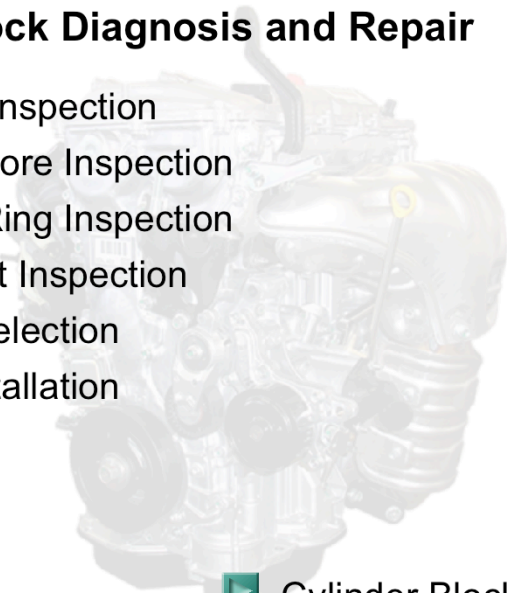


Section 6 Topics

Cylinder Block Diagnosis and Repair

- 
- ▶ Warpage Inspection
 - ▶ Cylinder Bore Inspection
 - ▶ Piston & Ring Inspection
 - ▶ Crankshaft Inspection
 - ▶ Bearing Selection
 - ▶ Piston Installation
- ▶ Cylinder Block Worksheet

Warpage Inspection

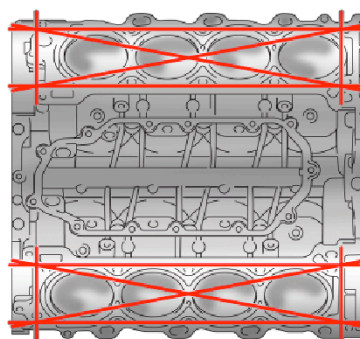
Using a precision straightedge and a feeler gauge.



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Measure the contact surfaces of the cylinder head gaskets at 6 locations as shown.

Maximum warpage: 0.07 mm

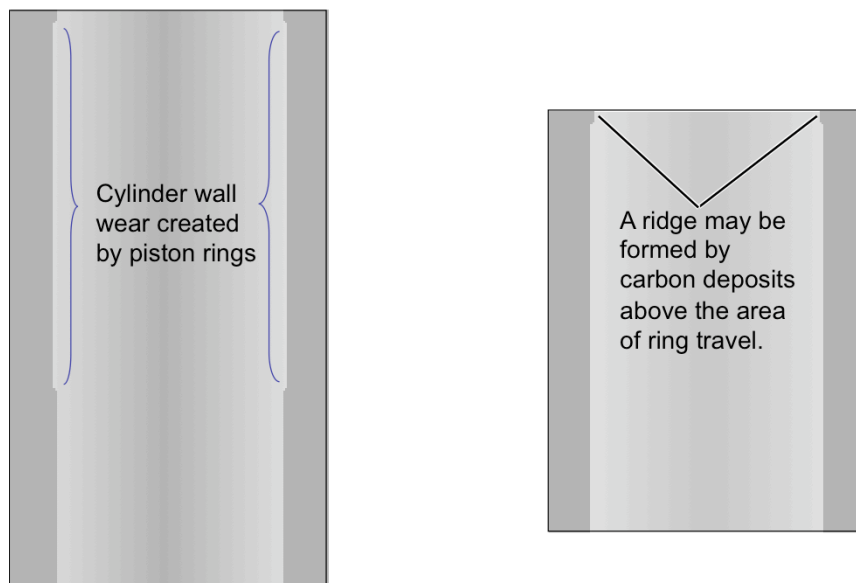


If the warpage is greater than the maximum, replace the cylinder block.

Warpage Inspection

Just like the cylinder head, a warpage check is necessary to verify the flatness of the cylinder block mating surface. Be sure the surface is clean and free of nicks, pitting, corrosion, or any other imperfections before measuring.

