

## 4.0L 6-CYL - VIN [S]

### 1993 Jeep Cherokee

1993 CHRYSLER CORP. ENGINES  
4.0L 6-Cylinder

Jeep: Cherokee, Grand Cherokee, Wrangler

### ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

The Vehicle Identification Number (VIN) is located on the upper left side of the dash and is visible through the windshield. The eighth character identifies engine size.

#### ENGINE IDENTIFICATION CODES TABLE

Application	VIN Code
4.0L 6-Cylinder PFI .....	S

Some engines are manufactured with oversize or undersize components. These engines are identified by a letter code stamped on a boss between ignition coil and distributor. Letters are decoded as follows:

- \* "B" indicates all cylinder bores are .010" (.25 mm) oversize.
- \* "C" indicates all camshaft bearing bores are .010" (.25 mm) oversize.
- \* "M" indicates all main bearing journals are .010" (.25 mm) undersize.
- \* "P" indicates one or more connecting rod journals are .010" (.25 mm) undersize.
- \* "PM" indicates all main journals and one or more rod journal are .010" (.25 mm) undersize.

### ADJUSTMENTS

#### VALVE CLEARANCE ADJUSTMENT

Engine is equipped with hydraulic valve lifters. Valve adjustment is not required.

### REMOVAL & INSTALLATION

#### \* PLEASE READ THIS FIRST \*

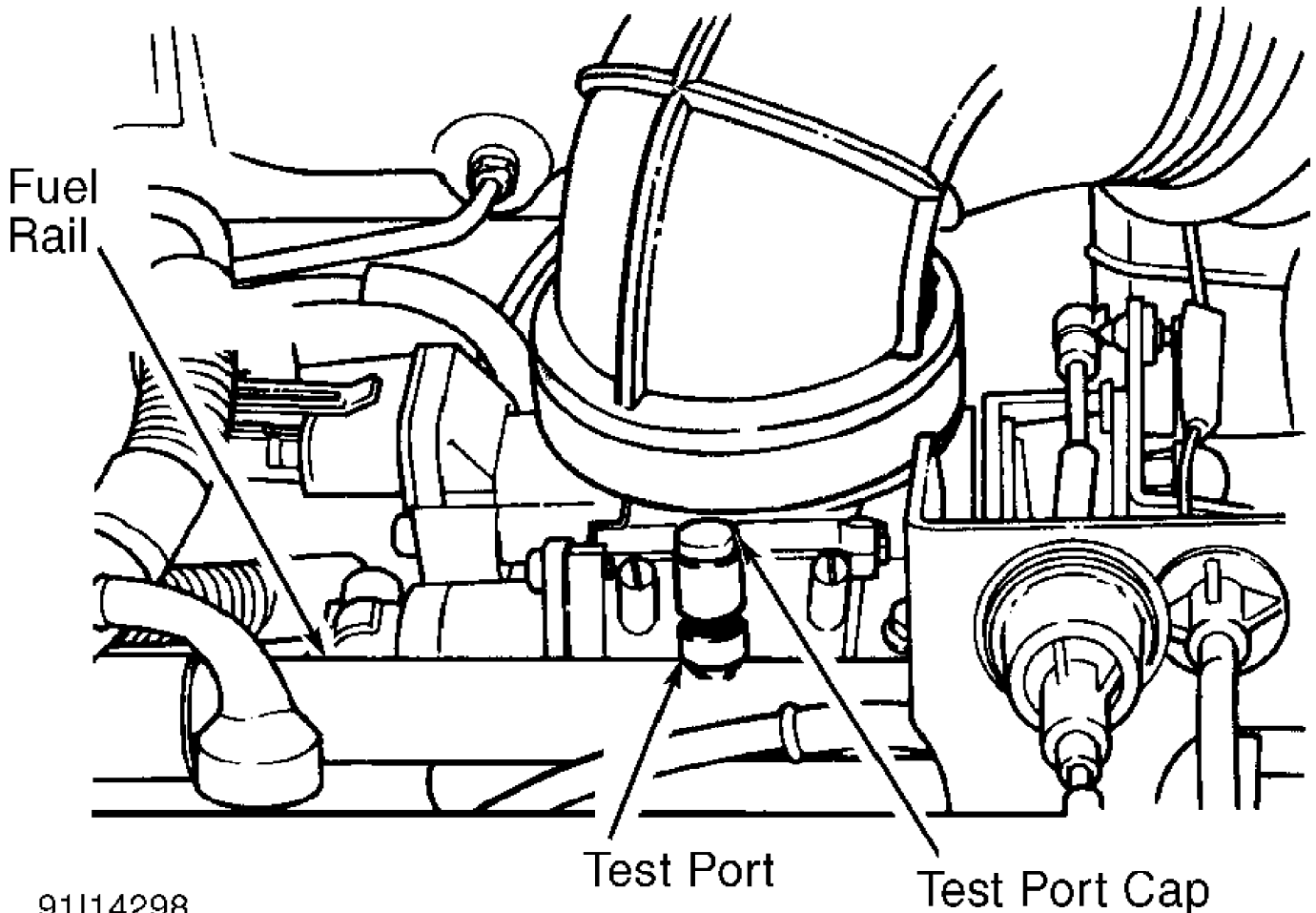
CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

## FUEL PRESSURE RELEASE

**CAUTION:** Fuel system is under constant pressure. This pressure must be released before disconnecting or servicing any fuel supply or return system component. Wear proper eye protection when releasing fuel system pressure.

Disconnect negative battery cable. Remove fuel filler cap. Remove cap from pressure test port on fuel rail. See Fig. 1. Place shop towels around pressure test port to absorb spilled fuel. Press test port valve with a small screwdriver or punch wrapped in shop towels. Remove shop towels and dispose of properly. Install pressure test port cap.



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Fig. 1: Locating Fuel Pressure Bleeding Test Port  
Courtesy of Chrysler Corp.

