GROUP

ENGINE 03

(6000 & 9000)

SECTION 03-00 Engine—Service

VEHICLE APPLICATION

Taurus/Sable and Taurus 3.0L/3.2L SHO.

DESCRIPTION

This Section covers various engine tests, adjustments, service procedures and cleaning / inspection procedures. Engine assembly and service specifications appear at the end of the appropriate engine Section.

For engine removal, disassembly, assembly, installation, adjustment procedures and specifications, refer to the appropriate engine Section.

These engines incorporate a closed-type positive crankcase ventilation (PCV) system and exhaust emission control system. All engine / emission control systems are covered in the Powertrain Control / Emissions Diagnosis Manual. [1]

To maintain the required exhaust emission levels, the fuel system, ignition system and engine must be kept in good operating condition and meet recommended adjustment specifications.

When performing tests, adjustments or service to the engine, ignition system or fuel system, it is essential to follow the procedures and specifications in the appropriate service section in this manual, and in the Powertrain Control / Emissions Diagnosis Manual. [1]

Before replacing damaged or worn engine components such as the crankshaft, cylinder heads, valve guides, valves, camshafts or cylinder block, ensure the part(s) are not serviceable.

WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS FIRST BEEN EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

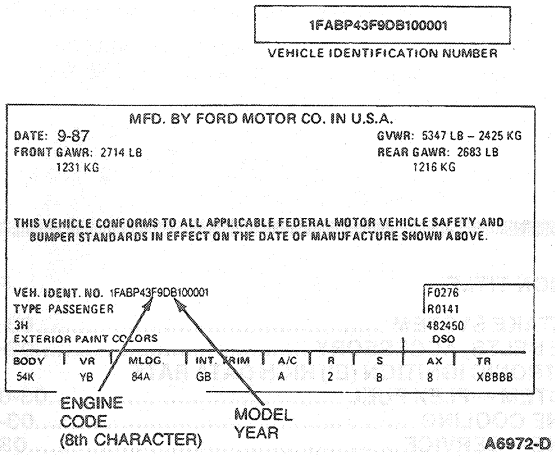
Exhaust Emission Control System

Operation, removal, installation and required maintenance of the exhaust emission control devices used on these engines are covered in the Powertrain Control / Emissions Diagnosis Manual. [1]

Engine Identification

For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine cubic inch displacement and model year. Engine decal information is located in Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).

Safety Certification Decal



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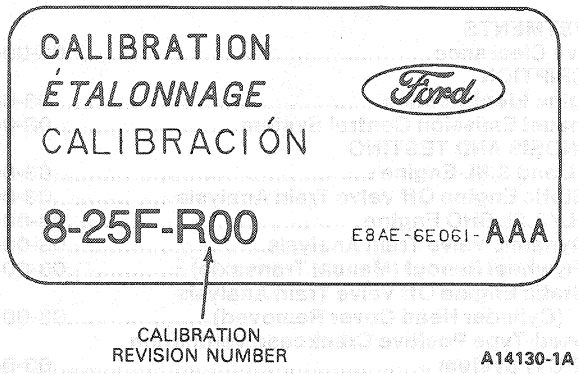
Emission Calibration Label

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

Engine Emission Calibration Number Label



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Always refer to these labels when replacement parts are required or when checking engine calibrations. Engine parts often differ within a CID family. Verification of identification codes will ensure that the proper parts are obtained. These codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application.

1 Can be purchased as a separate item.

DIAGNOSIS AND TESTING

Closed-Type Positive Crankcase Ventilation (PCV) System

CAUTION: The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation resulting in a shortened engine life.

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the positive crankcase ventilation system and making idle speed adjustments. To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, refer to the Powertrain Control / Emissions Diagnosis Manual. [2]

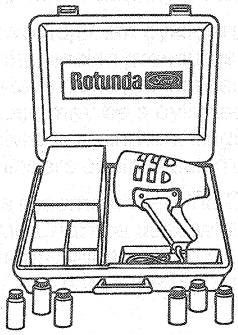
Engine Oil Leaks

Tools Required:

- Rotunda Oil Leak Detector 112-00030

When diagnosing engine oil leaks, it is important that the source and location of the leak be positively identified before service. The following procedure has been found to be very effective and requires minimum equipment. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), rocker cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

To perform oil leak diagnosis use Rotunda Oil Leak Detector 112-00030 or equivalent, perform the following procedure.



ROTUNDA OIL LEAK DETECTOR 112-00030

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Fluorescent Oil Additive Method

1. Clean engine with a suitable solvent to remove all traces of oil.
2. Drain engine oil crankcase and refill with recommended oil, premixed with Fluorescent Oil Additive ESE-M99C103-A or equivalent. Use a minimum 14.8ml (1 / 2 oz) to a maximum 29.6ml (1 oz) of fluorescent additive to all engines. If oil is not premixed, fluorescent additive must be added to crankcase first.
3. Run engine for 15 minutes. Stop engine and inspect all seal and gasket areas for leaks using Rotunda Oil Leak Detector 112-00030 or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
4. If necessary, pressurize main oil gallery system to locate leaks due to improperly sealed, loose or cocked plugs. If flywheel bolts leak oil, look for sealer on threads.
5. Service all leaks as required.

Pressure Method

Alternative Testing Procedure

The crankcase can be pressurized to locate oil leaks. The following materials are required to fabricate the tool to be used.

1. Air supply and air hose.
2. Air pressure gauge that registers pressure in one psi increments.
3. Air line shutoff valve.
4. Appropriate fittings to attach the above parts to oil fill, and PCV grommet holes and rocker arm cover tube.
5. Appropriate plugs to seal any openings leading to the crankcase.
6. A solution of liquid detergent and water to be applied with a suitable applicator such as a squirt bottle or brush

   Fabricate the air supply hose to include the air line shutoff valve and the appropriate adapter to permit the air to enter the engine through the PCV valve opening. Fabricate the air pressure gauge to a suitable adapter for installation on the engine at the oil fill opening.

Testing Procedure

1. Open air supply valve until pressure gauge maintains 34.5 kPa (5 psi).
2. Inspect the sealed and / or gasketed areas for leaks by applying "Snoop Pressure Check" or a solution of liquid detergent and water over the areas for the formation of bubbles, which indicates leakage.

Possible Leakage Points

Examine the following areas for oil leakage

2 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Underhood

- Rocker cover gaskets
- Intake manifold gaskets
- Cylinder head gasket
- Front cover gasket
- Distributor O-ring
- Oil level indicator (dipstick) tube connection
- Oil pressure sending unit
- Cup plugs and / or pipe plugs at the end of oil passages

Under Engine—With Vehicle on Hoist

- Oil pan gasket
- Oil pan front and rear end seals
- Crankshaft front seal
- Camshaft rear bore plug

With Transaxle and Flywheel Removed

- Crankshaft rear seal

Air leakage in the area around a crankshaft rear oil seal does not necessarily indicate a rear seal leak. However, if no other cause can be found for oil leakage, it can be assumed that the seal is the cause of the oil leakage.

- Rear main bearing cap parting line.
- Rear main bearing cap and seals.
- Rear cup plugs and or pipe plugs at the end of oil passages.

Oil leaks at crimped seams in sheet metal parts and cracks in cast or stamped parts can be detected when pressurizing the crankcase.

NOTE: Light foaming (similar to beer foam) equally around rocker arm cover bolts and crankshaft seals is not detrimental and no corrections are required in such cases.

Compression Tests

Tools Required:

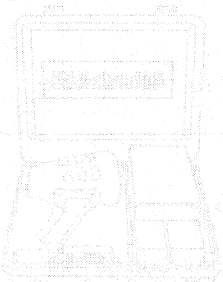
- Rotunda Compression Tester 059-00009

Compression Gauge Check

1. Ensure oil in crankcase is of the correct viscosity and at proper level and battery is properly charged. Operate vehicle until engine is at normal operating temperature. Turn ignition switch to the OFF position, then remove all spark plugs.
2. Set throttle plate in wide-open position.
3. Install a compression gauge such as Rotunda Compression Tester 059-00009 or equivalent in No. 1 cylinder.
4. Install auxiliary starter switch in starting circuit. With ignition switch in OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat test on each cylinder cranking the engine approximately the same number of compression strokes.

Test Conclusion

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest. Refer to the Compression Pressure Limit Chart.



DIAGNOSIS AND TESTING (Continued)

Compression Pressure Limit Chart

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	164	123	194	145	224	168
136	102	166	124	196	147	226	169
138	104	168	126	198	148	228	171
140	105	170	127	200	150	230	172
142	107	172	129	202	151	232	174
144	108	174	131	204	153	234	175
146	110	176	132	206	154	236	177
148	111	178	133	208	156	238	178
150	113	180	135	210	157	240	180
152	114	182	136	212	158	242	181
154	115	184	138	214	160	244	183
156	117	186	140	216	162	246	184
158	118	188	141	218	163	248	186
160	120	190	142	220	165	250	187
162	121	192	144	222	166		

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If one or more cylinders read low, squirt approximately one tablespoon of XO-20W30-QR (ESR-M2C179-A) or equivalent engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, piston rings are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, the cause may be a cylinder head gasket leak between cylinders. Engine oil and / or coolant in cylinders could result from this problem.

   It is recommended the Compression Pressure Limit Chart be used when checking cylinder compression so that the lowest reading number is 75 percent of the highest reading.

Example

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi and the lowest pressure reading was 155 psi, the engine is within specification and the compression is considered satisfactory.

Excessive Engine Oil Consumption

Tools Required:

- Rotunda Engine Cylinder Leak Detection Kit 014-00705

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 12000 km (7500 miles) when a new engine is being broken in or until certain internal engine components become conditioned. Vehicles used in heavy duty operation may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Engine block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. The thin film of oil is burned away on the firing stroke during combustion. If an engine burned a drop of oil during each firing stroke, oil consumption would be about one quart for every mile traveled. Fortunately modern engines use much less oil than this example. However, even efficient engines will use some oil or they would quickly wear out. Additionally as the vehicle is operated, some oil is drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.

Many different conditions can affect oil consumption rates. The following is a partial list of these items:

DIAGNOSIS AND TESTING (Continued)

- Engine size
- Operator driving habits
- Ambient temperature
- Quality and viscosity of the oil

Operation under varying conditions can be frequently misleading. A vehicle that has been run for several thousand miles of short trip operation or below freezing ambient temperatures, may have consumed a "normal" amount of oil. However, when checking the engine oil level, it may measure up to the full mark on the dipstick due to dilution (condensation and fuel) in the engine crankcase. The vehicle then might be driven at high speeds on the highway where the condensation and fuel boil off. The next time the engine oil is checked, it may appear that a quart of oil was used in a hundred or so miles. This perceived 160 km (100 miles) per quart oil consumption rate causes customer concern even though the actual overall oil consumption rate was about 2400 km (1500 miles) per quart.

Make sure the selected engine oil meets the recommended API performance category "SG" and SAE viscosity grade as shown in the vehicle Owner Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions. Refer to Section 00-03, Maintenance and Lubrication.

The following diagnostic procedure is intended to be used to determine the source of excessive internal oil consumption.

1. Determine what is considered excessive oil consumption, i.e., how many miles are driven per quart of oil? Also, determine owner's driving habits, i.e., sustained high speed operation, towing, extended idle, etc.

Oil usage is normally greater during the first 7500 miles of service. As mileage increases, oil usage generally decreases. Vehicles in normal service should get at least 900 miles per quart after 7500 miles of service. High speed driving, towing, high ambient temperature etc. may result in greater oil usage.

NOTE: Vehicles over 8500 GVW will consume more oil.