Cylinder Bore Wear



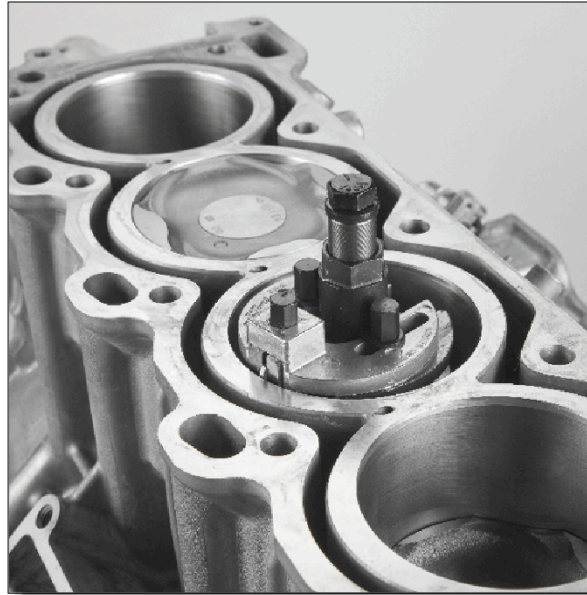
Cylinder Bore Wear

Piston rings rubbing against the cylinder wall can eventually wear away the cylinder wall lining. This can be detected by measuring the cylinder diameter and comparing to specifications.

Cylinder bore wear from today's low tension piston rings is much less than with earlier high tension rings. If cylinder bore wear exceeds specifications, however, a new short block is needed. Boring out the cylinders is not an option for many Toyota engines because oversize replacement pistons are not available.

Ridge Reamer

A ridge of carbon deposits at the top of the cylinder can be removed using a ridge reamer.

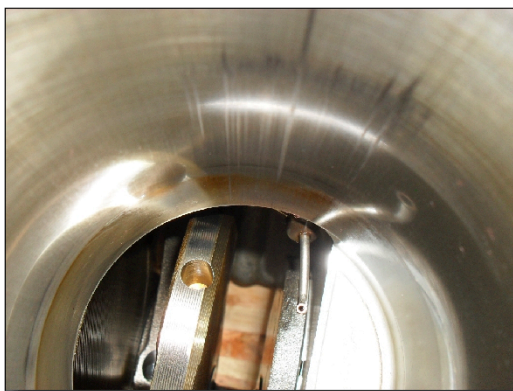


Ridge Reamer Before removing a piston, check the cylinder for a ridge of carbon deposits above the area of ring travel. If present, the ridge can interfere with the piston rings during removal.

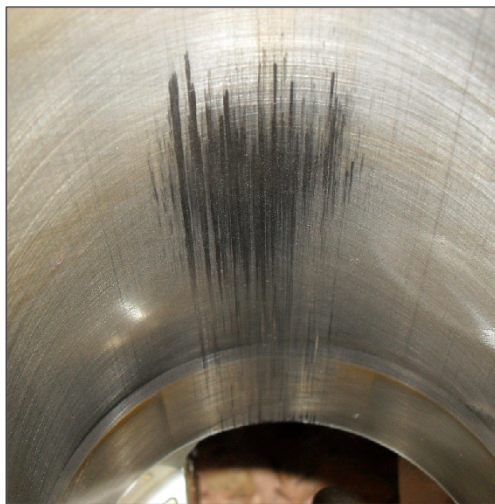
When necessary, remove the ridge of carbon using a ridge reamer.

Cylinder Bore Visual Inspection

- Visually check the cylinder for vertical scratches.
- If deep scratches are present, replace the cylinder block.



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Cylinder Bore Visual Inspection

Visually check the cylinder bore for vertical scratches. If deep scratches are present, replace the cylinder block. Remember to always ask the question, "Why?" If vertical scratches are present; what are the most likely causes? If it was a lack of lubrication problem, the lubrication system should be diagnosed before replacing the short block.

