



200 TROUBLESHOOTING

TROUBLESHOOTING



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ENGINE WILL NOT CRANK

Possible Cause	Correction
1. Batteries have low output.	1. Check the batteries. Charge or replace as required.
2. Loose or corroded battery connections.	2. Clean and tighten battery connections.
3. Broken or corroded wires.	3. Check voltage at the following connections: — Switch to starter — Battery to starter Replace as required.
4. Faulty starter or starter solenoid.	4. Check operation of starter and solenoid. Repair as required.
5. Faulty key switch.	5. Replace key switch.
6. Internal seizure.	6. Bar the engine over one complete revolution. If the engine cannot be turned, internal damage to the clutch is indicated. Disassemble clutch or engine and repair as required.

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ENGINE CRANKS — WILL NOT START

Possible Cause	Correction
1. Slow cranking speed.	1. Check corrections listed in preceding section, ENGINE WILL NOT CRANK.
2. Emergency shut-off valve closed or partially closed.	2. Check emergency shut-off system. Make necessary repairs.
3. No fuel to engine.	3. Check for fuel in the fuel tank. Also check for plugged fuel tank connections, restricted or kinked fuel suction lines, fuel transfer pump failure, or clogged fuel filters.
4. Governor throttle shaft linkage binding/improper setting of accelerator linkage.	4. Check throttle shaft and accelerator linkage. Repair as necessary.
5. Defective fuel transfer pump.	5. Check transfer pump for minimum output pressure. Change fuel filters if low. Look for air leaks and recheck pressure. If still below minimum, replace transfer pump.
6. Poor quality fuel or water in fuel.	6. Drain fuel from tank. Replace fuel filters and fill fuel tank with MACK-specified diesel fuel.
7. Incorrect engine oil viscosity.	7. Drain oil. Replace oil filters and fill crankcase with recommended grade oil.
8. Low compression.	8. Check cylinder compression. If low, refer to LOW COMPRESSION in this section.
9. Injection pump-to-engine timing incorrect.	9. Check injection pump-to-engine timing. Setting is protected by seals, and must be checked by an authorized MACK Fuel Injection System Repair facility.

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ENGINE MISFIRES

Possible Cause	Correction
1. Poor quality fuel, or water or dirt in the fuel.	1. Drain fuel from tanks. Replace fuel filters and fill tank with MACK-specified diesel fuel.
2. Air in fuel system.	2. Check fuel system for air leaks. Repair as necessary. (Air generally gets into the fuel system on the suction side of the fuel pump.)
3. Broken or leaking high-pressure fuel lines.	3. Check for fuel leaks. Repair as necessary.
4. Restricted fuel lines or drain lines.	4. Check for proper fuel flow. If no flow, replace lines.
5. Low fuel-supply pressure.	5. Check to be sure there is fuel in the fuel tank. Check for sharp bends or kinks in the fuel line between the fuel tank and the fuel transfer pump. Also check for clogged suction pipe (in the fuel tank) or a plugged fuel suction hose. Check for air in the fuel system, and check the fuel pressure. If the pressure is lower than specified, replace the fuel filters. If still low, replace the transfer pump.
6. Improper valve lash adjustment.	6. Check adjustment. Correct as necessary.
7. Defective fuel injection nozzles or fuel pump.	7. Run engine at speed which gives maximum misfiring or rough running. Cut the fuel flow to each cylinder, one at a time, by loosening the fuel line nut on the injection pump. If engine rpm does not change when the fuel is cut to a cylinder, it indicates that the cylinder is not firing. Remove the injection nozzle and check. Repair or replace as necessary. If nozzle is OK, check cylinder for low compression. If no fuel is present when line is loosened, pump may be defective. Repair or replace as required.
8. Improper timing.	8. Check fuel injection pump to engine timing.
9. Cylinder head gasket leakage.	9. Check for visible signs of leakage, coolant in the oil, or traces of oil in the coolant. Use a compression tester to check each cylinder. Replace cylinder head gasket if necessary.
10. Worn camshaft lobe.	10. With valve lash properly adjusted, check rocker arm movement. If not within specifications, replace worn parts.

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ENGINE STALLS AT LOW SPEEDS

Possible Cause	Correction
1. Idle speed set too low.	1. Check idle setting. Adjust as necessary.
2. Fuel tank vent clogged or partially clogged.	2. Check fuel tank vents. Repair as necessary.
3. Low fuel supply.	3. Check for sufficient fuel in the fuel tank. Check for fuel leaks. Check for kinks or sharp bends in the fuel lines. Check fuel pressure; it must be within specifications. If not, replace fuel filters. If still low, repair or replace transfer pump.
4. Injection pump overflow valve leaking, or stuck open or closed.	4. Repair or replace valve.
5. Defective fuel injection nozzle.	5. Isolate defective nozzle and replace. Refer to item 7 in preceding ENGINE MISFIRES section.
6. Defective fuel injection pump.	6. Remove, repair, and reinstall pump.
7. High parasitic load.	7. Check for excessive loading due to engaged auxiliary attachments.

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ERRATIC ENGINE SPEED

Possible Cause	Correction
1. Air leaks in fuel suction line. 2. Throttle linkage loose or out of adjustment. 3. Injection pump governor failure.	1. Check for air leaks. Repair as necessary. 2. Check throttle linkage. Repair or adjust as necessary. 3. Remove injection pump and have it checked as follows by an authorized MACK Fuel Injection System Repair facility: — Check for damaged or broken springs or other components. — Check for free travel of the fuel rack. — Make sure the correct governor springs are installed. — Repair or replace damaged parts as necessary. — Recalibrate the injection pump and reinstall.

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NOTE

When diagnosing low-power complaints, it is possible to trace the trouble to chassis components rather than the engine. Make sure the chassis rolls freely when the brakes are released.

LOW POWER

Possible Cause	Correction
1. Restrictions in the air-intake system such as a clogged air filter(s). 2. Poor quality fuel. 3. Damage or restrictions in the accelerator/shut-off cable linkage. 4. Low fuel pressure. 5. Improper valve lash adjustment. 6. Incorrect fuel injection timing. 7. Plugged fuel tank vents. 8. Fuel injection nozzle failure. 9. Carbon or other friction-causing deposits in turbocharger. 10. Internal fuel injection pump wear which prevents full rack travel. 11. High-altitude operation. 12. Low boost pressure. 13. Exhaust restriction. 14. Low compression. 15. Restrictions in cooler. 16. Restrictions in cooler inlet or outlet tubes. 17. Leaking cooler.	1. Check the air pressure in the air-intake manifold. Replace the air filter and make necessary repairs to the air system. 2. Drain fuel tank(s), clean system and replace fuel filters. Fill tank with MACK-specified diesel fuel. Bleed system. 3. Check linkage and adjust to achieve full travel. Replace if damaged or bent. 4. Check fuel supply lines for kinks or restrictions. Check for air in system. Check fuel pressure. If low, replace fuel filters. If still low, replace or repair fuel transfer pump. Also check for sticking, binding or defective fuel overflow valve. Repair or replace. 5. Adjust valve lash to specified clearance. 6. Adjust fuel injection pump timing. 7. Clean the fuel tank vents. 8. Isolate defective nozzle. Repair or replace. 9. Inspect turbocharger. Clean, repair or replace as required. 10. Remove injection pump. Send the pump to an authorized MACK Fuel Injection System Repair facility for repair and recalibration. Then reinstall the pump. 11. Engines lose horsepower with increases in altitude. The percentage of power loss is governed by the altitude at which the engine is operated. Make necessary adjustments. 12. Check for restrictions in the air-intake system. 13. Check for restrictions in the exhaust system. 14. Check items listed for low compression. 15. Perform restriction pressure test. Clean any restrictions. 16. Disconnect tubing and clean restrictions. 17. Repair or replace leaking cooler.

