Engine Removal and Installation

REMOVAL OF ENGINE

CAUTION

- **Only use the engine coolant specified. Other engine coolants may affect warranty coverage, cause an internal buildup of rust and scale and or shorten engine life.**
- **Prevent dirt and debris from contaminating engine coolant. Carefully clean the radiator cap and the surrounding area before you remove the cap.**
- **NEVER mix different types of engine coolants. This may adversely affect the properties of the engine coolant.**

A WARNING

SHOCK HAZARD!

- **Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.**
- **Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. ALWAYS keep the connectors and terminals clean.**
- **Failure to comply could result in death or serious injury.**

1. Disconnect the battery cables at the battery.
2. Disconnect the throttle cable and vehicle electrical harness from the engine
3. Drain the engine coolant. Disconnect the radiator hoses from the engine.
4. Drain the engine oil..
5. Disconnect the exhaust system from the exhaust manifold.
6. Remove the engine from the vehicle. Fix the engine on a horizontal base.

A CAUTION

Be sure to fix the engine securely to prevent injury or damage to parts due to falling during the work.

7. Clean the engine by washing with solvent, air or steam cleaning. Carefully operate so as to prevent any foreign matter from entering the engine.

Cylinder Head, Camshaft, and Valve Mechanism Repair

REMOVE

1. Disconnect connections at battery.

2. Drain cooling system.

3. Remove air cleaner, throttle cable (if equipped), intake manifold, and exhaust manifold.

4. Remove coolant hoses.

5. Remove the V belt.

6. Remove the cooling fan.

7. Remove bracket for cooling fan.

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CYLINDER BLOCK

Distortion at Top Surface	0.15 mm (0.0059 in.)
Grinding Limit	0.20 mm (0.008 in.)
Bore Diameter	86.00 to 86.019 mm (3.3858 to 3.3866 in.)
Wear Limit	0.15 mm (0.0059 in.)

PISTONS

Diameter, Standard	85.945 to 85.965 mm (3.3836 to 3.3844 in.)
0.25 mm (0.01 in.) Oversize	86.193 to 86.215 mm (3.394 to 3.3943 in.)
0.50 mm (0.02 in.) Oversize	86.44. to 86.465 mm (3.4033 to 3.4041 in.)
Clearance between Piston and Bore	0.035 to 0.076 mm (0.0014 to 0.0030 in.)
Service Limit	21.988 to 21.998 mm (0.8657 to 0.8660 in.)
Groove Width for Piston Rings Nos. 1 and 2	1.520 to 1.540 mm (0.0598 to 0.0606 in.)
Groove Width for Oil Ring	4.020 to 4.040 mm (0.1583 to 0.1591 in.)
Piston Ring Clearance in Groove (Nos. 1 and 2)	0.03 to 0.07 mm (0.0012 to 0.0028 in.)
Service Limit	0.15 mm (0.0059 in.)
Piston Ring End Clearance:	
Top Ring	0.20 to 0.35 mm (0.008 to 0.014 in.)
Second Ring	0.15 to 0.30 mm (0.006 to 0.012 in.)
Oil Control Ring	0.20 to 0.70 mm (0.008 to 0.027 in.)
Service Limit (All Rings)	1.0 mm (0.039 in.)

OIL PUMP

Clearance between Inner Rotor Tip and Outer Rotor	
Service Limit	0.18 mm (0.007 in.)
Clearance between Housing and Outer Rotor	0.090 to 0.176 mm (0.0036 to 0.0069 in.)
Service Limit	0.20 mm (0.008 in.)
Side Clearance between Rotors and Housing	0.03 to 0.09 mm (0.0012 to 0.0035 in.)
Service Limit	0.10 mm (0.004 in.)