Cylinder Bore Measurement

Using a cylinder bore gauge or T-Gauge, measure the cylinder bore diameter at positions A and B in the thrust and axial directions.

Cylinder Bore Gauge



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T-Gauge

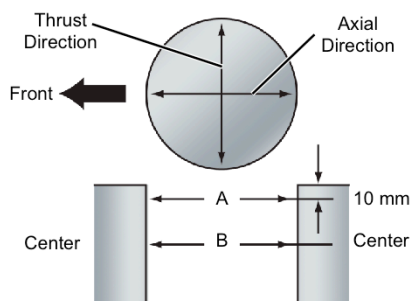


Standard diameter:

- 94.000 to 94.012 mm

Maximum diameter:

- 94.200 mm



If the diameter is greater than the maximum, replace the cylinder block.

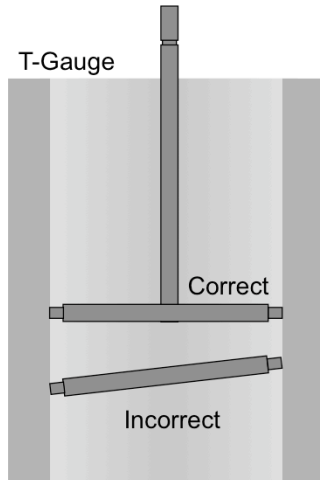
Cylinder Bore Measurement

Measuring the diameter of the cylinder bore reveals whether cylinder wear exceeds specifications. Excessive cylinder wear can cause oil consumption, smoky exhaust and engine noise.

Using a cylinder bore gauge or T-Gauge, measure the cylinder bore diameter at positions A and B in the thrust and axial directions. If the diameter is greater than the maximum specified in the Repair Manual, replace the cylinder block.

Cylinder Bore Measurement

When measuring cylinder diameter, be sure the measuring tool is perpendicular to the cylinder wall, or the measurement will be inaccurate.



If the T-Gauge binds when being removed, it indicates the measurement was taken at an angle.

Cylinder Bore Gauge



When using the cylinder bore gauge, rock it back and forth slightly.

The tool is perpendicular to the cylinder wall when the reading is at its minimum diameter.

Cylinder Bore Measurement (cont'd)

When measuring the diameter of the cylinder bore, it is important to know your measurement instrument. T-Gauges take some practice to confidently find true 90 degrees to the cylinder bore. The bore gauge, however, uses a dial indicator that allows for a confident measurement of the cylinder bore with little set up time. Always refer to the Repair Manual for cylinder bore specifications.

Piston Inspection



Scoring

Broken Rings or Lands



Piston Inspection

Pistons are subject to extreme heat, pressure, and motion. Pistons must withstand this abuse under varying operating conditions. When an engine fails, it is important to inspect the condition of the pistons to evaluate the root cause.

Inspect pistons for the following:

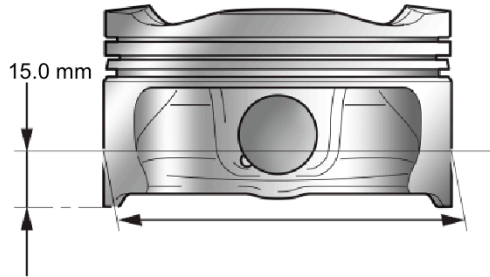
Scoring – Scoring is an indication of improper piston to cylinder wall clearance or insufficient lubrication.

Broken or Stuck Rings – Inspect for broken rings and ring lands. Inspect for stuck rings, especially oil rings. Stuck rings are a good indicator of an oil consumption issue.

Piston Oil Clearance

Inspect Piston Diameter

- Using a micrometer, measure the piston diameter at a position that is 15.0 mm (0.591 in.) from the bottom of the piston.