**CAUTION:** Always replace "O" rings, spacers and retainers whenever fuel system quick-connect fittings are disconnected. Ensure fuel connections are secure by verifying that only retaining tabs protrude from connectors and by pulling on tubes to verify they are locked into place.

## COOLING SYSTEM BLEEDING

**CAUTION:** Engine coolant may be hot. To avoid scalding, carefully

release system pressure before removing radiator cap or opening drain cock.

Add coolant only when engine is cold. Fill radiator completely and install pressure cap. Fill reserve/overflow tank to FULL mark. Operate engine until it reaches normal operating temperature. Shut off engine and allow it to cool. Recheck coolant level in reserve/overflow tank as necessary.

## ENGINE

Removal (Except Wrangler)

1) Remove hood. Disconnect battery cables. Remove battery. Remove air cleaner. Unplug quick-connect vacuum hose fittings at intake manifold. Drain cooling system. Remove radiator hoses and radiator support. Disconnect harness from electric fan motor (if equipped). Remove fan shroud and fan. Disconnect transmission cooler lines (if equipped). Remove radiator.

2) Discharge A/C system (if equipped) using approved refrigerant recovery/recycling equipment. Remove A/C service valves. Cap compressor ports. Remove A/C condenser. Disconnect heater hoses at water pump and thermostat housing. Disconnect cruise control (if equipped) and throttle linkage. Disconnect distributor wiring, oil pressure sender wire and fuel injection wire harness at each injector. Tag connectors for installation reference.

3) Disconnect line pressure cable to A/T (if equipped). Release fuel pressure. See FUEL PRESSURE RELEASE. Disconnect fuel supply quick-connect fittings at fuel rail. Remove fuel line bracket from intake manifold. Remove check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

4) Tag and disconnect any remaining vacuum hoses and electrical connectors as required. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Remove starter and flywheel cover. Disconnect oxygen (O<sub>2</sub>) sensor. Disconnect engine speed sensor.

5) On A/T models, mark converter and flexplate for installation reference. Remove converter-to-flexplate bolts. Remove upper and loosen lower bellhousing bolts. Remove engine mount bracket bolts. Lower vehicle.

6) Attach lifting device to engine. Lift engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Remove engine.

Removal (Wrangler)

1) Pad windshield frame using cloth. Raise hood, and rest it against windshield frame. Drain cooling system. Disconnect battery cables. Remove battery. Disconnect wiring from alternator, ignition coil, distributor, oil pressure sending unit and fuel injection wiring harness. Disconnect wires at starter solenoid and injector harness connector.

2) Disconnect fuel line quick-connect couplings at fuel rail. Remove fuel line bracket from intake manifold. Remove engine ground strap. Remove air cleaner. Disconnect vacuum purge hose from vapor canister tee. Unplug idle speed actuator connector. Disconnect throttle cable and remove it from bracket.

3) Disconnect throttle rod at bellcrank. Disconnect cruise control cable (if equipped). Unplug O<sub>2</sub> sensor connector. Disconnect coolant hoses at radiator, intake manifold and thermostat housing. Remove fan shroud and radiator. Remove fan and spacer. Install a 5/16 x 1/2" bolt through fan pulley into water pump flange to maintain pulley and water pump alignment.

4) Remove check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

5) Tag and disconnect any remaining hoses or electrical connectors. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Remove starter. Remove flywheel housing access cover. Remove engine mount through-bolts. Remove upper bellhousing bolts. Loosen lower bellhousing bolts.

6) Lower vehicle. Attach lifting device to engine. Raise engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Lift engine from engine compartment.

#### Installation (All Models)

1) Remove engine mount cushions from brackets to aid alignment of engine and transmission. Replace fuel line quick-connect "O" rings, spacers and retainers.

2) Be careful not to damage trigger wheel on flywheel when installing engine into vehicle with automatic transmission. To complete installation, reverse removal procedure. Adjust throttle and cruise control linkage (if equipped). Tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Check fluid levels, and refill if necessary.

## INTAKE MANIFOLD

### Removal

1) Disconnect negative battery cable. Remove air inlet from throttle plate assembly. Remove air cleaner. Disconnect throttle and cruise control (if equipped) cables. Disconnect line pressure cable to A/T (if equipped).

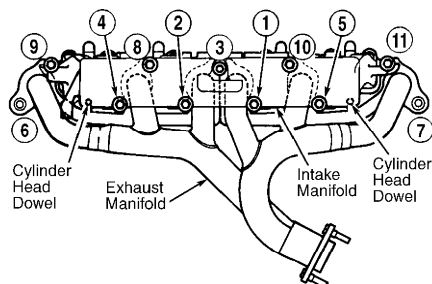
2) Unplug all electrical connectors from intake manifold. Release fuel system pressure. See FUEL PRESSURE RELEASE. Disconnect fuel line quick-connect fittings at fuel rail. Loosen accessory drive belt and tensioner.

3) Remove power steering pump and bracket. Wire pump aside. Remove fuel rail retaining bolts. Remove fuel rail and injector assembly. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Lower vehicle. Remove retaining bolts. Remove intake and exhaust manifolds as an assembly.

### Installation

1) Ensure all gasket surfaces are clean. Install NEW gasket. Install exhaust manifold and tighten bolt No. 3 finger tight. Install intake manifold and remaining bolts loosely. Replace fuel line quick-connect "O" rings, spacers and retainers.

2) Tighten bolts in proper sequence to specification. See Fig. 2. See TORQUE SPECIFICATIONS TABLE at the end of this article. Reverse removal procedure to complete installation.



91E14302

Fig. 2: Manifold Tightening Sequence  
Courtesy of Chrysler Corp.

## EXHAUST MANIFOLD

### Removal & Installation

Remove exhaust manifold with intake manifold. See INTAKE MANIFOLD.

## CYLINDER HEAD

### Removal

1) Disconnect negative battery cable. Drain cooling system. Remove air cleaner and fuel pipe. Remove molded hoses from cylinder head cover. Remove cylinder head cover.

