GENERAL PROCEDURES

BEARING INSPECTION

1. Inspect bearings for the following defects. Possible causes are shown.
    1. Cratering - fatigue failure.
    2. Spot glazing - incorrect seating.
    3. Scratching - dirty.
    4. Base exposed - poor lubrication.
    5. Both edges worn - journal damaged.
    6. One edge worn - journal tapered or bearing not seated.

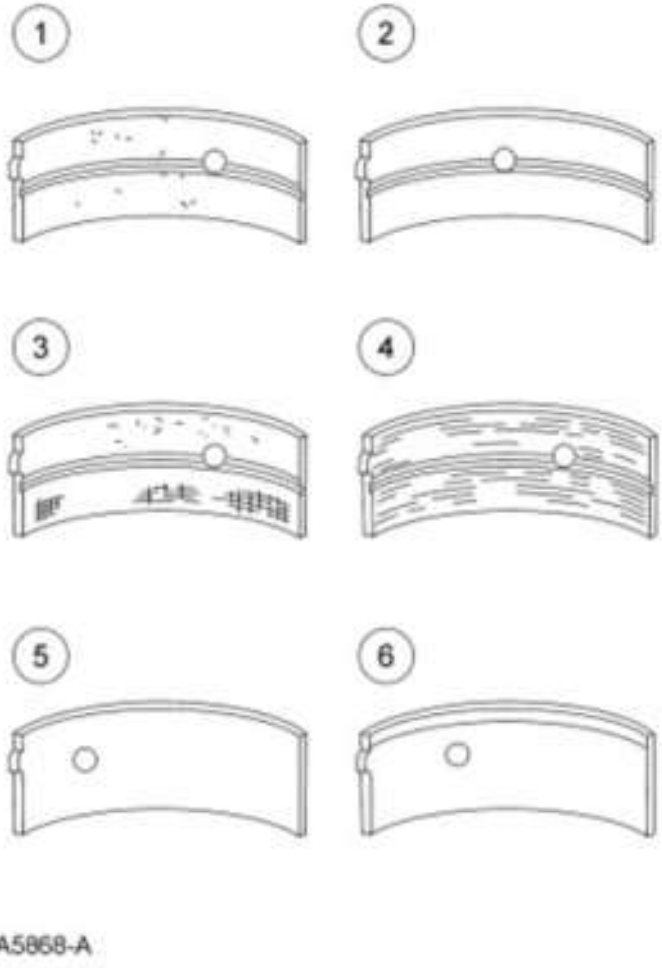


Fig. 7: Inspecting Bearings
Courtesy of FORD MOTOR CO.

CAMSHAFT BEARING JOURNAL DIAMETER

NOTE: This engine utilizes hydraulic valve tappets with roller followers. Therefore, a roller follower guide is needed to maintain correct roller-to-cam lobe orientation. Normal clearance between the valve tappet and guide allows for slight tracking of the roller across the cam lobe. This

tracking of the valve tappet roller is a normal characteristic as the roller accelerates and decelerates during typical engine operation. Consequently, a typical wear pattern on the cam lobes will exhibit tracks from side to side and have wide and narrow areas from the loading and unloading of the follower. The visual wear pattern (tracking) is normal and does not require installation of a new camshaft.

1. Inspect the camshaft. If any lobes are scuffed, scored or cracked, install a new camshaft.

NOTE: When measuring the camshaft with a micrometer, always take 2 measurements 90 degrees apart.

2. Beyond visual inspection, evaluate camshaft main journal diameter as follows:
   - Use a 50-75 mm (2-3 in) micrometer to measure camshaft bearing journal diameter. Record these measurements for later use in camshaft bushing inspection. If bearing journals are worn beyond limits, install a new camshaft. For additional information, refer to **SPECIFICATIONS**.

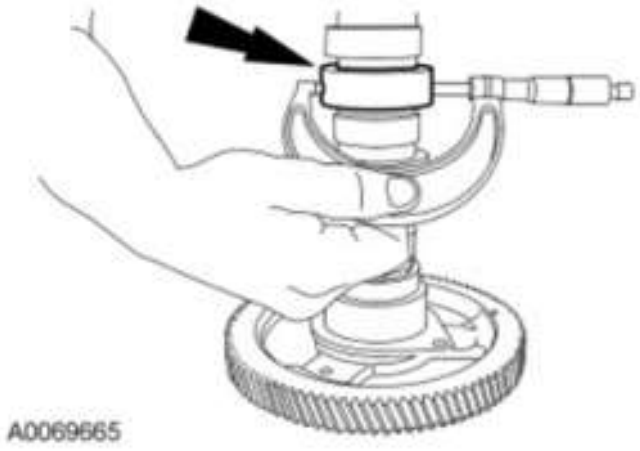


Fig. 8: Measuring Camshaft Bearing Journal Diameter
Courtesy of FORD MOTOR CO.

CAMSHAFT JOURNAL TO BEARING CLEARANCE

1. Inspect the 5 camshaft bushings for wear and correct running clearance.
2. Use a telescoping gauge and a 50-75 mm (2-3 in) micrometer to measure the camshaft bushing inside diameter with the bushings installed in the crankcase.

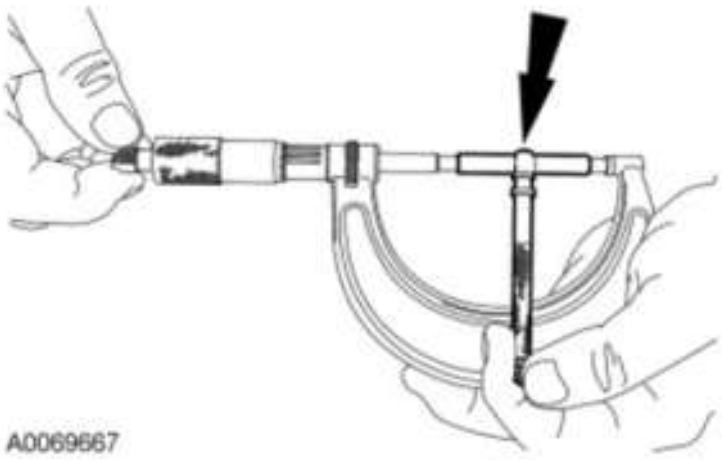


Fig. 9: Measuring Camshaft Bushing Inside Diameter With Bushings Installed In Crankcase
Courtesy of FORD MOTOR CO.

3. To determine running clearance, subtract previous camshaft journal diameter readings from camshaft bushing inside diameter readings.
4. If maximum allowable running clearance is exceeded, install new camshaft bushings. For additional information, refer to **SPECIFICATIONS**.

CAMSHAFT LOBE LIFT

1. To check the intake and exhaust lobes, measure across diagonally (A-C) and across horizontally (B-D). Subtract (B-D) from (A-C). This will give cam lobe lift. Install a new camshaft when cam lobe lift wear exceeds specifications. For additional information, refer to **SPECIFICATIONS**.

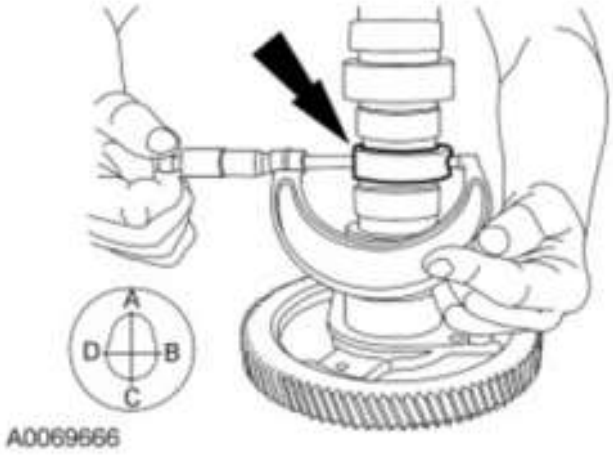


Fig. 10: Measuring Camshaft Lobe Across Diagonally (A-C) And Across Horizontally (B-D)
Courtesy of FORD MOTOR CO.

2. Inspect the thrust plate for wear, cracks or distortion.
3. Inspect the camshaft drive gear for worn or damaged teeth.
4. Wash the camshaft in cleaning solvent with a soft brush. Dry with filtered, compressed air.

COMPRESSION TEST

Special Tool(s)

SPECIAL TOOLS CHART

 ST2709-A	Adapter, Compression Test 303-757

1. Make sure the oil in the crankcase is the correct viscosity and at the correct level.
2. Operate the engine until it is at normal operating temperature. Turn the ignition switch to the OFF position.

NOTE: Failure to remove all the glow plugs may result in inconsistent test results.