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ENGINE WILL NOT ACHIEVE NO-LOAD GOVERNED RPM

Possible Cause	Correction
1. Air in fuel system.	1. Check system for air leaks and correct as required. Air will generally enter the fuel system on the suction side of the fuel transfer pump.
2. Accelerator linkage loose or out of adjustment.	2. Check linkage. Make necessary adjustments.
3. Restricted fuel lines or stuck overflow valve.	3. Check flow in fuel lines. Check overflow valve for defects, improper setting, sticking, or defective spring.
4. High idle adjustment set too high.	4. Check high idle adjustments. Adjust as required.
5. Chassis equipped with MACK Maxi-Miser: Air leaks in the air supply line or defective control valve.	5. Leaks in the air supply line to the transmission, or from the transmission to the fuel injection pump governor, will restrict maximum engine rpm in all gears. Check all lines and connections for leaks and repair as required. Replace control valve if necessary.
6. Fuel injection pump calibration incorrect.	6. Remove injection pump and nozzle assemblies from the engine. Send the pump to an authorized MACK Fuel Injection System Repair facility for repair and recalibration. Then reinstall the pump.
7. Internal fuel pump governor wear.	7. Remove the injection pump. Send the pump to an authorized MACK Fuel Injection System Repair facility for repair and recalibration. Then reinstall the pump.

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EXCESSIVE ENGINE VIBRATION

Possible Cause	Correction
1. Loose vibration damper hub nut bolt.	1. Check condition of mounting. Make necessary repairs and retorquing.
2. Defective or damaged vibration damper.	2. Replace damper if it is verified as damaged or defective.
3. Fan blade not balanced.	3. Loosen or remove fan belts. Run the engine for a short period of time at the rpm where the vibration was most noticeable. If the vibration disappears, replace the fan assembly.
4. Engine supports loose, worn or defective.	4. Tighten all mounting bolts, or replace components as required.
5. Engine misfiring or running rough.	5. Check items listed in ENGINE MISFIRES in this section.

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EXCESSIVE BLACK OR GRAY SMOKE

Possible Cause	Correction
1. Insufficient air for combustion.	1. Check air cleaner for restrictions. Check inlet manifold pressure, and inspect the turbocharger for proper operation. Repair or replace as required.
2. Excessive exhaust back pressure.	2. Check for faulty exhaust piping or restrictions in the muffler. Repair or replace as required.
3. Improper grade of fuel.	3. Drain fuel from tank(s). Replace fuel filters and fill tank(s) with MACK-specified diesel fuel.
4. Faulty fuel injection nozzle.	4. Isolate faulty nozzle and replace. Refer to item 7 in ENGINE MISFIRES in this section.
5. Improper injection pump-to-engine timing.	5. Check timing and adjust as required.

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EXCESSIVE BLUE OR WHITE SMOKE

Possible Cause	Correction
1. Engine lubricating oil level too high.	1. Drain excess lubricating oil. If the oil is contaminated with either fuel or coolant, completely drain the oil pan. Change the oil filters. Locate the source of the leak and correct. Fill with MACK-specified engine oil. Check the oil level with the dipstick. DO NOT overfill.
2. Turbocharger oil seal failure.	2. Check for oil in the inlet manifold. Install remanufactured turbocharger.
3. Worn piston rings.	3. Check cylinder walls for scuffing. Clean or replace sleeves as required. Install new piston rings.
4. Engine misfiring or running rough.	4. Check items as outlined in ENGINE MISFIRES in this section.
5. Incorrect fuel injection pump-to-engine timing.	5. Check and reset timing as required.

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EXCESSIVE FUEL CONSUMPTION

Possible Cause	Correction
1. Restrictions in the air induction system.	1. Inspect system. Remove restrictions and replace defective parts as required.
2. External fuel system leakage.	2. Check external piping on fuel system for signs of fuel leakage. Repair as required.
3. Incorrect fuel injection pump-to-engine timing.	3. Check fuel injection pump-to-engine timing. Reset as required.
4. Defective injection nozzle assembly.	4. Isolate defective nozzle assembly. Repair or replace as required.
5. Incorrect fuel injection pump calibration.	5. Remove injection pump and nozzle assemblies from the engine. Send the pump to an authorized MACK Fuel Injection System Repair facility for recalibration. Then reinstall the pump and nozzle assemblies.
6. Internal engine wear.	6. Overhaul engine.

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EXCESSIVE OIL CONSUMPTION

Possible Cause	Correction
1. External oil leaks.	1. Check engine for visible signs of oil leakage. Look for loose or stripped oil drain plugs, broken gaskets (cylinder head cover, etc.) and front and rear oil seal leakage.
2. Clogged crankcase breather pipe.	2. Remove obstructions.
3. Excessive exhaust back pressure.	3. Check exhaust pressure. Repair as required.
4. Worn valve guides.	4. Replace valve guides.
5. Air compressor passing oil.	5. Repair or replace air compressor.
6. Turbocharger sealing rings failure.	6. Check for oil in the inlet manifold. Install remanufactured turbocharger.
7. Internal engine wear.	7. Overhaul engine.

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ENGINE OVERHEATS

Possible Cause	Correction
1. Coolant level low.	1. Locate cause. Look for leaking gaskets or loose or leaking hoses. Repair, replace or tighten as required. Replenish coolant.
2. Loose or worn fan belts.	2. Adjust belt tension or replace belts as required.
3. Restricted airflow through radiator.	3. Remove any restrictions from the outer surface of the radiator.
4. Defective radiator pressure cap.	4. Test pressure of the radiator cap. Replace cap, if required.
5. Defective coolant thermostat or temperature gauge.	5. Check opening temperature of thermostat. Check for correct installation. Check temperature gauge. Replace if defective.
6. Fan improperly positioned or viscous drive fan not operating properly.	6. Check fan operation. Repair as required.
7. Shutters not opening properly (for chassis equipped with shutters).	7. Check shutter operation. Repair as required.
8. Combustion gases in coolant.	8. Determine point where gases are entering the cooling system. Repair or replace parts as required.
9. Plugged oil cooler.	9. Remove oil cooler. Disassemble, remove restrictions/replace parts as required. Reinstall.
10. Defective water pump.	10. Remove, repair or reinstall water pump as required.
11. Incorrect fuel injection pump-to-engine timing.	11. Check fuel injection pump to engine timing. Reset timing as required.
12. Improper valve lash adjustment.	12. Adjust valve lash to specified clearance.