2) Remove rocker arms, bridges, pivots and push rods. See ROCKER ARMS. Tag all parts for reassembly reference. Loosen serpentine drive belt at power steering pump (if equipped) or at idler pulley. Remove alternator bracket-to-cylinder head bolt. Disconnect power steering pump bracket. DO NOT disconnect hoses. Wire power steering pump aside.

3) Remove manifolds. See INTAKE MANIFOLD and EXHAUST MANIFOLD. Remove A/C compressor bracket bolts from cylinder head (if equipped). Loosen through bolt at bottom of A/C compressor bracket. Remove A/C compressor, and wire it aside.

4) Tag and disconnect spark plug wires. Remove spark plugs. Disconnect temperature sending unit. Remove ignition coil and bracket assembly.

5) Remove cylinder head bolts. Pull bolt No. 14 out as far as possible and hold in position using tape. Bolt No. 14 cannot be removed until head is moved forward. Remove cylinder head. Stuff clean lint-free shop towels into cylinder bores.

### Inspection

1) Inspect cylinder head for cracks and damage. Using straightedge, check cylinder head for warpage across bolt holes and diagonals. Repair or replace cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

2) Cylinder head bolts may only be reused once. If this is first time cylinder head has been removed, put a dab of paint on head of each bolt. If bolts already have paint on them or if it is unknown whether bolts have been used before, discard bolts and replace them with NEW head bolts.

### Installation

1) Clean carbon from combustion chambers and tops of pistons. Ensure all gasket surfaces, head bolts and head bolt holes are clean. Install NEW cylinder head gasket with numbers or word "TOP" upward. DO NOT apply gasket sealant to cylinder head gasket. Ensure all holes are aligned. Install cylinder head bolt No. 14, and hold in raised position using tape. Cylinder head bolt No. 14 cannot be installed after head is in position on block. Install cylinder head.

2) Apply sealant to threads of cylinder head bolt No. 11 before installation. Install cylinder head bolts. Tighten all bolts to specification in 3 stages and in sequence. During final tightening stage, bolt No. 11 will be tightened to a lower torque than others. See Fig. 3. See TORQUE SPECIFICATIONS TABLE at the end of this article.

3) To install remaining components, reverse removal procedure. Install all valve train components into original locations. Adjust A/T linkage. Refill cooling system. Start engine, and check for leaks.

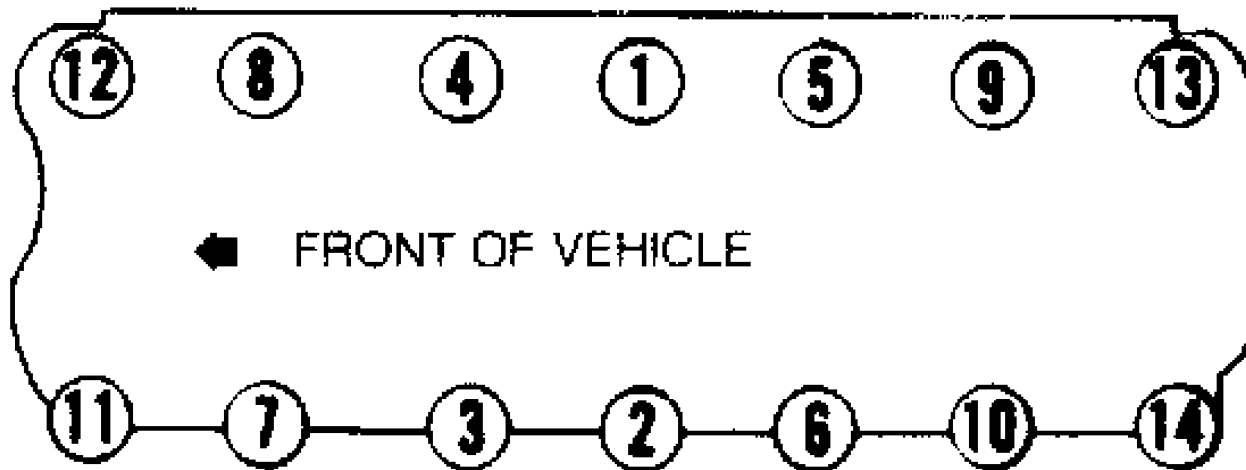


Fig. 3: Cylinder Head Bolt Tightening Sequence  
 Courtesy of Chrysler Corp.

### FRONT COVER OIL SEAL

#### Removal

1) Disconnect negative battery cable. Remove drive belts, fan shroud, fan and hub assembly. Remove accessory drive pulley. Remove vibration damper retaining bolt and washer.

2) Using Puller (8068), remove vibration damper and key. Remove front cover oil seal.

#### Installation

1) Position seal on Seal Installer (6139), with seal open end facing toward cover. Apply thin coat of RTV sealant on outside diameter of seal. Lightly coat crankshaft with engine oil.

2) Position installer over end of crankshaft. Insert draw screw into end of crankshaft. Tighten draw screw nut until seal is fully seated in front cover. Remove installer. Check seal for proper installation. To complete installation, reverse removal procedure.

### TIMING CHAIN & SPROCKETS

#### Removal

1) Disconnect negative battery cable. Remove drive belts, fan shroud, fan and hub assembly. Remove accessory drive pulley. Remove vibration damper retaining bolt and washer.

2) Using Puller (8068), remove vibration damper and key. Remove alternator bracket assembly and A/C compressor bracket (if equipped). Remove oil pan-to-front cover bolts. Remove cover-to-block retaining bolts. Remove front cover. Take care that tension spring and thrust pin do not fall out of camshaft preload bolt into oil pan. Remove tension spring and thrust pin from preload bolt. Rotate crankshaft until timing marks on sprockets are aligned. See Fig. 4. Remove preload bolt. Remove timing chain and sprockets as an assembly.