3. Remove the glow plugs. For additional information, refer to **GLOW PLUG SYSTEM - 6.4L DIESEL** .

NOTE: The battery charger must be left connected during the compression test and disconnected when the test is complete.

4. Connect a battery charger to the battery.

NOTE: It may be necessary to install a commercially available adapter fitting to connect the Crankcase Pressure Test Adapter to the commercially available diesel compression gauge.

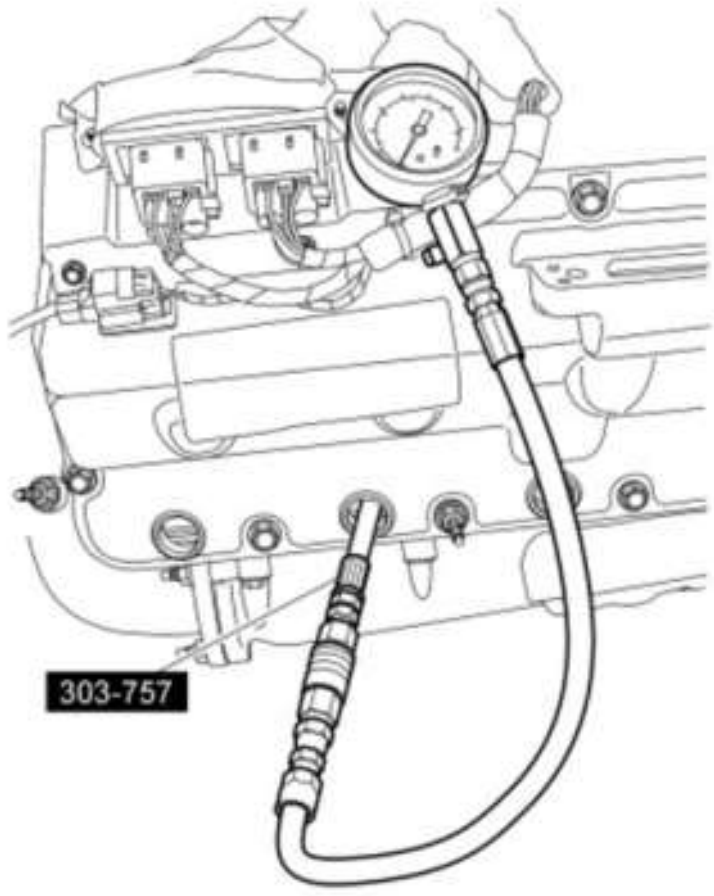


Fig. 11: Installing Compression Test Adapter
Courtesy of FORD MOTOR CO.

5. Install the Compression Test Adapter and a commercially available diesel engine compression gauge.
6. Install an auxiliary starter switch to the starting circuit. With the ignition switch in the OFF position, crank the engine a consistent number of strokes (minimum of 2 compression strokes to 12 compression strokes). Record the readings.
7. Repeat the test on each cylinder, cranking the engine the same number of compression strokes, record the readings. Compare the readings of the 8 cylinders.
    - There must be no more than a 10% difference between the readings.
8. Investigate and repair any cylinder(s) that are outside of the 10% range.
9. Install the glow plugs. For additional information, refer to **GLOW PLUG SYSTEM - 6.4L DIESEL** .

CONNECTING ROD BEARING JOURNAL TAPER AND OUT-OF-ROUND

1. Mark each connecting rod and its corresponding rod cap for correct installation.
2. Using a suitable solvent, thoroughly clean the connecting rod and rod cap.
3. Use a telescoping gauge and a 50-75 mm (2-3 in) micrometer to measure the connecting rod bearing bore.
    - Remove the connecting rod bearings from the connecting rod and the connecting rod cap.

Install the connecting rod cap onto the connecting rod and tighten the bolts in 2 stages.

- Stage 1: Tighten to 45 Nm (33 lb-ft).
- Stage 2: Tighten to 68 Nm (50 lb-ft).

- Measure and record the connecting rod bearing bore as indicated. Install new connecting rods if not within specification. For additional information, refer to **SPECIFICATIONS**.

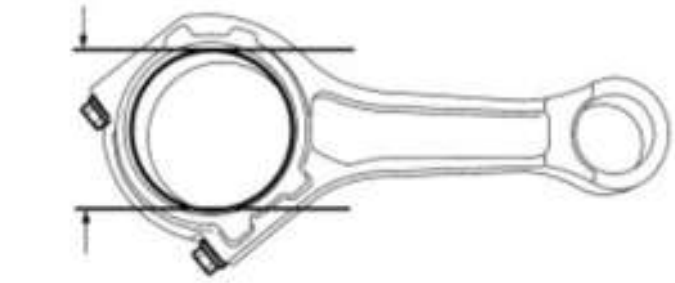


Fig. 12: Measuring Connecting Rod Bearing Bore
Courtesy of FORD MOTOR CO.

4. Use a telescoping gauge and a 50-75 mm (2-3 in) micrometer to measure the connecting rod bearing bore taper.
    1. Measure the bearing bore inside diameter near the large chamfer.
    2. Measure the bearing bore inside diameter near the small chamfer.
        - The difference between the 2 readings is the bore taper. Install new connecting rods if not within specifications. For additional information, refer to **SPECIFICATIONS**.

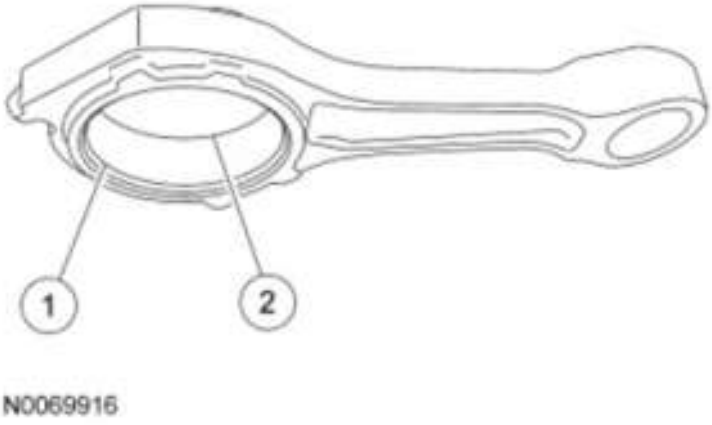


Fig. 13: Measuring Bearing Bore Inside Diameter Near Large Chamfer
Courtesy of FORD MOTOR CO.

CONNECTING ROD BUSHING DIAMETER

1. Using a suitable solvent, thoroughly clean the connecting rod and cap.
2. Mark each connecting rod and its corresponding cap.
3. Use a telescoping gauge and a 25-50 mm (1-2 in) micrometer to measure the inside diameter of the

piston pin bushing. Install a new connecting rod if not within specifications. For additional information, refer to **SPECIFICATIONS**.

Fig. 14: Measuring Inside Diameter Of Piston Pin Bushing
Courtesy of FORD MOTOR CO.

4. Measure the piston pin diameter in 2 directions at the points shown in the illustration. Verify the diameter is within specification. For additional information, refer to **SPECIFICATIONS**.
    - If out of specification, install a new piston pin.

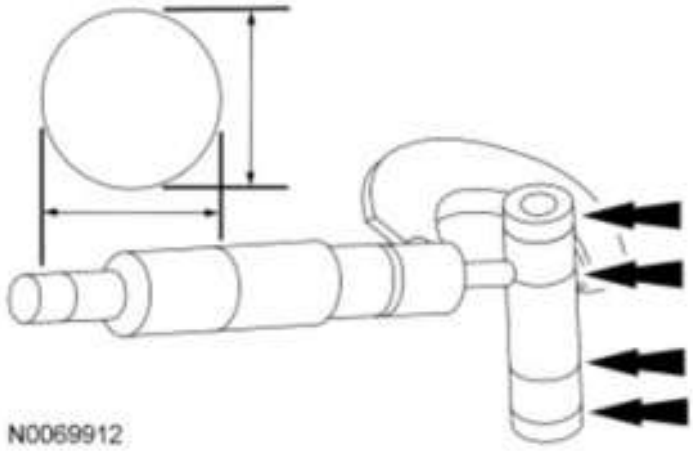


Fig. 15: Measuring Piston Pin Diameter
Courtesy of FORD MOTOR CO.

CRANKSHAFT CONNECTING ROD BEARING JOURNAL DIAMETER

1. Inspect crankshaft journals for scratches, grooves and scoring.
2. Use a 75-100 mm (3-4 in) micrometer to measure the diameter of each journal. Measure each journal at 2 points, 90 degrees apart. Move the micrometer over the entire width of the journal. For additional information, refer to **SPECIFICATIONS**.

