

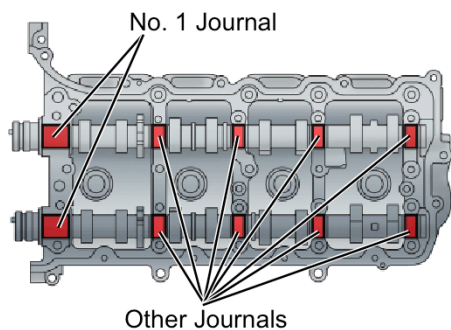
Section 5 Topics

Cylinder Head Diagnosis and Repair

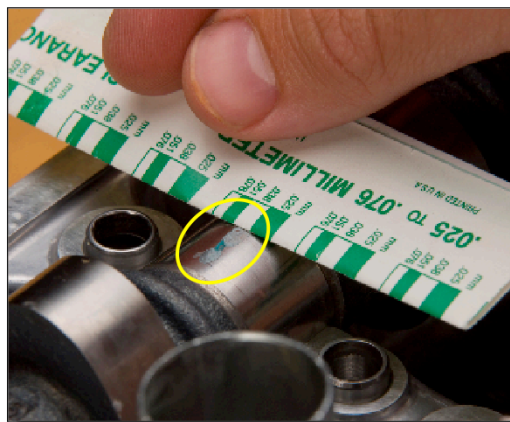
- 
- ▶ Camshaft Inspection
 - ▶ Valve, Guide, and Spring Inspection
 - ▶ Warpage Inspection
 - ▶ Crack Inspection
 - ▶ Head Bolt Inspection
 - ▶ Timing Chain Inspection
 - ▶ Hydraulic Valve Lash Adjusters
 - ▶ Mechanical Valve Lash Adjustment
- ▶ Cylinder Head Disassembly Worksheet
 - ▶ Valve Lash Adjustment Worksheet

Camshaft Oil Clearance

- Apply Plastigage® on all journals
- Install bearing caps following the proper torque sequence
- Remove bearing caps and measure oil clearance



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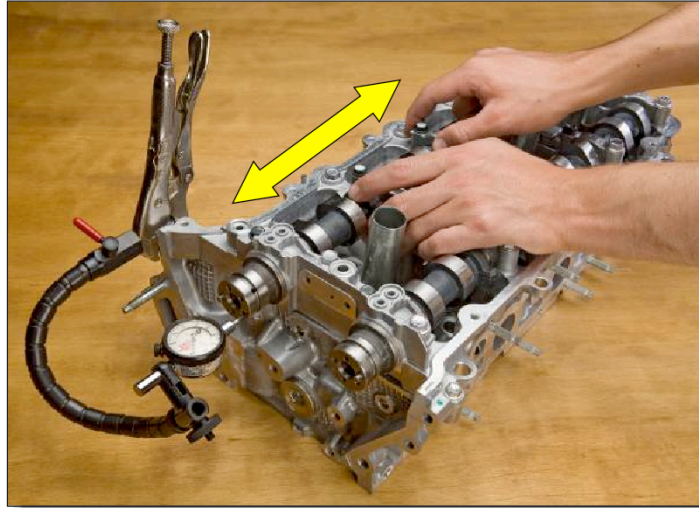
- If oil clearance exceeds specifications, replace parts as needed

Camshaft Oil Clearance

Always inspect camshaft journals for visual wear or damage. If there are no visual indications of wear, inspect the camshaft oil clearance with Plastigage. Be sure to properly clean the oil clearance surfaces and use the proper torque sequence. Do not rotate the camshafts during this inspection.

Camshaft Thrust Clearance

With bearing caps properly torqued, measure thrust clearance with a dial gauge.



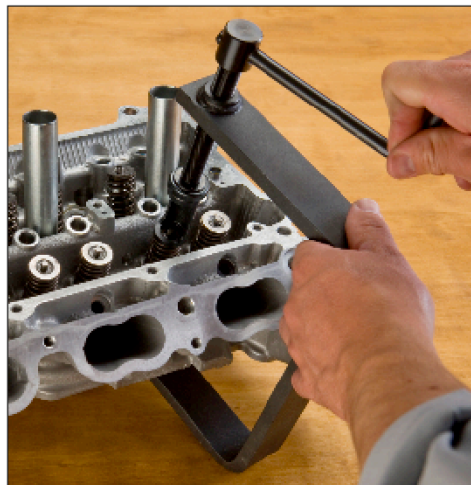
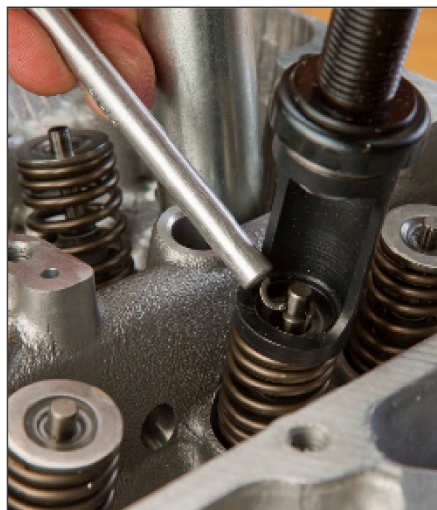
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Camshaft Thrust Clearance

The camshaft thrust clearance ensures the camshaft journals and lobes are properly aligned. Excessive clearance may cause noise or premature wear to other valvetrain components.