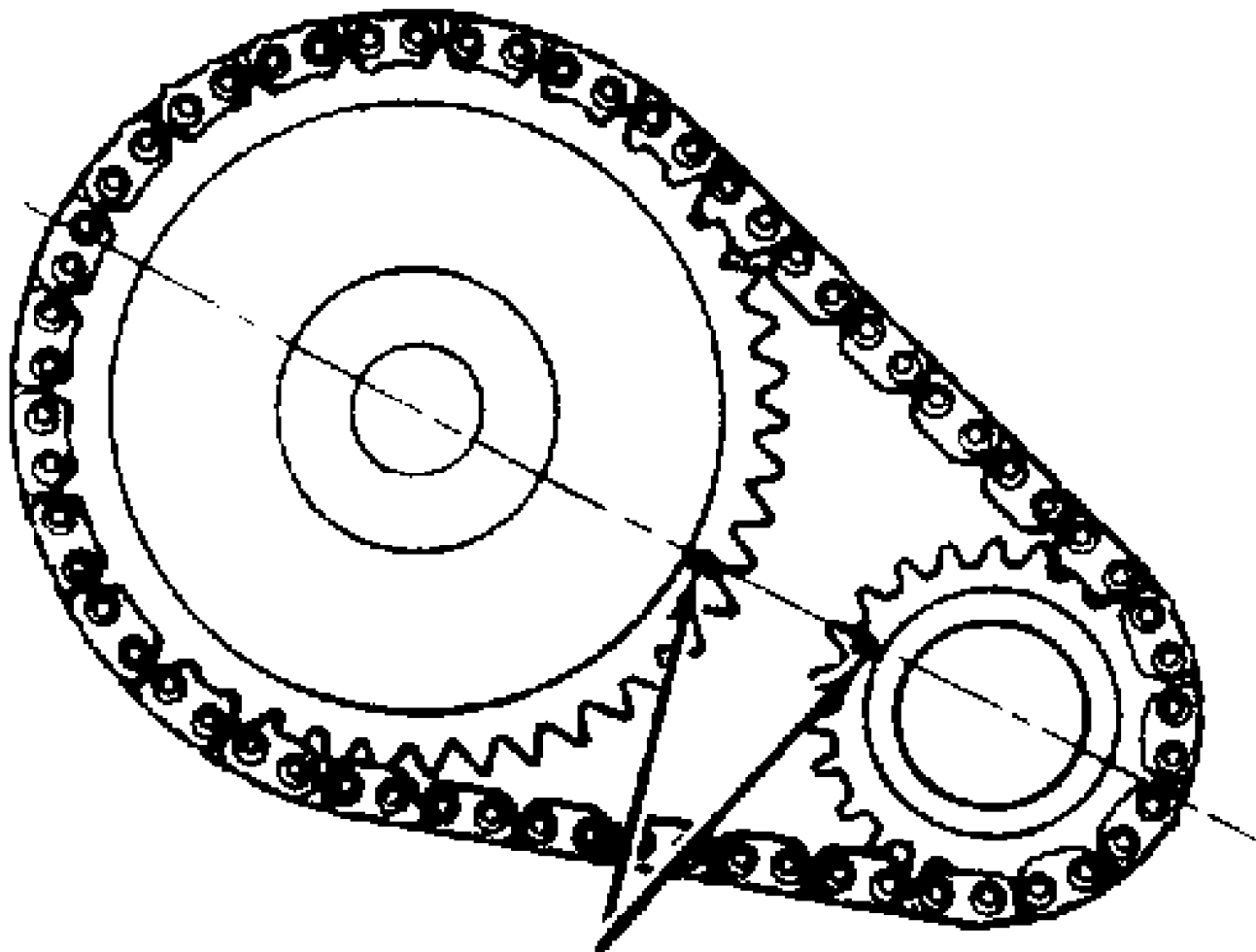
#### Installation

1) Install timing chain and sprockets as an assembly. Ensure timing marks align. Lubricate tension spring, thrust pin and thrust pin bore with Mopar Engine Oil Supplement (4318002) before installation. Install preload bolt and washer. Tighten to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

2) Verify proper installation by rotating crankshaft until

timing mark on camshaft is at approximately one o'clock position. Timing sprockets are installed correctly if 15 timing chain pins are between timing marks on both sprockets.

3) Install NEW front cover oil seal. Cut oil pan gasket tabs even with face of cylinder block. Remove tabs. Remove gasket from oil pan. Remove crankshaft oil seal from front cover. Clean front cover, oil pan and cylinder block gasket surfaces. Install front cover. To install remaining components, reverse removal procedure. See TORQUE SPECIFICATIONS TABLE at the end of this article.



## Timing Marks

Fig. 4: Aligning Sprocket Timing Marks  
Courtesy of Chrysler Corp.

### ROCKER ARMS

NOTE: All reused camshaft/valve train components must be reinstalled in original locations.

#### Removal

Remove valve cover. Alternately loosen rocker arm cap screws one turn at a time to prevent damaging bridges. Remove bridges, pivots, rocker arms and push rods. Tag all parts for installation reference.

#### Installation

1) Install all reused components into original locations. Ensure bottom ends of push rods are centered in valve lifters. Lubricate pivot contact area of rocker arms with Mopar Engine Oil Supplement (4318002). Install cap screws loosely, and then tighten alternately one turn at a time to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

2) Reverse removal procedure to complete installation. Pour remaining engine oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km). Refill cooling system. Adjust ignition timing. Check for leaks.

### CAMSHAFT

#### Removal

1) Disconnect negative battery cable. Drain cooling system. Remove radiator and A/C condenser (if equipped), but DO NOT discharge system. Mark distributor and engine block for installation reference. Remove distributor and ignition wiring. Remove cylinder head. See CYLINDER HEAD.

2) Remove valve lifters using Hydraulic Valve Lifter Remover/Installer (C-4129-A). Tag each valve lifter for installation reference. Remove timing chain and sprockets. See TIMING CHAIN & SPROCKETS. Remove front bumper and/or grille as required. Remove camshaft.

#### Inspection

Inspect lobes, journals, bearings and distributor drive gear for wear. Inspect valve lifters for abnormal wear. If camshaft sprocket or chain rubs against engine front cover, examine oil pressure relief holes in rear camshaft journal and ensure they are free of debris. Replace components as necessary. If camshaft requires replacement, valve lifters MUST also be replaced.