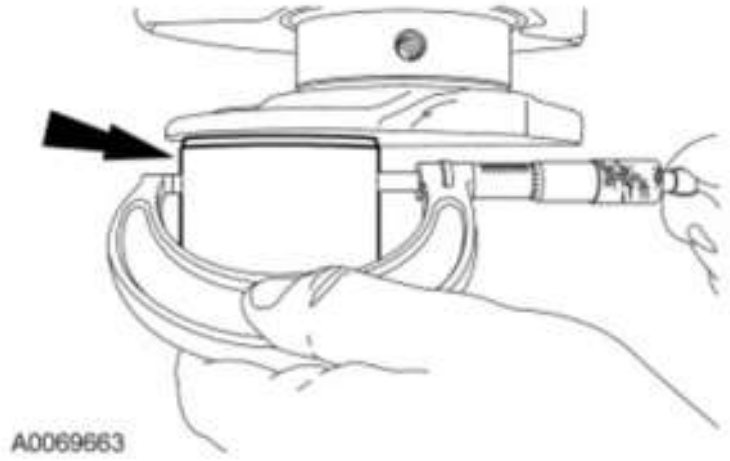


Fig. 16: Measuring Crankshaft Connecting Rod Bearing Journal Diameter
Courtesy of FORD MOTOR CO.

CRANKSHAFT MAIN BEARING JOURNAL DIAMETER

1. Clean the crankshaft with a suitable solvent. Dry with compressed air.
2. Use a stiff nylon brush to clean all internal oil passages of the crankshaft. Loosen all accumulated dirt, sludge and deposits. Flush oil passages with a suitable solvent.
3. Inspect crankshaft journals for scratches, grooves and scoring.
4. Inspect crankshaft main bearings for scratches, grooves, scoring, pitting and inconsistent coloring.
5. Use a 75-100 mm (3-4 in) micrometer to measure the diameter of each journal. Measure each journal at 2 points, 90 degrees apart. Move the micrometer over the entire width of the journal. For additional information, refer to **SPECIFICATIONS**.

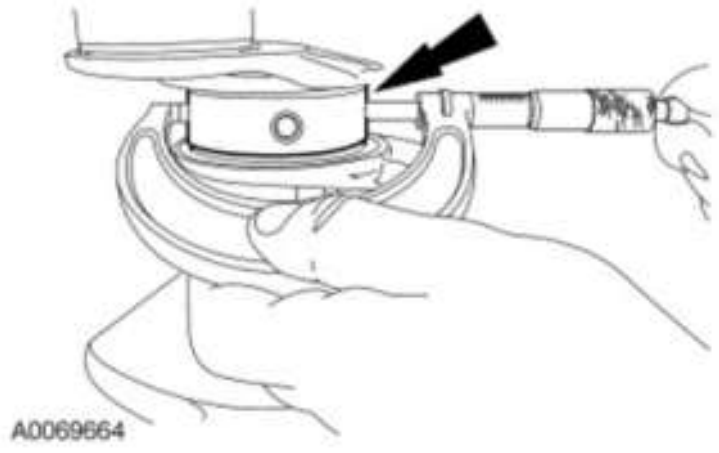


Fig. 17: Measuring Crankshaft Main Bearing Journal
Courtesy of FORD MOTOR CO.

CRANKSHAFT MAIN BEARING JOURNAL TAPER AND OUT-OF-ROUND

NOTE: To prevent engine damage, the crankshaft must be reground or a new crankshaft installed if journals exceed maximum out-of-round and/or taper specifications.

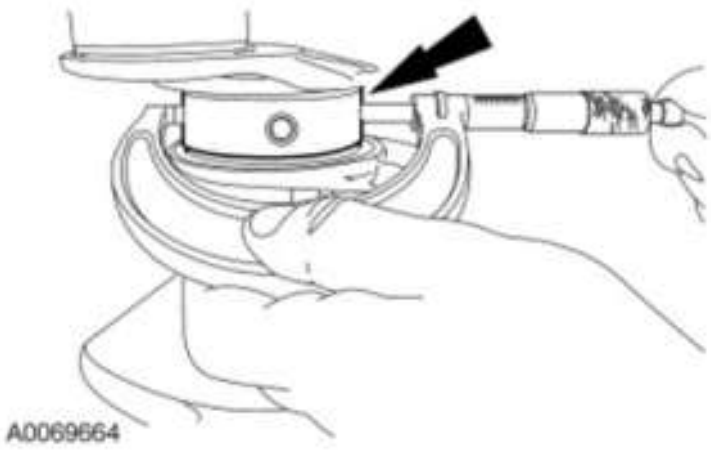


Fig. 18: Measuring Crankshaft Main Bearing Journal
Courtesy of FORD MOTOR CO.

1. Use a 75-100 mm (3-4 in) micrometer to measure the diameter of each main journal. Measure the journal at 2 points, 90 degrees apart. Measure and record readings for each of the 4 main journals. The difference between readings will be the main journal out-of-round value. For additional information, refer to **SPECIFICATIONS**.

CORE PLUG REPLACEMENT

Material

MATERIAL SPECIFICATIONS

Item	Specification
Threadlock 262 TA-26	WSK-M2G351-A6

1. To remove the cylinder block core plug, use a punch and hammer near the edge of the plug and strike with a hammer.
    - Clean the crankcase opening.
2. Coat the edges of the new cylinder block core plug and crankcase with threadlock prior to installing the cup plug.
3. Using an appropriate tool, install the new cylinder block core plug. It should be flush with the crankcase surface to approximately 1.50 mm (0.05 in) below the surface.
    - Clean off the excess threadlock.

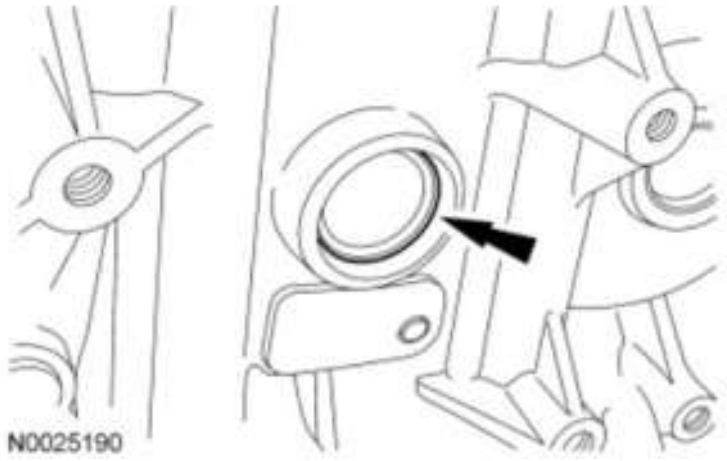


Fig. 19: Locating Cylinder Block Core Plug
Courtesy of FORD MOTOR CO.

CYLINDER BLOCK DISTORTION

Special Tool(s)

SPECIAL TOOLS CHART

	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent

NOTE: **Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.**

1. Using the Feeler Gauge Set and a calibrated straightedge, inspect the cylinder block for flatness.
    - If the measurement does not meet specification, install a new cylinder block. For additional information, refer to **SPECIFICATIONS**.

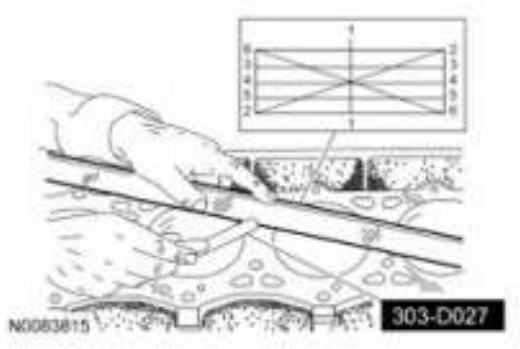


Fig. 20: Inspecting Cylinder Block For Flatness
Courtesy of FORD MOTOR CO.

CYLINDER BORE HONING

Material

MATERIAL SPECIFICATIONS

Item	Specification
Penetrating and Lock Lubricant (US); Penetrating Fluid (Canada) XL-1 (US); CXC-51-A (Canada)	-
Threadlock 262 TA-26	WSK-M2G351-A6

1. The most preferred cylinder block cleaning method is the "hot tank" method. All gallery plugs must be removed prior to hot tanking the cylinder block. If a hot tank is not available, soap and water is the approved alternative cleaning method.
2. Remove the gallery plugs in the following sequence.
    1. Remove the tappet oil gallery plugs.
    2. Remove the main oil gallery plug.

NOTE: A sealing compound must be applied to the gallery plugs prior to installation.

