

CO/HC INSPECTION

EMOKQ-07

HINT:

This check is used only to determine whether or not the idle CO/HC complies with regulations.

1. INITIAL CONDITIONS

- (a) The engine is at normal operating temperature.
- (b) Air cleaner is installed.
- (c) All pipes and hoses of the air induction system are connected.
- (d) All accessories are switched OFF.
- (e) All vacuum lines are properly connected.

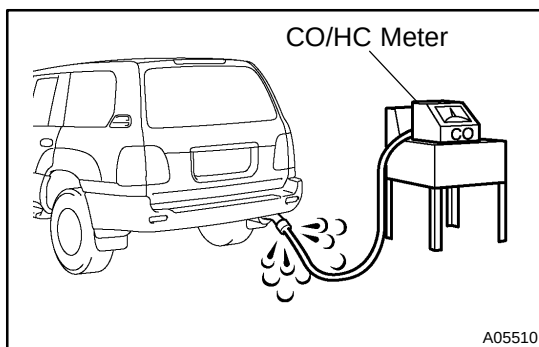
HINT:

All vacuum hoses should be properly connected.

- (f) SFI system wiring connectors are fully plugged.
- (g) Ignition timing is set correctly.
- (h) Transmission is in neutral range.
- (i) Tachometer and CO/HC meter are calibrated by hand.

2. START ENGINE

3. RACE ENGINE AT 2,500 RPM FOR APPROX. 180 SECONDS



- 4. INSERT CO/HC METER TESTING PROBE AT LEAST 40 cm (1.3 ft) INTO TAILPIPE DURING IDLING
- 5. IMMEDIATELY CHECK CO/HC CONCENTRATION AT IDLE AND/OR 2,500 RPM

HINT:

When performing the 2 mode (2,500 rpm and idle) test, follow the measurement order prescribed by the applicable local regulations.

6. TROUBLESHOOTING**HINT:**

If the CO/HC concentration does not comply with the regulations, perform troubleshooting in the order given below.

See the table below for possible causes, and then inspect and correct the applicable causes if necessary.

CO	HC	Problems	Causes
Normal	High	Rough idle	1. Faulty ignitions: ★Incorrect timing ★Fouled, shorted or improperly gapped plugs 2. Incorrect valve clearance 3. Leaky intake and exhaust valves 4. Leaky cylinders
Low	High	Rough idle (fluctuating HC reading)	1. Vacuum leaks: ★PCV hoses ★Intake manifold ★Throttle body ★Brake booster line 2. Lean mixture causing misfire
High	High	Rough idle (Black smoke from exhaust)	1. Restricted air filter 2. Faulty SFI systems: ★Faulty pressure regulator ★Defective ECT sensor ★Faulty ECM ★Faulty injectors ★Faulty throttle position sensor ★Faulty MAF meter

COMPRESSION INSPECTION

EMOKR-09

HINT:

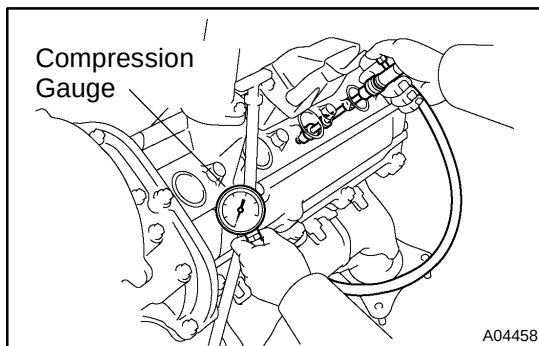
If there is a lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. WARM UP AND STOP ENGINE

Allow the engine to warm up to the normal operating temperature.

2. REMOVE SPARK PLUGS

(See page [IG-1](#))



3. CHECK CYLINDER COMPRESSION PRESSURE

- (a) Insert a compression gauge into the spark plug hole.
- (b) Fully open the throttle.
- (c) While cranking the engine, measure the compression pressure.

HINT:

Always use a fully charged battery to obtain the engine speed at 250 rpm or more.

- (d) Repeat steps (a) to (c) for each cylinder.

NOTICE:

This measurement must be done as quickly as possible.

Compression pressure:

1,324 kPa (13.5 kgf/cm², 192 psi) or more

Minimum pressure:

981 kPa (10.0 kgf/cm², 142 psi)

Difference between each cylinder:

98 kPa (1.0 kgf/cm², 14 psi) or less

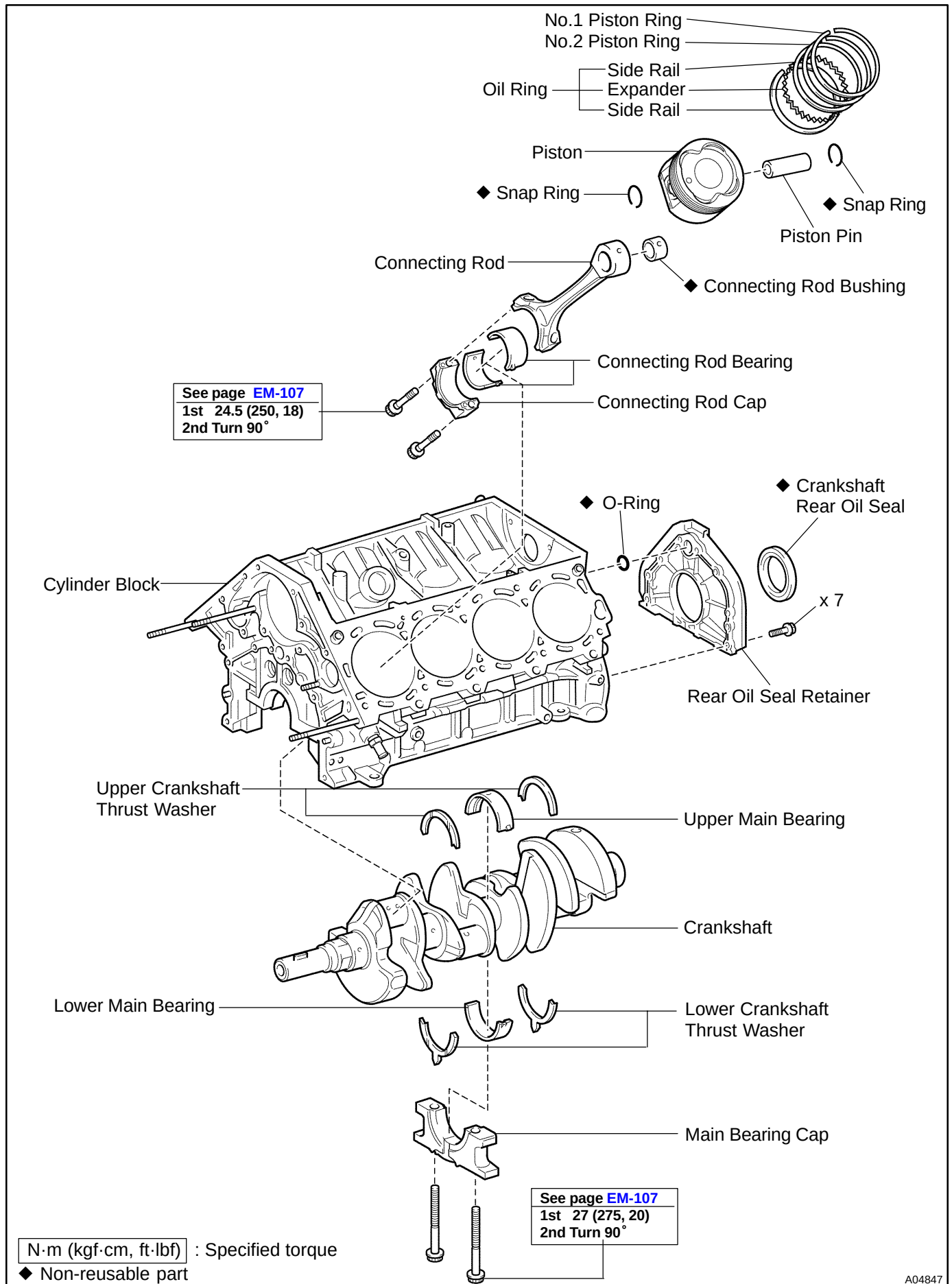
- (e) If the cylinder compression in one or more cylinders is lower than the specification, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (a) to (c) for the cylinders.
 - ★ If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
 - ★ If the pressure stays low, a valve may be sticking or the seating is improper, or there may be leakage past the gasket.

4. REINSTALL SPARK PLUGS

(See page [IG-1](#))

EM0E9-15

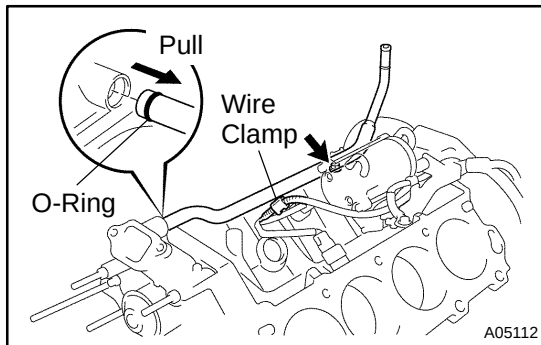




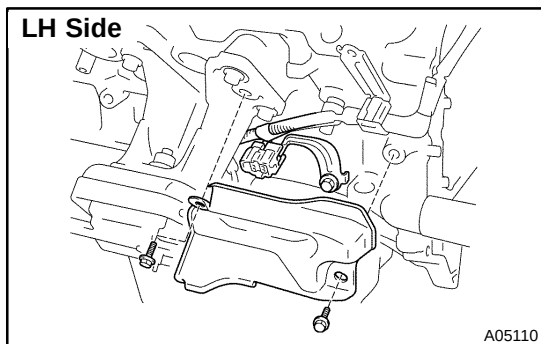
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DISASSEMBLY