#### Installation

1) Lubricate camshaft and dip valve lifters into MOPAR Engine Oil Supplement (4318002). Install camshaft. Reverse removal procedure to complete installation.

2) Pour remaining engine oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km). Refill cooling system. Adjust ignition timing. Check for leaks.

### REAR CRANKSHAFT OIL SEAL

#### Removal

1) Remove transmission and flywheel or torque converter plate. Remove oil pan. See OIL PAN removal in this section. Remove rear main bearing cap (No. 7).

2) Push upper seal out of groove. Ensure crankshaft and seal groove are not damaged. Remove lower half of seal from bearing cap.

#### Installation

1) Remove the rear main bearing cap. Wipe the seal surface area of the crankshaft until it is clean. Apply a thin coat of engine oil. Position the upper seal into the cylinder block. The lip of the seal faces toward the front of the engine.

2) Place lower half of seal into bearing cap No. 7. Coat both sides of the lower seal end tabs w/Jeep Gasket-in-a-Tube, or equivalent. Do not apply sealant to the lip of the seal. Coat the outer curved surface of the lower seal with soap and the lip of the seal w/engine oil.



3) Position the lower seal into the bearing cap recess and seat it firmly. Be sure seal is flush with cylinder block pan rail. Apply Loctite 515, or equivalent on rear bearing cap. The bead should be 0.125" (3 mm) thick. Do not apply Loctite 515, or equivalent to lip of seal.

CAUTION: Do not apply Loctite 515, or equivalent to lip of seal.

4) Install the rear main bearing cap. Do not strike cap more than twice for proper engagement. Tighten all main bearing bolts to 80 ft-lbs (108 Nm) torque. Install oil pan gasket and oil pan. Install transmission inspection plate.

## WATER PUMP

### Removal

Disconnect negative battery cable. Drain coolant. Remove fan shroud retaining screws and drive belts. Remove fan. Disconnect heater hoses and lower radiator hose at water pump. Remove power steering pump bracket (if equipped) at water pump boss. Remove retaining bolts and water pump.

### Installation

Clean all gasket surfaces. Install water pump. Tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Ensure pump turns freely. Ensure belt is correctly installed or engine may overheat because pump rotates in wrong direction. To complete installation, reverse removal procedures. Fill cooling system.

## OIL PAN

### Removal

1) Disconnect negative battery cable. Raise and support vehicle at side sills. Drain engine oil. Disconnect exhaust pipe at exhaust manifold. Disconnect exhaust hanger at catalytic converter. Lower exhaust pipe. Remove starter. Remove flywheel access cover.

2) Position jackstand directly under vibration damper. Place wooden block between vibration damper and jackstand. Remove through bolts from engine mounts. Raise engine enough to remove oil pan. Remove oil pan retaining bolts. Remove oil pan by sliding it to rear.

### Installation

1) Ensure all gasket surfaces are clean. Fabricate 4 alignment dowels from 1 1/2 x 1/4" bolts. Cut heads off bolts and cut slot in end of bolts to allow removal with screwdriver. Install 2 dowels in timing cover and 2 dowels in block. Slide gasket over dowels into position against block and timing cover.

2) Install oil pan. Install sufficient bolts to hold oil pan in place. Remove alignment dowels. Install remaining oil pan bolts and tighten to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. To complete installation, reverse removal procedure. Fill crankcase. Start engine. Check for leaks.

## OVERHAUL

### CYLINDER HEAD

#### Cylinder Head Service

Inspect for cracks in combustion chambers, coolant passages, ports and exhaust valve seats. Using straightedge, check cylinder head for warpage across bolt holes and diagonals. Resurface or replace

cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valve Springs

Use Valve Spring Tester (C-647 or J-22738-02) to test each valve spring. Measure free length of each valve spring. Replace valve springs that do not meet specifications. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.

#### Valve Stem Oil Seals

Replace valve stem oil seals if they have deteriorated or whenever valves are serviced. Oil seals are marked "INT" and "EXH" for intake and exhaust valves, respectively.

#### Valve Guides

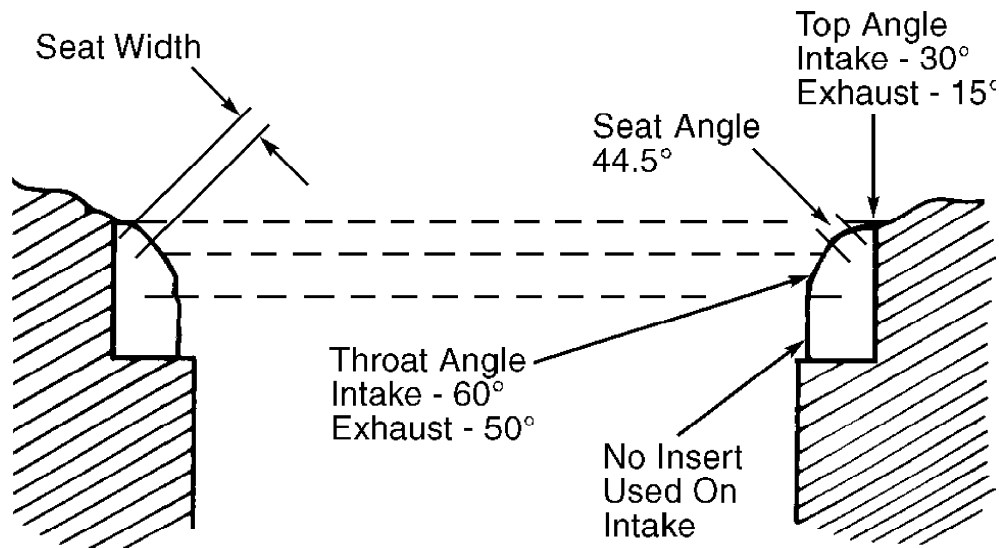
Measure diameter of valve guide approximately 3/8" (10 mm) from valve spring side of head, both parallel and at right angles to long axis of head. If difference between measurements exceeds .0025" (.063 mm), or if diameter exceeds specification by .003" (.08 mm), ream valve guide for oversize valve stem. Valve seats must be refaced after reaming valve guides. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valve Seats

Reface valve seats to specification. Remove only enough metal to provide smooth finish. Use tapered stones to obtain specified seat width. See Fig. 5. Seat width runout should not exceed .0025" (.063 mm) after refacing. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valves

Reface valves to specification. At least .031" (.79 mm) margin must remain after refacing valve. Valve stem tip can be resurfaced and chamfered when worn. DO NOT remove more than .01" (.25 mm). See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.