3. Apply a coating of threadlock to the gallery plugs and install.

NOTE: Continuously spray the cylinder wall with penetrating and lock lubricant while honing. Do not exceed more than 25 strokes per cylinder bore because too much could be removed from the cylinder wall.

4. Spray the cylinder wall using lubricant.

NOTE: Remove the piston cooling oil jets prior to honing the cylinders. Failure to do so will cause damage to the piston cooling oil jets.

NOTE: Always remove the hone from the cylinders while the hone is still rotating. Failure to do so may cause an inconsistent pattern to form

allowing excess engine oil to enter the combustion chamber.

NOTE: **An air or electric drill motor with an adjustable speed down to 100 RPM is required to hone the cylinders. If a drill motor meeting this requirement is not available, cylinder honing cannot be carried out or cylinder block damage may occur.**

NOTE: **It is not necessary to remove the crankshaft to hone the cylinder block. However, it is recommended to oil the crankshaft journals then wrap them with clean shop towels and tape.**

NOTE: **A 101.6 mm (4 in) deglazing hone is required to hone the cylinders of this diesel engine.**

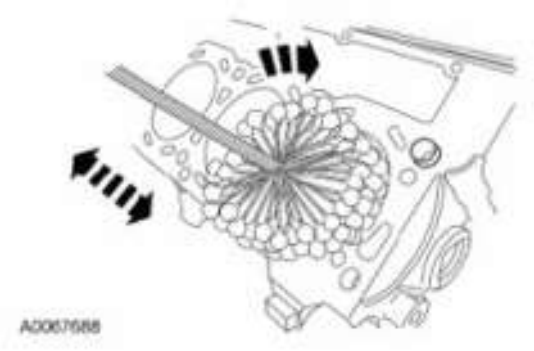


Fig. 21: Honing Cylinder
Courtesy of FORD MOTOR CO.

5. Insert the hone into a cylinder and begin honing for 3 seconds at a cycle of 2 strokes per second. Remove the hone from the cylinder.
6. Wipe a section of the cylinder wall and inspect the crosshatch pattern, comparing it to the neighboring (untouched) cylinder.

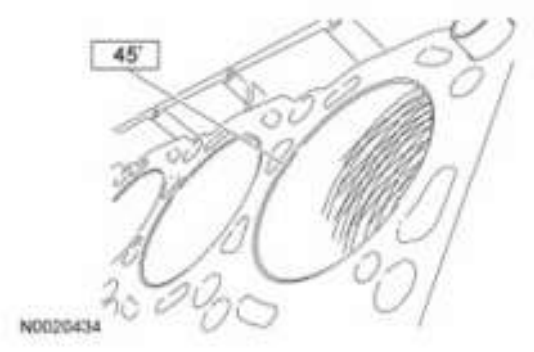


Fig. 22: Inspecting Crosshatch Pattern
Courtesy of FORD MOTOR CO.

NOTE: **Continuously spray the cylinder wall with penetrating and lock lubricant while honing. Do not exceed more than 25 strokes per cylinder bore because too much could be removed from the cylinder wall.**

7. Repeat the honing process until the cylinder wall has a satin-like finish, or the maximum 25 strokes are achieved.

NOTE: If the following steps are not followed, rusting of the cylinder bore(s) may occur.

8. Clean and preserve the cylinder bores in the following sequence.
    1. Clean the cylinder bores using a mild soap and water solution.
    2. Dry the cylinder bores thoroughly using a clean, lint-free cloth.
    3. Soak a clean cloth in clean engine oil, and wipe the cylinder bores with the cloth.
    4. Drape a clean cloth over the cylinder block to keep contaminants out of the cylinder bores.

NOTE: There is no authorized repair for cracks in the cylinder block. Reinstalling a repaired cylinder block may result in catastrophic engine failure. If cracks are present, install a new cylinder block.

NOTE: Do not substitute rubbing alcohol for wood alcohol. Using rubbing alcohol will affect the results of this check.

9. Inspect the cylinder block for cracks not visible to the eye in the following sequence.
    1. Coat the suspected area with a mixture of 25% kerosene and 75% light engine oil.
    2. Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the damaged area.

CYLINDER BORE OUT-OF-ROUND

1. Use a cylinder bore gauge to check the cylinder bore for out-of-round conditions.
    - Measure the diameter of the cylinder bore at the top of piston travel. Be sure to measure at a right angle to the center line of the crankshaft. Record the reading as dimension A.
    - Measure the bore so that the gauge reading coincides with the center line of the crankshaft. Record the reading as dimension B.
    - The difference between dimension A and dimension B is the out-of-round condition at the top of the cylinder bore. For additional information, refer to **SPECIFICATIONS**.

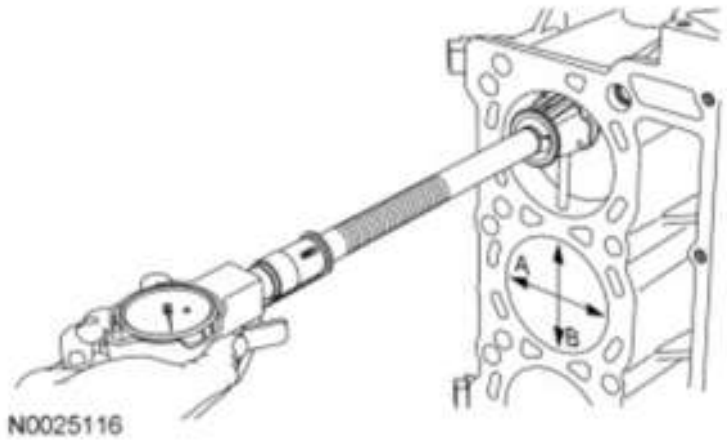


Fig. 23: Measuring Cylinder Bore Out-Of-Round
Courtesy of FORD MOTOR CO.

2. Repeat the same procedure at the bottom of the ring travel to check for out-of-round conditions.

CYLINDER HEAD CLEANING

Material

MATERIAL SPECIFICATIONS

Item	Specification
Metal Brake Parts Cleaner PM-4-A or PM-4-B (US); CPM-4 (Canada)	-

NOTE: The cylinder head cleaning and the cylinder head distortion check procedures are different than other engines. Watching the video prior to carrying out the procedure may be helpful if doing the procedure for the first time.

1. **Click here to view a video version of this procedure** .

NOTE: Do not clean the cylinder heads with steel scrapers or blades, which can cause scratches or gouges that result in leak paths. Also, do not use rotary abrasive tools including: pads, disc, wire brushes, sand paper or emery cloth. These products can alter the surface finish of the head, adversely affecting the combustion chamber sealing.

NOTE: Cleaning the cylinder head employing any other method may cause a non-warrantable condition.

NOTE: Use a brass scraper such as the Grainger 5LL98 brass scraper and a non-abrasive Scotch-Brite™ General Purpose Scouring Pad 96, or equivalent to clean the cylinder head.

2. With the valves installed, clean all the cylinder head gasket surfaces with metal brake parts cleaner and a brass scraper to remove the hardened carbon deposits. Repeat the process as necessary to remove the hardened carbon deposits. Then, use the general purpose scouring pad to remove the remaining residual deposits.
   - Use only a lint-free rag to wipe the head gasket surface after cleaning.

NOTE: Staining of the metal surface is normal and does not affect sealing ability.

NOTE: Witness marks or indentations in the cylinder head resulting from the head gasket fire rings are normal and do not affect sealing ability.

3. Clean all bolt holes and be sure that the gasket surfaces, oil return holes and coolant passages are clean. After rinsing thoroughly in hot water, blow the passages out using filtered compressed air.

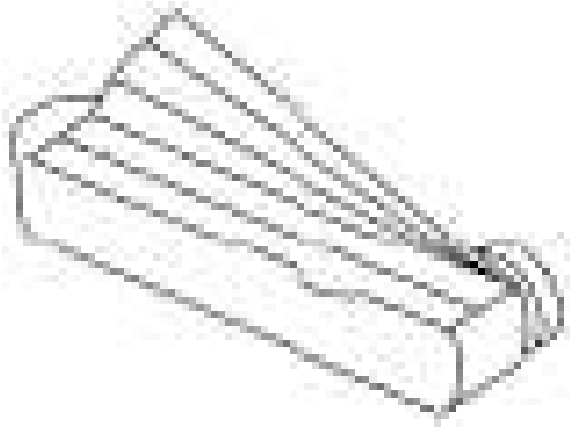
NOTE: The cylinder heads used on the diesel engine cannot be resurfaced.