2. Verify engine has no external oil leak as outlined under Engine Oil Leaks.
3. Verify engine has correct engine oil indicator dipstick.
4. Verify that the engine is NOT being run in an overfilled condition. Check the oil level at least 5 minutes after a hot shutdown with the vehicle parked on a level surface. In no case should the level be above the top of cross-hatch area and "F" in FULL. If a significant overfill is indicated, perform steps 5a through 5d.
5. Perform an oil consumption test:
   a. Drain engine oil, remove filter and refill with one quart less than the recommended oil.
   b. Run the engine for three minutes (10 minutes if cold), then allow oil to drain for at least 5 minutes. (Vehicle on level surface)
   c. Remove engine oil dipstick and wipe clean. (Do not wipe with anything contaminated with silicone compounds). Re-install dipstick being sure to seat the dipstick firmly in the tube. Remove the dipstick and scribe a mark on the back (unmarked) surface at the indicated oil level. (This level should be about the same as the ADD mark on the face of the dipstick.)
   d. Add one quart of oil. Restart the engine and allow to idle for at least two minutes. Shut off the engine and allow oil to drain back for at least 5 minutes. Mark the dipstick using the procedure above. (This level may range from slightly below the top of the cross-hatched area to slightly below the letter "F" in FULL).
   e. Record vehicle's mileage.
   f. Instruct the owner to drive the vehicle as usual and:
      (1) Check the oil level regularly at intervals of 100 to 150 miles.
      (2) Return to the service point when the oil level drops below the lower (ADD) mark on the dipstick.
      (3) In an emergency, add only full quarts of the same oil and note the mileage at which the oil is added.
   g. Check the oil level under the same conditions and at the same location as in steps c and d above.
      (1) Measure the distance from the oil level to the UPPER scribe mark on the dipstick and record.
      (2) Measure the distance between the two scribe marks and record.
      (3) Divide the first measurement by the second.
      (4) Divide the distance driven during the oil test by the result. This quantity is the approximate oil consumption rate in miles per quart (MPQ).
   h. If the oil consumption rate determined is unacceptable, proceed to Step 6.
6. Check PCV valve system. Make sure system is not plugged.
7. Check for plugged oil drain-back holes in cylinder head(s), and cylinder block.
8. If, after performing the above, the condition still exists, proceed to Step 9.
9. Perform a cylinder compression test as outlined, and / or perform a cylinder leak detection test with Tester 014-00705. This can be helpful in determining source of oil consumption, i.e., valves, piston rings, etc.

DIAGNOSIS AND TESTING (Continued)

10. Check valve guides for excessive guide clearance. Replace all valve stem / guide seals after correct valve guide clearance has been verified.
11. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on tip of spark plugs can be a clue to internal oil consumption. If internal oil consumption still persists, proceed as follows:
    a. Remove engine from vehicle and place it on an engine work stand. Remove intake manifold(s), cylinder head(s), oil pan and oil pump. Refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).
    b. Check piston ring clearance, ring gap and ring orientation. Service as required.
    c. Check for excessive bearing clearance. Service as required.

    NOTE: After checking for worn parts, if it is determined parts should be replaced, make sure correct replacement parts are used.
12. Perform oil consumption test as outlined to confirm oil consumption concern has been resolved.

3.0L and 3.8L Engine

Static Engine Off Valve Train Analysis

(Rocker Arm Cover Removed)

NOTE: Refer to the appropriate engine Section for the Removal and Installation of the engine rocker arm cover.

Check for damaged and / or severely worn parts, for correct assembly, and ensure use of correct parts by proceeding, as follows, with the static engine analysis.

Rocker Arm Assemblies

- Check for loose mounting stud and nut or bolt.
- Check for plugged oil feed in the rocker arm or cylinder head.

Push Rods (if equipped)

- Check for bent push rods and restriction in oil passage.

Valve Springs

- Check for broken or damaged parts.

Retainer and Keys

- Check for proper seating of keys on valve stem.

Positive Rotator and Keys

- Check for proper seating in the positive rotator, and on valve stem.

Valves and Cylinder Head

- Check the cylinder head gasket for proper installation.
- Check for plugged oil drain back holes.
- Check for worn or damaged valve tips.
- Check for missing or damaged guide-mounted valve stem oil seals.
- Check collapsed tappet gap, hydraulic tappet applications.
- Check installed spring height.
- Check for missing or worn valve spring seats, if equipped.

Static checks (engine off) are to be made on the engine prior to the following dynamic procedure.

Dynamic Valve Train Analysis

Start the engine and while running at idle, check for proper operation of all parts. Check the following:

Rocker Arm Assemblies, Individually Mounted

- Check for plugged oil feed in rocker arm or cylinder head.
- Check for proper overhead valve train lubrication.
- Check for plugged oil feed in rocker arm.

Rocker Arm Assemblies

- Check for plugged oil feeds.
- Check for proper overhead valve train lubrication.

If a condition of insufficient oiling is suspected, accelerate the engine to 1200 rpm ± 100 rpm with the transaxle in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arm are well oiled and / or, with the rocker arm cover off, oil splash may overshoot rocker arm. If oiling is insufficient for this condition to occur, check oil passages for blockage.

Push Rods

- Check for bent push rods and restriction in oil passage.
- Check for proper rotation of push rod (non-roller tappets).

Positive Rotator and Keys

- Check for proper operation of positive rotator.

Valves and Cylinder Head

- Check for plugged oil drain back holes.
- Check for missing or damaged valve stem oil seals or guide mounted oil seals.

If a condition of insufficient oiling is suspected, check oil passages for blockage, then accelerate the engine to 1200 rpm with the transaxle in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arms are well oiled. With the rocker arm cover off, some oil splash may overshoot rocker arm.

DIAGNOSIS AND TESTING (Continued)

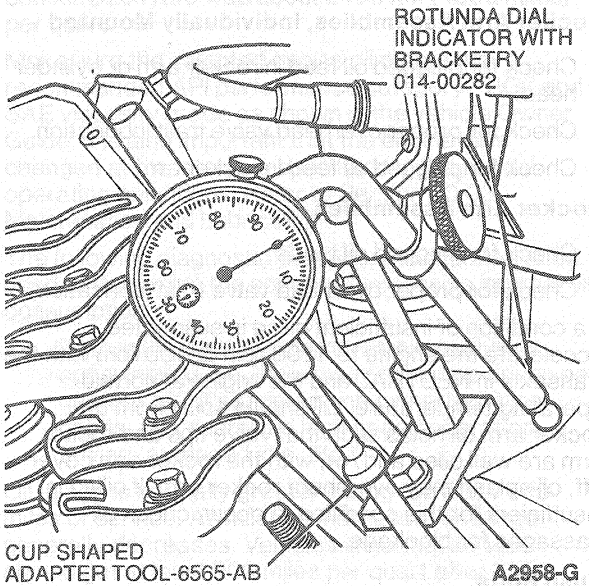
Camshaft Lobe Lift

Tools Required:

- Cup Shaped Adapter TOOL-6565-AB
- Rotunda Dial Indicator with Bracketry 014-00282

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove valve rocker arm cover(s).
2. Remove rocker arm fulcrum bolts, fulcrum and rocker arm.
3. Ensure tappet is seated against cam. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent in such a manner as to have ball socket adapter of indicator on top of tappet, or Cup Shaped Adapter TOOL-6565-AB or equivalent on top of push rod and in same plane as tappet or push rod movement.



4. Remove spark plugs.
5. Connect an auxiliary starter switch in starting circuit. Crank engine with ignition switch in OFF position. Bump crankshaft over until tappet is on base circle of camshaft lobe. At this point, tappet will be in its lowest position. If checking during engine assembly, turn crankshaft using a socket or ratchet.
6. Zero dial indicator. Continue to rotate crankshaft slowly until tappet is in fully raised position (highest indicator reading).
7. Compare total lift recorded on indicator with specifications.
8. To check accuracy of original indicator reading, continue to rotate crankshaft until indicator reads zero.

   NOTE: If lift on any lobe is below specified service limits, camshaft and tappet operating on worn lobe(s) must be replaced, as well as any tappet showing pitting or having contact face worn flat or concave. Refer to Camshaft and Hydraulic Lash Adjuster as outlined.
9. Remove dial indicator, adapter and auxiliary starter switch.

   CAUTION: After installing rocker arms, do not rotate crankshaft until tappets have had sufficient time to bleed down. To do otherwise may cause serious valve damage. Manually bleeding down will reduce waiting time.
10. Install valve rocker arm cover.
11. Install spark plugs.

Hydraulic Tappet/Lash Adjuster

Tools Required:

- Hydraulic Tappet Leakdown Tester TOOL-6500-E

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.
6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, incorrect initial adjustment, or wear of tappet face, push rod, rocker arm, rocker arm fulcrum, or valve tip. With tappet collapsed, check gap between valve tip and rocker arm to determine if any other valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips or varnish causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan, or by air being drawn into the system through a hole, crack or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, the leakdown rate should be checked and any outside the specification should be replaced.

DIAGNOSIS AND TESTING (Continued)

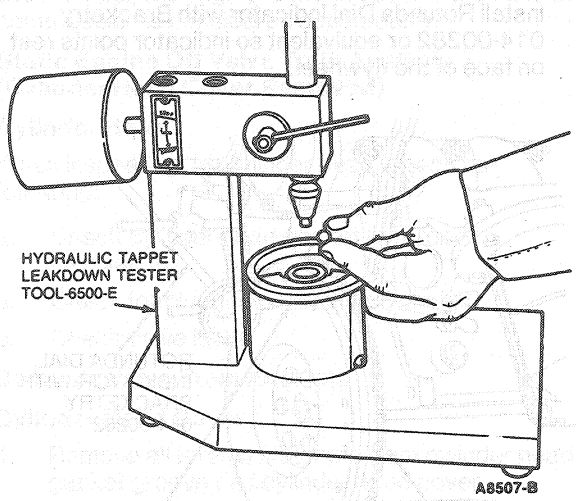
Assembled tappets can be tested with Hydraulic Tappet Leakdown Tester TOOL-6500-E or equivalent to check the leakdown rate. The leakdown rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.7kg (50 lb) load. Test the tappets as follows:

Leakdown Testing

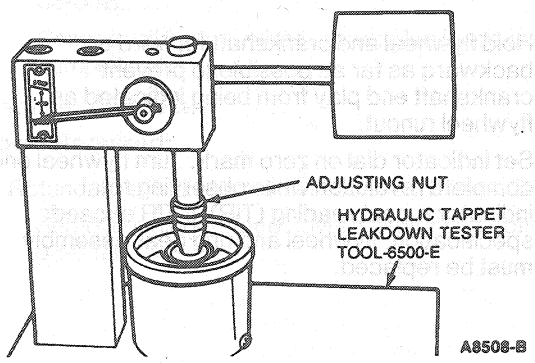
1. Disassemble and clean the tappet to remove all traces of engine oil.

   NOTE: Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.

   NOTE: Tappets cannot be checked with engine oil in them. Only the testing fluid can be used.
2. Place tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.
3. Place 7.94mm (5 / 16 inch) steel ball provided with tester in plunger cap.



4. Adjust length of ram so pointer is 1.59mm (1 / 16 inch) below starting mark when ram contacts tappet plunger, to facilitate timing as pointer passes the Start Timing mark.



Use the center mark on the pointer scale as Stop Timing point instead of the original Stop Timing mark at top of scale.

5. Work tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.
6. Allow ram and weight to force tappet plunger downward. Measure exact time it takes for pointer to travel from Start Timing to the Stop Timing marks of tester.
7. A tappet that is satisfactory must have a leakdown rate (time in seconds) within minimum and maximum limits specified.
8. If tappet is not within specification, replace it with new tappet. If a worn flat tappet is replaced with a new tappet it is recommended that a new camshaft be installed. It is not necessary to disassemble and clean new tappets before testing, because oil contained in new tappets is test fluid.
9. Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will aid in depressing tappet plungers when checking valve clearance.