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HIGH EXHAUST TEMPERATURE

Possible Cause	Correction
1. Operating chassis in wrong gear ratio for load, grade and/or altitude.	1. Instruct operator on correct gear selection for load and grade conditions.
2. Restrictions in the air induction system.	2. Inspect air induction system. Remove restrictions and/or replace defective parts.
3. Air leaks in the air induction system.	3. Check pressure in the air intake manifold. Look for leaking piping, and/or loose clamps. Make necessary repairs.
4. Leaks in the exhaust system (before the turbocharger).	4. Check exhaust system for leaks. Make necessary repairs.
5. Incorrect fuel injection pump-to-engine timing.	5. Check fuel injection pump-to-engine timing. Adjust as required.
6. Restrictions in the exhaust system.	6. Inspect system. Make necessary repairs.
7. Improper valve lash adjustment.	7. Adjust valve lash setting to specified clearance.
8. Defective fuel injection nozzle assembly.	8. Isolate defective nozzle assembly. Remove, repair and/or replace and reinstall.
9. Incorrect fuel injection pump calibration.	9. Remove injection pump and nozzle assemblies. Send fuel injection pump to an authorized MACK Fuel Injection System Repair facility for recalibration. Then reinstall the pump and nozzle assemblies.
<i>High Pyrometer — Normal Boost</i>	
10. Loose ducting.	10. Repair loose connections.
11. Core fin obstructions.	11. Clean core fins.
<i>High Pyrometer — Low Boost</i>	
12. Blockage in ducting between the air cleaner and the turbocharger.	12. Check for blockage and repair.
13. Dirty turbocharger.	13. Remove turbocharger and clean.
14. Leaks in the pressurized side of the air induction system.	14. Check for leaks. Repair as required.
15. Core leak or inlet manifold leak.	15. Check for damaged core gaskets.
16. Open petcock.	16. Close petcock.
17. Core leakage.	17. Pressure test core. Remove, repair or replace core if test results are unsatisfactory.

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LOW ENGINE OIL PRESSURE

Possible Cause	Correction
1. Oil level insufficient. Oil leaking from oil line, gasket, etc.	1. Check engine oil level. Add oil if necessary. Check for oil leaks. Repair as required.
2. Incorrect oil viscosity.	2. Drain oil, change oil filters, and fill with the proper grade oil meeting MACK specifications.
3. Defective oil pressure gauge.	3. Check the operation of the oil pressure gauge. If defective, replace.
4. Clogged oil filter(s).	4. Replace oil filters. Clean or replace oil cooler. Drain oil and refill with oil meeting MACK specifications.
5. Engine oil diluted with diesel fuel.	5. Check fuel system for leaks. Make necessary repairs. Drain diluted oil, change oil filters, and refill with oil meeting MACK specifications.
6. Defective oil pump relief valve.	6. Remove oil pressure relief valve and check condition of seat. Check that relief valve spring is not sticking, and check for proper spring tension. Check cap. Check assembly parts. Using the incorrect parts will result in incorrect oil pressure. Make any necessary repairs or install a new relief valve.
7. Oil pump gears not meshing properly.	7. Check mounting arrangement. If the engine has been rebuilt, check that the gear ratio of the oil pump drive and driven gears are correct. Incorrect gear combinations will result in immediate gear failure and possible engine damage. Check for correct oil pad gasket.
8. Excessive clearance between crankshaft and bearings.	8. Overhaul the engine. Replace any worn/defective parts.

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OIL IN THE COOLING SYSTEM

Possible Cause	Correction
1. Defective oil cooler core.	1. Disassemble and repair or replace oil cooler core.
2. Blown head gasket.	2. Replace head gasket.

COOLANT IN ENGINE OIL

Possible Cause	Correction
Cylinder sleeve seat seal failure.	Repair cylinder sleeve seat seals.

LOW COMPRESSION

Possible Cause	Correction
1. Improper valve lash adjustment.	1. Adjust valve lash to specified clearance.
2. Blown head gasket.	2. Replace head gasket.
3. Broken or weak valve springs.	3. Check and replace defective parts.
4. Burned valves, seats or parts.	4. Remove, recondition, and reinstall heads.
5. Piston rings stuck, worn, broken or improperly seated.	5. Overhaul engine.
6. Camshaft or valve lifters worn.	6. Replace camshaft and/or valve lifters. Overhaul engine if required.

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CAMSHAFT TIMING CHECK

Correct camshaft timing is essential for proper engine performance. Incorrect camshaft timing may be suspected if soon after engine overhaul, lack of performance, unusual noise or excessive smoke are reported.

NOTE

Camshaft timing can be checked using either cylinder No. 3 or No. 4 inlet valve. For example purposes, No. 3 cylinder will be used in the steps below.

1. Remove cylinder head cover over cylinder No. 3.
2. Locate inlet valve(s) for the No. 3 cylinder (the sixth valve from front of the engine). Position No. 3 piston at Top Dead Center (TDC) (compression stroke).
3. Loosen (back off) the inlet valve rocker adjusting screw. Ensure valve yoke is correctly adjusted. Adjust inlet valve to zero lash.
4. Position dial indicator (magnetic-base type) probe on valve spring retainer. Preload indicator to 1/2 indicator plunger travel.
5. Bar the engine in direction of normal rotation and carefully observe direction in which needle of indicator travels. Use dial indicator to determine when the inlet valve is fully open.
6. Stop rotating engine when travel of dial indicator needle stops. If dial indicator needle reverses direction, full-open position is passed. Repeat procedure.
7. Check timing indicator. Pointer should be within three degrees (retard or advance) of timing indicator specification given in table that follows. A difference of approximately 10 degrees indicates crankshaft to camshaft timing gears may be mismatched one tooth.
8. If the engine has a front timing indicator, the pointer marked **PUMP** must be used for the camshaft timing check. The pointer marked **VALVE** is used only for valve adjustment.

CAMSHAFT AND TIMING INDICATOR RELATIONSHIP

Camshaft Part No.	Timing Indicator
583, 583A	20 degrees BTDC
5142	26 degrees BTDC
5205	27 degrees BTDC

CAMSHAFT LOBE LIFT CHECK

When diagnosing potential lifter or camshaft failures, 0.030 inch (0.76 mm) less than the lift of a new camshaft is considered the minimum acceptable camshaft lobe lift for used components. Intake lobe lift differs depending on the camshaft part number. Camshaft lobe lift is measured by using a dial indicator at the push rod with the rocker arm adjusted to zero lash. Refer to the chart below for the minimum acceptable camshaft lobe lift for the different part number E7 camshafts.