4. Wash all bolts (except head bolts, which must be replaced) with a suitable solvent and dry thoroughly.

CYLINDER HEAD DISTORTION

Special Tool(s)

SPECIAL TOOLS CHART

	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent
	Gauge Bar 307-400

Cleaning and Visual Inspection

NOTE: **The cylinder head cleaning and the cylinder head distortion check procedures are different than other engines. Watching the video prior to carrying out the procedure may be helpful if doing the procedure for the first time.**

1. **Click here to view a video version of this procedure** .

NOTE: **It is important that the cylinder head be thoroughly cleaned prior to taking cylinder head distortion measurements. Failure to remove carbon deposits or other material from measurement areas will result in inaccurate measurements.**

2. Clean the cylinder head. For additional information, refer to **CYLINDER HEAD CLEANING**.

NOTE: **Cylinder heads that contain carbon buildup in the coolant areas may show evidence of surface pitting when cleaned. Surface pitting in the coolant areas is not cause for replacement of the cylinder head.**

NOTE: **Staining of the metal surface is normal and does not affect sealing ability.**

NOTE: **Witness marks or indentations in the cylinder head resulting from the head gasket fire rings are normal and do not affect sealing ability.**

NOTE: **The surface finish on the cylinder head may appear to contain "record grooves", which is a normal condition.**

NOTE: **The cylinder head combustion chamber area may exhibit very small "surface fissures" or "microcracks" during a Magnaflux inspection process. These surface fissures or microcracks are typically located between the glow plug and the valve seats. They DO NOT extend into the coolant jacket and will not cause coolant loss or cooling system overpressurization. The presence of surface fissures or microcracks is not cause for replacement of the cylinder head.**

3. Inspect the cylinder head for obvious signs of damage or distortion.

Cylinder Head Distortion Check

NOTE: **Do not measure for cylinder head distortion along the length, across the full width, or across a diagonal of the cylinder head. These types of measurement will provide inaccurate results.**

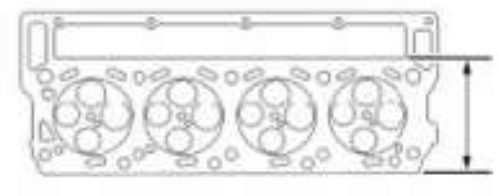


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Fig. 24: Measuring Only Inboard Surface Of Cylinder Head, From Push Rod Openings To Outer Edge Of Exhaust Side Of Cylinder Head
Courtesy of FORD MOTOR CO.

1. Measure only the inboard surface of the cylinder head, from the push rod openings to the outer edge of the exhaust side of the cylinder head.

NOTE: **When checking the 13 locations on the combustion chamber sealing surface, keep the Feeler Gauge Set away from the valves area as they may lead to incorrect measurements**

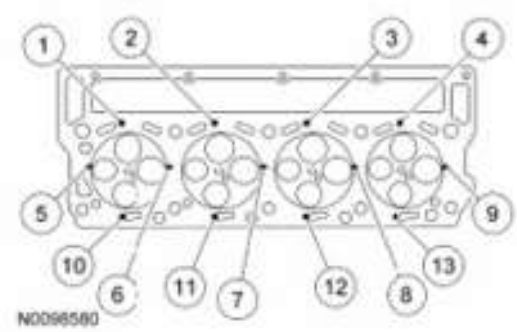

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Fig. 25: Identifying Combustion Chamber Sealing Points
Courtesy of FORD MOTOR CO.

2. Check for distortion only at the 13 locations shown in the illustration.

NOTE: **Avoid running the tip of the Feeler Gauge Set into the Gauge Bar (or straightedge). This may cause damage to, or distort the tip of, the Feeler Gauge Set. The result may be inaccurate readings.**

NOTE: **If the Gauge Bar is not available, use a calibrated straightedge that is calibrated by the manufacturer to be flat within 0.0127 mm (0.0005 in) per running foot length, such as a Snap-On® GA438A, or equivalent.**

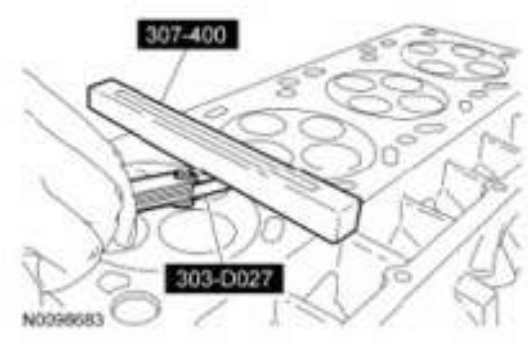


Fig. 26: Placing Feeler Gauge On Cylinder Head
Courtesy of FORD MOTOR CO.

3. Place the 0.1 mm (0.004 in) feeler gauge on the cylinder head at one of the specified locations. Then place the Gauge Bar (or straightedge) on top of the feeler gauge. Lightly press on the center of the Gauge Bar (or straightedge) while checking the measurement.
4. Attempt to pull the feeler gauge out from under the Gauge Bar (or straightedge).

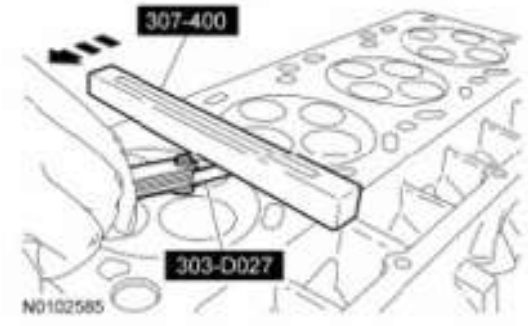


Fig. 27: Pulling Feeler Gauge Out From Under Gauge Bar
Courtesy of FORD MOTOR CO.

NOTE: **If a location is measured to be out of specification, verify that all carbon deposits that may influence measurement accuracy have been removed with a brass scraper and re-measure.**

NOTE: **The cylinder heads used on the diesel engine cannot be resurfaced. Do not attempt to machine or resurface the cylinder heads.**

5. If the 0.1 mm (0.004 in) feeler gauge can be easily pulled out from under the Gauge Bar (or straightedge) without resistance, the cylinder head is out of specification and must be replaced.
6. Repeat the cylinder head distortion measurement at each of the 13 locations shown in the illustration.

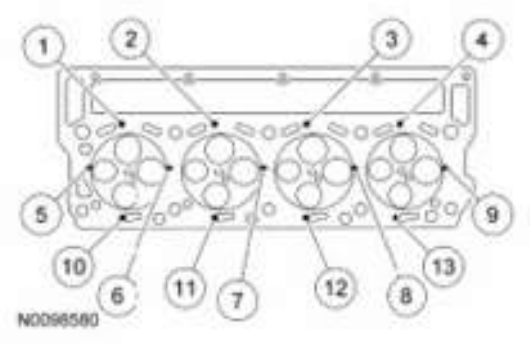
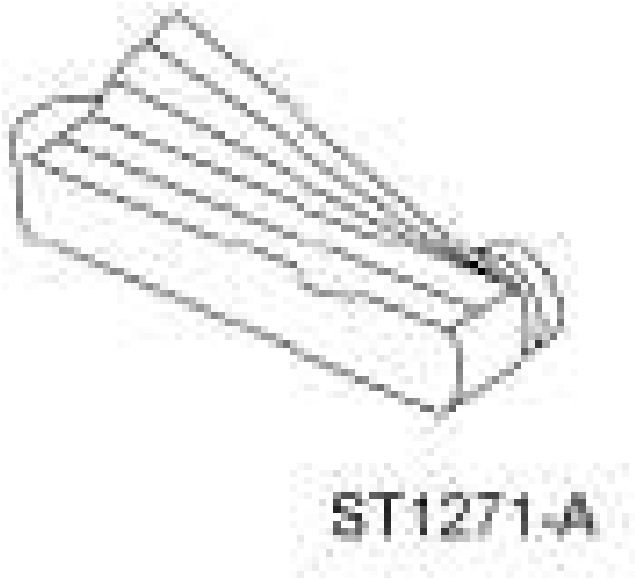


Fig. 28: Identifying Combustion Chamber Sealing Points
Courtesy of FORD MOTOR CO.

OIL PUMP ROTOR INSPECTION

Special Tool(s)

SPECIAL TOOLS CHART

	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent

1. Inspect the oil pump housing for excessive metal particles.
2. Inspect the oil pump housing for gouging, cracks or deep scratches.
3. Inspect the oil pump inner and outer gear rotors for damage or excessive wear.
4. Using a straightedge and the Feeler Gauge Set, measure the height clearance between the oil pump housing and the inner and outer rotors. If the measurement does not meet specifications, install new gerotors as a set. For additional information, refer to **SPECIFICATIONS**.