Removing Valve Assemblies

Removing valve assemblies requires a spring compression tool.



When the spring is compressed, the retainer locks can be removed with a magnetic finger.

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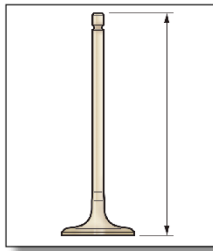
Removing Valve Assemblies

Removing valve assemblies requires a spring compression tool. The tools pictured above are SST 09202-70020 (the part with the crank) and SST 09202-00010 (the adapter that fits over the spring). Note that different engines may require different adapter SSTs.

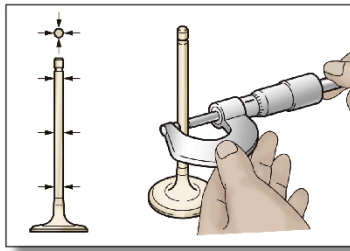
Other types of spring compression tools are commercially available.

When the spring is compressed, the retainer locks can be removed with a magnetic finger. After removing the retainer locks, the valve and spring can be removed for inspection.

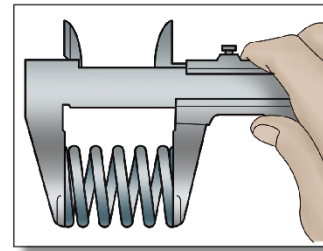
Valve, Guide, and Spring Inspection



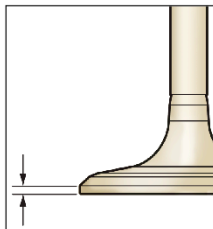
Overall Length



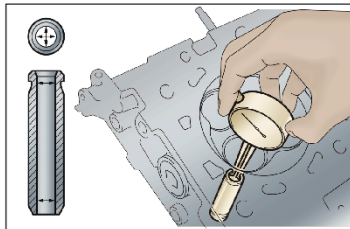
Valve Stem Diameter



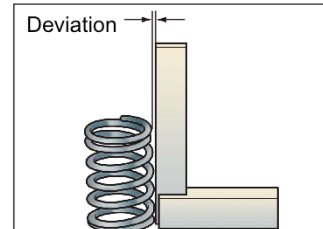
Spring Length



Margin Thickness



Guide Bush Diameter



Spring Deviation

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Valve, Guide, and Spring Inspection

Overall Length:

The overall length is crucial for proper valve opening. Excessively long or short valves may cause the valve to be held open or may cause excessive noise. If a valve is too long or short, that cylinder's performance is reduced.

Valve Stem Diameter:

Valve stem diameter ensures proper clearance between the stem and the valve guide bushing and allows for proper heat transfer.

Spring Length:

Spring length or spring height ensures the spring has not deformed or lost its spring tension.

Margin Thickness:

A great deal of heat is generated in the combustion chamber, and extremely hot exhaust gases pass by the exhaust valve. If the valve head thickness is not enough the exhaust valve may fail (burn) causing compression loss. The margin thickness ensures proper valve head thickness at the point where the valve seats to the cylinder head.

Guide Bushing Diameter:

The correct guide bushing diameter ensures the proper clearance between the valve stem and the guide bushing and allows for proper heat transfer.

Spring Deviation:

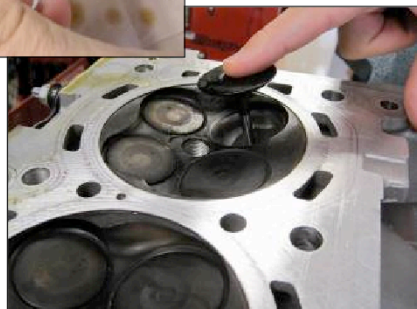
A spring with excessive deviation may cause uneven valve guide wear or possibly allow valve stem keepers to become dislodged.

Valve Seat Inspection

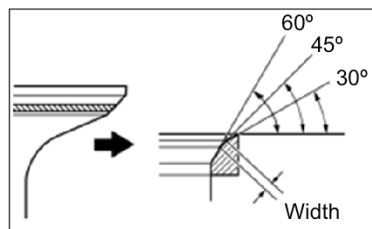
1. Apply a light coat of Prussian blue to the valve face.