91C14300

Fig. 5: Measuring Valve Seat Dimensions  
Courtesy of Chrysler Corp.

## VALVE TRAIN

#### Rocker Arms

Inspect pivot and valve stem contact surfaces of each rocker arm. Replace any rocker arm that is scuffed, pitted, cracked or excessively worn.

#### Push Rods

Inspect push rods for excessive wear. If wear is excessive because of lack of oil, replace and inspect corresponding valve lifter for excessive wear. Roll push rods on a flat surface to check for straightness. Replace push rod and/or valve lifter, if necessary. If wear exists along length of push rod, inspect cylinder head for obstruction.

### CYLINDER BLOCK ASSEMBLY

#### Piston & Rod Assembly

1) Position piston on support. See Fig. 6. Press piston pin from piston. Discard pin. Piston pin cannot be reused after removal. Inspect piston pin bore in connecting rod for nicks and burrs, and remove as necessary. Clean and dry piston pin bore and NEW piston pin.

2) Clean piston pin bore and replacement piston pin. Piston and piston pin must be at room temperature when measuring fit. Piston pin should fall through piston at room temperature. If pin jams in pin bore, replace piston.

3) Ensure arrow on piston crown is pointing up. Insert piston pin through piston pin bore and into connecting rod pin bore. Assemble connecting rod and piston so oil squirt hole faces camshaft and arrow on piston points to front of engine when installed.

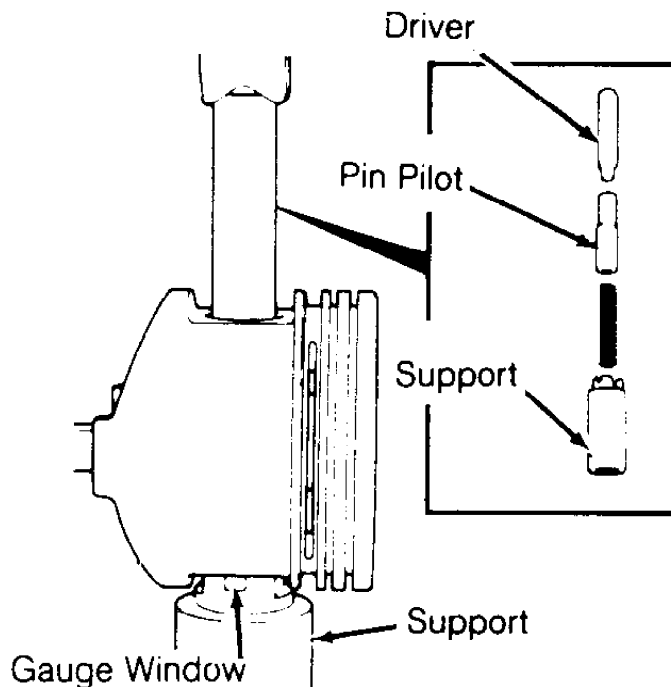


Fig. 6: Removing & Installing Piston Pin  
Courtesy of Chrysler Corp.

4) Press pin through rod and piston until pilot indexes with mark on support. Pin should be centered in rod. Piston pin

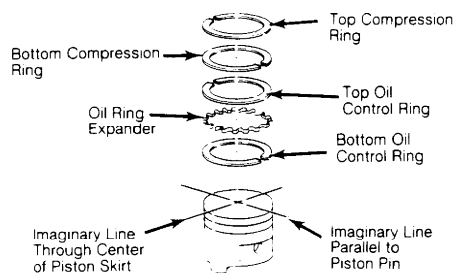
installation requires approximately 2000 lbs. (900 kg) of force. Replace connecting rod if noticeably less force is required, or if rod moves on pin.

#### Fitting Pistons

Measure cylinder bore  $2 \frac{5}{16}$ " (59 mm) below top of bore. Measure piston diameter at right angle to piston pin at center line of pin. Piston clearance is difference between measurements. Pistons up to .004" (.10 mm) undersize may be enlarged by knurling or shot peening. Replace pistons if they are .004" (.10 mm) or more undersize.

#### Piston Rings

Install piston rings. Ensure ring end gap and side clearance are within specification. Install compression rings with dot(s) on ring surface toward top of piston. DO NOT interchange compression rings. Top ring has Gray scraping surface; second ring has Black scraping surface. Position ring end gaps in specified area. Ring gaps may vary 20 degrees from positions illustrated. See Fig. 7. See PISTONS, PINS & RINGS table under ENGINE SPECIFICATIONS.



93H75900

Fig. 7: Positioning Piston Ring Gaps  
Courtesy of Chrysler Corp.

#### Rod Bearings

1) Inspect bearings for wear or damage. Replace as necessary. Using Plastigage, check bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available for standard and undersize applications.

2) If necessary, different size upper and lower bearings may be combined to obtain correct oil clearance. Lubricate bearing surfaces with oil before installation. Tighten bolts to specification. Check rod side play. Rotate crankshaft to ensure freedom of movement. See TORQUE SPECIFICATIONS TABLE at the end of this article. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

NOTE: Avoid combining bearing inserts in excess of .001" (.03 mm) difference in size. Odd size inserts must be on bottom (rod cap) side.

#### Crankshaft & Main Bearings

1) Inspect bearings for wear or damage. Replace as necessary. Using Plastigage, check bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available in standard and undersize. If necessary, different size upper and lower bearings may be installed to obtain correct oil clearance. Lubricate bearings before installation.