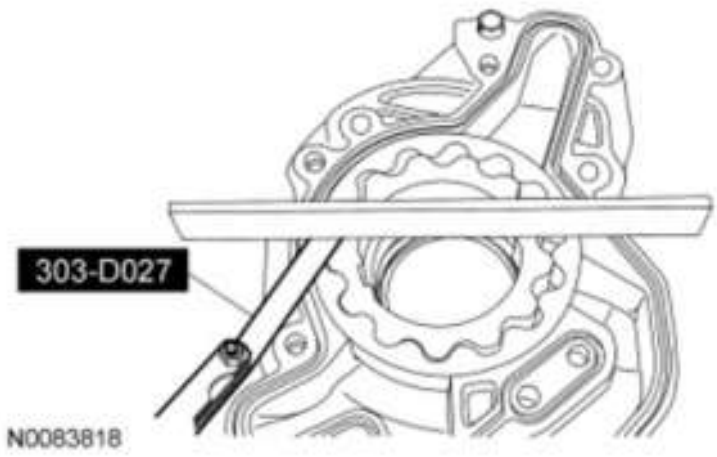


Fig. 29: Measuring Height Clearance Between Oil Pump Housing And Inner And Outer Rotors
Courtesy of FORD MOTOR CO.

5. Using the Feeler Gauge Set, measure the clearance between the outer rotor and inner rotor. If the measurement does not meet specifications, install new gerotors as a set. For additional information, refer to **SPECIFICATIONS**.

Fig. 30: Measuring Clearance Between Outer Rotor And Inner Rotor
Courtesy of FORD MOTOR CO.

PISTON DIAMETER

NOTE: When considering installing a new piston, check the cylinder bore out-of-round specifications, cylinder boring may be necessary. Cylinder bore reconditioning will require oversize service pistons.

1. Use a 75-100 mm (3-4 in) micrometer to measure the piston skirt. Verify piston size by measuring the skirt diameter.
   - Measure 15.5 mm (0.61 in) from the bottom, at 90 degrees to the piston pin, at room temperature of 19-21°C (66-70°F).
   - Install a new piston if not within specification. For additional information, refer to **SPECIFICATIONS**.

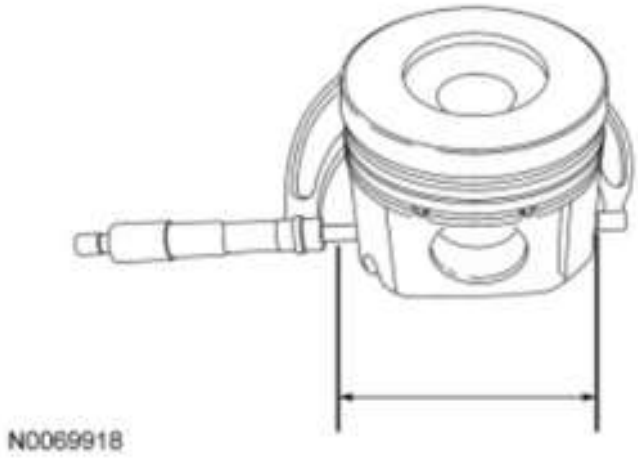


Fig. 31: Measuring Piston Skirt
Courtesy of FORD MOTOR CO.

PISTON INSPECTION

Special Tool(s)

SPECIAL TOOLS CHART

	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent

NOTE: Do not use a caustic cleaning solution or a wire brush to clean pistons or piston damage may occur.

NOTE: Extreme care must be used when cleaning piston ring grooves on aluminum pistons or piston damage may occur.

1. Clean the pistons with liquid soap and water.

NOTE: **Use the top compression ring to clean the top ring groove, and the bottom compression ring to clean the bottom ring groove. Because the ring grooves are different designs, using the wrong compression ring to clean each ring groove will damage the piston.**

2. Break the old compression rings in half, then use the compression rings to clean the piston ring groove areas of the piston.
3. Inspect the piston ring lands, skirts, oil ring slot corners and pin bosses for scoring, scuffing or cracks. Install a new piston if these types of damage appear.
4. Measure the keystone piston ring groove wear.
    1. Select 2.10 mm (0.083 in) piston gauge pins.
    2. Install the gauge pins in the top groove.
    3. Using a 75-100 mm (3-4 in) micrometer, measure the distance between the gauge pins. Install a new piston if not within specification. For additional information, refer to **SPECIFICATIONS**.

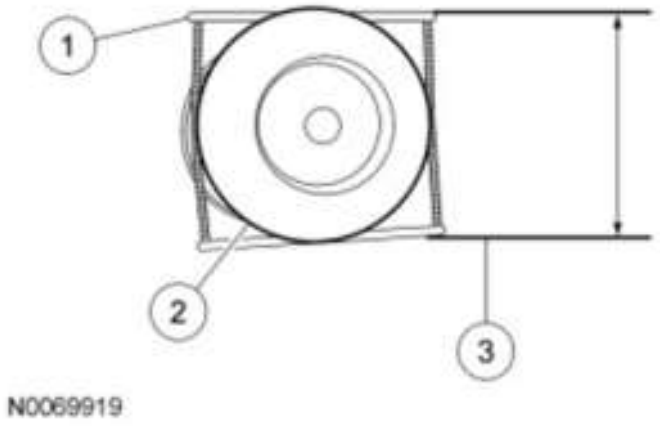


Fig. 32: Measuring Keystone Piston Ring Groove Wear
Courtesy of FORD MOTOR CO.

5. Check the side clearance of the intermediate ring groove.
    - Place the outer edge of the new ring in its respective ring groove.
    - Roll the entire ring around the piston in its groove. Make sure the ring can move freely in its groove.
    - Use the Feeler Gauge Set to check the side clearance. Install a new piston if it is not within specifications. For additional information, refer to **SPECIFICATIONS**.

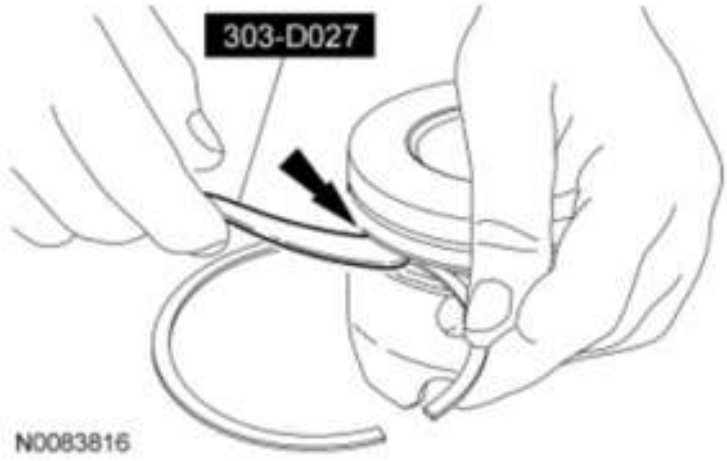


Fig. 33: Checking Side Clearance Of Intermediate Ring Groove
Courtesy of FORD MOTOR CO.

6. Check the side clearance of the oil control ring groove.
    - Place the outer edge of the new ring in its respective ring groove.
    - Roll the entire ring around the piston in its groove. Make sure the ring can move freely in its groove.
    - Use the Feeler Gauge Set to check the side clearance. Install a new piston if it is not within specifications. For additional information, refer to **SPECIFICATIONS**.
7. Use a 25-50 mm (1-2 in) micrometer to measure the piston pin diameter in 2 directions at the points shown in the illustration. Verify the diameter is within specification.
    - If out of specification, install a new piston pin. For additional information, refer to **SPECIFICATIONS**.

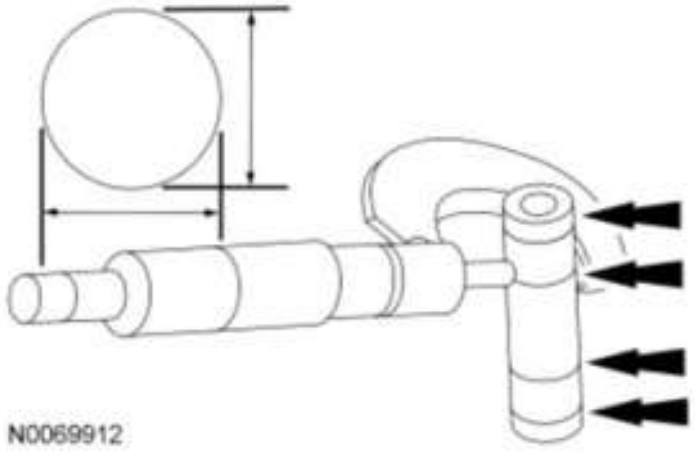


Fig. 34: Measuring Piston Pin Diameter
Courtesy of FORD MOTOR CO.