2. Lightly press the valve face against the valve seat



3. If the valve does not seat properly, send the head to a machine shop to repair the valve seat.



Valve Seat Inspection

To inspect valve seats, use Prussian blue. Prussian blue is an oil paint traditionally used to identify high or low spots in machining applications.

To check valve seat fit, apply a light coat of Prussian blue to the valve face and lightly press it against the valve seat. (Do not rotate the valve while pressing.)

Carefully remove the valve and inspect the stain on the valve face and valve seat.

- The contact surfaces of the valve seat and valve face should be in the middle area of their respective surfaces, with the width as specified in the Repair Manual.
- The evidence of contact between the valve seat and valve face should be even around the entire valve seat.

If either of these conditions is not met, send the cylinder head to a machine shop to have the valve seats corrected.

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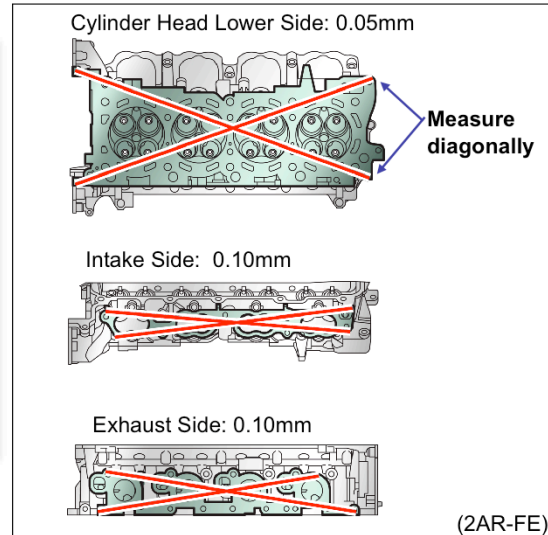
Warpage Inspection

Use a precision straightedge and a feeler gauge.



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Example specifications of maximum warpage



Warpage Inspection

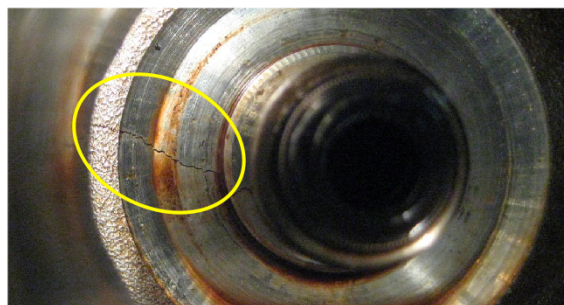
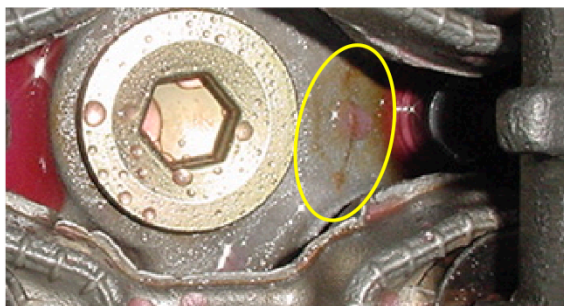
If an engine overheats or has a head gasket failure, it is extremely important to verify mating surface flatness. When engines overheat the likelihood of component warping increases. Mating surfaces in an engine must be within a certain tolerance of flatness to properly seal.

To check for warpage, thoroughly clean the cylinder head and visually inspect mating surfaces for pitting, nicks, or other imperfections. Place a long, precision straightedge along the length of the cylinder head and check the clearance between the straightedge and the cylinder head mating surface with a feeler gauge. Refer to the Repair Manual for vehicle-specific warpage tolerance.

Crack Inspection

Cracks in the cylinder head or cylinder block can result in:

- Compression loss
- Oil consumption
- Coolant loss



Crack Inspection

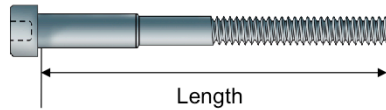
Although, cracks in the cylinder head or cylinder block are not common, an undiscovered crack can result in a misdiagnosis and a failed repair attempt. It's important to check for cracks, especially around the combustion chamber, coolant passages and oil passages.

One way to check for cracks is to use dye penetrant. This multistep application uses various dyes and chemicals to highlight trouble areas that could be otherwise hard to see. If you are not confident using this product it's advisable to send the components to a professional machine shop to have the component checked using alternative methods.

Head Bolt Inspection

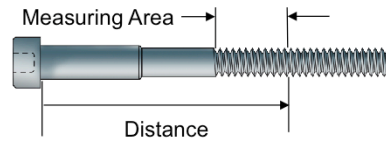
Inspection for Stretching

Using a vernier caliper, measure the length of the cylinder head bolt from the seat to the end.