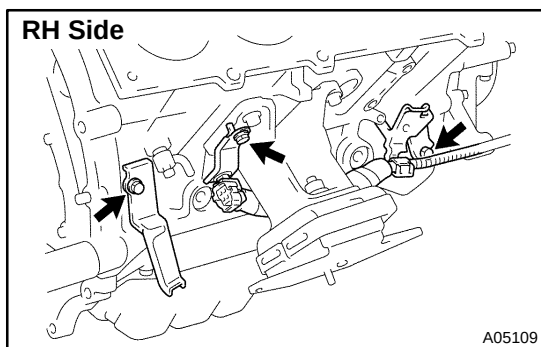
1. **INSTALL ENGINE TO ENGINE STAND**
2. **REMOVE TIMING BELT AND PULLEYS**
(See page [EM-15](#))
3. **REMOVE CYLINDER HEAD** (See page [EM-35](#))



4. **REMOVE WATER BYPASS PIPE**
 - (a) Disconnect the wire clamp (for knock sensor 1, 2) from the bracket of the water bypass pipe.
 - (b) Remove the bolt.
 - (c) Pull out the water bypass pipe from the water pump.
 - (d) Remove the O-ring from the water bypass pipe.
5. **REMOVE STARTER** (See page [ST-5](#))
6. **REMOVE KNOCK SENSORS** (See page [SF-55](#))



7. **DISCONNECT ENGINE WIRE FROM LH SIDE OF CYLINDER BLOCK**
 - (a) Remove the 2 bolts and the engine wire cover from the LH side of the cylinder block.
 - (b) Remove the bolt, disconnect the bracket on the engine wire from the cylinder block.



8. **DISCONNECT ENGINE WIRE FROM RH SIDE OF CYLINDER BLOCK**

Remove the 2 bolts, and disconnect the 2 brackets on the engine wire from the cylinder block.

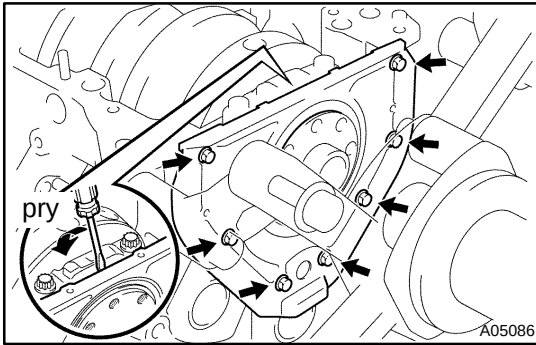
9. **REMOVE OIL COOLER PIPE BRACKET FOR A/T**

Remove the bolt and bracket.

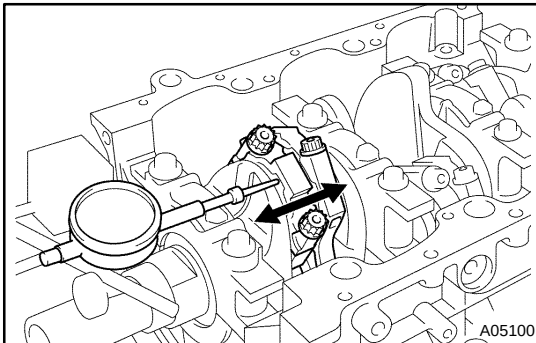
10. **REMOVE ENGINE MOUNTING BRACKETS**

Remove the 4 bolts and the mounting bracket. Remove the 2 mounting brackets

11. **REMOVE WATER PUMP** (See page [CO-6](#))
12. **REMOVE NO.2 OIL PAN** (See page [LU-8](#))
13. **REMOVE OIL PAN BAFFLE PLATE**
14. **REMOVE NO.1 OIL PAN** (See page [LU-8](#))
15. **REMOVE OIL STRAINER**
16. **REMOVE OIL PUMP** (See page [LU-8](#))
17. **REMOVE ENGINE COOLANT DRAIN UNIONS**
Remove the 2 drain unions.

**18. REMOVE REAR OIL SEAL RETAINER**

- (a) Remove the 7 bolts.
- (b) Using a screwdriver, pry off the oil seal retainer and the main bearing cap with a screwdriver.
- (c) Remove the O-ring.

**19. CHECK CONNECTING ROD THRUST CLEARANCE**

Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

Standard thrust clearance:

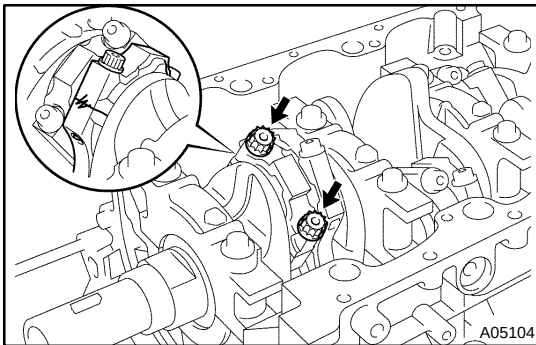
0.160 - 0.290 mm (0.0063 - 0.0138 in.)