MINIMUM ACCEPTABLE CAMSHAFT LOBE LIFT

Camshaft Part No.	Exhaust Lobe	Intake Lobe
454GC583, 454GC583A	0.300"	0.300"
454GC5142	0.300"	0.270"
454GC5205	0.300"	0.280"



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PROPER FIRE RING/CYLINDER SLEEVE-TOP COMBINATIONS

General Information

Two types of cylinder head gasket/fire ring kits are available for E7 engines: a flat fire-ring kit and a stepped fire-ring kit. Both kits include instructions.

Two sleeve-top configurations are also available. Use the correct fire ring and cylinder sleeve combination to ensure full contact support and improved combustion sealing. MACK recommends using the latest cylinder sleeve configuration when replacing all six sleeves. The hardware selections for single cylinder sleeve replacement and complete overhauls are sometimes different. Either of the two correct sleeve/fire ring configurations provide equal combustion sealing.

CAUTION

Failure to use the correct fire ring can result in insufficient sealing and damage to the engine.

NOTE

To identify the fire ring/sleeve-top configuration, look at the sleeve top outboard of the coining bead. If the surface between the coining bead and the sleeve OD is flat, it is an older sleeve and requires a stepped fire ring. If the surface has a step, use a flat fire ring. Refer to Figures 9-1 and 9-2.

Engines Built Prior to 1993

Refer to Figure 9-1.

All pre-1991 E7 engines were manufactured with the type of cylinder sleeve shown in Figure 9-1, and originally used flat fire rings. MACK no longer recommends this combination. Replace the fire rings on both heads with the stepped fire ring.

E7 engines built between January 1991 and June 1993 (before 3L serial number) require stepped fire rings. The sleeve and piston ring sets for these engines are different from earlier engines, but the sleeve-top design is the same.

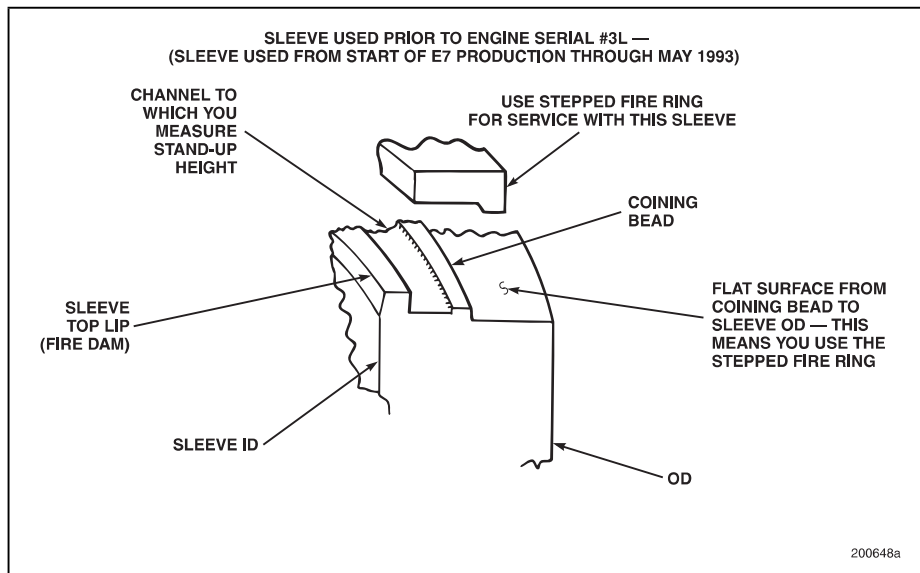


Figure 9-1— Cylinder Sleeve/Fire Ring Configuration (Through May 1993)



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If replacing less than a full set of six sleeves, use the same original production sleeve. For each sleeve replaced, use a new crevice seal and apply Silastic at the cylinder block sleeve seat. Depending on their condition, new piston ring sets may also be needed. O-rings are no longer used in the cylinder block groove below the sleeve seats.

When it is necessary to replace all the sleeves, use the new full-contact type sleeves with flat fire rings. Also use new crevice seals, Silastic and new piston ring sets. O-rings are no longer used in a groove in the cylinder block below the sleeve seats.

NOTE

Some engines built before June 1993 may be fitted with sleeves which use flat fire rings. Always visually examine all six sleeves to determine which sleeve-top configuration applies.

If replacing head gaskets with original parts, use the sleeve-top configuration shown in Figure 9-1 and the cylinder gasket kit with the stepped fire ring.

Engines Built from June 1993 to Present (3L Serial Number and Later)

Refer to Figure 9-2.

E7 engines built since June 1993 use the full-contact type of cylinder sleeve. This sleeve provides full-contact support for the flat fire ring.

If replacing sleeves, either a full or partial set, use the same type sleeve. For each sleeve replaced, use a new crevice seal and apply Silastic to each cylinder block sleeve seat. Depending on their condition, new piston ring sets may also be needed for each sleeve replaced. O-rings are no longer used in the cylinder block groove below the sleeve seats.

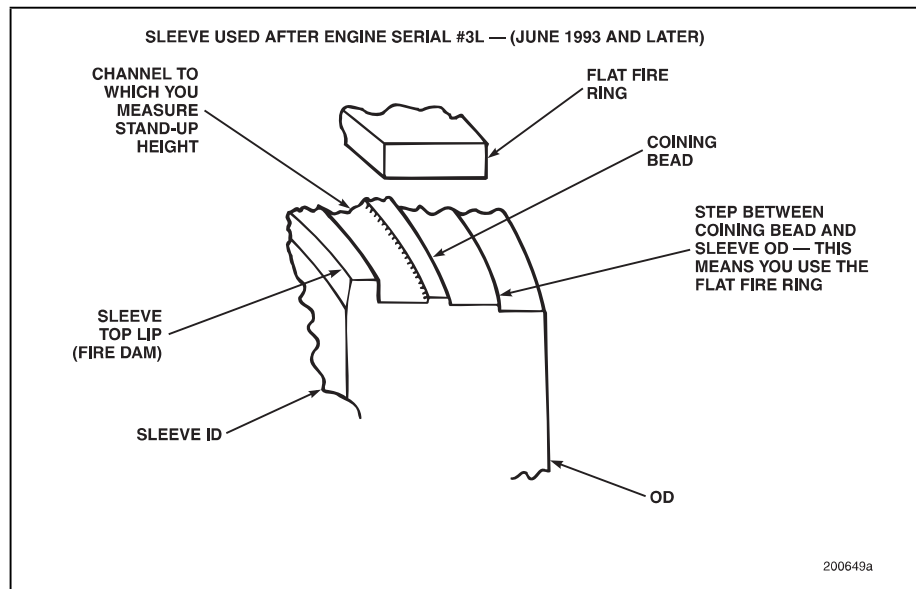


Figure 9-2— Cylinder Sleeve/Fire Ring Configuration (June 1993 and Later)



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Cylinder Head and Cylinder Block Leak Test Procedure

Verify suspected leaks in the cylinder heads or cylinder block by pressure testing before deciding to replace the cylinder head or block. Do not use magnaflux inspections alone as replacement criteria.