NOTE: If different size bearings are used, odd size bearings must all be uniform in location (upper or lower). DO NOT use bearings with a thickness difference exceeding .001" (.03 mm).

2) Install upper bearing inserts. Install bearing caps and lower inserts. Tighten bearing caps in 3 stages to specification. Rotate crankshaft to ensure freedom of movement after tightening each cap. See TORQUE SPECIFICATIONS TABLE at the end of this article. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

#### Thrust Bearing

Check crankshaft end play. If end play is not within specification, replace thrust bearing. If end play is still not within specification, replace crankshaft.

#### Cylinder Block

1) Thoroughly clean all gasket surfaces. Using a tap, clean head bolt holes. Clean oil gallery by blowing compressed air into oil filter adapter, filter by-pass, oil gallery and crankshaft oil feed holes.

2) Measure cylinder bore diameter crosswise to cylinder block about 1/2" below top of bore. Repeat measurement at bottom of bore. Subtract smaller diameter from larger diameter to determine taper. Repeat measurements for each cylinder.

3) Repeat measurements with measuring device rotated 120 degrees. Repeat this step for a total of 3 measurements. Cylinder out-of-round is difference between measurements. Repeat for each cylinder.

4) Bore and hone cylinders for oversize pistons if taper or out-of-round exceeds specification. Move hone up and down to provide a 60-degree crosshatch pattern. DO NOT use a rigid hone or exceed 10 strokes per cylinder. See CYLINDER BLOCK table under ENGINE SPECIFICATIONS.

## LUBRICATION

### ENGINE OILING

An oil pump driven by distributor supplies oil through a full-flow oil filter into an internal oil passage. This passage provides oil to valve lifter bores and then to camshaft and crankshaft bearings. Oil then flows from hydraulic valve lifters through push rods to rocker arms.

#### Crankcase Capacity

Oil capacity is 6.0 qts. (5.7L) with filter change.

#### Oil Pressure

Minimum oil pressure should be 13 psi (89.6 kPa) at 600 RPM. Normal oil pressure should be 37-75 psi (255.1-517.1 kPa) above 1600 RPM. Oil pressure relief is 75 psi (517.1 kPa).

### OIL PUMP

#### Removal & Disassembly

Remove mounting bolts and oil pump. DO NOT move oil pick-up pipe in pump body. If oil pick-up pipe is moved, pick-up pipe MUST be replaced to ensure an airtight seal. Remove pump cover. Disassemble pump.

#### Inspection

Inspect for wear or damage. Place Plastigage across full width of each gear. Install cover temporarily and tighten bolts to 70 INCH lbs. (8 N.m). Remove cover. Examine Plastigage to determine end clearance. Measure clearance between each tooth and oil pump body directly opposite point of mesh. Replace oil pump if not within specifications. See OIL PUMP SPECIFICATIONS table.

OIL PUMP SPECIFICATIONS TABLE

Application	In. (mm)
Gear End Clearance .....	.002-.006 (.05-.15)
Gear-to-Body Clearance .....	.002-.004 (.05-.10)

Reassembly & Installation

1) Apply sealant to pick-up pipe and pump cover area prior to installation. To install pick-up pipe use Pipe Installer (7624). Ensure pick-up pipe support bracket aligns with pump cover bolt. If relief valve is replaced, ensure replacement valve is the same diameter as that removed.

2) Fill pump cavity with petroleum jelly. Install cover. Tighten cover bolts to specification. Check pump gears for freedom of rotation. Install NEW gasket and oil pump. Tighten retaining bolts to specification. See TORQUE SPECIFICATIONS table.

**TORQUE SPECIFICATIONS**

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Preload Bolt .....	80 (108)
Connecting Rod Cap Nut .....	33 (45)
Converter-To-Flexplate Bolts .....	(1)
Cylinder Head Bolts (2)	
Stage 1 .....	22 (30)
Stage 2 .....	45 (61)
Stage 3 .....	(2) 110 (149)
Exhaust Manifold Bolts (3)	
Bolts No. 1-5 .....	24 (33)
Bolts No. 6 & 7 .....	17 (23)
Bolts No. 8-11 .....	24 (33)
Fan Bolt .....	18 (24)
Flexplate-To-Converter Bolts .....	40 (54)
Flexplate-To-Crankshaft Bolts .....	55 (75)
Flywheel-To-Crankshaft Bolts .....	(1)
Intake Manifold Bolts (3)	
Bolts No. 1-5 .....	24 (33)
Bolts No. 6 & 7 .....	17 (23)
Bolts No. 8-11 .....	24 (33)
Main Bearing Cap Bolts	
Stage 1 .....	40 (54)
Stage 2 .....	70 (95)
Stage 3 .....	80 (108)
Oil Pump Retaining Bolts	
Long .....	17 (23)
Short .....	10 (14)
Pulley-To-Vibration Damper Bolts .....	20 (27)
Rocker Arm Bolts .....	21 (29)
Starter Bolts .....	33 (45)
Vibration Damper Bolt (4) .....	80 (108)
Water Pump Bolts .....	22 (30)

INCH Lbs. (N.m)

Front Cover Bolts .....	62 (7)
Oil Pan Bolts	

1/4" X 20 .....	114 (13)
5/16" X 18 .....	156 (18)
Oil Pump Cover Bolts .....	70 (8)
Valve Cover Bolts .....	80 (9)

- (1) - Information is not available from manufacturer.
- (2) - All bolts except No. 11. Tighten bolt No. 11 to 100 ft. lbs. (136 N.m) See Fig. 3.
- (3) - Tighten in sequence. See Fig. 2.
- (4) - With bolt cleaned and threads lubricated with oil.