Maximum thrust clearance: 0.35 mm (0.0138 in.)

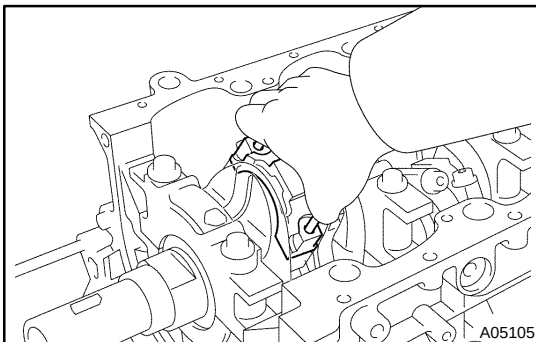
If the thrust clearance is greater than the maximum, replace the connecting rod assembly(s). If necessary, replace the crankshaft.

Connecting rod thickness:

22.880 - 22.920 mm (0.9008 - 0.9024 in.)

**20. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE**

- (a) Check the matchmarks on the connecting rod and cap to ensure correct reassembly.
- (b) Remove the 2 connecting rod cap bolts.



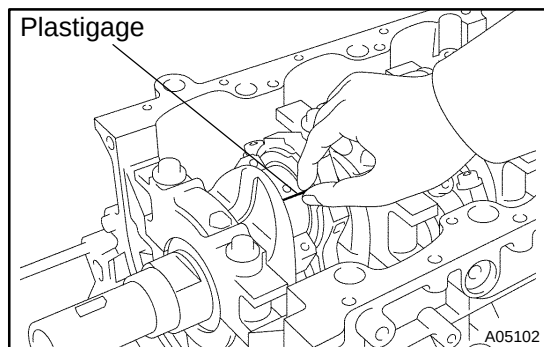
- (c) Using the 2 removed connecting rod cap bolts, remove the connecting rod cap and the lower bearing by wiggling the connecting rod cap right and left.

HINT:

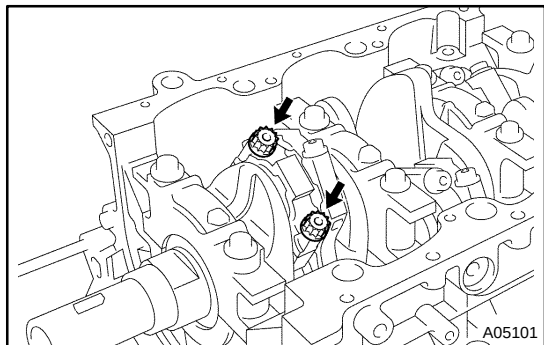
Keep the lower bearing inserted with the connecting rod cap.

- (d) Clean the crank pin and the bearing.
- (e) Check the crank pin and the bearing for pitting and scratches.

If the crank pin or the bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



- (f) Lay a strip of plastigage across the crank pin.

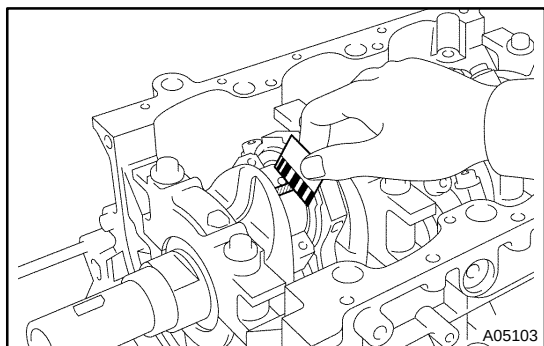


- (g) Install the connecting rod cap with the 2 bolts.
(See page [EM-107](#))

NOTICE:

Do not turn the crankshaft.

- (h) Remove the 2 bolts, the connecting rod cap and the lower bearing. (See procedure (b) and (c) above)



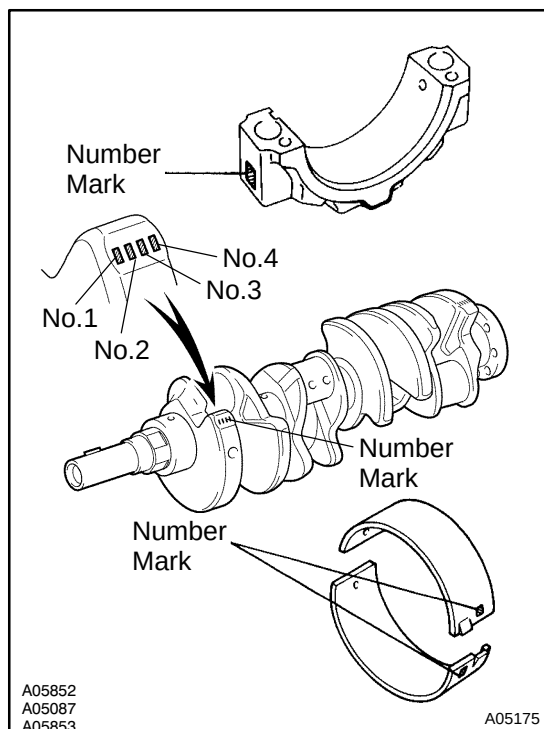
- (i) Measure the plastigage at its widest point.

