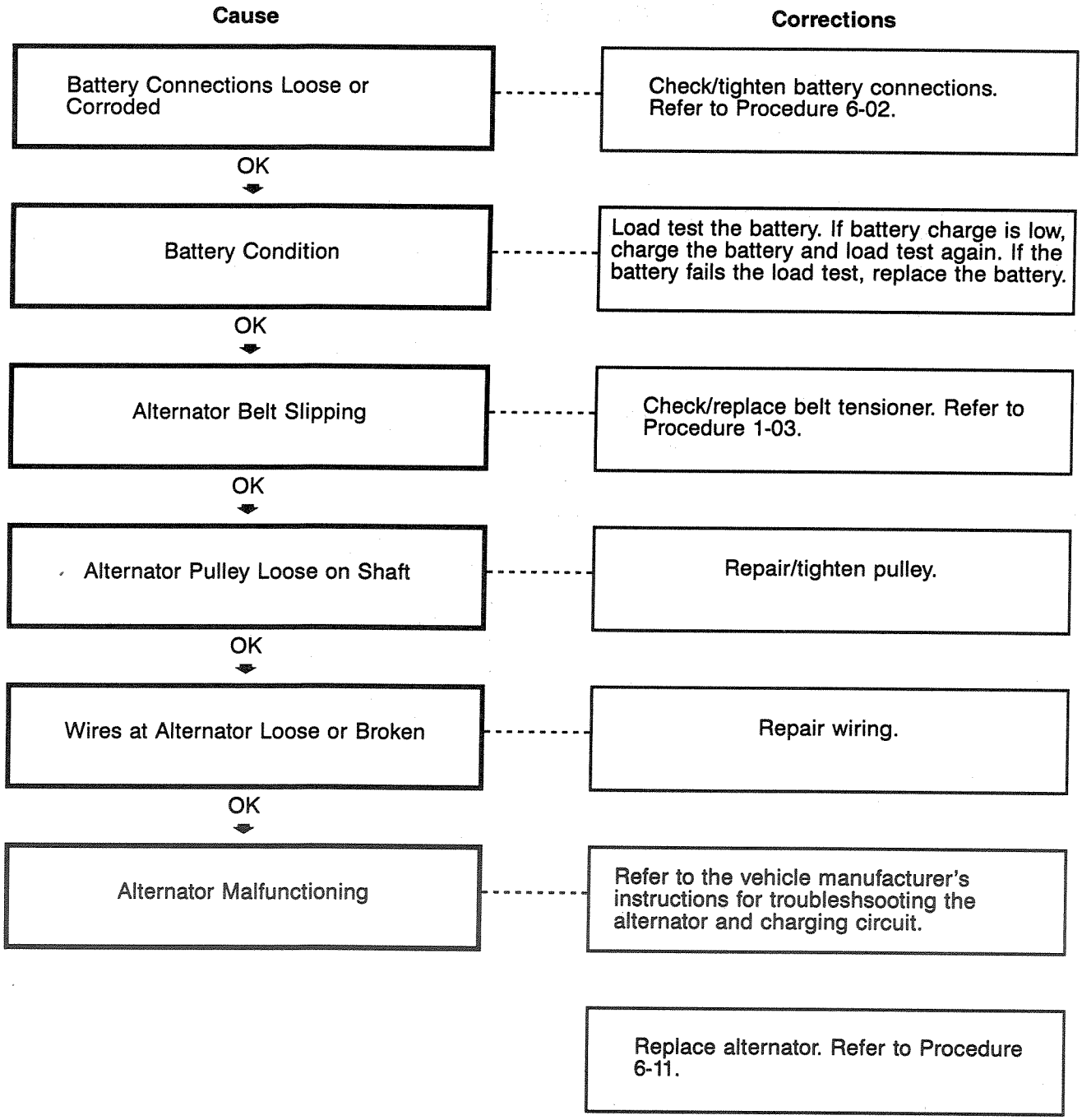
Cummins® Cummins® ReCon HOLSET® Fleetguard® Premium Blue®