Torque Specifications

Camshaft Pulley Lock Bolt	48 to 66 N•m (35 to 49 lb. ft.)
Camshaft Cap	18 to 27 N•m (13 to 20 lb. ft.)
Cooling Fan	27 N•m (20 lb. ft.)
Connecting Rod Cap	66 to 70 N•m (49 to 52 lb. ft.)
Crankshaft Pulley	12 to 17 N•m (9 to 13 lb. ft.)

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Engine Timing Adjustment

The base ignition timing is adjustable by rotating the cam angle sensor housing. To check or set the timing, perform the following procedures:

1. Warm up the engine to normal operating temperature.
2. Make sure all accessories are OFF.
3. Verify the engine speed is between 500 to 900 rpm.
4. Install a jumper wire across the engine control unit (ECU) timing test port connector terminals

Engine Specifications

ENGINE DATA

Engine Type	In-line, Four Cylinders
Bore × Stroke (2.2L)	86 mm (3.39 in.) ×94 mm (3.70 in.)
Displacement (2.2L)	2184 cm ^{3} (133.2 in. ^{3})
Firing Order	1 - 3 - 4 - 2
Valve Clearance (Exhaust, Engine cold)	0.35 ±0.05 mm (0.0138 ±0.002 in.)
Valve Clearance (Intake, Engine Cold)	0.15 ±0.05 mm (0.0059±0.002 in.)
Compression Ratio	
Gasoline	8.6:1
Compression Ratio	
LPG (2.2L)	10.1:1
Compression Pressure	
Gasoline	1130 kPa (164 psi) @ 270 rpm
Compression Pressure	
LPG	1130 kPa (164 psi) @ 270 rpm
Maximum Difference	
Between Cylinders	196 kPa (28 psi)
Engine Timing (No. 1 Cylinder):	
Gasoline	6° BTDC (Orange Mark)
LPG	6° BTDC (Orange Mark)
Oil Pressure @ 2400 rpm	226 to 362 kPa (33 to 53 psi)

2012 and Later, Emission Compliant Engines

Engine Speed, 1.5 to 2 Ton Lift Trucks, 2.2L:	
Idle Speed	720 ±25 rpm
Governed Speed	2400 ±25 rpm
Engine Speed, 2.0 to 3.5 Ton Lift Trucks, 2.2L:	
Idle Speed	720 ±25 rpm
Governed Speed	2700 ±25 rpm
Stall Speed (New 2.2L Engine):	
Gasoline	1990 ±100 rpm
LPG	2010 ±100 rpm
Stall Speed (2.2L Engine with 30 Hours or More):	
Gasoline	2010 ±100 rpm
LPG	2050 ±100 rpm

THERMOSTAT

Starts to Open	82 ±1.5°C (180 ±35°F)
Fully Open	95 ±1.5°C (203 ±35°F)

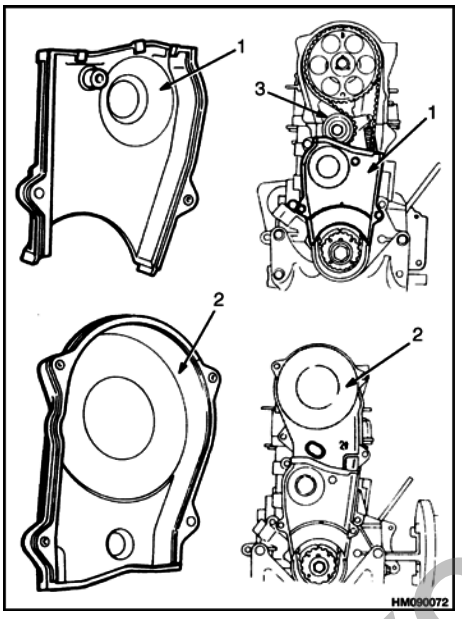
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8. Remove the six capscrews retaining the crankshaft pulley to the timing pulley and remove the crankshaft pulley.