Camshaft End Play

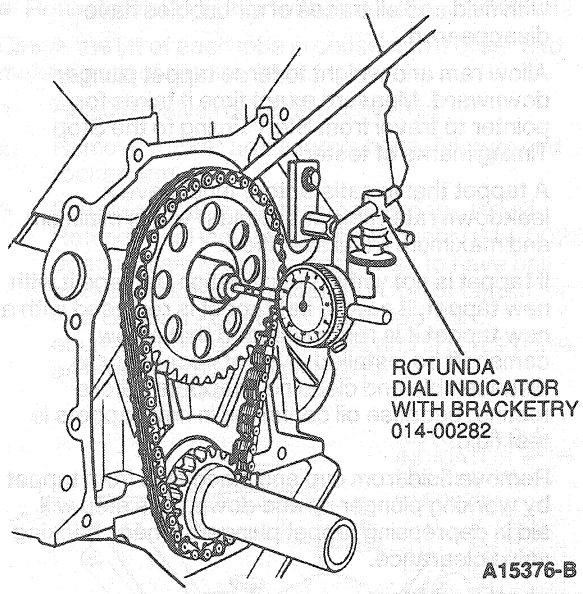
Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

CAUTION: Prying against the camshaft gear with the valve train load on the camshaft can break or damage the gear. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

DIAGNOSIS AND TESTING (Continued)

1. Push camshaft toward rear of engine. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so indicator point is on camshaft sprocket retaining screw.



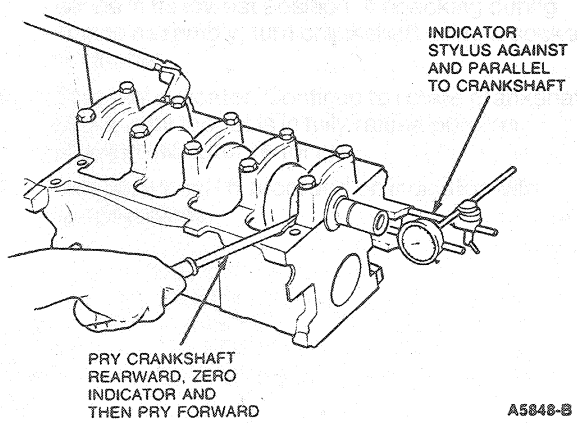
2. Zero dial indicator. Pull camshaft forward and release it. Compare dial indicator reading with specifications. If end play is excessive, replace camshaft thrust plate.
3. Remove dial indicator.
4. After replacing thrust plate, check end play again. If it is still out of specified range, inspect camshaft and cylinder head / cylinder block for excessive wear.

Crankshaft End Play

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Force crankshaft toward rear of engine.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis.



3. Zero dial indicator. Push crankshaft forward and note reading on dial.
4. If the end play exceeds the wear limit listed in the specific engine Section, replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or dirt. If thrust faces are not damaged or dirty, they probably were not aligned properly. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure recommended in the appropriate engine Section. Check the crankshaft end play.

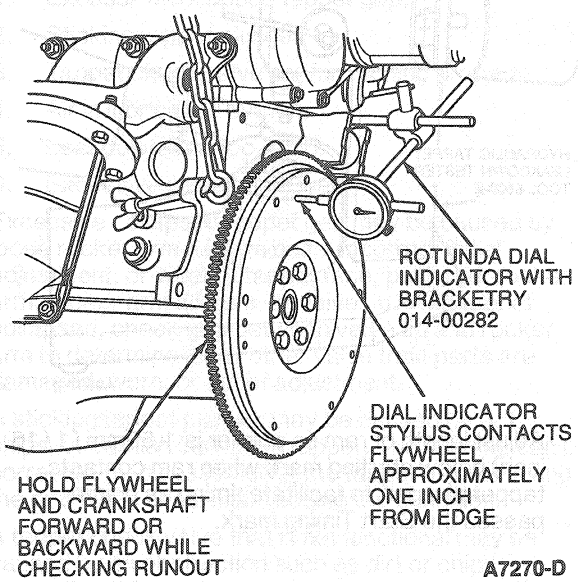
3.0L / 3.2L SHO Engine

Flywheel Runout (Manual Transaxle)

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Remove spark plugs.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so indicator points rest on face of the flywheel.



3. Hold flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.
4. Set indicator dial on zero mark. Turn flywheel one complete revolution while observing total indicator runout reading (TIR). If TIR exceeds specification, flywheel and ring gear assembly must be replaced.

DIAGNOSIS AND TESTING (Continued)

5. If clutch face runout exceeds specification, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft flywheel mounting face sufficiently to true-up the surface.

Engine Oil Leaks

Tools Required:

- Rotunda Oil Leak Detector 112-00030

Rotunda Oil Leak Detector 112-00030 or equivalent may be used to check for oil leaks.

Compression Tests

Test Conclusion

The compression reading of the lowest cylinder should be within 85-100 percent of the highest.

Example

If, after checking the compression pressures in all cylinders, it was found that the normal reading obtained was 199 psi and the lowest pressure reading was 171 psi, the engine is within specification and the compression is considered satisfactory.

Static Engine Off Valve Train Analysis (Cylinder Head Cover Removed)

Cylinder Head

When inspecting the cylinder head, check the following:

a. Check cylinder head gasket for proper installation.
b. Check for plugged oil drain back holes.
c. Check valve lash.

Dynamic Valve Train Analysis

Cylinder Head Cover

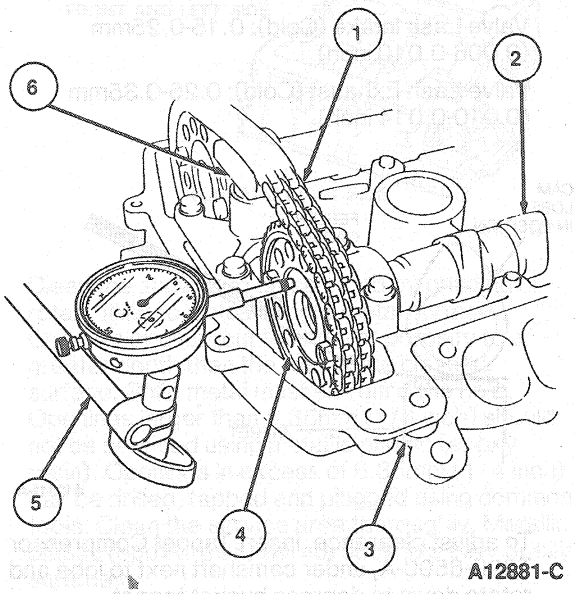
1. Remove all foreign materials from cylinder head gasket groove and cylinder head cover.
2. Apply a coat of Silicone Gasket and Sealant F1AZ-19562-A (WSE-M4G320-A2) or equivalent at gasket corners on each cylinder head as shown.
3. Install cylinder head cover bolts. Tighten to specification in sequence. Refer to Section 03-01B.
4. Connect all hoses, wires, spark plug leads and components.

Camshaft End Play

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Remove cylinder head covers. Refer to Section 03-01B.
2. Using Rotunda Dial Indicator with Bracketry 014-00282 or equivalent, measure end play while moving camshaft back and forth. If the end play is greater than 0.30mm (0.0118 inch), replace camshaft and/or cylinder head.
3. Install cylinder head covers. Tighten bolts to specification in sequence. Refer to Section 03-01B.



Item	Part Number	Description
1	6268	Camshaft Timing Chain
2	6250	Camshaft
3	6049	Cylinder Head
4	6256	Camshaft Timing Chain Sprocket
5	014-00282	Rotunda Dial Indicator with Bracketry
6	6K261	Chain Tensioner

ADJUSTMENTS

Valve Clearance

3.0L/3.2L SHO

Tools Required:

- Tappet Compressor T89P-6500-A
- Tappet Holder T89P-6500-B
- Pick Tool T71P-19703-C

1. Disconnect negative battery cable.

ADJUSTMENTS (Continued)

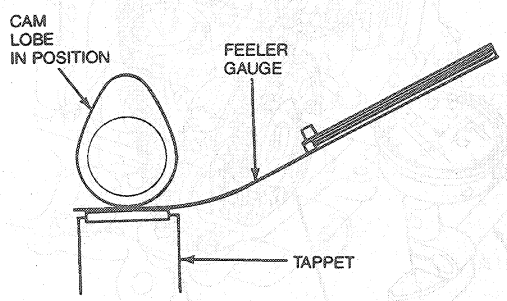
2. Remove intake manifold assembly and cylinder head covers on 3.2L SHO, remove the EGR tube sub assembly from the RH exhaust manifold to obtain clearance to remove the RH rocker cover. Refer to Section 03-01B.

   NOTE: Cam lobes must be directed 90 degrees or more away from tappets.

3. Insert feeler gauge under lobe at 90 degree angle to camshaft.

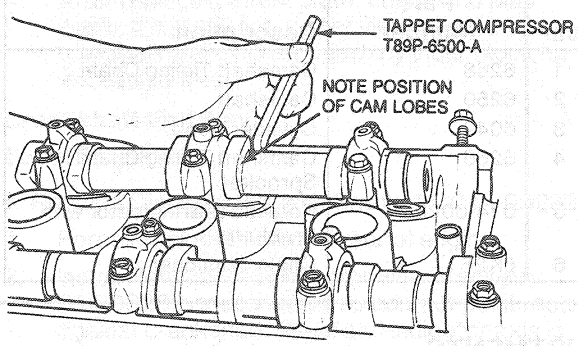
   Valve Lash Intake (Cold): 0.15-0.25mm (0.006-0.010 inch).

   Valve Lash Exhaust (Cold): 0.25-0.35mm (0.010-0.014 inch).



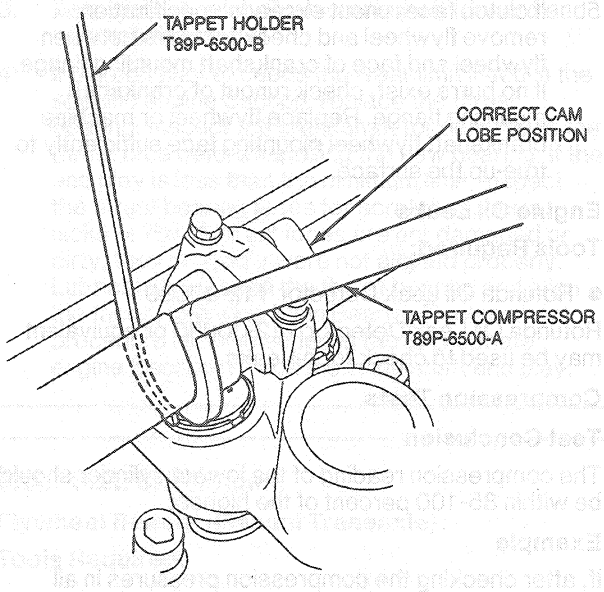
A12911-A

4. To adjust clearance, insert Tappet Compressor T89P-6500-A, under camshaft next to lobe and rotate down to depress bucket tappet.



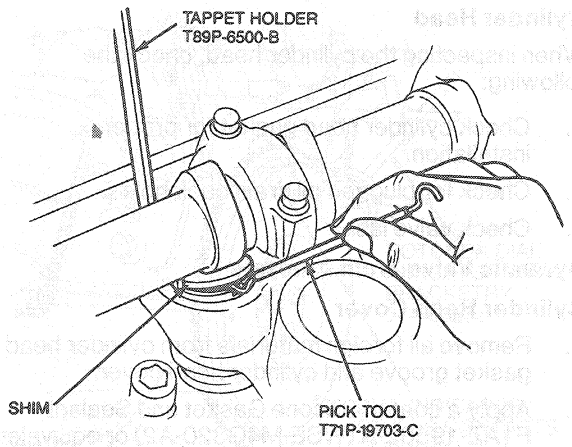
A12910-A

5. Insert Tappet Holder T89P-6500-B, and remove compressor tool.



A12909-A

6. Using Pick Tool T71P-19703-C, lift adjusting shim and remove shim with magnet.



A12908-A

7. Determine size of shim by numbers on bottom face of shim or by measuring with a micrometer. Install replacement shim that will permit specified clearance. Refer to Section 03-01B. Install shim with numbers down. Ensure shim is properly seated.
8. Release tappet holder by installing tappet compressor tool.
9. Repeat procedure for each valve by rotating engine crankshaft as necessary.
10. After all valve clearances are checked and/or adjusted, inspect all valve shims to ensure that they are fully seated in their bucket tappets.