Before proceeding with the following tests, make sure leakage is not from the oil cooler or air compressor. Watch for small bubbles indicating minor leaks that can develop into more severe leaks during engine operation.

NOTE

To prevent unnecessary engine disassembly, perform the simpler checks first.

CYLINDER HEAD AND HEAD GASKET CHECK — IN CHASSIS

1. Look for coolant stains around the 3/4-inch NPT pipe plugs on top of the cylinder heads. Check plug torque. Plug torque specification is 28 lb-ft (38 N•m). Refer to Figure 9-3.

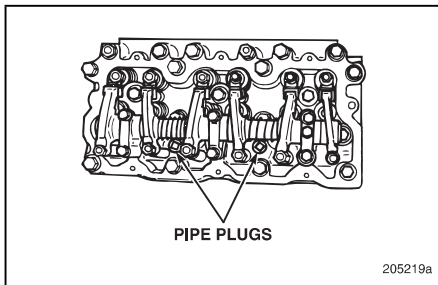


Figure 9-3 — Cylinder Head Pipe Plugs (3/4-Inch NPT)

2. Before removing thermostat, drain coolant from the cooling system until coolant level is below the thermostat housing.
3. Remove the thermostat and leave the thermostat housing open. Install a short section of hose, approximately 6–8 inches (152–203 mm) long, on thermostat housing. Add enough coolant to fill the thermostat housing.
4. Remove fan belts from the water pump.

5. Start engine and run at 1000 rpm.
6. Observe coolant in the thermostat housing for air bubbles. This indicates combustion pressurization of the cooling system and possible cylinder head gasket failure. Air bubbles may also indicate leakage from the cylinder head or oil passage.
7. Apply a soap-and-water solution between two cylinder heads to check for external combustion leakage.

CYLINDER HEAD FUEL PASSAGES LEAK CHECK — IN CHASSIS

NOTE

The symptoms of coolant-in-fuel are a loss of coolant with no apparent external leak, together with one or more of the following: coolant in fuel tank, coolant in fuel filter or yellow fuel out of fuel return line.

1. Disconnect the return fuel inter-connecting tube between the front and rear cylinder heads. Run a line from each cylinder head into a container.
2. Pressurize the cooling system with a maximum of 15 psi (103 kPa) air pressure and look for coolant coming out of a fuel return line.
3. An alternative method is to disconnect the fuel return line at the front of the front cylinder head. Introduce a maximum air pressure of 25 psi (172 kPa) to the fitting in the cylinder head. Then look for air bubbles in the coolant.
4. After determining which cylinder head is suspected of leaking, remove the nozzles from that cylinder head and pressurize the cooling system with a maximum of 15 psi (103 kPa). Look into each nozzle sleeve bore for signs of coolant leakage.
5. A cracked or leaking nozzle sleeve should be replaced as an on-engine repair using the procedures described in the ENGINE DISASSEMBLY section. If replacing the nozzle sleeve(s) and the re-pressure test shows that the problem still exists, the cylinder head(s) should be replaced.



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CYLINDER BLOCK/CYLINDER HEAD COOLANT PASSAGES LEAK CHECK — IN CHASSIS

Refer to Figure 9-4.

1. Drain coolant from the engine.
2. Remove the engine oil pan and valve lifter covers.
3. Remove the water pump assembly and use a suitable plate and gasket to seal opening.
4. Remove the upper and lower hoses from the thermostat housing. Remove the thermostat housing and thermostat.
5. Secure a suitable plate and gasket over the thermostat housing opening.
6. Install an air fitting into one of the pipe plug holes in the coolant manifold.
7. Reinforce the hose connecting the coolant manifold sections by installing a hose clamp around the center of the hose to prevent the hose from rupturing during testing.
8. Remove one of the large pipe plugs from the water manifold and add hot water to fill the cooling system. Increase cylinder block temperature to 150°F (66°C). Loosen one of the pipe plugs near the top of the cylinder block to bleed air from the water jacket while filling. Also open the block drain to allow water to flow out. This will help warm the cylinder block.
9. After cylinder block is sufficiently heated, close block drain and apply approximately 50 psi (345 kPa) air pressure to the air connection.

CAUTION

Do not exceed 50 psi (345 kPa) air pressure. Damage to seals or cup plugs may result.

10. Check for coolant leaks at the bottom of each cylinder bore.

- Coolant leaking between the cylinder sleeve outside diameter and cylinder block indicates a leaking cylinder sleeve seat.
- Coolant leaking down the inside diameter of the cylinder sleeve indicates a leaking head gasket.

NOTE

Water leaking from the No. 2 or No. 5 cam bushings or from the No. 2 or No. 5 main bearings can indicate a breakthrough between the rocker arm feed passage and the water jacket.

Refer to the repair procedures in this manual to correct leaks.



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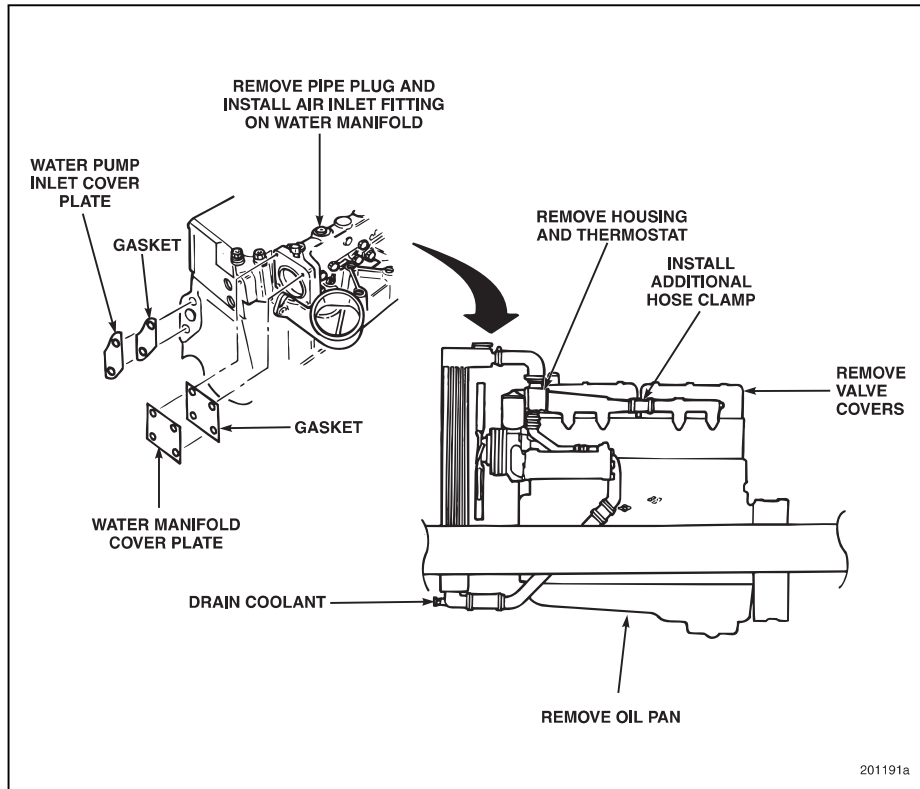


Figure 9-4 — Cylinder Block/Cylinder Head Leak Check (In Chassis)



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CYLINDER HEAD OIL PASSAGE LEAK CHECK — OUT OF CHASSIS

Refer to Figure 9-5.