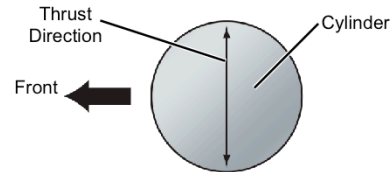


- If the diameter is less than the specification in the Repair Manual, replace the piston.

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Determine Piston Oil Clearance

- Measure the cylinder bore diameter in the thrust direction.



- Subtract the piston diameter measurement from the cylinder bore diameter measurement.
- If the oil clearance is greater than the maximum, replace **all the pistons**. If necessary, replace the cylinder block.

Piston Oil Clearance

Piston oil clearance is extremely important in modern internal combustion engines. The fine layer of oil on the cylinder wall must be thick enough to provide adequate lubrication but thin enough to be wiped away by the rings to avoid oil getting into the combustion chamber.

NOTE

When measuring piston diameter, be sure the micrometer does not damage the resin coating on the piston.

Crankshaft Journal Visual Inspection

Visually inspect each main journal and crank pin for signs of wear or bluing/darkening indicating excessive heat.



- If signs of wear or excessive heat are seen, measure and compare the journal or crank pin diameter to specifications, and check for taper and out-of-round
- If necessary, replace the crankshaft

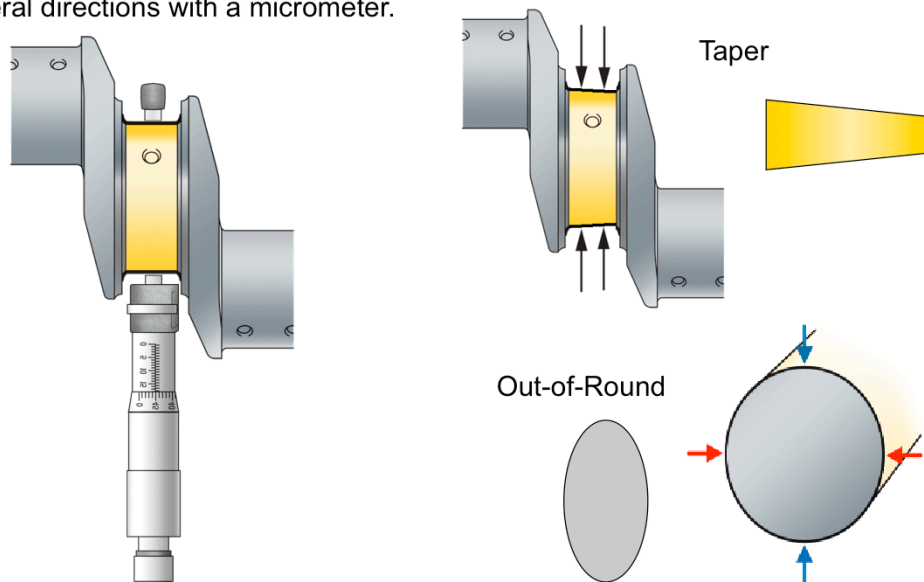
Crankshaft Journal Visual Inspection

Crankshaft journals should look just as they looked when the vehicle rolled off the assembly line. The crankshaft journals withstand extreme pressure and motion. Without proper lubrication bearings and crankshaft journals deteriorate very fast. Journals should be smooth and your finger nail should not catch on any vertical scratches. Some bluing or darkening may be seen at the edges of the journal/crankpin. This is considered normal and is part of the hardening process from the factory.

If significant wear is present, replacement is necessary. Remember to ask why this wear happened. If lack of lubrication is suspected, further diagnosis of the lubrication system is necessary to determine the root cause.

Journal Taper and Out-of-Round

Check main journal and crank pin diameter in several directions with a micrometer.



Journal Taper and Out-of-round

Check each main journal and crank pin for taper by measuring with a micrometer at the front and back of the journal. The difference in the two measurements is the taper.