ADJUSTMENTS (Continued)

11. Inspect cylinder head cover gaskets and replace if damaged.
12. Install cylinder head covers and intake manifold assembly. Refer to Section 03-01B.
13. Connect negative battery cable.

OVERHAUL

Service Limit Specifications

Service limit specifications are intended to be a guide only, to be used when overhauling or reconditioning an engine or engine component. A determination can be made whether a component is suitable for continued service or should be replaced for extended service while the engine is disassembled.

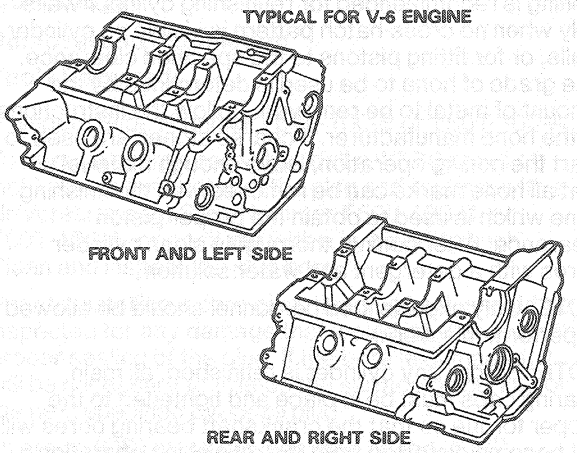
Cylinder Block

Servicing Sand Holes or Porous Engine Castings

Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes. A complete inspection of engine and transaxle should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), service can be made with an epoxy sealer meeting specification M3D35-A (E) or equivalent. **Do not service cracks with this material.** Service with this metallic plastic epoxy resin must be confined to those cast iron engine component surfaces where the inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:

a. Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket but not including machined areas.
b. Lower rear face of the cylinder block.
c. Intake manifold casting. **Service is not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 260°C (500°F).**
d. Cylinder front cover on engines using cast iron material.
e. Cylinder head, along the valve rocker arm cover gasket surface.

The following procedure should be used to service porous areas or sand holes in cast iron.



1. Clean the surface to be serviced by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 6.35mm (1/4 inch) should not be serviced using metallic plastic (epoxy resin). Openings in excess of 6.35mm (1/4 inch) can be drilled, tapped and plugged using common tools. Clean the service area thoroughly. Metallic plastic (epoxy resin) will not stick to a dirty or oily surface.
2. Mix the metallic plastic (epoxy resin) base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the service mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the epoxy into the hole or porosity.
4. Allow the service mixture to harden. This can be accomplished by two methods. Heat cure with a 250-watt lamp placed 254mm (10 inches) from the serviced surface, or air dry for 10-12 hours at temperatures above 10°C (50°F).
5. Sand or grind the serviced area to blend with the general contour of the surrounding surface.
6. Paint the surface to match the rest of the block.

Cylinder Walls, Refinishing

Tools Required:

- Engine Cylinder Hone Set T73L-6011-A

OVERHAUL (Continued)

Honing is recommended for refinishing cylinder walls only when no cross-hatch pattern is visible on cylinder walls, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance. After honing, thoroughly clean cylinder bores with a detergent and water solution.

NOTE: Only experienced personnel should be allowed to perform this work.

NOTE: Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Cylinder walls that are severely marred and / or worn beyond the specified limits should be refinished. Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance. Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

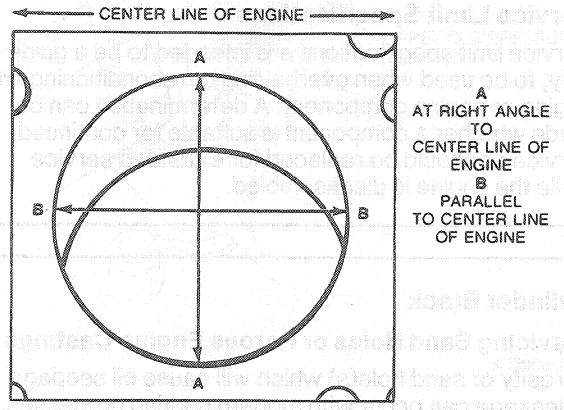
Refinish the cylinder to within approximately 0.038mm (0.0015 inch) of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained. For the proper use of the refinishing equipment, follow the instructions of the manufacturer.

Use a motor-driven, spring pressure-type Engine Cylinder Hone Set T73L-6011-A, hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 0.20-0.60 mμ (millimicron) per cylinder in production and 0.30-0.51 mμ (millimicron) average for all cylinders.

CAUTION: After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean with a detergent and water solution and oil the cylinder walls.

When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil. Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

Refinish cylinders that are deeply scored, out-of-round, and / or taper exceeds the specification If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings, providing the piston clearance is within specification. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).



1. OUT-OF-ROUND = DIFFERENCE BETWEEN A AND B
2. TAPER = DIFFERENCE BETWEEN THE A MEASUREMENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE.

A2905-B

Cleaning

CAUTION: If these procedures are not followed, rusting of the cylinder bore(s) may occur.

After any cylinder bore service operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally, wipe the bore(s) with a clean cloth dipped in XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil.

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages, then clean out all the passages. Blow out all passages, then bolt holes, etc., with compressed air. Ensure threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove all deposits. Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

Inspection

After the block has been thoroughly cleaned, check it for cracks. Tiny cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

OVERHAUL (Continued)

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

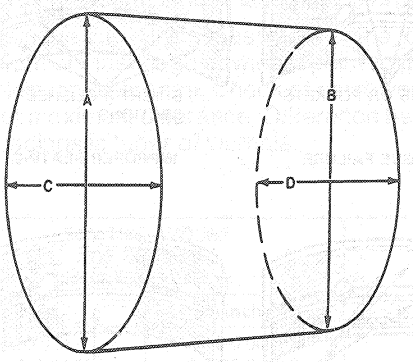
Check the cylinder bore for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications listed in Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L), **but not to exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.**

Replace all plugs that show evidence of leakage. Inspect the cylinder walls for scoring, roughness or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine. **Use only measurements obtained at 90 degrees to the engine centerline when calculating the piston-to-cylinder bore clearance.**

Inspect the main and connecting rod journals for cracks, scratches, grooves, scores or rough finish. Inspect the crankshaft oil seal surface for nicks, sharp edges, or burrs that might damage the oil seal during installation or cause premature seal wear.

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A7267-B

Core Plugs

Removal and Installation

Tools Required:

- Impact Slide Hammer T59L-100-B or T50T-100-A

To remove a large core plug, drill a 12.70mm (1 / 2 inch) hole in the center of the plug and remove with a Universal Impact Slide Hammer T59L-100-B, or T50T-100-A, or pry it out with a large drift punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged, it will be necessary to true-up the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the "OS" stamped in the flat located on the cup side of the plug.

Coat the plug and / or bore lightly with an oil resistant (oil galley) Stud and Bearing Mount E0AZ-19554-BA (WSK-M2G349-A1) or Threadlock 262 E2FZ-19554-B (WSK-M2G351-A6), or equivalent, and install it following the procedure for cup-type or expansion-type below:

Cup-Type

Cup-type core plugs are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter at the outer (sealing) edge.

Expansion-Type

Expansion-type core plugs are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

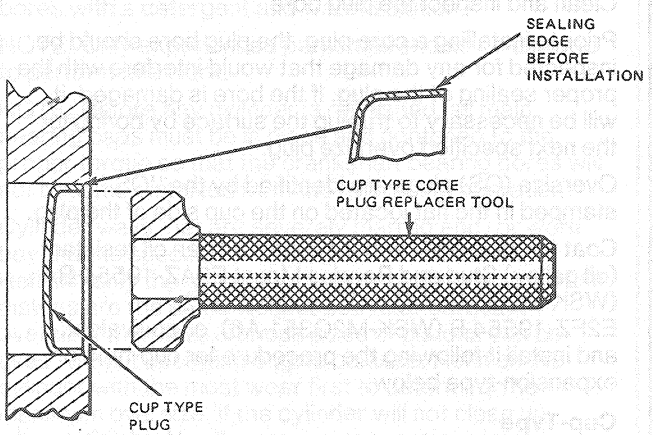
CAUTION: It is imperative to push or drive the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and / or plug bore.

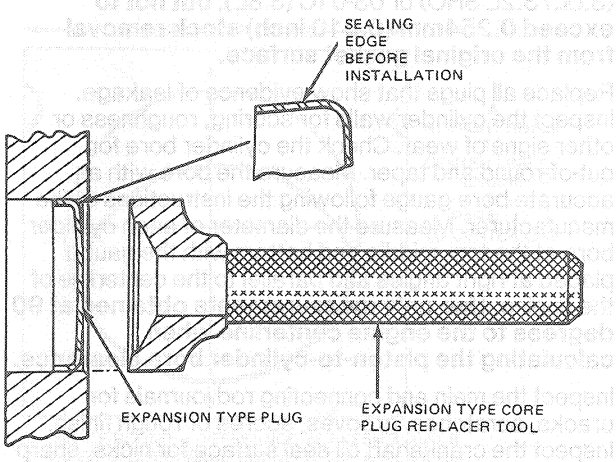
When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

OVERHAUL (Continued)

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CAUTION: It is imperative to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.





A3217-2B

NOTE: If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

Main and Connecting Rod Bearings

Cleaning

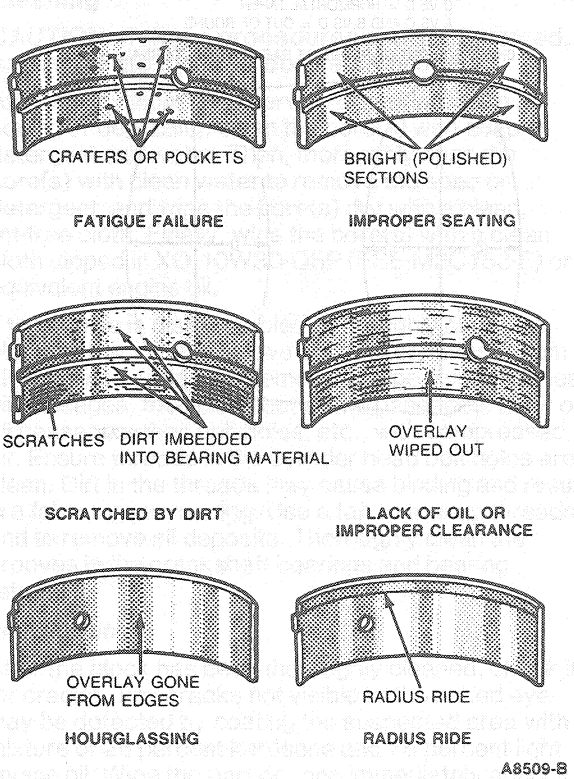
Bearings that are to be reused should be identified so they can be installed in their original locations.

CAUTION: Do not scrape gum or varnish deposits from the bearing shells.

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air.

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in the illustration. The copper lead bearing base may be visible through the bearing overlay. If the base showing is less than 20 percent of the total area, the bearing is not excessively worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as outlined.