Standard length: 141.3 to 142.7 mm
Maximum length: 143.7 mm
If the length is more than the maximum, replace the cylinder head bolt.

Using a micrometer, measure the thread diameter at the measuring area.



Distance:

- 103 mm for intake side bolt.
- 108 mm for exhaust side bolt

Standard diameter: 10.85 to 11.00 mm
Minimum diameter: 10.60 mm

If the diameter is less than the minimum, replace the cylinder head bolt.

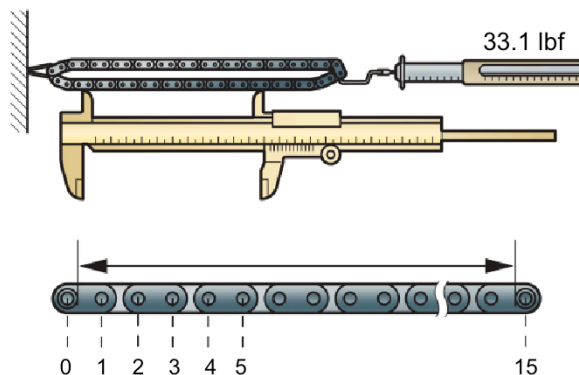
Head Bolt Inspection

When torqued properly, cylinder head bolts undergo a process called bolt stretch. This stretch provides a “spring loaded” tension against the part it’s fastening. A bolt can only be stretched so far before it runs the risk of deformation or breakage. With this in mind, it is important to inspect each head bolt or any other stretch bolt for signs of excessive stretching.

This inspection should be done by measuring the length of the bolt, and the diameter of the bolt in a prescribed area. It’s also important to visually inspect the bolt outside of the measurement area for places that may appear deformed or stretched. If a bolt does not meet specifications, replace it.

Timing Chain Inspection

Using a spring scale, pull the chain with a force of 33.1 lbf.



- Measure the length of 15 pins using a vernier caliper. Perform the measurement at 3 random places.
- Maximum chain length: 136.9 mm

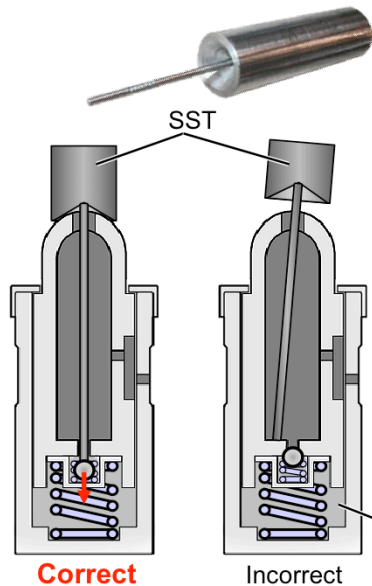
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Timing Chain Inspection

Although extremely rare, it is important to inspect the timing chain for stretching. If a timing chain is stretched, various engine timing issues may occur. To inspect, use a spring scale to apply a specified tension on the chain. Then count a specified number of chain link pins and measure the length. Do this in at least three different locations around the chain.

Priming Hydraulic Valve Lash Adjusters

SST: 09276-75010



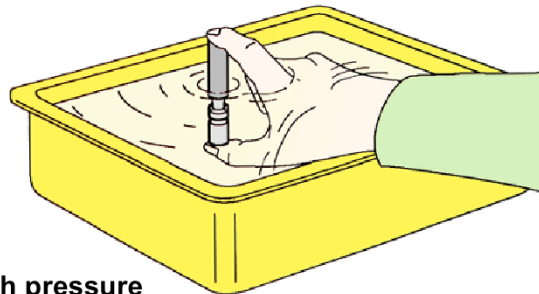
Correct

Incorrect

High pressure chamber

Before inspecting, bleed air from the high pressure chamber

- Open check ball with SST
- Immerse lash adjuster in clean oil
- Press and release SST and adjuster 5 to 6 times to fill with oil