9. Remove the spark plugs from the cylinder head.

10. Remove upper and lower timing belt covers. See Figure 2.



1. LOWER TIMING BELT COVER
2. UPPER TIMING BELT COVER
3. TIMING BELT TENSIONER

Figure 2. Timing Belt Covers

11. Loosen capscrews for timing belt tensioner and remove spring. Remove capscrews and timing belt tensioner.

12. Use chalk to mark direction of timing belt rotation. See Figure 3. Remove timing belt.

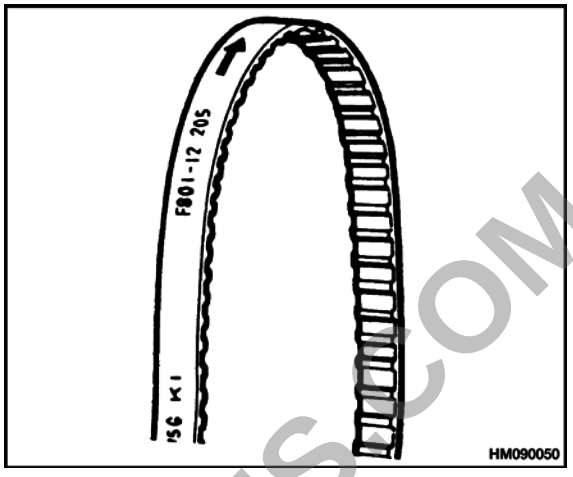


Figure 3. Timing Belt

13. Remove the CAM angle sensor

14. Remove camshaft pulley. Keep pulley from rotating and loosen capscrew. Remove capscrew and pulley. See Figure 4

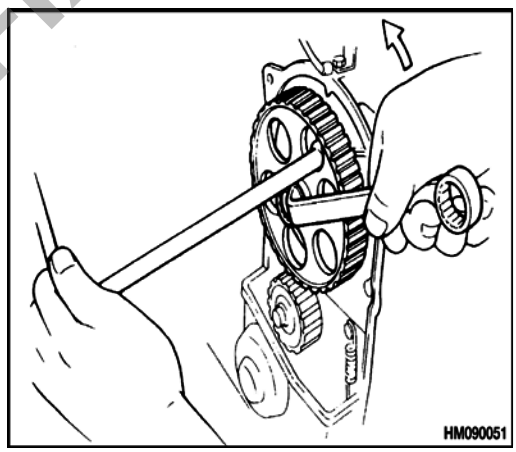


Figure 4. Camshaft Gear Removal

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Cylinder Head	81 to 88 N•m (60 to 65 lb. ft.)
Engine Mount to Engine	55 N•m (41 lb. ft.)
Engine Mount Capscrew	150 N•m (111 lb. ft.)
Exhaust Manifold	22 to 29 N•m (16 to 21 lb. ft.)
Flywheel	96 to 103 N•m (71 to 76 lb. ft.)
Flywheel Housing	M10 Capscrews 38 N•m (28 lb. ft.) M14 Capscrews 114 to 136 N•m (84 to 100 lb. ft.)
Front Housing	19 to 26 N•m (14 to 19 lb. ft.)
Heat Gauge Unit	11.8 to 17.6 N•m (105 to 156 lb. in)
Intake Manifold	19 to 31 N•m (14 to 23 lb. ft.)
Main Bearing Cap	84 to 90 N•m (62 to 66 lb. ft.)
Oil Pan	8 to 12 N•m (71 to 106 lb. in)
Oil Pressure Switch	12 to 17 N•m (9 to 13 lb. ft.)
Oil Pan Drain Plug	30 to 41 N•m (22 to 30 lb. ft.)
Oil Pump	M8 Capscrews 19 to 26 N•m (14 to 19 lb. ft.) M10 Capscrews 38 to 53 N•m (28 to 39 lb. ft.)
Oil Strainer	8 to 12 N•m (71 to 106 lb. in)
Rocker Cover	6 to 8 N•m (52 to 70 lb. in)
Rear Cover	8 to 12 N•m (70 to 106 lb. in)
Rocker Shaft Assembly	18 to 27 N•m (13 to 20 lb. ft.)
Spark Plugs	15 to 23 N•m (11 to 16 lb. ft.)
Starter	38 N•m (28 lb. ft.)
Thermostat Housing Capscrews	19 to 26 N•m (14 to 19 lb. ft.)
Timing Belt Cover Capscrews	7 to 10 N•m (62 to 89 lb. in)
Timing Belt Tension Lock Bolt	38 to 53 N•m (28 to 39 lb. ft.)
Timing Pulley Lock Bolt	157 to 167 N•m (116 to 123 lb. ft.)
Water Pump	19 to 26 N•m (14 to 19 lb. in)