8. Using a 1-2 inch telescoping gauge and a 25-50 mm (1-2 in) micrometer, measure each piston pin bore inside diameter, at 2 locations 90 degrees apart. Record the reading.
    - To check the piston pin clearance, subtract the piston pin outside diameter from the piston bore inside diameter. If the clearance exceeds specifications, install a new piston pin and recheck the clearance. For additional information, refer to **SPECIFICATIONS**.

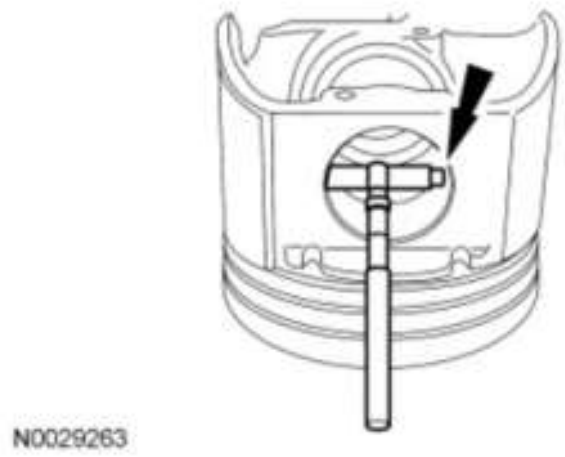


Fig. 35: Measuring Piston Pin Bore Inside Diameter
Courtesy of FORD MOTOR CO.

PISTON RING END GAP

Special Tool(s)

SPECIAL TOOLS CHART

	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent

NOTE: Faulty rings cannot always be detected by visual inspection. Therefore, whenever a piston is removed from a cylinder, install new piston rings.

1. Inspect the new piston rings for cleanliness.
2. Before installing new piston rings on the piston, check the gap for each ring.
   - Push the piston rings into the cylinder bore. Make sure the piston ring is square with the cylinder wall. An inverted piston head may be used to push the piston ring to the desired location of the measurement (usually at the top of the piston ring travel).

3. Using the Feeler Gauge Set, measure the gap between the ends of each piston ring. For additional information, refer to **SPECIFICATIONS**.

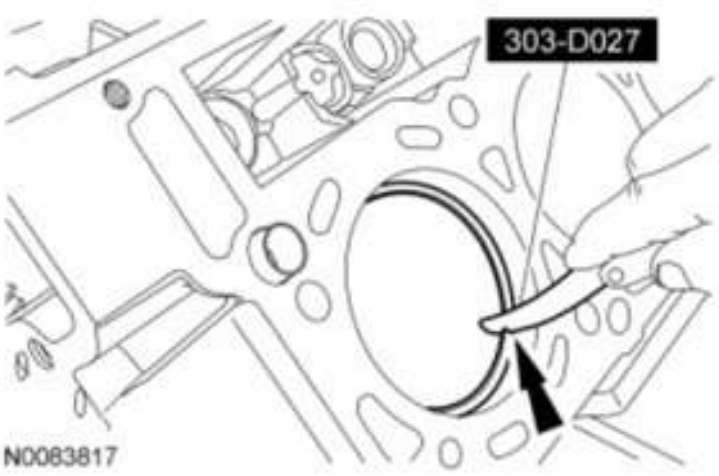


Fig. 36: Measuring Gap Between Ends Of Each Piston Ring
Courtesy of FORD MOTOR CO.

4. If the gap does not meet specifications, select another ring or recheck the cylinder bore wear.

PUSH ROD CLEANING AND INSPECTION

1. Thoroughly clean each push rod using a suitable solvent. Dry using filtered, compressed air.
2. Inspect each push rod for wear and deposits which may restrict the flow of oil into the rocker arm assembly. Install a new push rod as needed.
3. Check all push rods for flatness by rolling them on a flat, smooth straight surface. If a push rod is not straight, install new as necessary. For additional information, refer to **SPECIFICATIONS**.

Fig. 37: Identifying Push Rod
Courtesy of FORD MOTOR CO.

ROCKER ARM CLEANING AND INSPECTION

Material

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-E

1. Disassemble the rocker arm from the fulcrum plate. With the rocker arm and fulcrum plate upside down in the palm, push down the fulcrum plate. Using the palm, move the rocker arm away from the

rocker arm ball and off the fulcrum plate.

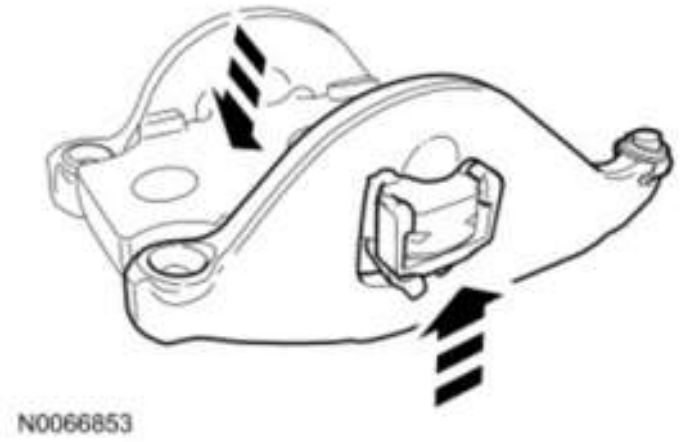


Fig. 38: Identifying Rocker Arm And Fulcrum Plate
Courtesy of FORD MOTOR CO.

NOTE: Be careful when removing the rocker arm. Do not lose the rocker arm ball.

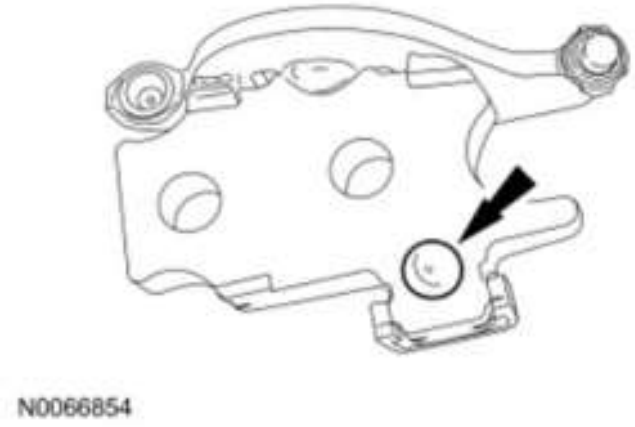


Fig. 39: Locating Rocker Arm Ball
Courtesy of FORD MOTOR CO.

2. Move the rocker off the ball, keeping the ball in the detent of the fulcrum plate. Remove the rocker arm ball.
3. Remove and discard the rocker arm clip.

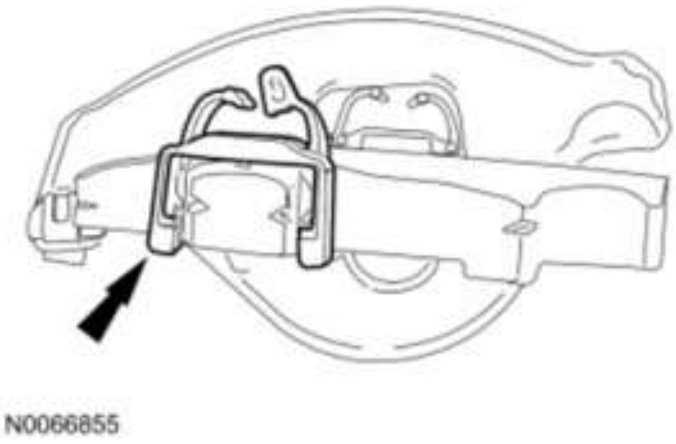


Fig. 40: Locating Rocker Arm Clip
Courtesy of FORD MOTOR CO.

4. Clean all parts with a suitable solvent. Use filtered, compressed air to dry the parts.
    - Inspect each rocker arm pivot foot and corresponding valve bridge for pitting and scuffing. Inspect each rocker arm ball and socket for scuffing. Install new rocker arms and valve bridges as required.
    - Inspect the rocker arm post ball socket for excessive wear. Inspect bolts for thread damage, install new components if worn or damaged.
5. Install a new rocker arm clip on the fulcrum plate.

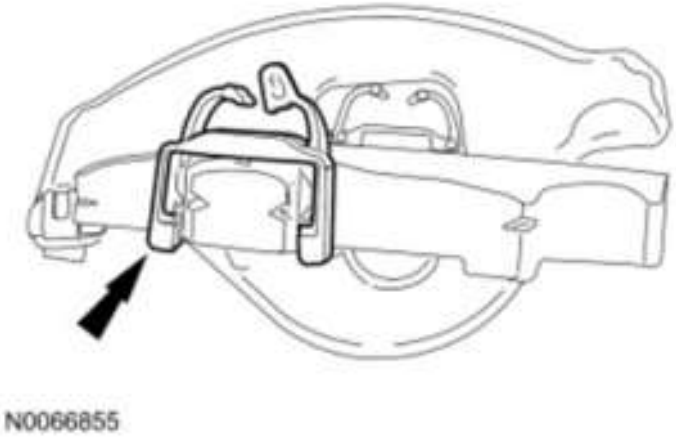


Fig. 41: Locating Rocker Arm Clip
Courtesy of FORD MOTOR CO.