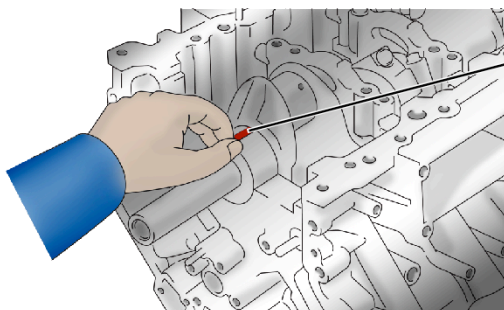
Check each main journal and crank pin for out-of-round by measuring with a micrometer at 90 degree angles. The difference in the two measurements is the out-of-round.

If the taper or out-of-round is greater than the maximum specified in the Repair Manual, replace the crankshaft.

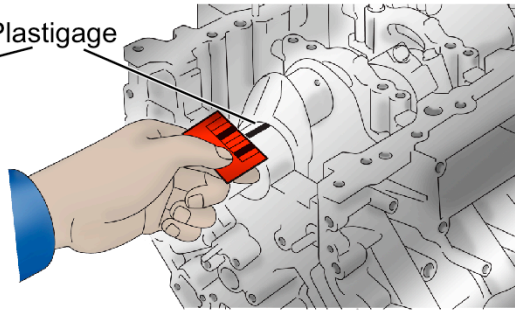
Crankshaft Oil Clearance

With the crankshaft in the cylinder block and the main bearing caps removed, lay a strip of Plastigage on each journal.

Remove bearing caps and use the gauge on the packaging to measure the width of flattened Plastigage to determine oil clearance.



Plastigage



Install all bearing caps and torque to specifications.

If the oil clearance is greater than the maximum specified in the Repair Manual, replace the bearings. If necessary, replace the crankshaft.

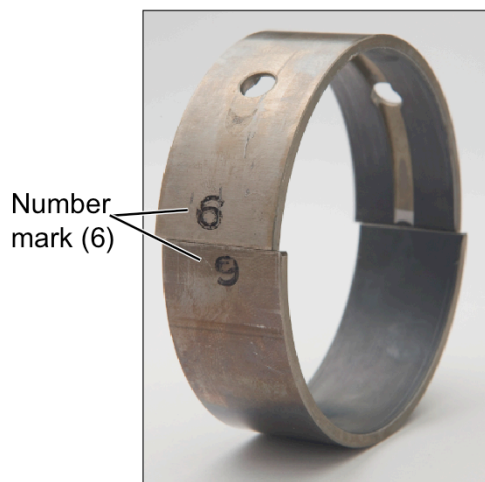
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Crankshaft Oil Clearance

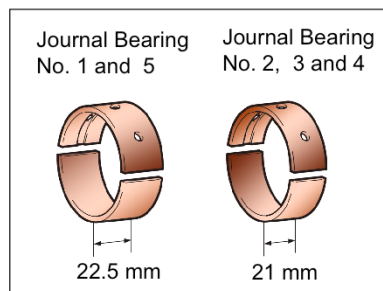
Modern Toyota engines use extremely tight oil clearance specifications. Verification of these oil clearances is very important to maintain the integrity of the engine. Using Plastigage is a simple but effective way to measure crankshaft oil clearance. Be sure to select the proper diameter Plastigage for the range being measured.

Bearing Selection and Replacement

If replacing a bearing, replace it with one that has the same number.



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There are 6 sizes of standard bearings.

- For the No. 1 and No. 5 position bearings, use bearings marked 4, 5, 6, 7, 8 and 9.
- For other bearings, use bearings marked 3, 4, 5, 6, 7 and 8.