## ENGINE SPECIFICATIONS

### GENERAL ENGINE SPECIFICATIONS

#### GENERAL SPECIFICATIONS

Application	Specification
Displacement .....	242 Cu. In. (4.0L)
Bore .....	3.88" (98.5 mm)
Stroke .....	3.44" (87.4 mm)
Compression Ratio .....	8.8:1
Fuel System .....	PFI
Horsepower @ RPM	
Except Wrangler .....	190 @ 4750
Wrangler .....	180 @ 4750
Torque Ft. Lbs. @ RPM	
Except Wrangler .....	225 @ 4000
Wrangler .....	220 @ 4000

### CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECIFICATIONS

#### CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS TABLE

Application	In. (mm)
Crankshaft	
End Play .....	.0015-.0065 (.038-.165)
Runout .....	(1)
Main Bearings	
Journal Diameter .....	2.4996-2.5001 (63.489-63.502)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0010-.0025 (.025-.064)
Connecting Rod Bearings	
Journal Diameter .....	2.0934-2.0955 (53.172-53.226)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0015-.0025 (.038-.064)

- (1) - Information is not available from manufacturer.

### CONNECTING RODS SPECIFICATIONS

#### CONNECTING RODS TABLE

Application	In. (mm)
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Bore Diameter	
Pin Bore	.9288-.9298 (23.591-23.617)
Crankpin Bore	2.2080-2.2085 (56.083-56.096)
Center-To-Center Length	6.123-6.127 (155.52-155.63)
Maximum Bend	.003 (.08)
Maximum Twist	.006 (.15)
Side Play	.010-.019 (.25-.48)

## PISTONS, PINS & RINGS SPECIFICATIONS

### PISTONS, PINS & RINGS TABLE

Application	In. (mm)
<b>Pistons</b>	
Clearance	.0013-.0021 (.033-.053)
Diameter	(1)
<b>Pins</b>	
Diameter	.9306-.9307 (23.637-23.640)
Piston Fit	.0003-.0007 (.007-.018)
Rod Fit	Press Fit
<b>Rings</b>	
No. 1	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0010-.0032 (.025-.081)
No. 2	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0017-.0032 (.043-.081)
No. 3 (Oil)	
End Gap	.010-.025 (.25-.64)
Side Clearance	.001-.009 (.03-.23)

(1) - Information is not available from manufacturer.  
 Replace pistons if piston clearance exceeds .004"  
 (.10 mm).

## CYLINDER BLOCK SPECIFICATIONS

### CYLINDER BLOCK TABLE

Application	In. (mm)
<b>Cylinder Bore</b>	
Standard Diameter	3.8751-3.8775 (98.427-98.488)
Maximum Taper	.001 (.03)
Maximum Out-Of-Round	.001 (.03)
Minimum Deck Height	9.429 (239.49)
Maximum Warpage	.008 (.20)

## VALVES & VALVE SPRINGS SPECIFICATIONS

### VALVES & VALVE SPRINGS TABLE

Application	Specification
<b>Intake Valves</b>	
Face Angle	45°
Head Diameter	1.91" (48.5 mm)
Minimum Margin	.031" (.79 mm)
Minimum Refinish Length	4.822" (122.47 mm)



Stem Diameter	.312"	(7.92 mm)
Valve Tip Maximum Refinish	.010"	(.25 mm)
Exhaust Valves		
Face Angle		45°
Head Diameter	1.5"	(38.1 mm)
Minimum Margin	.031"	(.79 mm)
Minimum Refinish Length	4.837"	(122.86 mm)
Stem Diameter	.312"	(7.92 mm)
Valve Tip Maximum Refinish	.010"	(.25 mm)
Valve Springs		
Free Length	1.82"	(46.2 mm)
Installed Height	1.625"	(41.29 mm)
Out-Of-Square		(1)
Spring Pressure (2)		
Valve Closed	66-74 @ 1.625	(29.94-33.56 @ 41.28)
Valve Open	205-220 @ 1.2	(92.98-99.78 @ 30.48)

(1) - Information is not available from manufacturer.

(2) - Lbs. @ In. (kg @ mm).

## CYLINDER HEAD SPECIFICATIONS

### CYLINDER HEAD TABLE

Application	Specification
Cylinder Head Height	(1)
Maximum Warpage	.008" (.20 mm)
Valve Seats	
Intake Valve	
Seat Angle	44.5°
Seat Width	.040-.060" (1.02-1.52 mm)
Maximum Seat Runout	.0025" (.064 mm)
Seat Bore Diameter	(1)
Exhaust Valve	
Seat Angle	44.5°
Seat Width	.040-.060" (1.02-1.52 mm)
Maximum Seat Runout	.0025" (.064 mm)
Seat Bore Diameter	(1)
Valve Guides	
Intake Valve	
Valve Guide I.D.	.312" (7.9 mm)
Valve Stem-To-Guide	
Oil Clearance	.001-.003" (.03-.08 mm)
Exhaust Valve	
Valve Guide I.D.	.312" (7.9 mm)
Valve Stem-To-Guide	
Oil Clearance	.001-.003" (.03-.08 mm)

(1) - Information is not available from manufacturer.

## CAMSHAFT SPECIFICATIONS

### CAMSHAFT TABLE

Application	In. (mm)
Bore Diameter	(1)
End Play (2)	0 (0)
Journal Diameter	
No. 1	2.029-2.030 (51.54-51.56)

No. 2	.....	2.019-2.020	(51.28-51.31)
No. 3	.....	2.009-2.010	(51.03-51.05)
No. 4	.....	1.999-2.000	(50.78-50.80)
Journal Runout	.....		(3)
Lobe Height	.....		(1)
Lobe Lift	.....	.253	(6.43)
Oil Clearance	.....	.001-.003	(.03-.08)

- (1) - Information is not available from manufacturer.  
(2) - Engine running.  
(3) - Information is not available from manufacturer.  
Manufacturer specifies .001" (.03 mm) maximum base  
circle runout.

## VALVE LIFTERS SPECIFICATIONS

### VALVE LIFTERS TABLE

Application		In. (mm)
Bore Diameter	.....	.9055-.9065 (22.999-23.025)
Lifter Diameter	.....	.9040-.9045 (22.962-22.974)
Oil Clearance	.....	.001-.0025 (.025-.063)