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OVERHAUL (Continued)

Fitting Main or Connecting Rod Bearings with Plastigage

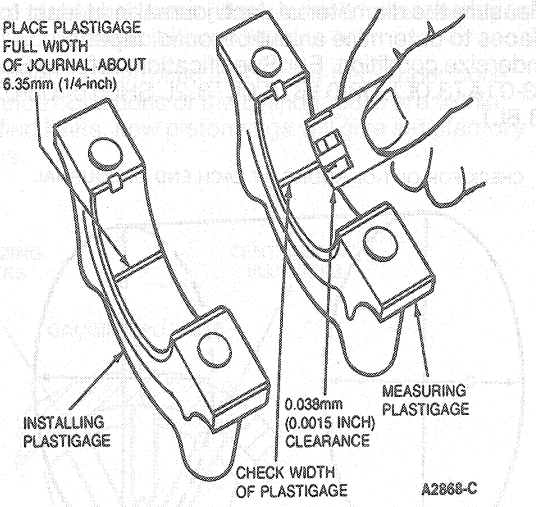
Tools Required:

- Plastigage D81L-6002-B

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear. **When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.** If the desired clearance cannot be obtained with a standard bearing, try one-half of a 0.025mm (0.001 inch) or 0.050mm (0.002 inch) undersize in combination with a standard bearing to obtain the proper clearance.

   CAUTION: Do not position jack under crankshaft pulley. Crankshaft post damage will result.

2. If fitting a main bearing in the vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage D81L-6002-B or equivalent, and provide an erroneous reading.
3. Place a piece of Plastigage D81L-6002-B or equivalent on bearing surface across full width of bearing cup and about 6.35mm (1/4 inch) off center.
4. Install cap and tighten bolts. For specifications, refer to the appropriate engine Section. Do not turn crankshaft while Plastigage is in place.
5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.



6. If bearing clearance exceeds the specified limits, try using one of the various combinations of undersize bearings as directed by the accompanying table. Use of any other bearing combination is not recommended. Bearing clearance must be within specified limits. Refer to appropriate Section under Specifications, for main and connecting rod bearing clearance limits. If use of these bearing combinations do not bring clearance to the desired limits, refinish the crank journal to 0.254mm (0.010 inch) undersize, and use the appropriate undersize bearing.
7. After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Tighten cap bolts to specification. Refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).
8. Repeat procedure for remaining bearings that require replacement.

FOR THIS AMOUNT OF BEARING CLEARANCE EXCESS		USE THIS BEARING SIZE			
		UPPER BEARING		LOWER BEARING	
mm	Inch	mm	Inch	mm	Inch
0.0-0.013	0.0-0.0005	0.025	0.001 U.S.	STANDARD	STANDARD
0.013-0.026	0.0005-0.0010	0.025	0.001 U.S.	0.025	0.001 U.S.
0.026-0.039	0.0010-0.0015	0.050	0.002 U.S.	0.025	0.001 U.S.
0.039-0.052	0.0015-0.0020	0.050	0.002 U.S.	0.050	0.002 U.S.

CA9330-A

Crankshaft

Cleaning

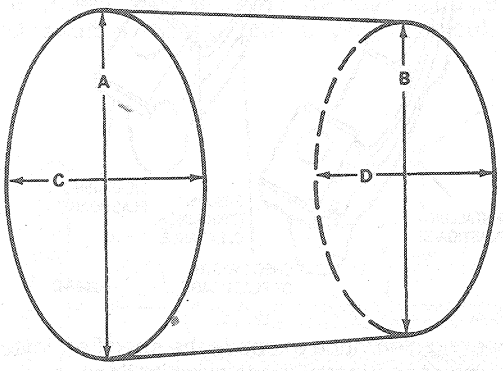
CAUTION: Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces.

Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

OVERHAUL (Continued)

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition. For Specification, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

A10094-1A

On engines with a manual transaxle, check the fit of the clutch pilot bushing in the bore of the crankshaft. A needle roller bearing and adapter assembly is used as a clutch pilot bearing. It is press fit directly into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the inside diameter of the bearing to see if it is worn, or damaged. The bearing and adapter assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transaxle. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Inspect the pilot bearing (roller bearing), if so equipped, for roughness, evidence of overheating or loss of lubricant. Replace it if any of these conditions are found.

Journals, Refinishing

CAUTION: Because the 3.8L V-6 engine crankshaft incorporates deep rolling of the main journal fillets, journal refinishing is limited to 0.25mm (0.010-inch) undersize of standard journal dimensions. Further main journal refinishing may result in fatigue failure of the crankshaft.

Dress minor imperfections such as scores, nicks or burrs with an oil stone. If the journals are severely marred or exceed the service limit, they should be refinished to size for the next undersize bearing.

If required, machine the journals to give the proper clearance with the next undersize bearing. If the journals will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes. Polish the journal with a No. 500 grit polishing cloth and engine oil (crocus cloth may also be used as a polishing agent) to obtain a smooth finish.

NOTE: On 3.0L V-6 journal radius is undercut and should be refinished. Do not grind more than 0.20-inch off 3.0L journal or deep fillet rolling for strength increase will be compromised.

Pistons, Pins and Rings

Fitting Pistons

Tools Required:

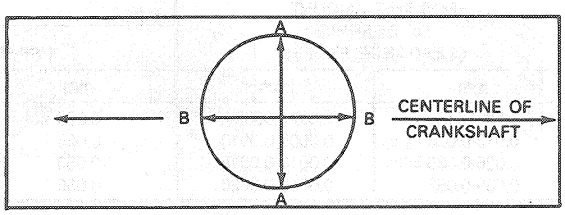
- Engine Cylinder Hone Set T73L-6011-A

Pistons are available for service in standard size and oversize shown in Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L) under Specifications.

The standard size pistons are color-coded red, blue or yellow on the dome.

Measure the cylinder bore and select the piston to ensure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third, a blue piston should be used. When the bore diameter is in the upper one-third, a yellow piston should be used.

NOTE: Cylinder bore must be clean and dry, and engine block must remain at room temperature (21°C / 70°F) for eight hours before taking cylinder measurements.



A - At Right angle to center line of engine
B - Parallel to center line of engine

Top Measurement: Make 12.70mm (1/2 inch) below top of block deck

Bottom Measurement: Make within 12.70mm (1/2 inch) above top of piston - when piston is at its lowest travel (B.D.C)

Bore Service Limit: Equals the average of "A" and "B" when measured at the center of the piston travel.

Taper: Equals difference between "A" top and "A" bottom.

Out-of-Round: Equals difference between "A" and "B" when measured at the center of piston travel.

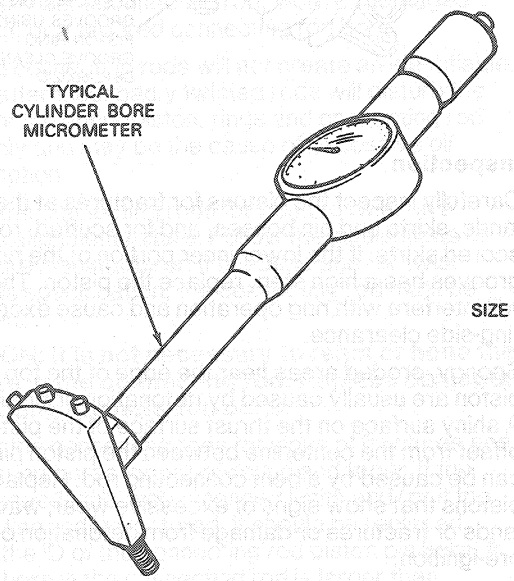
Refer to Specification tables at end of each engine section.

A4165-1G

OVERHAUL (Continued)

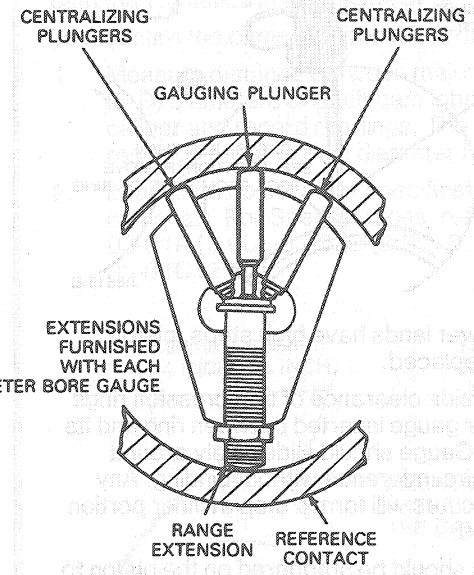
Measure the piston diameter to ensure the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger or smaller to achieve the specified clearance.

If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.



When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

If the taper, out-of-round and piston-to-cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service.



POSITIVE CENTRALIZATION

CENTRALIZING PLUNGERS AUTOMATICALLY LOCATE THE GAUGING CONTACTS CENTRALLY ON THE BORE DIAMETER EVEN WHEN THE GAUGE IS INSERTED AT AN ANGLE.

A8793-2D

If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze using only spring-loaded Engine Cylinder Hone Set T73L-6011-A, and only if there is no visible sign of cross-hatch markings on the cylinder walls. (Refer to Cylinder block, Cylinder Walls, Refinishing.) Always clean the cylinder bore thoroughly with detergent and water solution.

NOTE: After any refinishing operation, allow cylinder bore to cool, and ensure piston and bore are clean and dry before piston fit is checked.

1. Calculate size piston to be used by taking a cylinder bore check. Follow procedures outlined previously.
2. Select proper size piston to provide desired clearance. Measure piston diameter in-line with centerline of piston pin and at 90 degrees to piston pin axis.
3. Ensure piston and cylinder block are at room temperature, 21°C (70°F).

Measure the piston diameter to ensure the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger or smaller to achieve the specified clearance.

Fitting Piston Rings

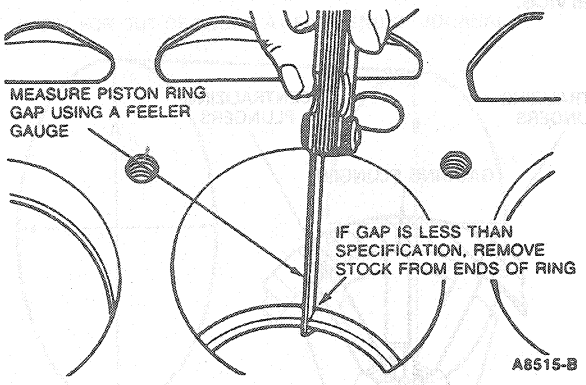
NOTE: Always use a piston ring expanding tool to install rings on a piston.

1. Select proper ring set for the size cylinder bore.
2. Position ring in cylinder bore in which it is going to be used.
3. Push ring down into bore area where normal ring wear is not encountered.

   CAUTION: Use care to avoid damage to ring or cylinder bore.
4. Position ring in bore so ring is square with cylinder wall.

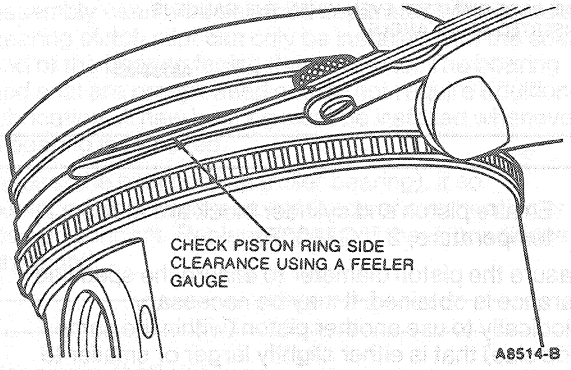
OVERHAUL (Continued)

5. Measure gap between ends of ring with a feeler gauge. If ring gap is less or greater than specified limits, try another ring set. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).



NOTE: If lower lands have high steps, piston should be replaced.

6. Check ring-side clearance of compression rings with a feeler gauge inserted between ring and its lower land. Gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land.
7. Piston rings should be staggered on the piston to insure the piston ring end gaps are **not** aligned.



Cleaning

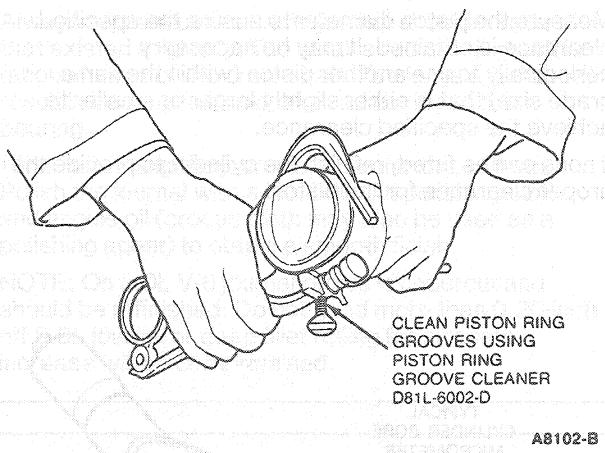
Tools Required:

- Piston Ring Groove Cleaner D81L-6002-D

CAUTION: Do not use a caustic cleaning solution or a wire brush to clean pistons.