Standard oil clearance:

0.027 - 0.053 mm (0.0011 - 0.0021 in.)

Maximum oil clearance: 0.065 mm (0.0026 in.)

If the oil clearance is greater than the maximum, replace the bearings. If necessary, replace the crankshaft.



HINT:

If using a standard bearing, replace it with the one having the same number. If the number of the bearing cannot be determined, sum up the numbers imprinted on the connecting rod cap and the crankshaft, then select the one with the same number as the total. There are 6 sizes of standard bearings, marked "2", "3", "4", "5", "6" and "7".

	Number mark											
Connecting rod cap	1	1	2	1	2	3	2	3	4	3	4	4
Crankshaft	1	2	1	3	2	1	3	2	1	3	2	3
Use bearing	2	3	4	5	6	7						

EXAMPLE:

Connecting rod cap "3" + Crankshaft "1"
= Total number 4 (Use bearing "4")

Reference**Connecting rod big end inside diameter:**

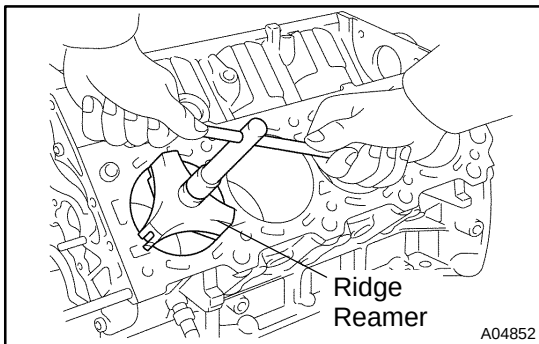
Mark "1"	55.000 - 55.006 mm (2.1654 - 2.1656 in.)
Mark "2"	55.006 - 55.012 mm (2.1656 - 2.1658 in.)
Mark "3"	55.012 - 55.018 mm (2.1658 - 2.1661 in.)
Mark "4"	55.018 - 55.024 mm (2.1661 - 2.1663 in.)

Crankshaft crank pin diameter:

Mark "1"	51.994 - 52.000 mm (2.0470 - 2.0472 in.)
Mark "2"	51.988 - 51.994 mm (2.0468 - 2.0470 in.)
Mark "3"	51.982 - 51.988 mm (2.0465 - 2.0468 in.)

Standard sized bearing center wall thickness:

Mark "2"	1.484 - 1.487 mm (0.0584 - 0.0585 in.)
Mark "3"	1.487 - 1.490 mm (0.0585 - 0.0587 in.)
Mark "4"	1.490 - 1.493 mm (0.0587 - 0.0588 in.)
Mark "5"	1.493 - 1.496 mm (0.0588 - 0.0589 in.)
Mark "6"	1.496 - 1.499 mm (0.0589 - 0.0590 in.)
Mark "7"	1.499 - 1.502 mm (0.0590 - 0.0591 in.)



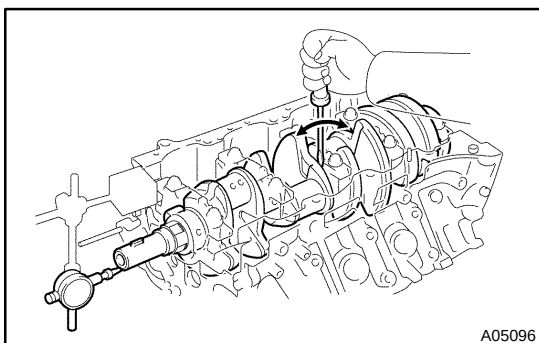
(j) Completely remove the plastigage.

21. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

- (a) Using a ridge reamer, remove all the carbon from the top of the cylinder.
- (b) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

HINT:

- ★ Keep the bearings, the connecting rod and the cap together.
- ★ Arrange the piston and connecting rod assemblies in correct order.