Priming Hydraulic Valve Lash Adjusters

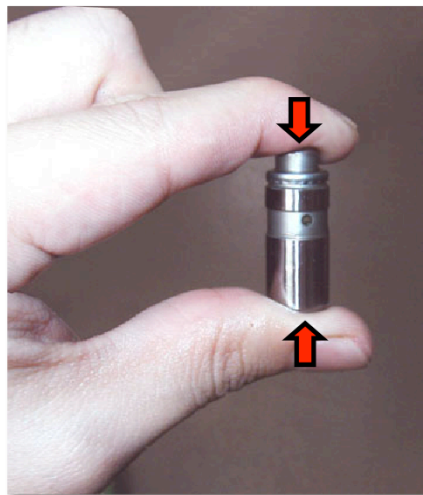
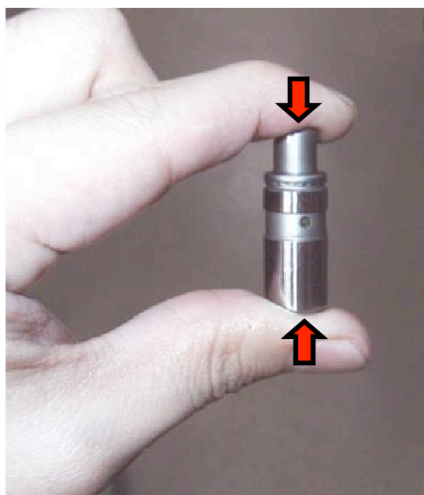
Hydraulic lash adjusters work using oil pressure. Oil pressure is feed to the high pressure chamber and sealed off by a check ball. The check ball prevents oil from leaking out of the high pressure chamber keeping the hydraulic lash adjuster primed prior to engine starting. It is important to check the operation of the lash adjusters and prime each adjuster before installation.

Use the SST to push on the check ball and immerse the lash adjuster in clean oil. Squeeze the lash adjuster several times to prime the high pressure chamber.

Hydraulic Valve Lash Adjusters Inspection

Press the plunger several times to test the operation of the check ball.

If the plunger can be compressed more than 3 times, replace the adjuster.

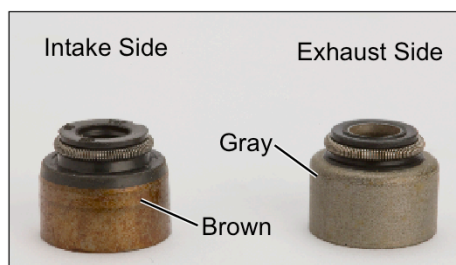


Lash Adjuster Inspection

After the lash adjuster has been properly primed, it is important to test whether or not the check ball is properly seated. Hold the adjuster as pictured and squeeze the plunger several times. If the plunger moves up and down in the bore more than three times, the check ball is defective and the lash adjuster must be replaced.

Installing Valve Spring Seats, Oil Seals

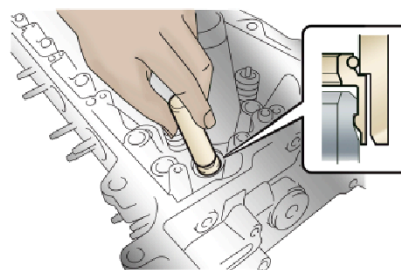
- Install the valve spring seats to the cylinder head.
- Apply a light coat of engine oil to new oil seals and push in the oil seals using SST 09201-41020



Note: Installing the intake oil seal into the exhaust side or installing the exhaust oil seal into the intake side can cause problems later.

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Failure to use the SST correctly will cause the seal to be damaged or improperly seated.



CORRECT

INCORRECT



Oil Seals

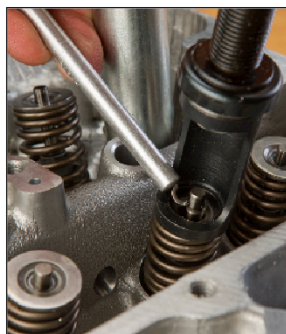
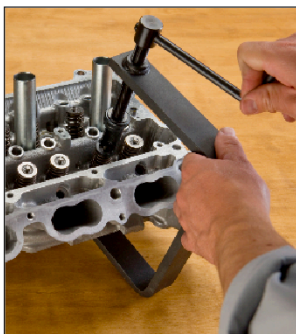
The intake and exhaust oil seals are different colors because the exhaust oil seal must withstand higher temperatures, and is therefore made of a different material. Use the applicable SST to install the seals correctly.

NOTE

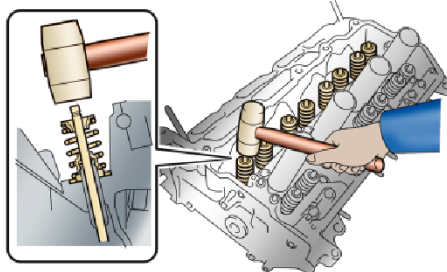
If oil seals are removed during disassembly, replace them; do not reuse.

Installing Valves

- Apply plenty of engine oil to the tip area of the valve stem
- Install the valve, compression spring and spring retainer to the cylinder head
- Using SST 09202-70020, compress the spring and install the retainer locks



Using a plastic-faced hammer, lightly tap the valve stem tip to ensure a proper fit.



Note: Be careful not to damage the retainer.

Note: Install the same parts in the same combination to their original locations.