Table of Contents

Non-Automotive Engine Specifications

General Engine Data	4B3.9	4BT3.9	4BTA3.9	6B5.9	6BT5.9	6BTA5.9
Bore - mm [in.]	102 [4.02]					
Stroke - mm [in.]	120 [4.72]					
Displacement - litre [in.^{3}]	3.9 [239]			5.88 [359]		
Engine Weight (Dry) Less Flywheel and Electrics-kg [lbs]	308 [680]	320 [705]	329 [725]	388 [855]	399 [880]	411 [905]
Firing Order	1.3.4.2			1.5.3.6.2.4		
Valve Clearances						
-Intake- mm [in.]	.25 [.010]					
-Exhaust- mm [in.]	.51 [.020]					
Compression Ratio	18.5:1	17.5:1	16.5:1	18.5:1	17.5:1	16.5:1
Rotation, viewed from the Front of the Engine	Clockwise					
Aspiration						
-Naturally Aspirated	X			X		
-Turbocharged		X	X		X	X
-Aftercooled			X			X
Lubrication System						
Lubricating Oil Pressure at Idle - (Minimum Allowable) kPa [PSI]	69 [10]					
Lubricating Oil Pressure at Rated - (Minimum Allowable) kPa [PSI]	207 [30]					
Regulating Valve Opening Pressure kPa [PSI]	449 [65]					
Differential Pressure to Open the Bypass Valve - kPa [PSI]	138 [20]					
Lubricating Oil Capacity						
Standard Pan Only - Liter [U.S. Quarts]	9.5 [10]	9.5 [10]	9.5 [10]	14.2 [15]	14.2 [15]	14.2 [15]
Total System - Liter [U.S. Quarts]	10.9 [11.5]	11 [11.6]	11 [11.6]	16.3 [17.2]	16.4 [17.3]	16.4 [17.3]
Number of Liters [U.S. Quarts] from Low to High	0.9 [1]	0.9 [1]	0.9 [1]	1.9 [2]	1.9 [2]	1.9 [2]
Cooling System						
Coolant Capacity (Engine Only) - Litre - [U.S. Qts.]	7 [7.4]	7 [7.4]	9.7 [10.3]	10.5 [11.1]	10.5 [11.1]	14.5 [15.3]
Standard Modulating Thermostat - Range - °C [°F]	Start 83 [180]			Fully Open 95 [203]		
Pressure Cap (kPa [PSI])						
104°C [220°F] Systems	103 [15]					
99°C [210°F] Systems	48 [7]					

Alternator Not Charging Or Insufficient Charging



Section 1 - Cooling System

Section Contents

Coolant System Components and Flow

The following illustration identifies the significant features of the coolant system.

A. Coolant is drawn from the radiator by the integrally mounted water pump. The output from the water pump empties into the oil cooler cavity of the cylinder block.