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CYLINDER HEAD

Height	91.95 to 92.05 mm (3.620 to 3.624 in.)
Distortion Limit	0.15 mm (0.006 in.)
Grinding Limit	0.20 mm (0.008 in.)

VALVE MECHANISM

Inside Diameter of Valve Guide	8.07 to 8.09 mm (0.3177 to 0.3185 in.)
Clearance in Guide (Exhaust)	0.030 to 0.065 mm (0.0012 to0.0026 in.)
Clearance in Guide (Intake)	0.025 to 0.060 mm (0.001 to 0.0024 in.)
Service Limit (Intake and Exhaust)	0.10 mm (0.004 in.)
Valve Length (Intake)	111.49 to 112.29 mm (4.390 to 4.420 in.)
Service Limit	111.19 mm (4.378 in.)
Valve Length (Exhaust)	111.29 to 112.09 mm (4.382 to 4.412 in.)
Service Limit	110.99 mm (4.370 in.)
Diameter of Valve Stem (Intake)	8.03 to 8.045 mm (0.3161 to 0.3167 in.)
Service Limit	7.980 mm (0.3142 in.)
Diameter of Valve Stem (Exhaust)	8.025 to 8.045 mm (0.3159 to 0.3167 in.)
Service Limit	7.975 mm (0.3140 in.)
Valve Head Thickness (Intake)	0.5 mm (0.020 in.)
Valve Head Thickness (Exhaust)	1.0 mm (0.040 in.)
Valve Face Angle (Intake and Exhaust)	30°
Spring Free Length	
Outer	52.2 mm (2.055 in.)
Service Limit	50.6 mm (1.992 in.)
Spring Free Length	
Inner	47.7 mm (1.878 in.)
Service Limit	46.3 mm (1.823 in.)
Spring Out of Square	
Outer	More than 1.82 mm (0.072 in.)
Spring Out of Square	
Inner	More than 1.66 mm (0.065 in.)
Rocker Arm Shaft Diameter	15.966 to 15.984 mm (0.6286 to 0.6293 in.)
Rocker Arm Bore Diameter	16.000 to 16.027 mm (0.6299 to 0.6311 in.)
Clearance between Rocker Arm and Shaft	0.016 to 0.061 mm (0.0006 to 0.0024 in.)
Service Limit	0.10 mm (0.004 in.)