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent.

Clean the ring grooves with Piston Ring Groove Cleaner D81L-6002-D or equivalent. Ensure oil ring slots (or holes) are clean.



Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves has a high step, replace the piston. The step will interfere with ring operation and cause excessive ring-side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters. Refer to Specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurement procedure. Measure the OD of the piston and check the ring side clearance following the procedure under Fitting Pistons, Pins and Rings.

Replace piston showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod.

Check the OD of the position pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specification. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).

CAUTION: Rings should not be transferred from one piston to another, regardless of mileage.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance.

Connecting Rods

Cleaning

CAUTION: Do not use a caustic cleaning solution.

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. Blow out all passages with compressed air.

OVERHAUL (Continued)

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L). Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings and connecting rod assembly and may be the cause of excessive oil consumption.

Check the connecting rods for bend to twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specification, the connecting rod must be replaced.

CAUTION: It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts.

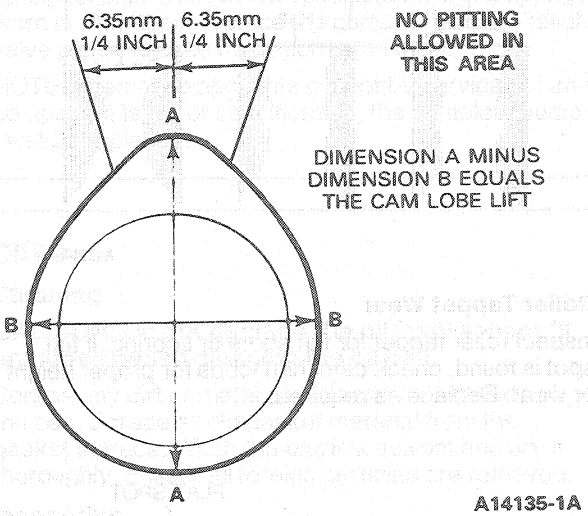
Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced. Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specification, install a 0.03mm (0.0012 inch) oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.005mm (0.0002 inch)—0.012mm (0.00048 inch) clearance (light slip fit). Assemble the piston, piston pin and connecting rod following the procedures for the specific engine being worked on.

Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe pitting in the general area of the lobe toe is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded specification or pitting has occurred in the lobe lift area.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers.

To measure the camshaft lobe lift, proceed as follows:

1. Measure distance between major (A-A) and minor (B-B) diameters of each cam lobe with a Vernier caliper and record readings. The difference in readings on each cam diameter is lobe lift.
2. If readings do not meet specification, replace camshaft. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).



Camshaft

Cleaning

Clean the camshaft in solvent and wipe it dry.

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

NOTE: If camshaft journals are excessively worn or scored, the camshaft must be replaced. Camshaft journals can be refinished to accommodate 0.38mm (0.015 inch) undersize bearing. If the journals do not "clean up," the camshaft must be replaced.

Inspection

Check camshaft bores for size, taper, roundness, alignment and finish. If any of these exceed the limits given in Specifications, install new camshaft bearings.

Hydraulic Tappets/Hydraulic Roller Tappets

CAUTION: If any part of the tappet assembly needs replacing, replace the entire assembly.

The tappet assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each tappet separately so as not to intermix. If a tappet is worn, it is recommended that all tappets and camshaft be replaced.

Cleaning

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

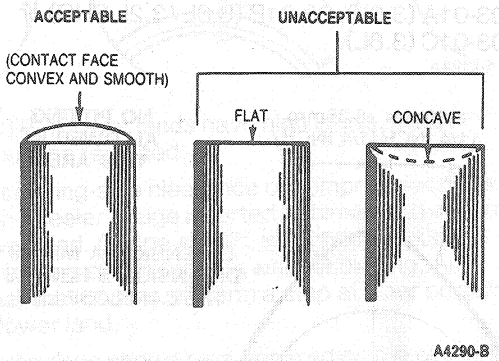
OVERHAUL (Continued)

Inspection

Inspect the parts and discard the entire lash adjuster, tappet assembly if any part shows pitting, scoring or excessive wear. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the adjuster tappet assembly and check for freeness of operation by pressing down on the plunger. The lash adjuster tappets can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the Hydraulic Lash Adjuster Tappet procedure under Diagnosis and Testing.

Flat Tappet Wear



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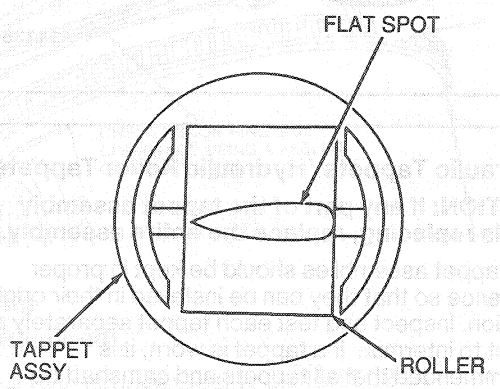
Roller Tappet Wear

Inspect roller tappet for flat spots or scoring. If flat spot is found, check camshaft lobes for proper height or wear. Replace as required.



A15295-A

Oil Pump

3.0L/3.8L

Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Ensure all dirt and metal particles are removed.

Inspection

Tools Required:

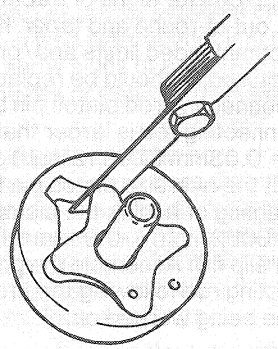
- Straight Edge D83L-4201-A

Refer to Specifications in Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L) for clearances and service limits.

Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover mating surface is worn, scored, or grooved, replace the pump (except 3.0L V-6 engines). Inspect the rotor for nicks, burrs or score marks. Remove minor imperfections with an oil stone.

Measure the inner rotor tip clearance.



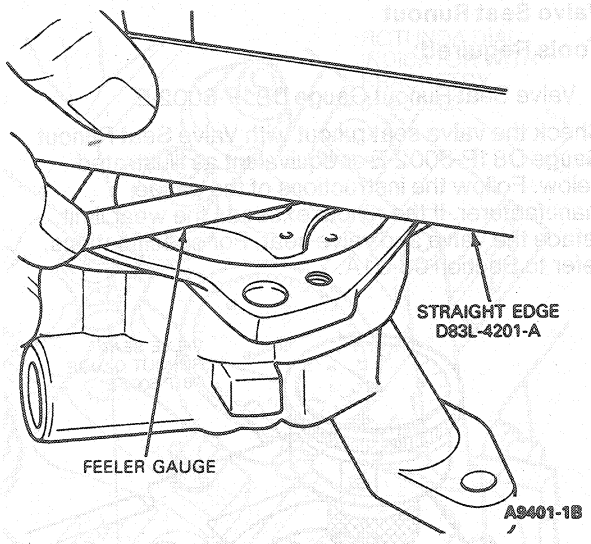
NOTE:
WITH ROTOR ASSEMBLY REMOVED FROM THE PUMP AND RESTING ON A FLAT SURFACE, THE INNER AND OUTER ROTOR TIP CLEARANCE MUST NOT EXCEED 0.30mm (0.012 IN) WITH FEELER GAUGE INSERTED 13mm (0.5 IN) MINIMUM.

A7541-1A

With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing.

OVERHAUL (Continued)

Measure the clearance (rotor end play) between the straightedge and the rotor and outer race. Maximum clearance must not exceed 0.13mm (0.005 inch).

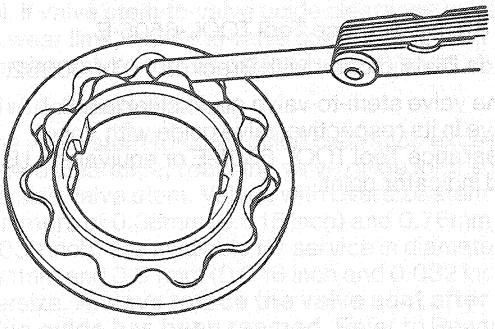


Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification and / or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

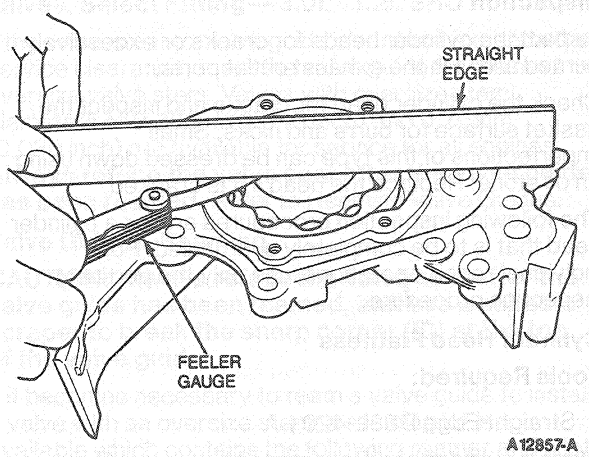
NOTE: Internal components are not serviced. If any component is out of specification, the complete pump must be replaced.

3.0L / 3.2L SHO

The inner rotor tip-to-outer rotor tip clearance must not exceed 0.06-0.18 (0.0024-0.0071 inch) with the feeler gauge inserted 12.7mm (1 / 2 inch) minimum and rotors removed from the pump housing.



With the rotor assembly installed in the pump housing, place a straightedge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straightedge and the rotor and outer race. The clearance should be 0.03-0.09mm (0.0012-0.0035 inch).



Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

NOTE: Internal components cannot be serviced. If any component is out of specification, the complete pump must be replaced.

Oil Pan

Cleaning

CAUTION: Do not damage the oil level sensor (if equipped) when cleaning the oil pan.

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Ensure all foreign particles are removed.

Inspection

Check the pan for cracks, holes, damaged drain plug threads. Check the gasket surface for damage caused by over-tightened bolts. Replace with a new oil pan if repairs cannot be made.

Cylinder Heads

Replace the head if it is cracked. **Do not plane or grind more than 0.25mm (0.010 inch) from the original cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes. Remove all deposits from the valve with a fine wire brush or buffing wheel.

OVERHAUL (Continued)

Inspection

Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Small imperfections of this type can be dressed down using an oil stone. Replace the head if it is cracked.

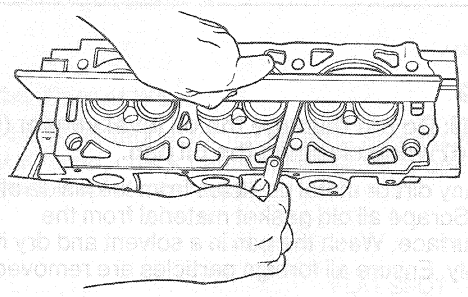
The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

Cylinder Head Flatness

Tools Required:

- Straight Edge D83L-4201-A

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specification using Straight Edge D83L-4201-A or equivalent and a feeler gauge. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L). If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.254mm (0.010 inch).**



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Cylinder Head—3.0L

Replace the head if it is cracked. **Do not plane or grind the cylinder head gasket surface.** Remove all burns or scratches with an oil stone.

When checking cylinder head gasket surfaces, warpage is not to exceed the following specifications. If warpage exceeds these specifications, the head must be replaced.