B. The coolant then circulates around each cylinder and crosses the block to the fuel pump side of the engine.

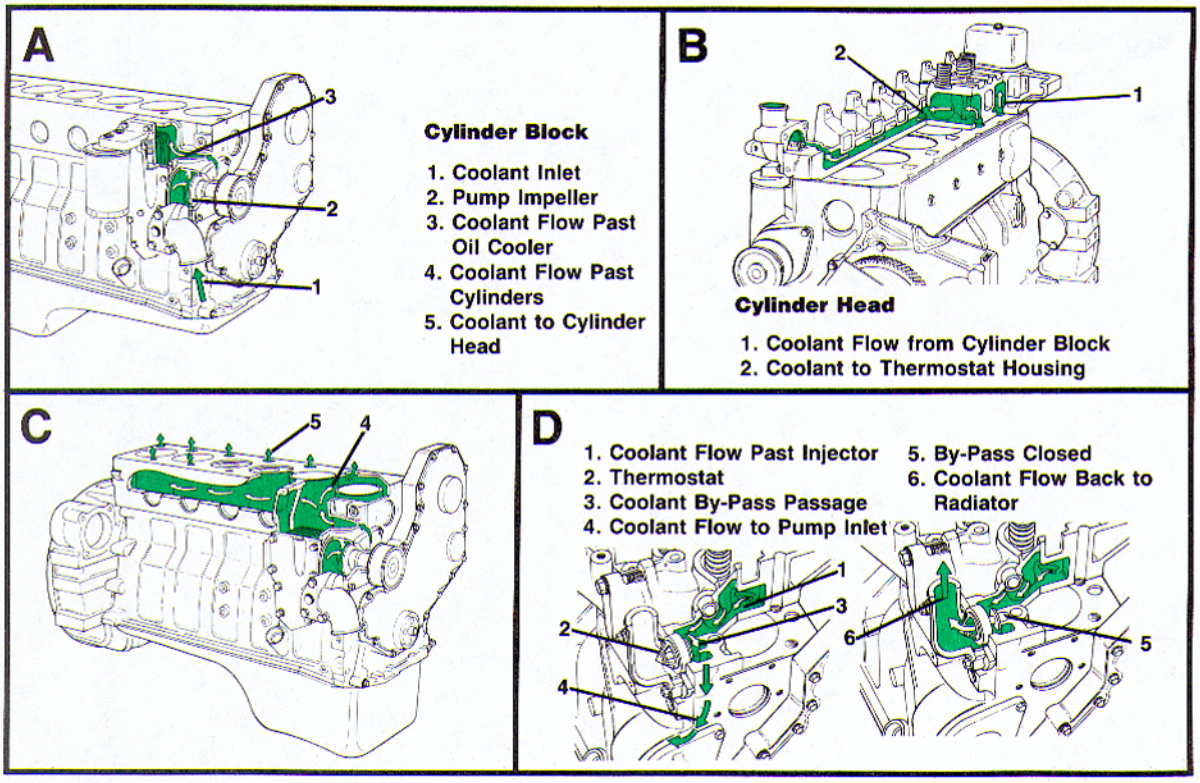
C. Coolant then flows up into the cylinder head, crosses over the valve bridges and down the exhaust manifold side of the engine to the integral thermostat housing.

D. As the coolant flows across the head toward the thermostat housing, it provides cooling for the injector. When the engine is below operating temperature, the thermostat is closed, and the coolant flow bypasses the radiator and goes to the water pump inlet through internal drillings in the block and cylinder head.

When operating temperature is reached, the thermostat open, blocking the bypass passage to the water pump and opening the outlet to the radiator.

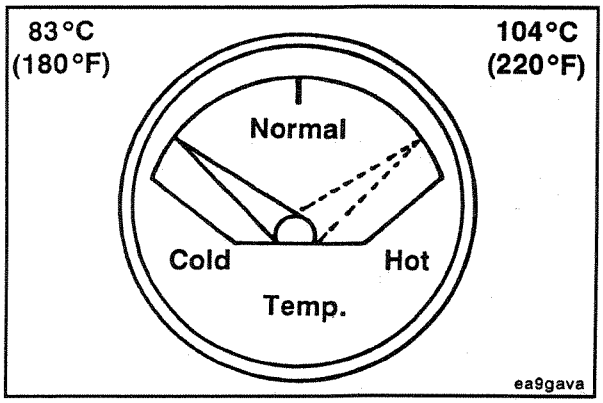
Caution: Never operate the engine without a thermostat. Without a thermostat, the coolant will not flow to the radiator and the engine will overheat.