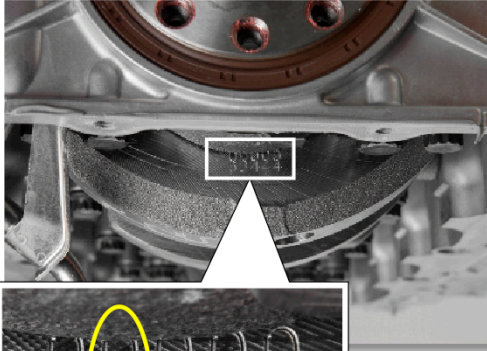
Bearing Selection and Replacement

From the factory, each journal bearing is select fit to ensure the proper oil clearance. When selecting bearings it is important to look at the number marks on the back side of the bearings. Replace the bearings with the same number selection that was originally used.

Bearing Selection and Replacement

If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the crankshaft and cylinder block.

Crankshaft (rear)

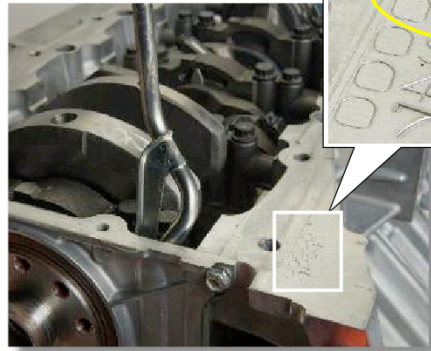


Journal 1 2 3 4 5

Bearing No. 2 = 03

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Cylinder Block



Bearing No. 2 = 07

Sum: 03 + 07 = 10

Use the sum (10) to select the corresponding bearings from the Bearing Selection Table in the Repair Manual.

Bearing Selection and Replacement (cont'd)

If bearing numbers are not marked on the back of the main bearings, use the numbers inscribed on the crankshaft and cylinder block.

- On the rear of the crankshaft counterweight you'll find a group of numbers corresponding to the main bearing journals.
- On the underside of the cylinder block you'll find another group of numbers corresponding to the main bearing journals.
- Adding together the appropriate numbers for a specific journal gives you a value you can use to select the correct bearing from the Bearing Selection Table in the Repair Manual. (See the example on the next page.)

For connecting rod/crank pin journals, you'll use the numbers on the front of the crankshaft counterweight and the numbers stamped on the connecting rods to select bearings.

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Using the Bearing Selection Table

For the desired journal, add the respective numbers from the crankshaft and cylinder block:

Example:

Cylinder Block Stamp for Main Bearing No. 2: 07

Crankshaft Stamp for Main Bearing No. 2: + 03

Total: = 10

In the appropriate table below, find (A) + (B) = 10.