6. Insert the ball in the detent of the fulcrum plate and lubricate with clean engine oil. Hold the rocker arm upside down in the palm of hand.

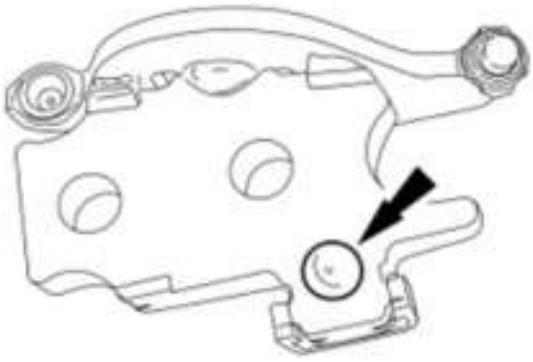


Fig. 42: Locating Rocker Arm Ball
Courtesy of FORD MOTOR CO.

7. Press the lower part of the rocker arm against the rocker arm clip, push up with the palm of hand and push the upper part of the rocker arm over the rocker arm ball. Check for freedom of movement of the rocker arm on the fulcrum plate.

Fig. 43: Identifying Rocker Arm And Fulcrum Plate
Courtesy of FORD MOTOR CO.

VALVE GUIDE INNER DIAMETER

1. Measure each valve guide by using a small hole gauge and a 0-25 mm (0-1 in) outside micrometer. Record each valve guide inner diameter so valve-to-guide running clearance may be determined. If valve guide inner diameter exceeds specifications, install a new cylinder head.

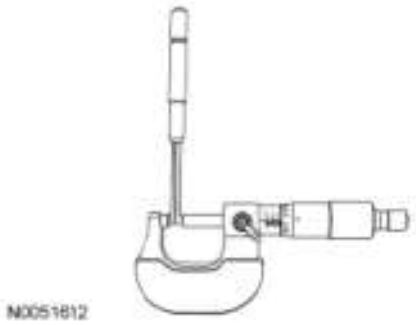


Fig. 44: Measuring Valve Guide Inner Diameter
Courtesy of FORD MOTOR CO.

2. Using the valve guide inside diameter and the valve stem diameter measurements, determine valve stem-to-guide running clearance, install new valves as required. For additional information, refer to **SPECIFICATIONS**.

VALVE INSPECTION

1. Remove all carbon from the valve stems and valve heads using a wire brush.
2. Inspect each valve, install new valves if they show evidence of burn marks, warpage, scuffing, bending or valve tip spalling.

NOTE: Measure the valve at 3 locations 90 degrees apart. Install new valves for those that exceed the minimum stem diameter.

NOTE: The intake valve has a larger diameter.

3. Measure each valve stem for wear using a 0-25 mm (0-1 in) micrometer to measure valve stem diameter. Install new valves if they exceed the minimum stem diameter specifications. For additional information, refer to **SPECIFICATIONS**.

NOTE: To prevent engine damage, the minimum valve face margin must be maintained across the entire valve face. An insufficient margin will not provide correct heat dissipation and may lead to valve warpage or breakage. Install a new valve if the margin is less than the specified minimum.

NOTE: If valve and seats are in a serviceable condition, they may be refaced to the specified angles.

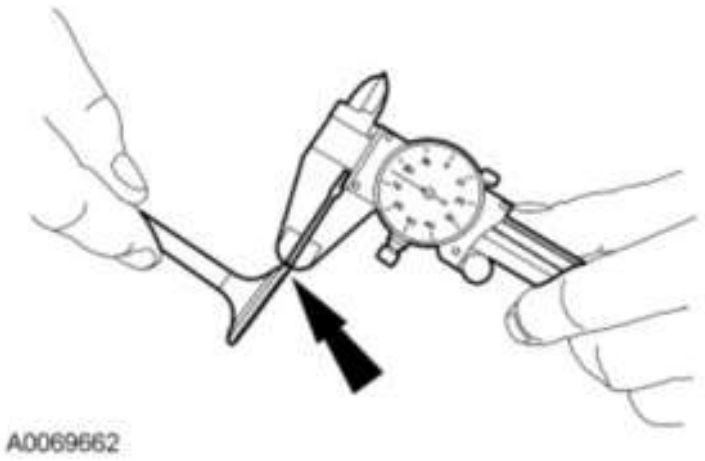


Fig. 45: Measuring Valve Face
Courtesy of FORD MOTOR CO.

4. Measure the valve face margin at 4 locations 90 degrees apart using a dial caliper. For additional information, refer to **SPECIFICATIONS**.

VALVE SPRING FREE LENGTH

1. Clean all valve springs in a suitable solvent.
2. Inspect valve springs for rust, pitting, distortion and cracks. If any of these conditions exist, install new valve springs.
3. Measure the valve spring tension by using a valve spring tester. Measure the valve spring free length. For additional information, refer to **SPECIFICATIONS**.

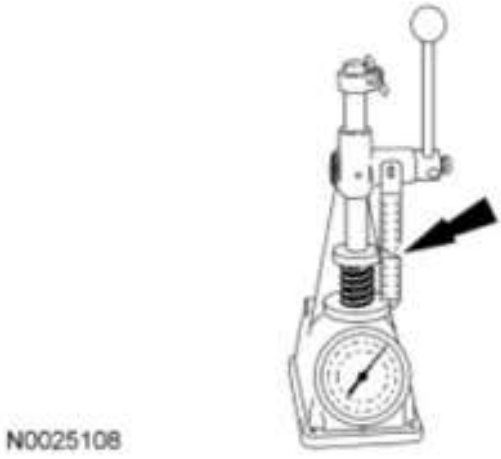


Fig. 46: Measuring Valve Spring Tension By Using Valve Spring Tester
Courtesy of FORD MOTOR CO.

4. Apply the appropriate test load to each spring and determine whether the test length is achieved. For additional information, refer to **SPECIFICATIONS**.

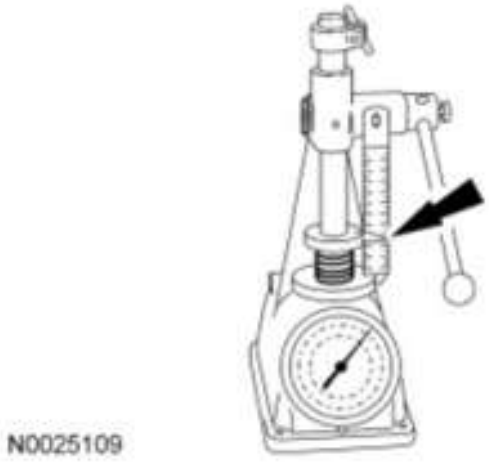


Fig. 47: Applying Appropriate Test Load To Each Spring And Determine Whether Test Length Is Achieved
Courtesy of FORD MOTOR CO.

VALVE SPRING SQUARENESS

1. Clean all valve springs in a suitable solvent.
2. Inspect valve springs for rust, pitting, distortion and cracks. If any of these conditions exist, install new valve springs.
3. Verify that the spring ends are flat and square to prevent lateral loads on the valve stem. Install new valve springs as necessary.

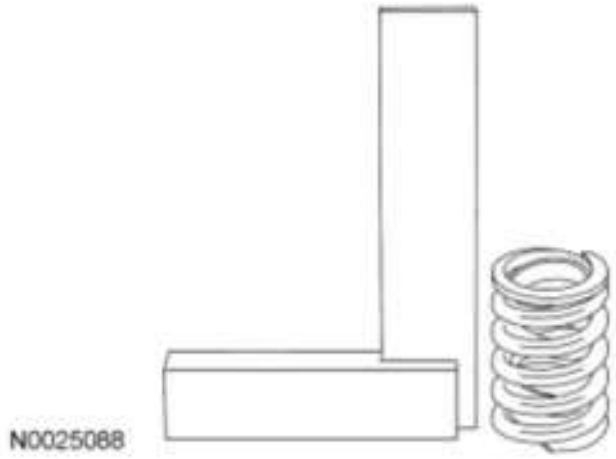


Fig. 48: Inspecting Valve Spring Squareness
Courtesy of FORD MOTOR CO.