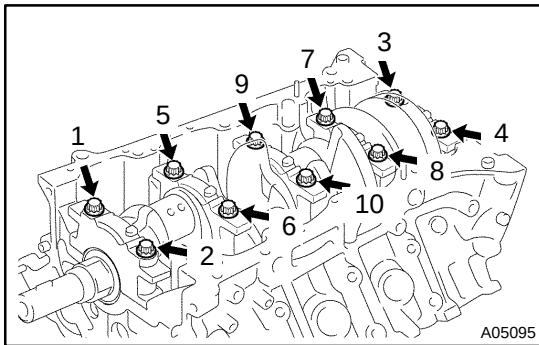
**22. CHECK CRANKSHAFT THRUST CLEARANCE**

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance:**0.020 - 0.220 mm (0.0008 - 0.0087 in.)****Maximum thrust clearance: 0.30 mm (0.0118 in.)**

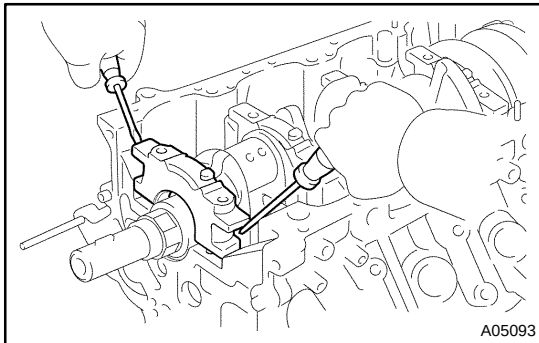
If the thrust clearance is greater than the maximum, replace the thrust washers as a set.

Thrust washer thickness:**2.440 - 2.490 mm (0.0961 - 0.0980 in.)**



23. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

- (a) Evenly loosen and remove the 10 main bearing cap bolts a little at time for several times, in the sequence shown.



- (b) Using 2 screwdrivers, pry out the main bearing cap, and remove the 5 main bearing caps, the 5 lower bearings and the 2 lower thrust washers (No.3 main bearing cap only).

NOTICE:

Be careful not to damage the cylinder block.

HINT:

- ★ Keep the lower bearing and the main bearing cap together.
- ★ Arrange the main bearing caps and lower thrust washers in correct order.

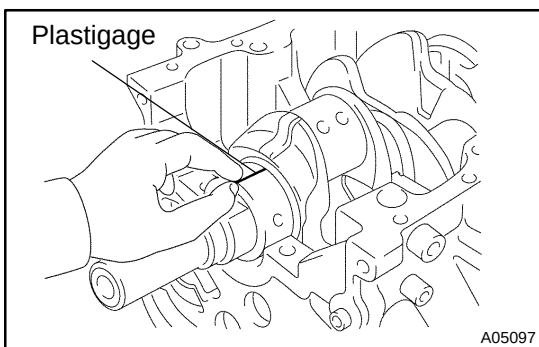
- (c) Lift out the crankshaft.

HINT:

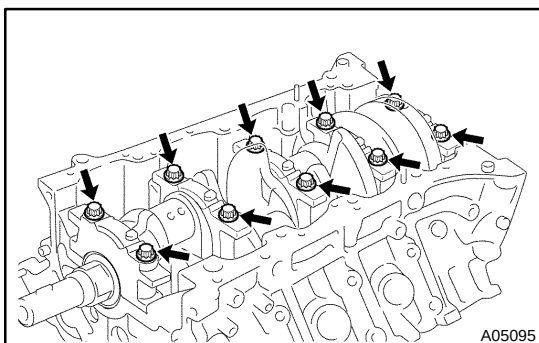
Keep the upper bearings and the upper thrust washers together with the cylinder block.

- (d) Clean each main journal and bearing.
 (e) Check each main journal and bearing for pitting and scratches.

If the journal or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



- (f) Place the crankshaft on the cylinder block.
 (g) Lay a strip of plastigage across each journal.

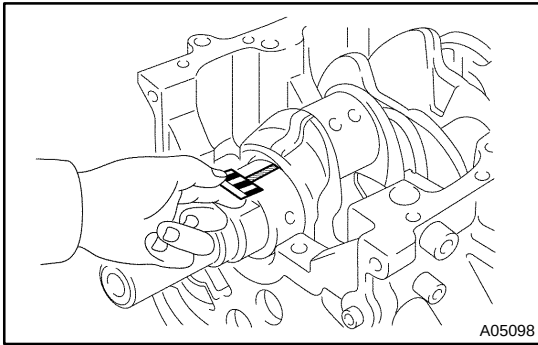


- (h) Install the main bearing caps.
 (See page [EM-107](#))

NOTICE:

Do not turn the crankshaft.