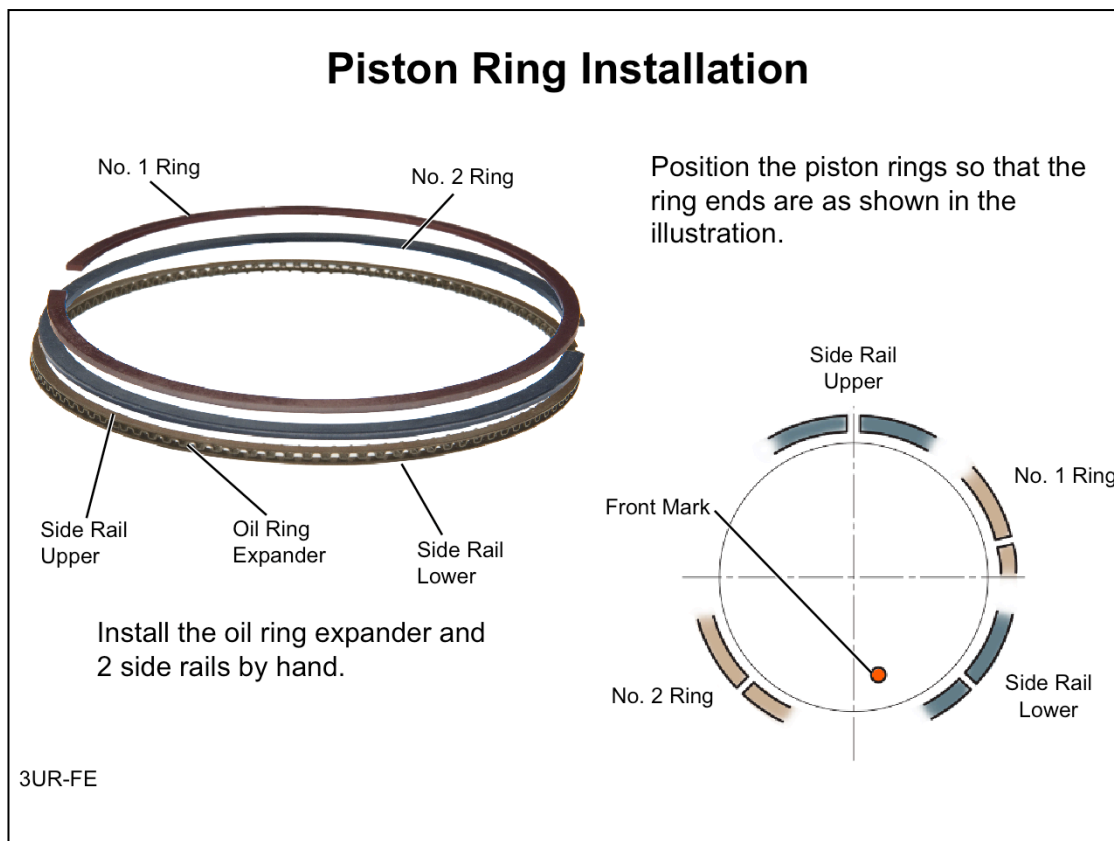
No. 1 and No. 5 Journals

(A) + (B)	Upper Bearing		Lower Bearing	
	Number Mark	Specified Condition	Number Mark	Specified Condition
00 to 02	4	2.501 to 2.504	5	2.488 to 2.491
03 to 05	5	2.504 to 2.507	5	2.488 to 2.491
06 to 08	5	2.504 to 2.507	6	2.491 to 2.494
09 to 11	6	2.507 to 2.510	6	2.491 to 2.494
12 to 14	6	2.507 to 2.510	7	2.494 to 2.497
15 to 17	7	2.510 to 2.513	7	2.494 to 2.497
18 to 20	7	2.510 to 2.513	8	2.497 to 2.500
21 to 23	8	2.513 to 2.516	8	2.497 to 2.500
24 to 26	8	2.513 to 2.516	9	2.500 to 2.503
27 to 28	9	2.516 to 2.519	9	2.500 to 2.503

Other Journals

(A) + (B)	Upper Bearing		Lower Bearing	
	Number Mark	Specified Condition	Number Mark	Specified Condition
00 to 02	3	2.482 to 2.485	4	2.501 to 2.504
03 to 05	4	2.485 to 2.488	4	2.501 to 2.504
06 to 08	4	2.485 to 2.488	5	2.504 to 2.507
09 to 11	5	2.488 to 2.491	5	2.504 to 2.507
12 to 14	5	2.488 to 2.491	6	2.507 to 2.510
15 to 17	6	2.491 to 2.494	6	2.507 to 2.510
18 to 20	6	2.491 to 2.494	7	2.510 to 2.513
21 to 23	7	2.494 to 2.497	7	2.510 to 2.513
24 to 26	7	2.494 to 2.497	8	2.513 to 2.516
27 to 28	8	2.497 to 2.500	8	2.513 to 2.516

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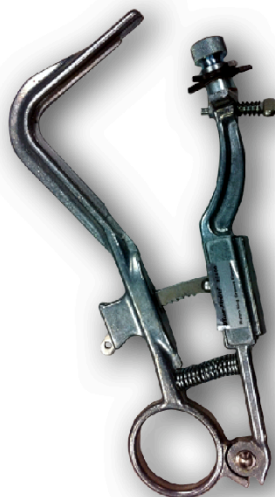
Piston Ring Installation

Assemble and install the oil ring by hand. Then, using a piston ring expander, install the 2 compression rings, and align the ring gaps as shown in the illustration.