1. Remove cylinder head from the engine.
2. Install a suitable plug to seal the rocker arm oil passage at deck side of head. There are two ways to plug the hole:
 - Drill and tap the oil passage to accept a pipe plug.
 - Insert a suitable rubber plug and clamp the plug in position with a C-clamp.
3. Install an air fitting in the rocker arm passage in the top of the head. Use a discarded rocker arm bracket, preferably with an oil feed passage. Cut the bracket through the rocker arm shaft bore parallel to the mounting surface. Drill and tap the oil supply passage to accept an air fitting.

4. Bolt the modified bracket, with air fitting, to the cylinder head over the oil supply passage.
5. Immerse cylinder head in water and heat to 150°F (66°C).
6. Apply up to 50 psi (345 kPa) air pressure to air fitting adapter installed in rocker arm oil passage. Check for air bubbles. The formation of air bubbles indicates internal leakage in cylinder head oil passage.

CAUTION

Do not exceed 50 psi (345 kPa). Damage to seals or cup plugs may result.

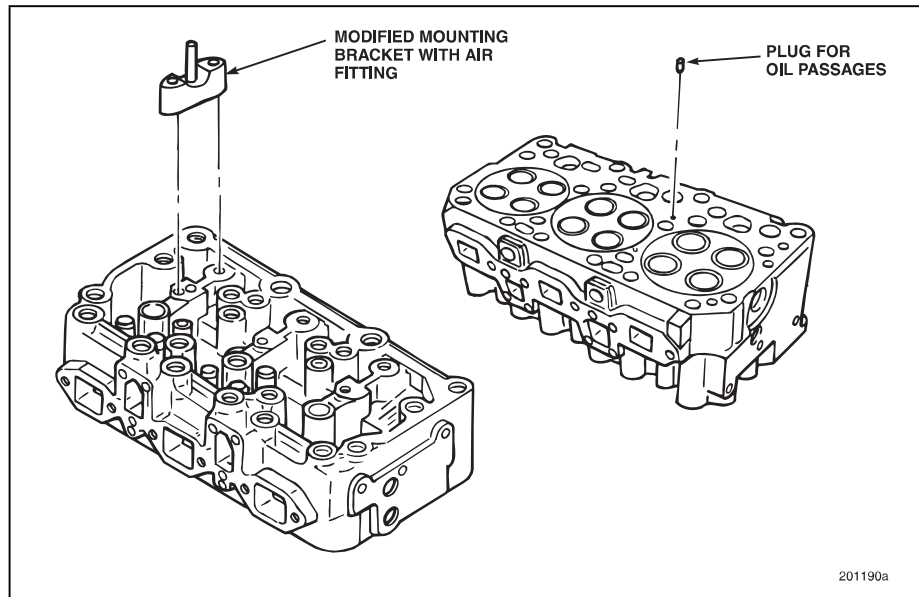


Figure 9-5 — Cylinder Head Oil Passage Leak Check (Out of Chassis)



200 TROUBLESHOOTING

CYLINDER HEAD COOLANT PASSAGE LEAK CHECK — OUT OF CHASSIS

Refer to Figure 9-6.

1. Remove cylinder head from engine.
2. Fabricate a suitable 3/4-inch-thick (19.1 mm) steel plate and a 1/4-inch (6.4 mm) rubber gasket. The plate must have cutouts for the entire combustion chamber. Position plate and gasket assembly on underside of head and secure with C-clamps.
3. Use suitable plate and gasket to seal water manifold openings. Install an air fitting onto the plate.
4. Immerse cylinder head in water. Heat water and head to 150°F (66°C).
5. Apply up to 50 psi (345 kPa) air pressure to the fitting installed in the plate covering the water manifold opening. Check for air bubbles. The formation of air bubbles indicates that cylinder head coolant passages may be leaking.

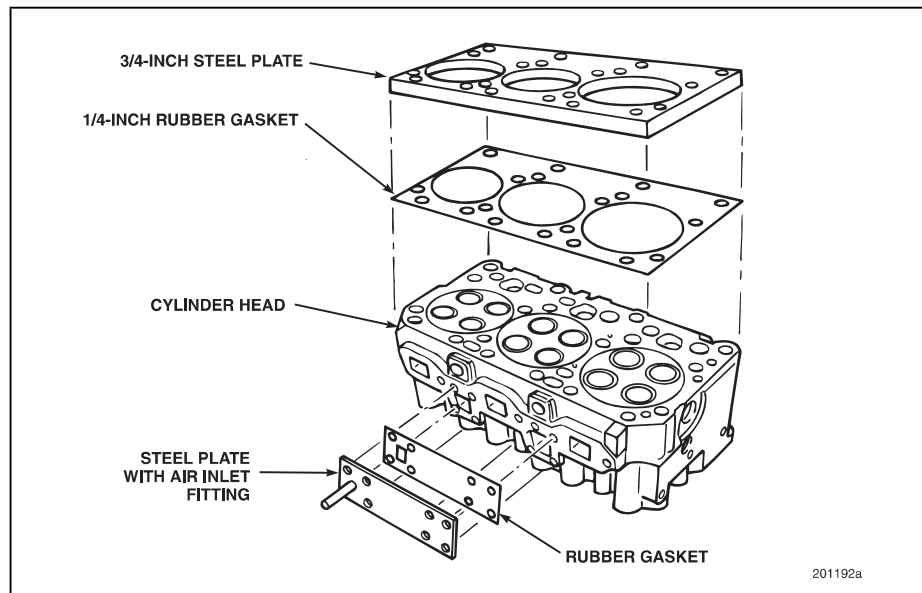


Figure 9-6 — Cylinder Head Coolant Passage Leak Check (Out of Chassis)



200 TROUBLESHOOTING

CYLINDER BLOCK COOLANT PASSAGE LEAK CHECK — OUT OF CHASSIS

Refer to Figure 9-7.