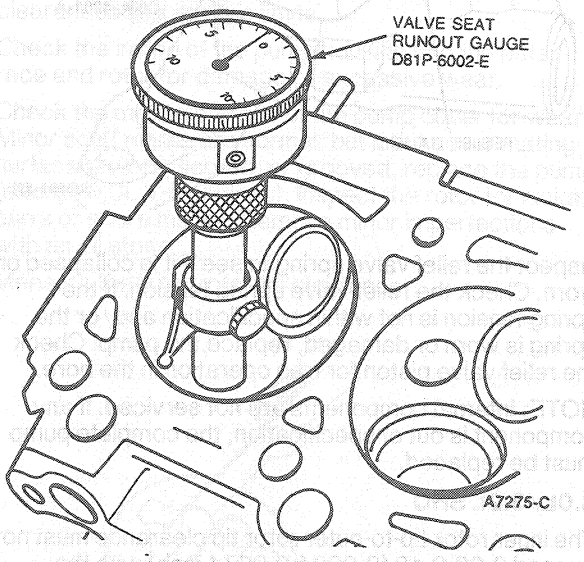
- Cylinder block side: 0.2mm (0.008 inch)
- Intake manifold side: 0.2mm (0.008 inch)
- Exhaust manifold side: 0.3mm (0.012 inch)

Valve Seat Runout

Tools Required:

- Valve Seat Runout Gauge D81P-6002-E

Check the valve seat runout with Valve Seat Runout Gauge D81P-6002-E or equivalent as illustrated below. Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. For specifications, refer to Section 03-01A.



Valve Stem-to-Guide Clearance

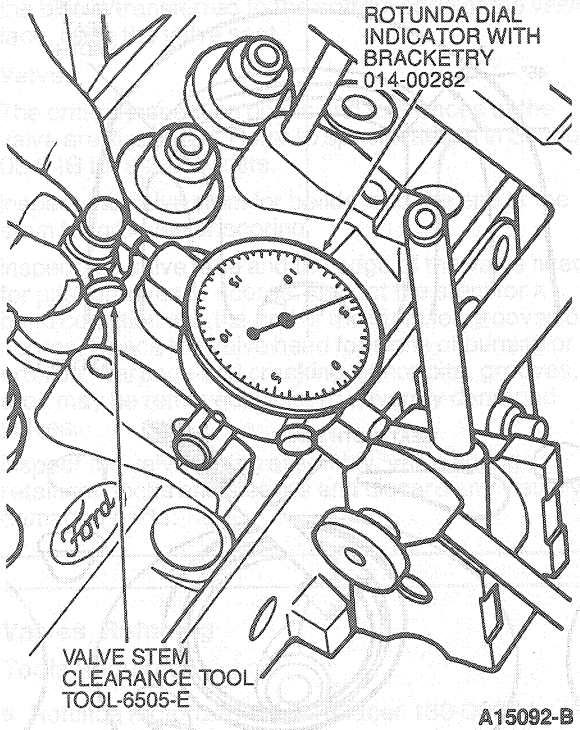
Tools Required:

- Valve Stem Clearance Tool TOOL-6505-E
- Rotunda Dial Indicator with Bracketry 014-00282.

Check the valve stem-to-valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance Tool TOOL-6505-E or equivalent. Use a flat end indicator point.

OVERHAUL (Continued)

Install the tool on the valve stem until it is fully seated. Tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.



Position the Rotunda Dial Indicator with Bracketry 014-00282 or equivalent with its flat tip against the center portion of the tool spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in-line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. If valve stem-to-valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem as outlined under Valves.

Valves, Select Fitting

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm (0.015 inch) and 0.76mm (0.030 inch) are available for service in diameters of 0.41mm and 0.81mm (0.016 inch and 0.032 inch) oversize. **Always reface the valve seat after the valve guide has been reamed.** Refer to Reaming Valve Guides.

In the case of valve stem-to-valve guide clearance, the service clearance is intended as an aid to diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to ensure extended service life.

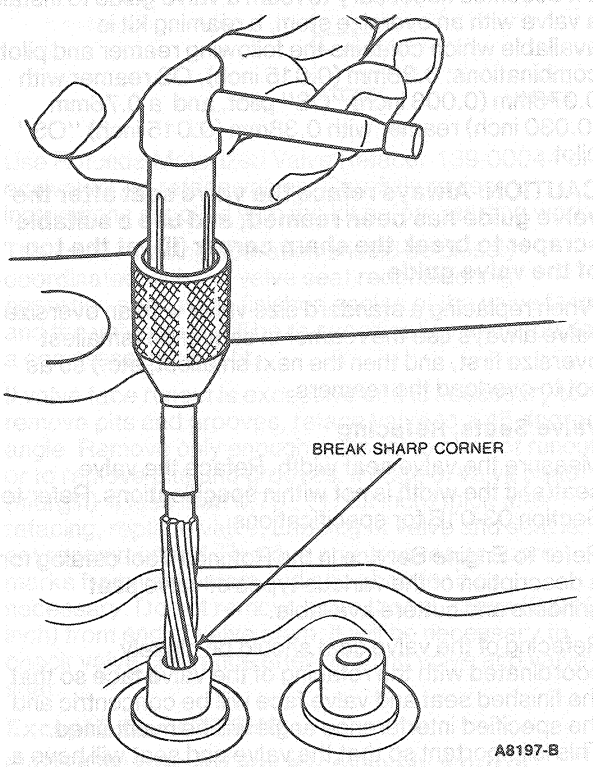
Valves, Select Fitting—3.0L/3.2L SHO

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm (0.015 inch) and 0.76mm (0.030 inch) are available for service for all engines. **Always reface the valve seat after the valve guide has been reamed.** Refer to Reaming Valve Guides.

Valve Guides, Reaming

CAUTION: Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: 0.38mm (0.015 inch) "OS" reamer with 0.076mm (0.003 inch) "OS" pilot, and a 0.76mm (0.030 inch) reamer with a 0.38mm (0.015 inch) "OS" pilot.



When replacing a standard size valve with an oversize valve always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers.

NOTE: If oversize valve stems and oversize stem seals are not available, bore out original guide and install service bushing. Ream ID for specified clearance for standard size valve. Reface valve seat, as required. Install standard size valve stem oil seal.

OVERHAUL (Continued)

CAUTION: The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.25mm (0.010 inch) from the end of the valve stem.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valve to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 0.79mm (1/32 inch) thick after grinding, replace the valve as the valve will run too hot in the engine.

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

Valve Guides, Reaming—3.0L/3.2L SHO

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: 0.38mm (0.015 inch), OS reamer with 0.076mm (0.003 inch) "OS" pilot, and a 0.76mm (0.030 inch) reamer with 0.38mm (0.015 inch) "OS" pilot.

CAUTION: Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

When replacing a standard size valve with an oversize valve always use the reamer in sequence (smallest oversize first, and then the next smallest, etc.) so as not to overload the reamers.

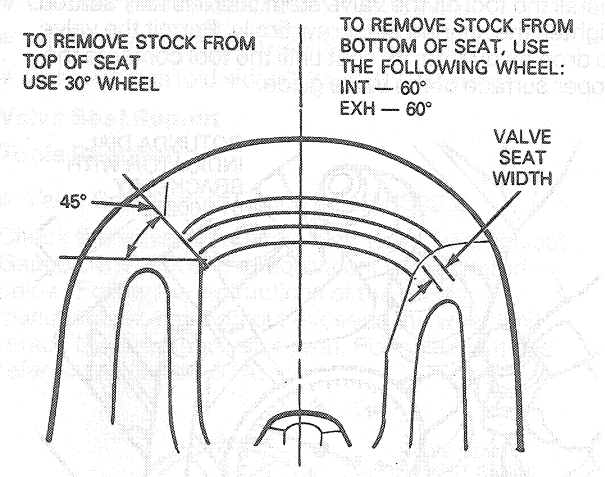
Valve Seats, Refacing

Measure the valve seat width. Reface the valve seat(s) if the width is not within specifications. Refer to Section 03-01B for specifications.

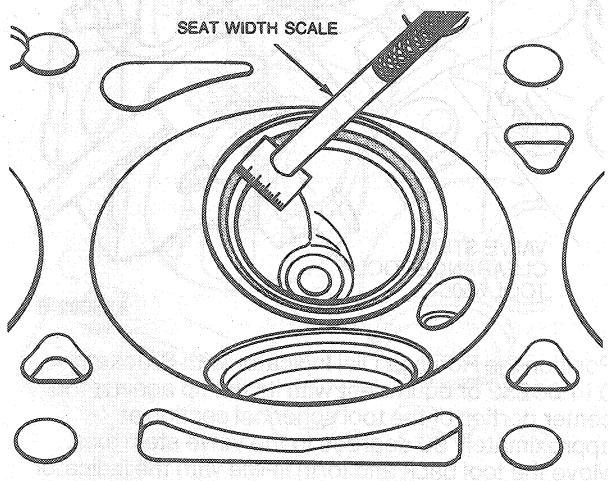
Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve seat grinders and cutters available.

Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Ensure refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width. Narrow the seat, if necessary, to bring it within specification. Refer to Section 03-01B for specifications.



A14138-1A



A6802-B

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of seat to reduce the width to specification.

For 3.0L and 3.8L engine intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seat (raise the seats). A 30 degree angle wheel is used to remove stock from the top of the seats (lower the seats).

On the intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats). A 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face.

OVERHAUL (Continued)

To do this, coat the seat with Prussian Blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

Valves

The critical inspection points and tolerances of the valve are illustrated. Refer to specifications in Section 03-01B for service limits.

Inspect the valve stem for bends, and the end of the stem for grooves or scoring.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bend condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve spring assembly, valve spring retainers, locks and sleeves and discard any visually damaged parts.

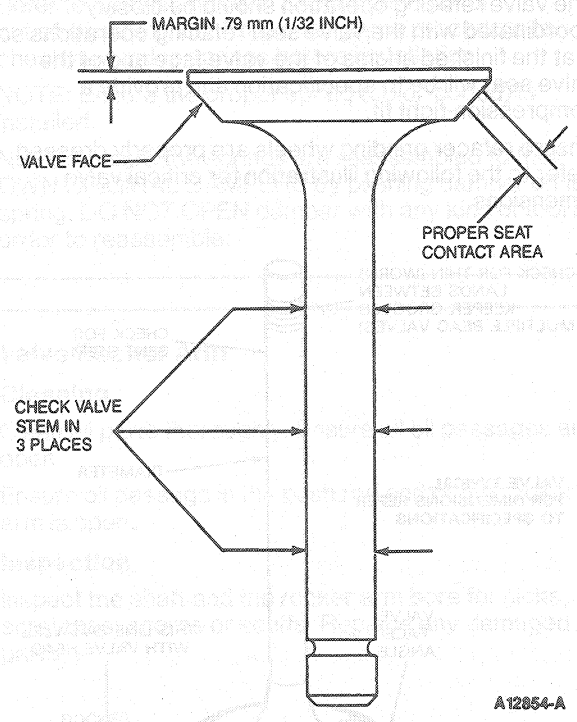
Valves, Refacing

Tools Required:

- Rotunda Motorized Valve Refacer 139-00041

3.0L/3.2L SHO

Using a micrometer, check valve stem in three places to ensure it is within specification. Refer to Section 03-01B for specifications. If the valve stem is not within specifications, or if the valve is damaged, **DISCARD VALVE.** Minor pits, grooves, or runout in the valve face may be removed by refacing.



Use Rotunda Motorized Valve Refacer 139-00041 or equivalent, to reface valves. Carefully review instructions supplied with the kit before starting work.

The valve refacing operation should be closely coordinated with the valve seat reconditioning operation so that the finished angles of the valve face and the valve seat will be to specification and provide a compression-tight fit.

If valve face runout is excessive or it is necessary to remove pits and grooves, reface valve to a 45 degree angle. Remove only enough material to correct runout or to remove pits and grooves. If edge of valve head (margin) is less than 0.79,, (1/32 inch) thick after refacing, replace valve. Lapping of valve and seat is not recommended. Remove any grooves or score marks from valve stem end and chamfer it as necessary. Do not remove more than 0.23mm (0.010 inch) from end of valve stem. It will be necessary to check valve clearance after refacing valve and valve seat.