Coolant System



Cooling System Specifications

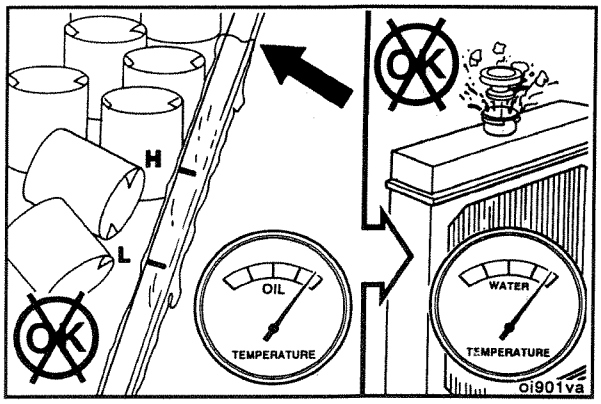
Cooling System Specifications	B3.9, 4B3.9	4BT3.9	4BTA3.9	6B5.9, 6BT5.9, B5.9	6BTA5.9
Coolant Capacity (Engine Only)- Litre [U.S. Qts.]..	7 [7.4]	7 [7.4]	9.7 [10.3]	10.5 [11.1]	14.5 [15.3]
Standard Modulating Thermostat - Range - °C [°F].....	----------	Start 83 [181]	----------	Fully Open 95 [203]	----------
Pressure Cap (kPa [PSI]) 104°C [220°F] Systems.....	103 [15]	103[15]	103 [15]	103 [15]	103 [15]
Pressure Cap (kPa [PSI]) 99°C [210°F] Systems.....	48 [7]	48 [7]	48 [7]	48 [7]	48 [7]



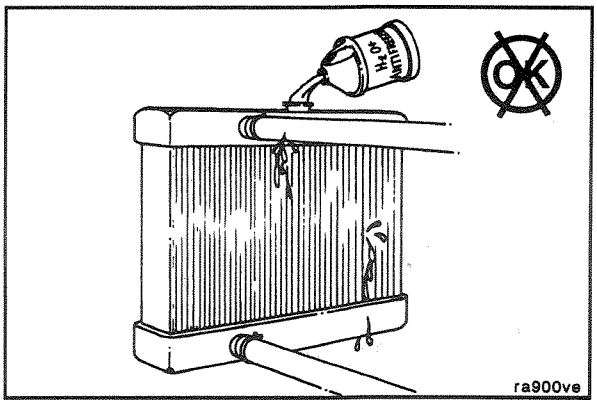
Coolant System Malfunctions (1-01)

Diagnosis

The function of the coolant system is to maintain a specified operating temperature for the engine. Some of the heat generated by the engine is absorbed by the coolant flowing through the passages in the cylinder block and head. Then, heat is removed from the coolant as it flows through the radiator. When you troubleshoot overheating, remember that too much oil in the oil pan can cause additional heat from friction when the rod journals are submerged in oil.

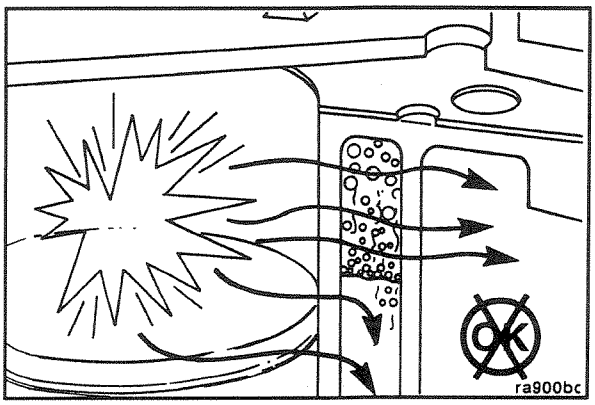


Overfilling with oil raises the oil temperature which is transferred to the coolant system at the oil cooler.



The system is designed to use a specific quantity of coolant. If the coolant level is low, the engine will run hot.

NOTE: The engine or system has a leak if frequent addition of coolant is necessary. Find and repair the leak.