1. Fabricate two 3/4-inch thick (19.1 mm) steel plates to simulate cylinder heads. The plates must have cutouts for the head capscrews and liners. Use a 1/4-inch (6.4 mm) rubber gasket as a seal. Install the plates onto the cylinder head.

NOTE

As an alternative to step 1, conduct the test using two known leak-free cylinder heads complete with gaskets and fire rings in place of the steel plates. With this alternative, a water manifold (with the outlet end sealed) can be used to seal off the cylinder head coolant ports. Fittings can be installed on the water manifold to introduce the heated water and air pressure needed for the test.

2. Remove water pump assembly and seal opening with a suitable plate and rubber gasket. The plate must be fabricated so that water heated to 150°F (66°C) and pressurized to 50 psi (345 kPa) can be introduced into the system.
3. Apply approximately 50 psi (345 kPa) air pressure into the cooling system. Visually inspect the cylinder block for signs of air and water leaks.

CAUTION

Do not exceed 50 psi (345 kPa). Damage to seals or cup plugs may result.



200 TROUBLESHOOTING

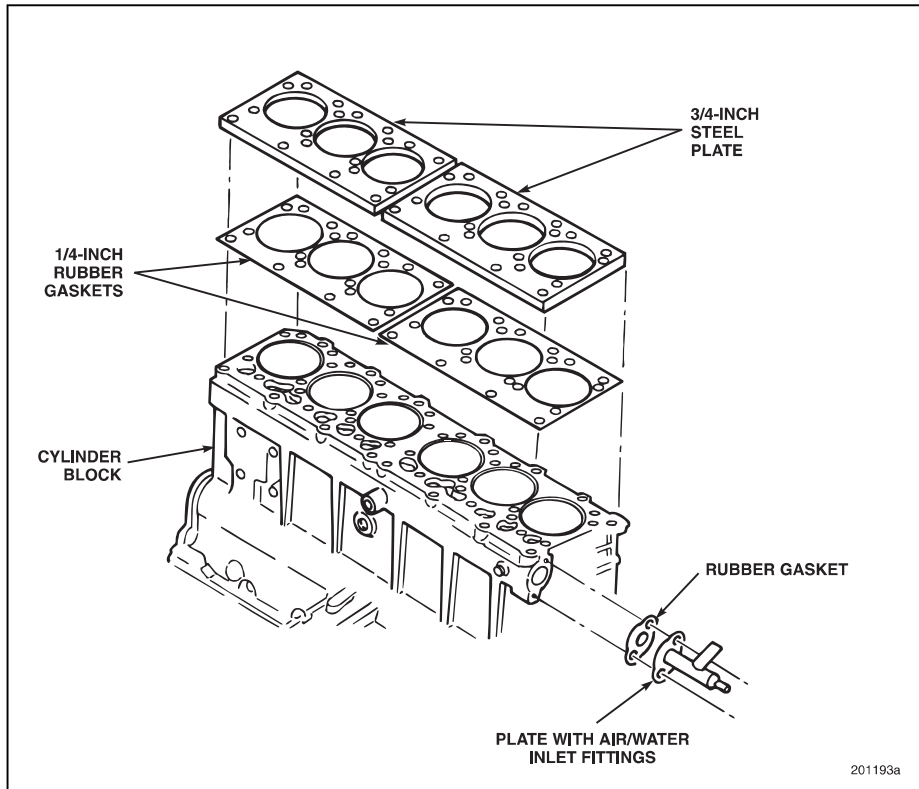


Figure 9-7 — Cylinder Block Coolant Passage Leak Check (Out of Chassis)



NOTES



200 APPENDIX

APPENDIX



200 APPENDIX

E7 ENGINE SERIAL NUMBERS, JACOBS BRAKE APPLICATION

The following is a list of selected 1990 E7 engine serial numbers requiring 0.080-inch (2.03 mm) Jacobs thickness gauge 017099 for Jacobs

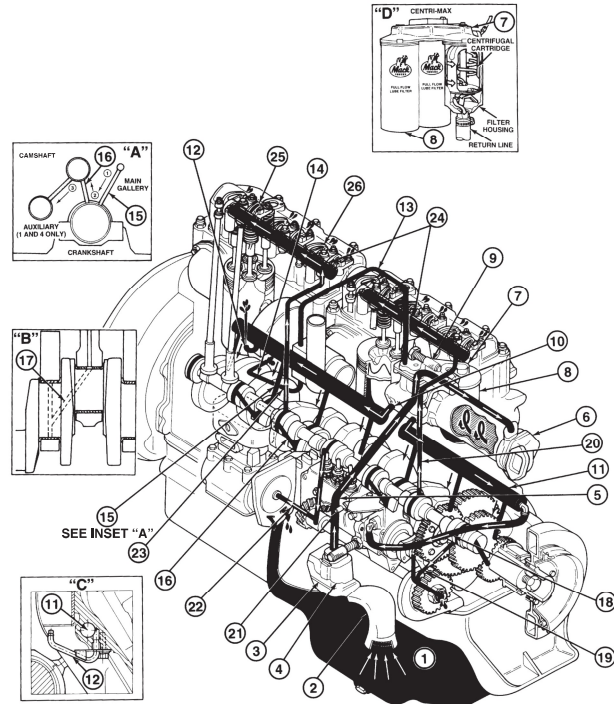
Brake slave piston adjustment. Refer to the Slave Piston Adjustment procedure in the SETUP AND ADJUSTMENTS section of this manual.

OW1577	OX0114	OX0115	OX0116	OX0169	OX0170	OX0234	OX0235
OX0258	OX0306	OX0307	OX0334	OX0417	OX0468	OX0481	OX0482
OX0483	OX0512	OX0549	OX0594	OX0595	OX0602	OX0603	OX0604
OX0605	OX0637	OX0638	OX0639	OX0640	OX0646	OX0647	OX0720
OX1134	OX1157	OX1158	OX1159	OX1168	OX1169	OX1273	OX1274
OZ0009	OZ0028	OZ0029	OZ0030	OZ0031	OZ0056	OZ0064	OZ0089
OZ0090	OZ0092	OZ0093	OZ0094	OZ0148	OZ0163	OZ0164	OZ0166
OZ0167	OZ0192	OZ0193	OZ0194	OZ0205	OZ0206	OZ0207	OZ0208
OZ0227	OZ0228	OZ0229	OZ0230	OZ0231	OZ0244	OZ0284	OZ0286
OZ0351	OZ0352	OZ0353	OZ0357	OZ0358	OZ0359	OZ0360	OZ0361
OZ0391	OZ0392	OZ0393	OZ0405	OZ0406	OZ0426	OZ0427	OZ0428
OZ0429	OZ0430	OZ0483	OZ0484	OZ0485	OZ0486	OZ0487	OZ0488
OZ0497	OZ0498	OZ0553	OZ0554	OZ0564	OZ0579	OZ0580	OZ0581
OZ0582	OZ0586	OZ0597	OZ0604	OZ0624	OZ0655	OZ0663	OZ0674
OZ0675	OZ0690	OZ0745	OZ0746	OZ0747	OZ0748	OZ0749	OZ0750
OZ0751	OZ0752	OZ0753	OZ0754	OZ0755	OZ0756	OZ0757	OZ0758
OZ0759	OZ0760	OZ0761	OZ0762	OZ0763	OZ0765	OZ0766	OZ0768
OZ0843	OZ0848	OZ0882	OZ0899	OZ0900	OZ0928	OZ0929	OZ0930
OZ0931	OZ0939	OZ0940	OZ0983	OZ0984	OZ0985	OZ0986	OZ0987
OZ0989	OZ0992	OZ0993	OZ0995	OZ0996	OZ0997	OZ0998	OZ1003
OZ1035	OZ1036	OZ1037	OZ1038	OZ1039	OZ1040	OZ1041	OZ1043
OZ1044	OZ1045	OZ1046	OZ1047	OZ1048	OZ1049	OZ1050	OZ1051
OZ1052	OZ1053	OZ1054					