- (i) Remove the main bearing caps.
 (See procedure (a) and (b) above)



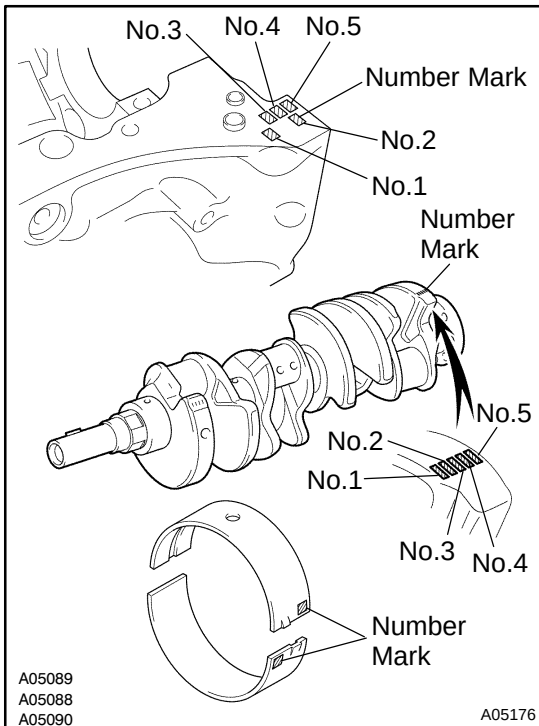
- (j) Measure the plastigage at its widest point.

Standard clearance:

0.040 - 0.058 mm (0.0016 - 0.0023 in.)

Maximum clearance: 0.070 mm (0.0028 in.)

If the oil clearance is greater than the maximum, replace the bearings. If necessary, replace the crankshaft.



HINT:

If using a standard bearing, replace it with the one having the same number. If the number of the bearing cannot be determined, sum up the numbers imprinted on the cylinder block and the crankshaft, then refer to the table below for the appropriate bearing number. There are 5 sizes of the standard bearings. For No.1 and No.5 position bearings, use bearings marked "3", "4", "5", "6" and "7". For others position bearings, use bearings marked "1", "2", "3", "4" and "5".

No.1, No.5:

		Use bearing
Cylinder block (A) + Crankshaft (B)	0 - 5	3
	6 - 11	4
	12 - 17	5
	18 - 23	6
	24 - 28	7

EXAMPLE:

Cylinder block "08" + Crankshaft "06"
= Total number 14 (Use bearing "5")

Others:

		Use bearing
Cylinder block (A) + Crankshaft (B)	0 - 5	1
	6 - 11	2
	12 - 17	3
	18 - 23	4
	24 - 28	5

EXAMPLE:

Cylinder block "08" + Crankshaft "06"
= Total number 14 (Use bearing "3")

Reference

Cylinder block main journal bore diameter (A):

Mark "00"	72.000 mm (2.8346 in.)
Mark "01"	72.001 mm (2.8347 in.)
Mark "02"	72.002 mm (2.8347 in.)
Mark "03"	72.003 mm (2.8348 in.)
Mark "04"	72.004 mm (2.8348 in.)
Mark "05"	72.005 mm (2.8348 in.)
Mark "06"	72.006 mm (2.8349 in.)
Mark "07"	72.007 mm (2.8349 in.)

Mark "08"	72.008 mm (2.8350 in.)
Mark "09"	72.009 mm (2.8350 in.)
Mark "10"	72.010 mm (2.8350 in.)
Mark "11"	72.011 mm (2.8351 in.)
Mark "12"	72.012 mm (2.8351 in.)
Mark "13"	72.013 mm (2.8352 in.)
Mark "14"	72.014 mm (2.8352 in.)
Mark "15"	72.015 mm (2.8352 in.)
Mark "16"	72.016 mm (2.8353 in.)

Crankshaft main journal diameter (B):

Mark "00"	67.000 mm (2.6378 in.)
Mark "01"	66.999 mm (2.6378 in.)
Mark "02"	66.998 mm (2.6377 in.)
Mark "03"	66.997 mm (2.6377 in.)
Mark "04"	66.996 mm (2.6376 in.)
Mark "05"	66.995 mm (2.6376 in.)
Mark "06"	66.994 mm (2.6376 in.)
Mark "07"	66.993 mm (2.6375 in.)
Mark "08"	66.992 mm (2.6375 in.)
Mark "09"	66.991 mm (2.6374 in.)
Mark "10"	66.990 mm (2.6374 in.)
Mark "11"	66.989 mm (2.6374 in.)
Mark "12"	66.988 mm (2.6373 in.)

**Standard bearing center wall thickness:
No.1 and No.5**

Mark "3"	2.481 - 2.484 mm (0.0977 - 0.0978 in.)
Mark "4"	2.484 - 2.487 mm (0.0978 - 0.0979 in.)
Mark "5"	2.487 - 2.490 mm (0.0979 - 0.0980 in.)
Mark "6"	2.490 - 2.493 mm (0.0980 - 0.0981 in.)
Mark "7"	2.493 - 2.496 mm (0.0981 - 0.0983 in.)

Others:

Mark "1"	2.481 - 2.484 mm (0.0977 - 0.0978 in.)
Mark "2"	2.484 - 2.487 mm (0.0978 - 0.0979 in.)
Mark "3"	2.487 - 2.490 mm (0.0979 - 0.0980 in.)
Mark "4"	2.490 - 2.493 mm (0.0980 - 0.0981 in.)
Mark "5"	2.493 - 2.496 mm (0.0981 - 0.0983 in.)