Except 3.0L/3.2L SHO

CAUTION: Discard any excessively worn or damaged valve train parts.

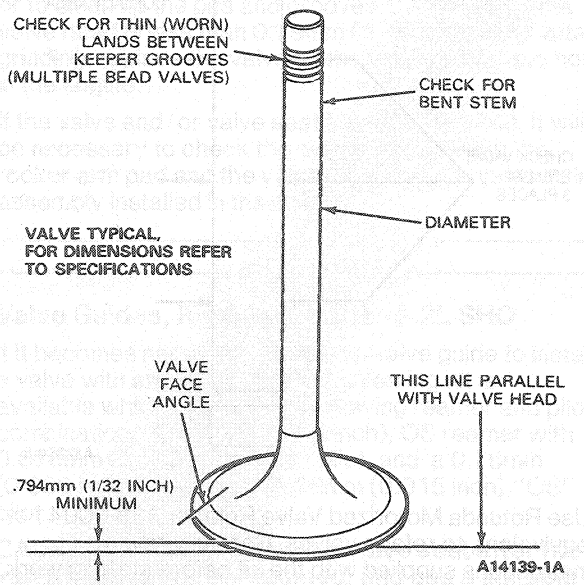
Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged if the face runout cannot be corrected by refinishing or stem clearance exceeds specification. Refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L) for specifications.

Refer to Engine Service in the Rotunda catalog for a description of the various types of valve resurfacing equipment available.

OVERHAUL (Continued)

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and of the valve seat will be to specification and provide a compression-tight fit.

Ensure refacer grinding wheels are properly dressed. Refer to the following illustration for critical valve dimensions.



Valve Seats, Refacing

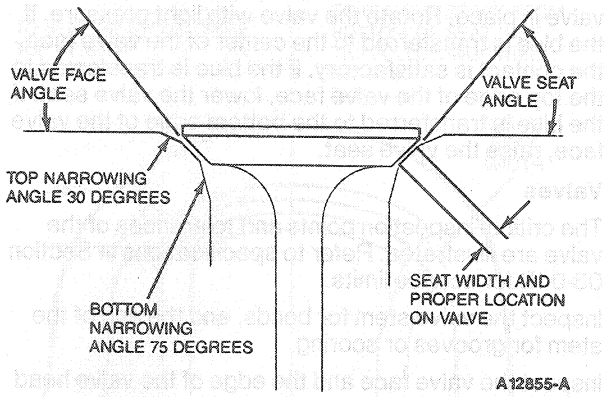
Tools Required:

- Rotunda Valve Seat Cutter Kit 139-00061

3.0L/3.2L SHO

Use Rotunda Valve Seat Cutter Kit 139-00061 or equivalent, to recondition valve seats. Carefully review the instruction booklet provided with the kit before starting work.

Reconditioning of valve seat should be closely coordinated with refacing of valve so that finished seat and valve face will be concentric and specified angle will be maintained. This is important so that valve and seat will have a compression-tight fit.



Select proper size pilot and insert it into finished valve guide. Using the 75 degree cutter, make a light cut until a clean line can be seen all the way around bottom of seat angle. Once this is done, use the 30 degree cutter until there is a clean line all the way around top of seat. Then use the 45 degree cutter until seat is clean, free from pits and has an even width all the way around.

Check seat location and width by coating face of freshly refaced valve with Prussian Blue and set valve in place. With light pressure on valve head, turn valve 1/4-turn and remove. Wipe Prussian Blue from valve and put it back in place. With light pressure on valve, turn it 1/4-turn and remove. Be careful not to touch valve face when removing. Look at valve face. There should be a line of blue about 1/3 of the way down face from margin, all the way around valve face.

If line is not in proper position, the following steps must be taken:

a. If line is too close to margin, use the 30 degree cutter to lower top edge of seat.

b. If line is to far from margin, use the 45 degree cutter to raise top edge of seat.

After moving contact point, always recheck work with Prussian Blue. Then check seat width with a seat width scale. Use the 75 degree cutter to narrow seat width.

Valve Spring Tension

Tools Required:

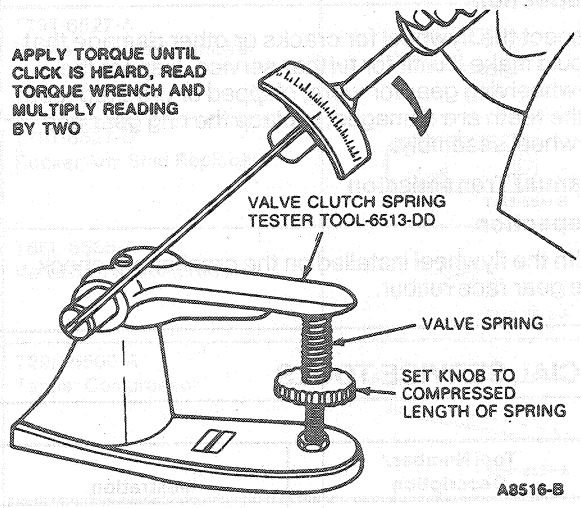
- Valve Clutch Spring Tester TOOL-6513-DD

Inspect the valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any damaged parts.

OVERHAUL (Continued)

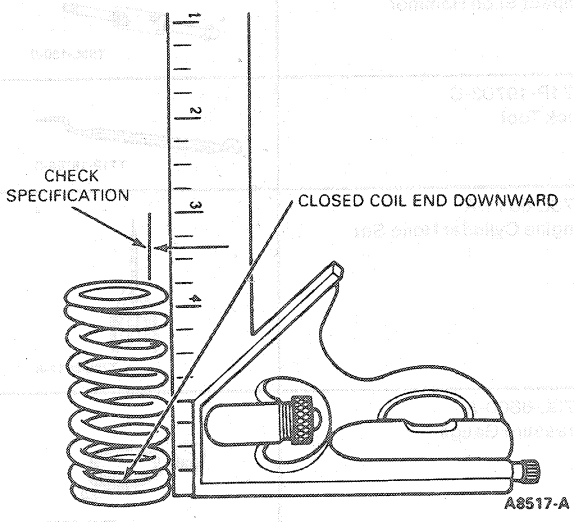
Check springs for proper pressure at the specified spring lengths using Valve / Clutch Spring Tester TOOL-6513-DD or equivalent. Weak valve springs cause poor engine performance. Replace any spring not within specification. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L). Manually rotating the valve spring assemblies while installed in the engine will not determine condition of valve springs.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.



Valve Spring Squareness

Check each spring for squareness, using a steel square and a flat surface. Stand the spring and square on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. Refer to the illustration below.



Refer to Specifications in Section 03-01B for out-of-square limits. Follow the same procedure to check new valve springs before installation.

NOTE: Ensure the proper spring (color-coded) is installed.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.

Valve Rocker Arm

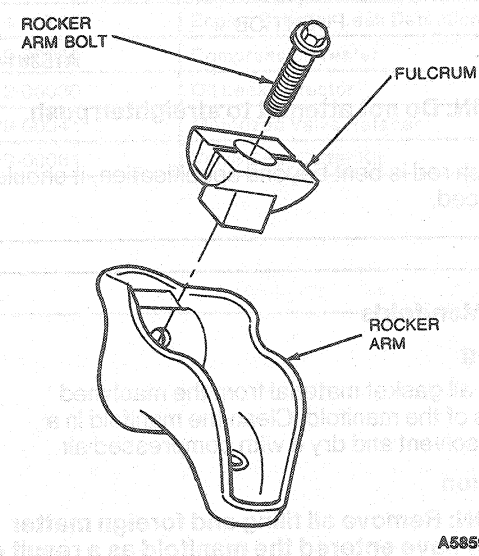
Cleaning

Clean all parts thoroughly. Ensure all oil passages are open.

Ensure oil passage in the push rod end of the rocker arm is open.

Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.



CAUTION: Do not attempt to true-up this surface by grinding. On pedestal mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm bolt for stripped or broken threads.

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm.

Push Rods

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

OVERHAUL (Continued)

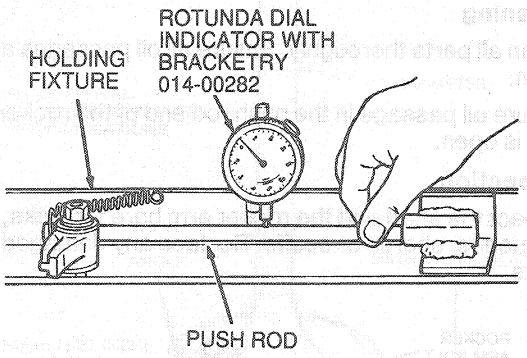
Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rods with compressed air.

Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with Rotunda Dial Indicator with Bracketry 014-00282 or equivalent.



A15361-B

CAUTION: Do not attempt to straighten push rods.

If the push rod is bent beyond specification, it should be replaced.

Intake Manifolds

Cleaning

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspection

CAUTION: Remove all filing and foreign matter that may have entered the manifold as a result of service.

CAUTION: Check the baffle plate(s) on the underside of the manifold if so equipped. The baffle(s) should be securely fastened.

Inspect the manifolds for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages.

Exhaust Manifolds

Cleaning

Remove all gasket or foreign material from all inlet and outlet sealing surfaces of the manifold.

Inspection

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifolds for cracks, damaged sealing surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

Flywheel

Automatic Transmission

Inspection

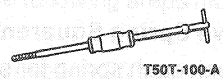
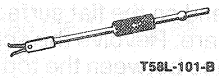
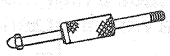
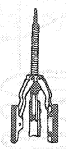
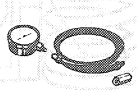
Inspect the flywheel for cracks or other damage that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

Manual Transmission

Inspection

With the flywheel installed on the crankshaft, check the gear face runout.

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T58L-101-B Puller Attachment	 T58L-101-B
T59L-100-B Impact Slide Hammer	 T59L-100-B
T71P-19703-C Pick Tool	 T71P-19703-C
T73L-6011-A Engine Cylinder Hone Set	 T73L-6011-A
T73L-6600-A Pressure Gauge	 T73L-6600-A

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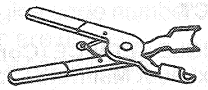
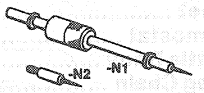
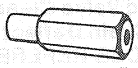
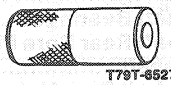
SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T78P-3504-N Seal Remover	 T78P-3504-N
T79T-6527-A Rocker Arm Stud Remover	 T79T-6527-A
T79T-6527-B Rocker Arm Stud Replacer	 T79T-6527-B
T86L-6565-A Valve Spring Compressor	 T86L-6565-A
T89P-6500-A Tappet Compressor	 T89P-6500-A
T89P-6500-B Tappet Holder	 T89P-6500-B

Tool Number	Description
D78P-4201-B	Dial Indicator Mag. Base
D78P-4201-F	Dial Indicator Bracketry
D78P-4201-G	Dial Indicator 1" Travel
D79P-100-A	Impact Slide Hammer
D79P-6666-A	Spark Plug Boot Puller
D81L-6002-A	Oil Stone
D81L-6002-B	Plastigage
D81L-6002-D	Piston Ring Groove Cleaner
D81P-6002-E	Valve Seat Runout Gauge
D81P-6666-A	Spark Tester
D83L-4201-A	Straight Edge
TOOL-6500-E	Hydraulic Tappet Leakdown Tester
TOOL-6505-E	Valve Stem Clearance Tool
TOOL-6513-DD	Valve / Clutch Spring Tester
TOOL-6565-AB	Cup Shaped Adapter

ROTUNDA EQUIPMENT

Model	Description
014-00282	Dial Indicator with Bracketry
014-00705	Engine Cylinder Leak Detection Kit
059-00009	Compression Tester
112-00030	Oil Leak Detector
139-00041	Motorized Valve Refacer
139-00061	Valve Seat Cutter Kit