200 APPENDIX

E7 LUBRICATION SYSTEM



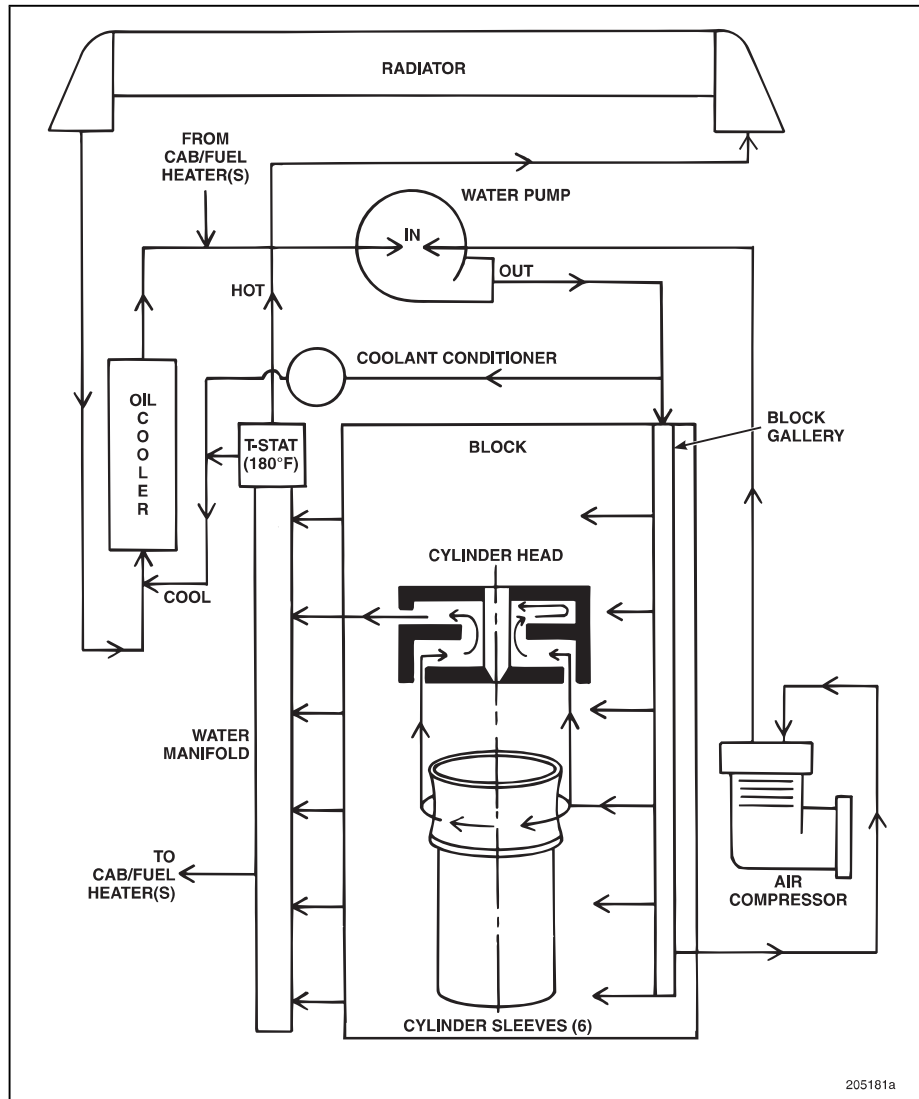
- | | |
|--|---|
| 1. OIL PUMP | 17. MAIN BEARING AND CONNECTING ROD BEARING LUBE OIL PASSAGES (SEE INSET "B") |
| 2. OIL PUMP INLET TUBE | 18. ECONOVANCE OIL SUPPLY LINE (V-MAC ENGINES) |
| 3. OIL PUMP | 19. LINE TO AUXILIARY SHAFT FRONT BUSHING FROM CAMSHAFT BUSHING NO. 1 |
| 4. OIL PRESSURE RELIEF VALVE (LOCATED IN PUMP) | 20. OIL SUPPLY FROM CAMSHAFT BUSHING NO. 2 TO ROCKER ARM SHAFT |
| 5. OIL PUMP DISCHARGE SUPPLY TO OIL COOLER | 21. LINE TO INJECTION PUMP (EXTERNAL) AND GOVERNOR FROM CAMSHAFT BUSHING NO. 4 |
| 6. OIL COOLER | 22. LINE TO AUXILIARY SHAFT REAR BUSHING AND COMPRESSOR FROM CAMSHAFT BUSHING NO. 4 |
| 7. OIL FILTER MOUNTING ADAPTER (SEE INSET "D") | 23. OIL SUPPLY FROM CAMSHAFT BUSHING NO. 5 TO ROCKER ARM SHAFT |
| 8. OIL FILTER(S) (SEE INSET "D") | 24. ROCKER ARM SHAFTS |
| 9. OIL FILTER BYPASS VALVE | 25. VALVE ROCKER ARM |
| 10. OIL SUPPLY ENTERING MAIN OIL GALLERY | 26. OIL SUPPLY FROM ROCKER ARM SHAFT TO ROCKER ARM TIP |
| 11. MAIN OIL GALLERY (SEE INSET "C") | |
| 12. PISTON COOLING OIL SPRAY NOZZLE (SEE INSET "C") | |
| 13. TURBOCHARGER OIL SUPPLY LINE (EXTERNAL) | |
| 14. TURBOCHARGER OIL RETURN LINE (EXTERNAL) | |
| 15. OIL SUPPLY FROM MAIN OIL GALLERY TO CRANKSHAFT MAIN BEARINGS (SEE INSET "A") | |
| 16. OIL FLOW FROM MAIN BEARINGS TO CAMSHAFT BEARINGS (SEE INSET "A") | |

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200 APPENDIX

E7 COOLING SYSTEM





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NOTES





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E7 ENGINE **OVERHAUL**

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