Piston Tools



Piston Ring Installation Tool



Land & Ring Groove Cleaning Tool

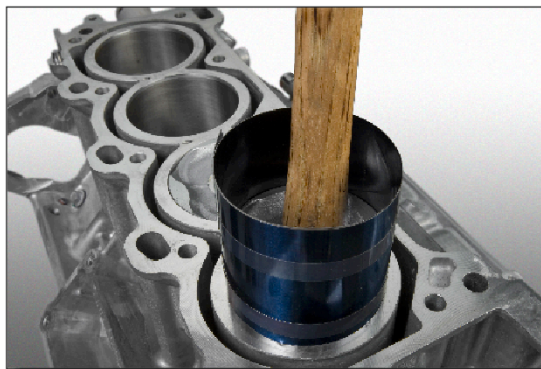
Piston Tools The piston ring tool can be used to install or remove piston rings. Today's low tension rings are extremely easy to break and should be installed carefully.

The land and ring groove cleaner is used to clean any carbon or other contaminants from the ring grooves. It is important to thoroughly clean the ring grooves before ring installation so compression rings seal properly, and so oil drains properly through the piston oil passages.

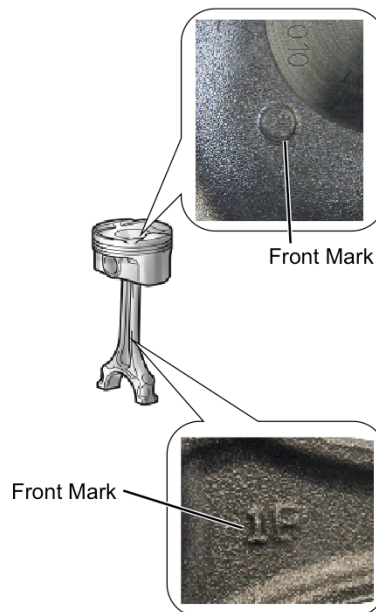
Piston Installation

Apply engine oil to the cylinder walls, the pistons, and the surfaces of the connecting rod bearings.

Using a hammer handle and piston ring compressor, push the correctly numbered piston and connecting rod into the cylinder with the front mark of the piston facing forward.



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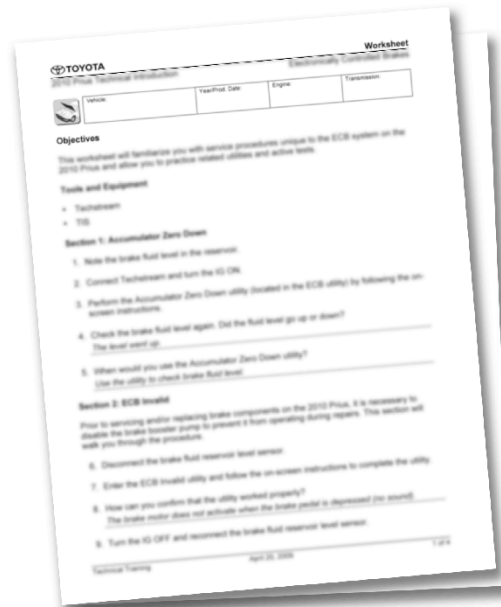
Piston Installation

Before installing the piston, apply engine oil to the cylinder walls, the pistons, and the surfaces of the connecting rod bearings. Firmly seat the ring compressor and piston into the bore. Tap gently on the head of the piston; do not use excessive force. Make sure the connecting rod does not come in contact with the cylinder wall, and guide the connecting rod onto the crankshaft journal.

Worksheet

Cylinder Block Inspection

In this worksheet, you will use Repair Manual procedures to perform inspections of cylinder block components.



Use this space to write any questions you may have for your instructor.

NOTES:

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