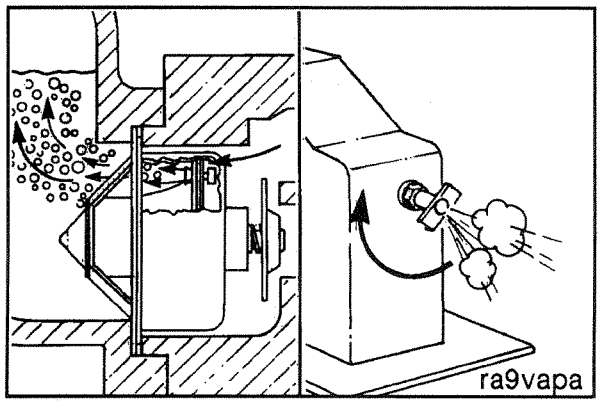


Caution: The engine coolant passages must be completely filled with coolant.

During operation entrapped air mixes with the coolant which results in cavitation corrosion and poor heat transfer. Highly aerated coolant can cause localized overheating of the cylinder head and block which can result in a cracked head, scored cylinder or blown head gasket.

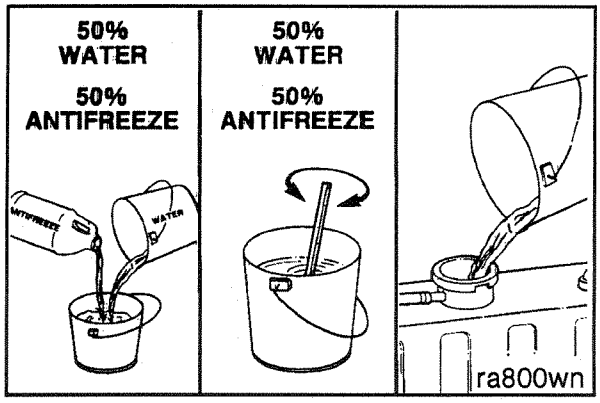
During filling, air must be vented from the engine coolant passages. The air vents through the "jiggle pin" openings to the top radiator hose and out the fill opening. Additional venting is provided for engines equipped with an aftercooler. Open the petcock during filling.

NOTE: Adequate venting is provided for a fill rate of 14 liters/minute [3.5 U.S. Gallon/minute].



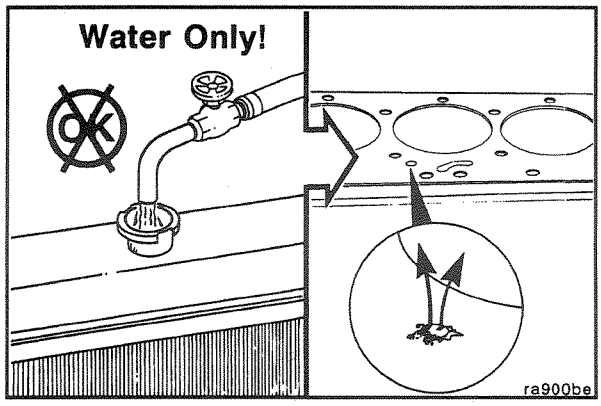
NOTE: A 50 percent mixture of antifreeze and water **must** be premixed before filling the system. The ability of antifreeze to remove heat from the engine is not as good as water, so pouring antifreeze into the engine first could contribute to an over heated condition before the liquids are completely mixed.

A mixture of 50% ethylene-glycol base antifreeze is required for operation of the engine in temperature environments above -37°C [-34°F]. A mixture of 40% water and 60% antifreeze is recommended for temperatures below -37°C [-34°F]. Never use more than 60% antifreeze.



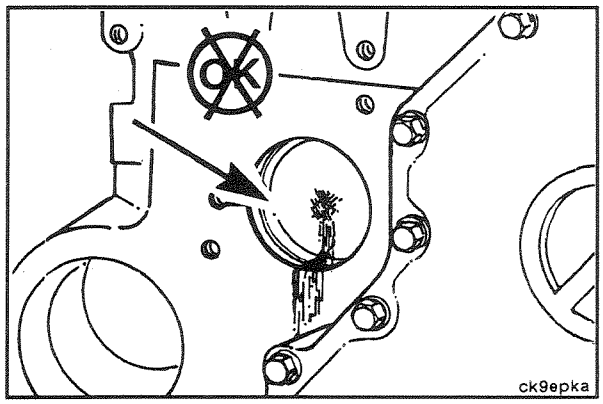
Caution: Never use water alone for coolant. Damage from corrosion can be the result of using water alone for coolant. The small holes in the head gasket are especially susceptible to plugging. These holes are orifices and their size is critical. Do not enlarge the size of the orifices. To do so will disturb the coolant flow and will not solve an overheating problem.