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Installing Valves

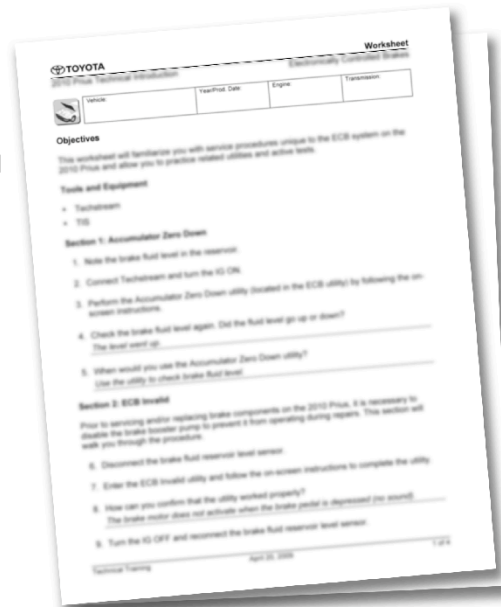
Make sure the work area is clean and well lit. Valve stem keepers are extremely easy to misplace or loose during installation. Take particular care during installation to properly seat each keeper before releasing the spring compressor. After installation is complete and a good visual check is made, tap each valve stem with a plastic-faced hammer to ensure valve stem keepers are properly seated.

Worksheet

Cylinder Head Disassembly and Inspection

In this worksheet you will:

- Partially disassemble a cylinder head
- Perform component inspections
- Reassemble the cylinder head

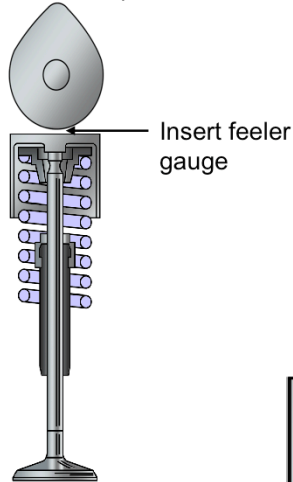


Use this space to write any questions you may have for your instructor.

NOTES:

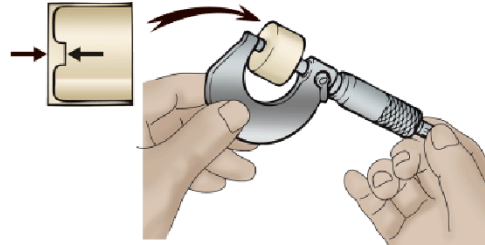
Mechanical Valve Lash Inspection

1. With camshaft and valves fully assembled, measure clearance between cam lobe and lifter (valve lash).

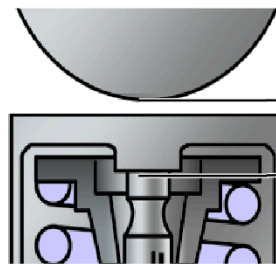


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2. If clearance exceeds specification, measure lifter thickness.



3. Determine new lifter size needed.



$$\begin{array}{r}
 \text{Current valve clearance} \\
 + \text{Current lifter thickness} \\
 \hline
 = \text{Lobe-to-stem distance} \\
 - \text{Specified valve clearance} \\
 \hline
 = \text{New lifter thickness}
 \end{array}$$

Mechanical Valve Lash Inspection

Engines with mechanical valve lash have a specified range of clearance between the heel of the cam lobe and the top of the valve. This space is necessary to provide adequate room for the components to expand during engine warm up. If the clearance is zero or less, the valve can be held open once the engine has reached operating temperature. If there is too much clearance, excessive noise will result.

To inspect mechanical valve lash, insert a feeler gauge into the space between the heel of the cam lobe and the valve. If the clearance is out of the specified range for that vehicle, then adjustment is necessary.

Valve Lash Adjustment

In some vehicles, valve lash is adjusted by replacing the lifter with another one of a specified thickness. The correct thickness can be calculated or looked up in a chart from the Repair Manual.

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Calculation Example The specified valve clearance (cold) is 0.15 to 0.25 mm (0.20 mm \pm 0.05).

The lifter measures 5.075 mm and the measured valve clearance is 0.365 mm.
Using the formula, we can calculate the ideal replacement lifter size.

$$\begin{array}{rcl}
 \text{Current lifter thickness} & & 5.075 \\
 + \text{Current valve clearance} & + & 0.365 \\
 - \text{Specified valve clearance} & - & \underline{0.200} \\
 = \text{New lifter thickness} & & 5.240
 \end{array}$$

If the calculation results in a size in between two available lifter (shim) sizes, select the larger of the two for longer service.