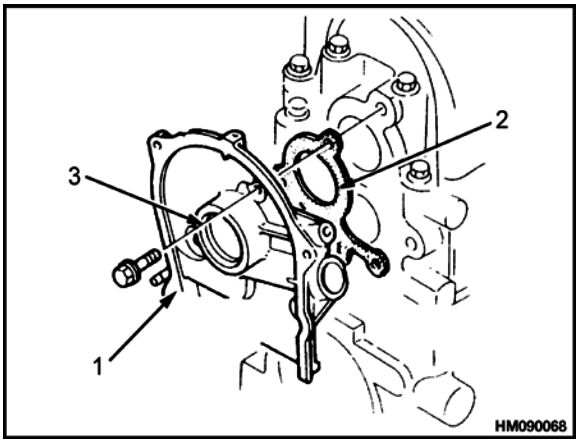
CAMSHAFT

Runout	Less than 0.03 mm (0.0012 in.)
Cam Lobes to Production Limit	37.370 mm (1.4713 in.)
Cam Lobes to Service Limit	37.170 mm (1.4634 in.)
Bearing Journals (Nos. 1 and 5)	31.940 to 31.965 mm (1.2575 to 1.2585 in.)
Bearing Journals (Nos. 2, 3, and 4)	31.910 to 31.935 mm (1.2563 to 1.2573 in.)
Bearing Journal Wear Limit	0.03 mm (0.0012 in.)
Clearance between Journals and Bore (Nos. 1 and 5)	0.035 to 0.085 mm (0.0014 to 0.0033 in.)
Clearance between Journals and Bore (Nos. 2, 3, and 4)	0.065 to 0.115 mm (0.0026 to 0.0045 in.)
Service Limit	0.15 mm (0.006 in.)
End Clearance	0.08 to 0.16 mm (0.003 to 0.006 in.)
Service Limit	0.20 mm (0.008 in.)

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15. Remove nuts and capscrews for front housing. Then remove housing. See Figure 5.



1. FRONT HOUSING
2. GASKET
3. OIL SEAL

Figure 5. Front Housing

16. Remove valve cover.

17. Loosen capscrews for rocker shaft supports in proper sequence. See Figure 6. Remove rocker shaft assembly and camshaft