Water will cause rust formation reducing the flow in the smaller coolant passages.



Also, water used as a coolant for even a relatively short period can result in the cup plugs rusting through allowing the coolant to leak.

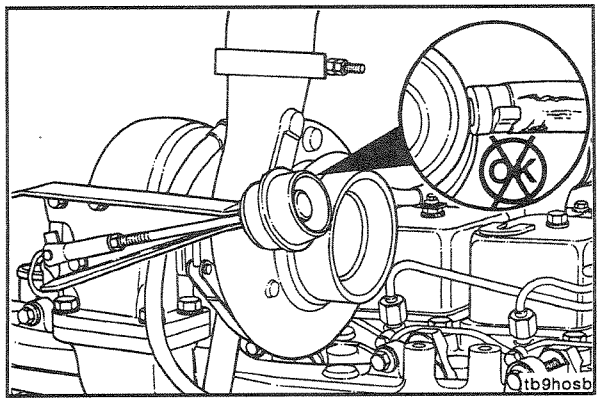
NOTE: A sudden loss of coolant from a heavily loaded engine can result in severe damage to the pistons and cylinder bore.



Turbocharger Wastegate Capsule (3-03)

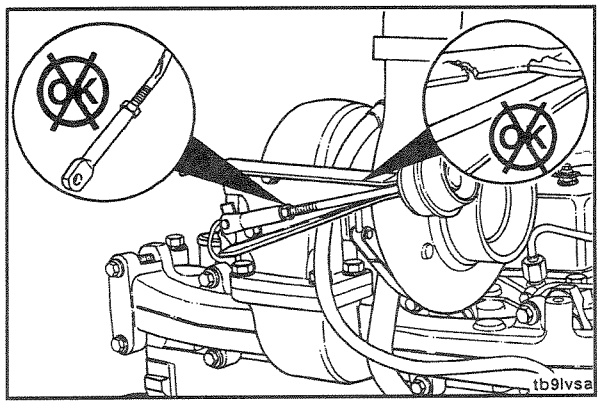
Checking

Visually inspect the wastegate actuator hose for cracks or holes. Replace the hose if damaged.



Visually inspect the wastegate mounting bracket, actuator rod, and lever for damage. A bent wastegate mounting bracket, actuator rod, or lever can cause improper operation.

If the wastegate mounting bracket, actuator rod, or lever is bent, it must be replaced. Refer to Procedure 3-05.



Turbocharger Wastegate Functional (3-04)

Checking

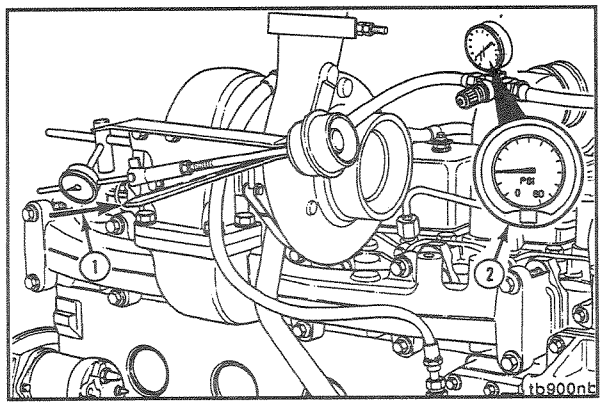
Attach a dial indicator (1) as shown, so that its shaft is in line with the wastegate actuator rod. Set the indicator to zero, with no air pressure applied to the wastegate capsule.