SHIM NO.	THICKNESS	SHIM NO.	THICKNESS	SHIM NO.	THICKNESS
06	5.060 mm	30	5.300 mm	54	5.540 mm
08	5.080 mm	32	5.320 mm	56	5.560 mm
10	5.100 mm	34	5.340 mm	58	5.580 mm
12	5.120 mm	36	5.360 mm	60	5.600 mm
14	5.140 mm	38	5.380 mm	62	5.620 mm
16	5.160 mm	40	5.400 mm	64	5.640 mm
18	5.180 mm	42	5.420 mm	66	5.660 mm
20	5.200 mm	44	5.440 mm	68	5.680 mm
22	5.220 mm	46	5.460 mm	70	5.700 mm
24	5.240 mm	48	5.480 mm	72	5.720 mm
26	5.260 mm	50	5.500 mm	74	5.740 mm
28	5.280 mm	52	5.520 mm	—	—

Valve Lifter Selection Chart

Instead of calculating the valve lifter thickness needed, you can look it up in this chart from the Repair Manual.

(A) = Measured clearance	0.365 mm
(B) = Measured thickness	5.075 mm

Example

0.365 mm

5.075 mm

		A	B
0.000 – 0.020 mm			
0.021 – 0.040 mm			
0.041 – 0.060 mm			
0.061 – 0.080 mm			
0.081 – 0.100 mm			
0.101 – 0.120 mm			
0.121 – 0.140 mm			
0.141 – 0.149 mm			
0.251 – 0.270 mm			
0.271 – 0.290 mm			
0.291 – 0.310 mm			
0.311 – 0.330 mm			
0.331 – 0.350 mm			
0.351 – 0.370 mm			
0.371 – 0.390 mm			
0.391 – 0.410 mm			
26	24	22	20
28	26	24	22
30	28	26	24

Table continues →

New Lifter: 5.240 mm

$$\begin{array}{r} \text{Current lifter thickness} \\ + \text{Current valve clearance} \\ - \text{Specified valve clearance} \\ \hline = \text{New lifter thickness} \end{array}$$

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Selection Chart Example

This is an example of how to use the Valve Lifter Selection Chart from the Repair Manual. (See the complete chart on the next page.)

Using the same measurements for the lifter and valve clearance as in the previous example:

- Look in column B of the chart (right side) to find the row with the value closest to the measured lifter thickness.
- Then in row A (top of the chart) find the column that matches the measured valve clearance.
- Where the column and row meet, you will find the optimum size for the replacement lifter (No. 24, which is 5.240 mm thick).

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Valve Lifter Selection Chart (Intake) An example of how to use this chart appears on the previous page.

		<div><div></div><div></div></div>																				A / B																						
0.000 - 0.020 (0.0000 - 0.0007/87)		0.021 - 0.040 (0.000827 - 0.00157)	0.041 - 0.060 (0.00161 - 0.00236)	0.061 - 0.080 (0.00240 - 0.00315)	0.081 - 0.100 (0.00319 - 0.00394)	0.101 - 0.120 (0.00398 - 0.00472)	0.121 - 0.140 (0.00476 - 0.00551)	0.141 - 0.160 (0.00555 - 0.00630)	0.161 - 0.180 (0.00634 - 0.00709)	0.181 - 0.200 (0.00713 - 0.00788)	0.201 - 0.220 (0.00792 - 0.00867)	0.221 - 0.240 (0.00871 - 0.00946)	0.241 - 0.260 (0.00950 - 0.01025)	0.261 - 0.280 (0.01029 - 0.01104)	0.281 - 0.300 (0.01108 - 0.01183)	0.301 - 0.320 (0.01187 - 0.01262)	0.321 - 0.340 (0.01266 - 0.01341)	0.341 - 0.360 (0.01345 - 0.01420)	0.361 - 0.380 (0.01424 - 0.01499)	0.381 - 0.400 (0.01503 - 0.01578)	0.401 - 0.420 (0.01582 - 0.01657)	0.421 - 0.440 (0.01661 - 0.01736)	0.441 - 0.460 (0.01740 - 0.01815)	0.461 - 0.480 (0.01819 - 0.01894)	0.481 - 0.500 (0.01898 - 0.01973)	0.491 - 0.510 (0.0193 - 0.0201)	0.511 - 0.530 (0.0201 - 0.0209)	0.531 - 0.550 (0.0209 - 0.0217)	0.551 - 0.570 (0.0217 - 0.0224)	0.571 - 0.590 (0.0225 - 0.0232)	0.591 - 0.610 (0.0233 - 0.0240)	0.611 - 0.630 (0.0241 - 0.0248)	0.631 - 0.650 (0.0248 - 0.0256)	0.651 - 0.670 (0.0256 - 0.0264)	0.671 - 0.690 (0.0264 - 0.0272)	0.691 - 0.710 (0.0272 - 0.0280)	0.711 - 0.730 (0.0280 - 0.0287)	0.731 - 0.750 (0.0288 - 0.0295)	0.751 - 0.770 (0.0296 - 0.0303)	0.771 - 0.790 (0.0304 - 0.0311)	0.791 - 0.810 (0.0311 - 0.0319)	0.811 - 0.830 (0.0319 - 0.0327)	0.831 - 0.850 (0.0327 - 0.0335)	0.851 - 0.870 (0.0335 - 0.0343)
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.060 (0.1992)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.080 (0.2000)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.100 (0.2008)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.120 (0.2016)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.140 (0.2024)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.160 (0.2031)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.180 (0.2039)							
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.200 (0.2047)							
74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.210 (0.2051)						
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.220 (0.2055)							
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72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.240 (0.2063)							
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.350 (0.2106)						
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.370 (0.2114)						
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.390 (0.2122)						
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.450 (0.2146)						
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.470 (0.2154)						
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74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.490 (0.2161)						
72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.500 (0.2165)							
74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0	5.510 (0.2169)						
72	70	68																																										