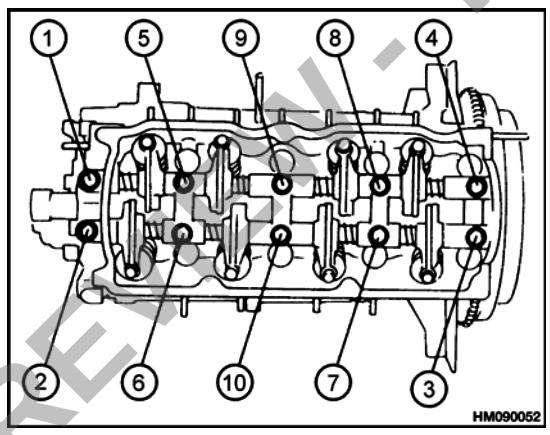


Figure 6. Rocker Assembly Removal Sequence

18. Remove capscrews for cylinder head in proper sequence. See Figure 8.

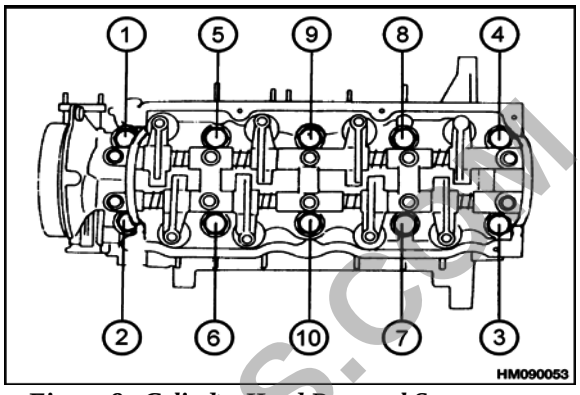


Figure 8. Cylinder Head Removal Sequence

29. Lift cylinder head from the block.

20. Use valve spring compressor to remove valve retainers, springs, and valves from head. See Figure 9

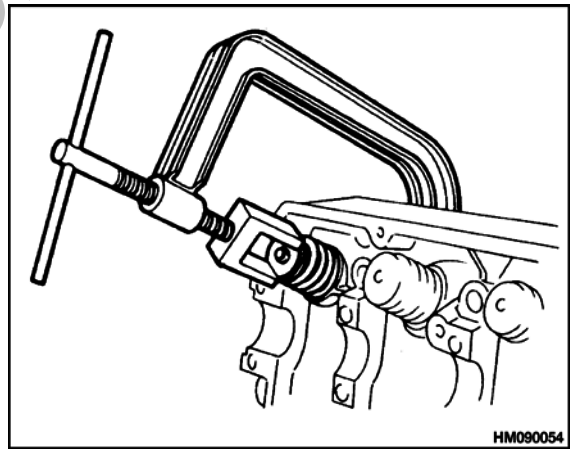


Figure 9. Valve Removal

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CRANKSHAFT

Runout	less than 0.03 mm (0.0012 in.)
Main Bearing Journal Diameter, Standard	59.937 to59.955 mm (2.3597 to 2.3604 in.)
Service Limit	0.05 mm (0.002 in.)
0.25 mm (0.01 in.) Undersize (Nos. 1, 2, 4, and 5)	59.679 to 59.736 mm (2.3496 to 2.3518 in.)
0.25 mm (0.01 in.) Undersize (No. 3)	59.673 to 59.730 mm (2.3494 to 2.3515 in.)
0.50 mm (0.02 in.) Undersize (Nos. 1, 2, 4, and 5)	59.429 to 59.486 mm (2.3398 to 2.3419 in.)
0.50 mm (0.02 in.) Undersize (No. 3)	59.423 to 59.480 mm (2.3395 to 2.3417 in.)
0.75 mm (0.03 in.) Undersize (Nos. 1, 2, 4, and 5)	59.179 to 59.236 mm (2.3299 to 2.3321 in.)
0.75 mm (0.03 in.) Undersize (No. 3	59.173 to 59.230 mm (2.3297 to 2.3318 in.)
Grinding Limit	0.75 mm (0.030 in.)
Clearance between Journals and Main Bearings (Nos. 1, 2, 4, and 5)	0.025 to 0.043 mm (0.000099 to 0.00169 in.)
Clearance between Journals and Main Bearings (No. 3)	0.031 to 0.049 mm (0.0012 to 0.0019 in.)
Service Limit	0.08 mm (0.003 in.)
Connecting Rod Journal Diameter, Standard	50.940 to 50.955 mm (2.0055 to 2.0061 in.)
0.25 mm (0.01 in.) Undersize	50.690 to 50.705 mm (1.9957 to 1.9962 in.)
0.50 mm (0.02 in.) Undersize	50.440 to 50.455 mm (1.9859 to 1.9864 in.)
0.75 mm (0.03 in.) Undersize	50.190 to 50.205 mm (1.9760 to 1.9765 in.)
0.25 mm (0.01 in.) Undersize (Nos. 1, 2, 4, and 5)	59.679 to 59.736 mm (2.3496 to 2.3518 in.)
Service Limit	0.05 mm (0.002 in.)
Grinding Limit	0.75 mm (0.030 in.)
Thrust Bearing Thickness, Standard	27.94 to 27.99 mm (1.1000 to 1.1019 in.)
0.25 mm (0.01 in.) Undersize	28.04 to 28.09 mm (1.1040 to 1.1060 in.)
0.50 mm (0.02 in.) Undersize	28.12 to 28.17 mm (1.1071 to 1.1090 in.)
0.75 mm (0.03 in.) Undersize	28.20 to 28.25 mm (1.1103 to 1.1122 in.)
Thrust Bearing	
Clearance	0.08 to 0.18 mm (0.003 to 0.007 in.)
Service Limit	0.30 mm (0.012 in.)

CONNECTING RODS

Distortion Limit	0.18 mm (0.007 in.) per 50 mm (1.97 in.)
Bending Limit	0.075 mm (0.003 in.) per 50 mm (1.97 in.)
Small End Bore	21.943 to 21.961 mm (0.8639 to 0.8646 in.)
Interference between Piston Pin and Bore	0.037 to 0.013 mm (0.0014 to 0.0006 in.)
Clearance Between Crankshaft Journals and Rod Bearings	0.027 to 0.067 mm (0.0011 to 0.0026 in.)

Service Limit ..... 0.10 mm (0.004 in.)

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