Connect clean regulated air pressure and a pressure gauge to the capsule (2). Apply 200 kPa [29 psi] to make sure the wastegate is functioning properly.

The rod should move approximately 5 mm [0.200 in] without any sticking or air leakage.

NOTE: No air should be heard to leak through a functional wastegate capsule.

NOTE: A small amount of travel when air pressure is first applied is normal, the tolerance is being removed from the system.



Fuel System Specifications

Distributor Type Fuel Injection Pumps

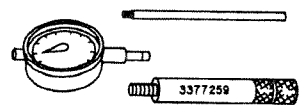
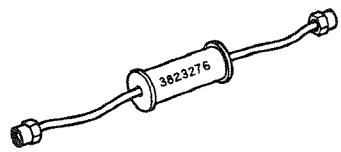
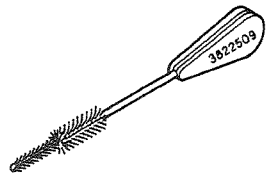
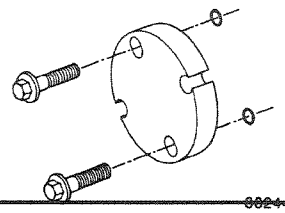
	4B3.9	4BT3.9	4BTA3.9	6B5.9	6BT5.9	6BTA5.9
Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed - mm Hg [in Hg]	100 [4]					
Maximum Allowable Return Line Restriction - mm Hg [in Hg]	518 [20.4]					
Maximum Allowable Pressure Drop Across Fuel Filter - kPa [psi]	35 [5]					
Maximum Inlet Pressure to the Injection Pump Must Not Exceed - kPa [psi]	70 [10]					

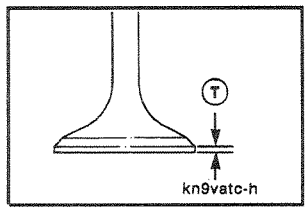
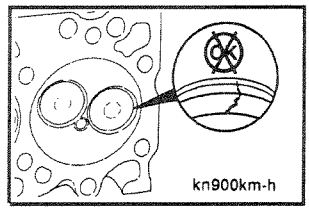
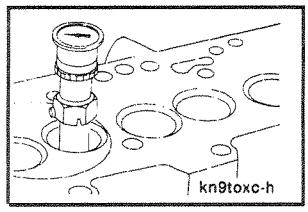
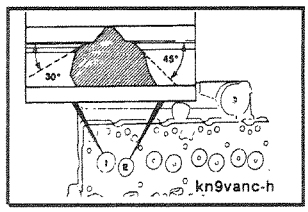
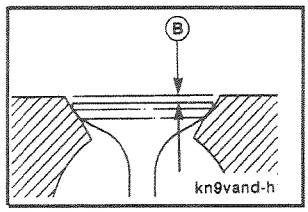
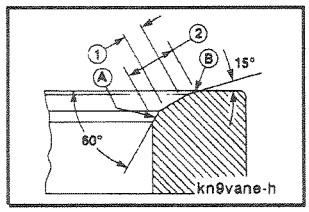
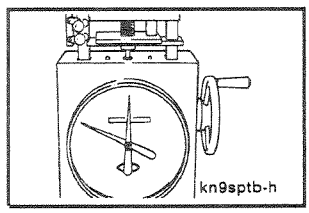
In-Line Type Fuel Injection Pumps