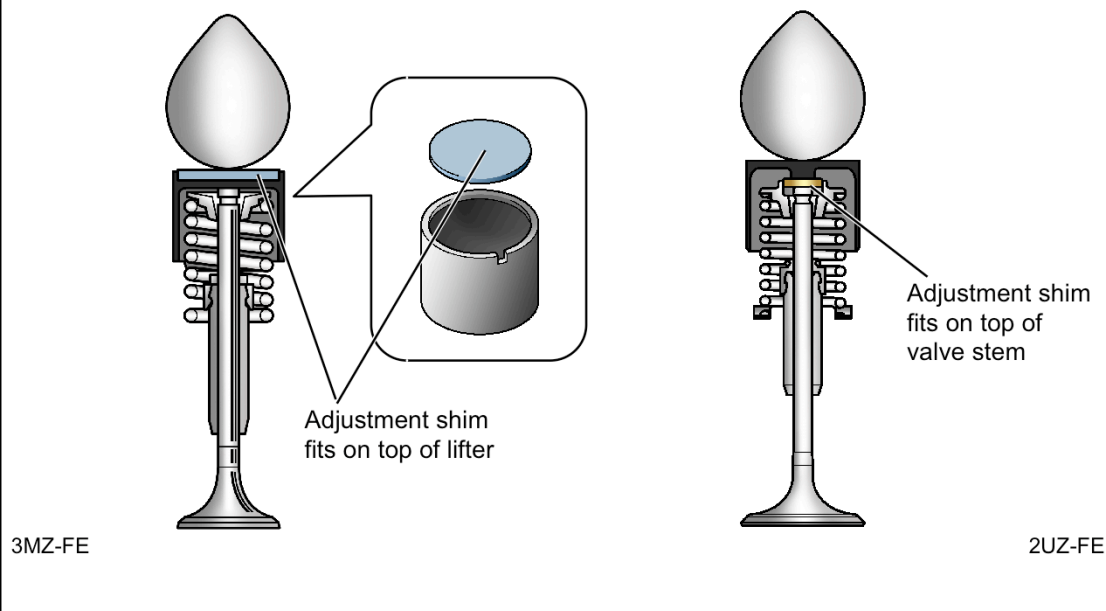
(A) Measured clearance mm (in.)

(B) Removed lifter thickness mm (in.)

2007 Tundra, 1GR-FE

Mechanical Valve Lash Adjusters

Some models use valve lash adjustment shims available in a wide selection of thicknesses.



Mechanical Valve Lash Adjusters

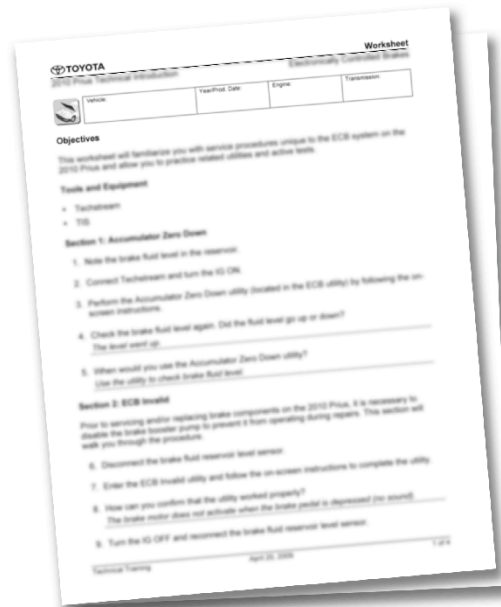
There are several different styles of mechanical valve lash adjusters. These are examples of replacing shims instead of lifters to change valve lash clearance. In one example, the shim is placed on top of the lifter. In the other example, the shim is placed on top of the valve stem. Refer to the Repair Manual for specific adjustment procedures for each vehicle.

Worksheet

Valve Lash Adjustment

In this worksheet you will:

- Measure valve clearance
- Measure lifter thickness
- Determine the correct size replacement lifter



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

NOTES:

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