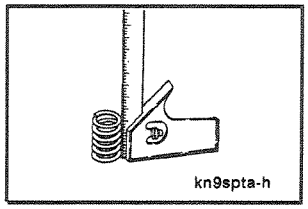
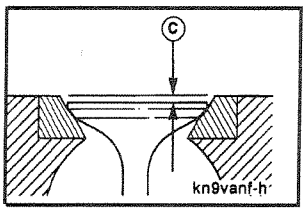
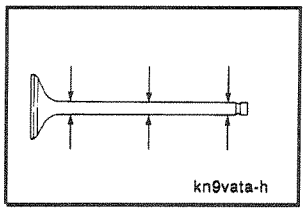
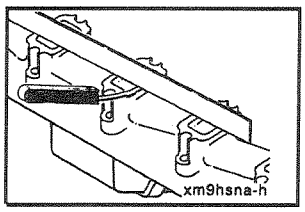
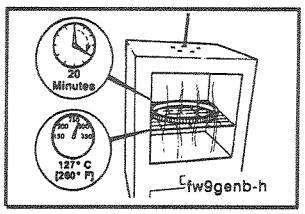
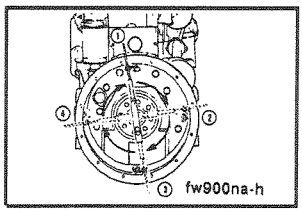
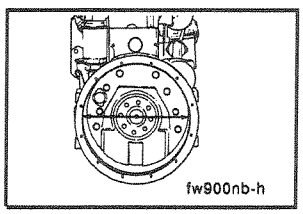
Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed mm Hg [in Hg]	100 [4]
Fuel Lift Pump Maximum Output Pressure - kPa [psi] @ Rated RPM	172 [25]
Fuel Filter Restriction (Maximum Pressure Drop Across Filters) - kPa [psi]	35 [5]
Fuel Pump Gallery Pressure - kPa [psi] Minimum @ Rated RPM	140 [20]
Fuel Return Maximum Restriction - mm Hg [in Hg]	518 [20.4]

Fuel System - Service Tools

The following special tools are recommended to perform procedures in Section 5. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
3377259	**Bosch Timing Tool (VE)**	 3377259
3823276	**Injector Puller** Used to pull the injector.	
3822509	**Injector Bore Brush** Used to clean the injector bore.	 3822509
3824469	**Fuel Pump Gear Puller** Used to pull the fuel pump gear.	

Component or Assembly (Procedure)	Ref.No./Steps	Metric		U.S.	
Valve Head Rim Thickness	T	0.79 mm	MIN	0.031 in	
Valve Seats Grinding Cleanup Depth		0.254 mm	MAX	0.010 in	
Valve Seat-to-Valve Guide Concentricity 360 Degrees		0.05 mm	MAX	0.002 in	
Valve Seat Grinding Angle		Intake: 30 Degrees Exhaust: 45 Degrees			
Valve Seat Grinding Depth Seat Grinding Depth is the Difference in Dimension "B" Before and After Grinding	B	0.254 mm	MAX	0.010 in	
Valve Seat Grinding Width Grind Area (A) with a 60 degree stone, (B) with a 15 degree stone	1 2	1.5 mm 2.0 mm	MIN MAX	0.060 in 0.080 in	
Valve Spring Compression Height 49.25 mm [1.94 in]		289.13 N 321.16 N	MIN MAX	65.0 lbf 72.2 lbf	

Component or Assembly (Procedure)	Ref.No./Steps	Metric		U.S.
 kn9spta-h	**Valve Spring Measurement**			
	Free Length	55.63 mm	MIN	2.190 in
	Inclination:	1.0 mm	MAX	0.039 in
 kn9vanf-h	**Valve Depth**	C		
		0.99 mm	MIN	0.039 in
		1.52 mm	MAX	0.060 in
 kn9vata-h	**Valve Inspection**			
	Valve Stem Diameter	7.94 mm	MIN	0.313 in
		7.98 mm	MAX	0.314 in
 xm9hsna-h	**Exhaust Manifold Flatness**	0.10 mm	MAX	0.004 in
 fw9genb-h	**Ring Gear Replacement**			
	Heat the new ring gear for 20 minutes in an oven preheated to 127°C [260°F].			
 fw900na-h	**Flywheel Bore Alignment T.I.R.**	SAE No.		
		1	0.020 mm	MAX 0.008 in
		2	0.020 mm	MAX 0.008 in
		3	0.020 mm	MAX 0.008 in
 fw900nb-h	**Flywheel Bore Runout T.I.R.**	0.127 mm	MAX	0.005 in