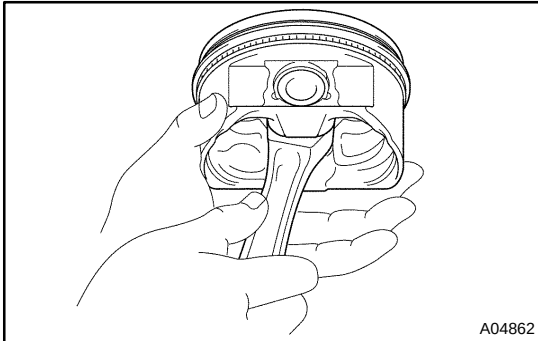
(k) Completely remove the plastigage.

24. REMOVE CRANKSHAFT

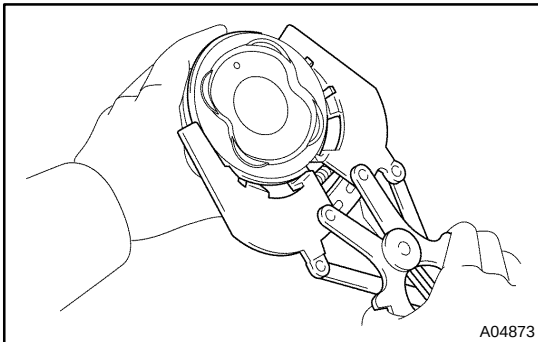
- (a) Lift up the crankshaft.
- (b) Remove the 5 upper main bearings and the 2 upper thrust washers from the cylinder block.

HINT:

Arrange the main bearing caps, bearings and thrust washers in correct order for installation.

**25. CHECK FIT BETWEEN PISTON AND PISTON PIN**

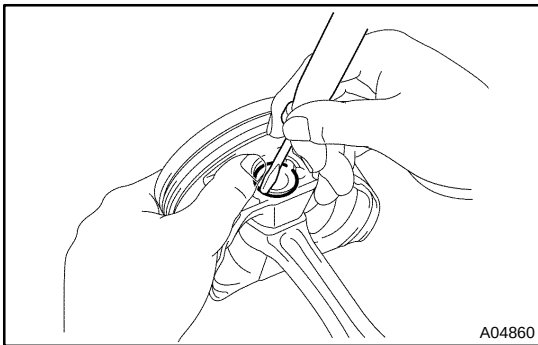
Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and pin as a set.

**26. REMOVE PISTON RINGS**

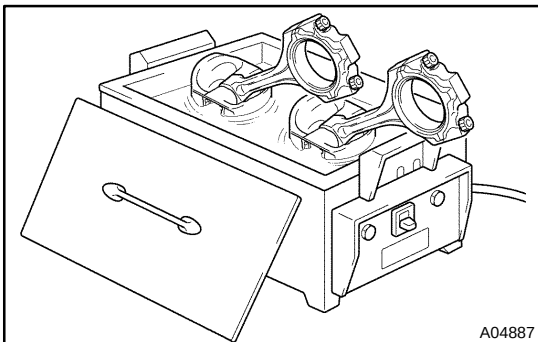
- (a) Using a piston ring expander, remove the 2 compression rings.
- (b) Remove the 2 side rails and the oil ring by hand.

HINT:

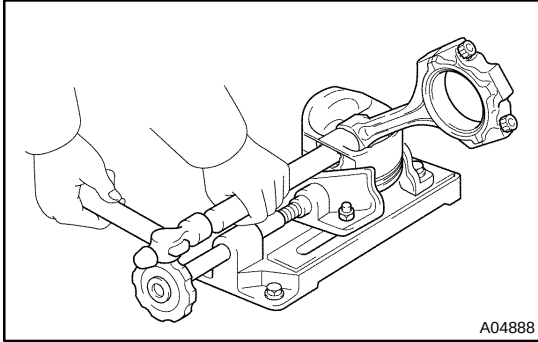
Arrange the piston rings in correct order for installation.

**27. DISCONNECT CONNECTING ROD FROM PISTON**

- (a) Using a small screwdriver, pry out the 2 snap rings.



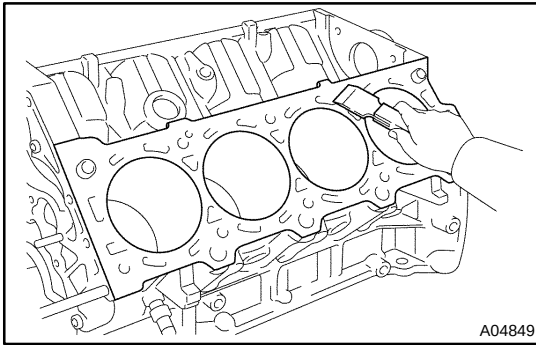
- (b) Gradually heat the piston to approx. 60°C (140°F).



- (c) Using a plastic-faced hammer and a brass bar, lightly tap out the piston pin and the pin and remove the connecting rod.

HINT:

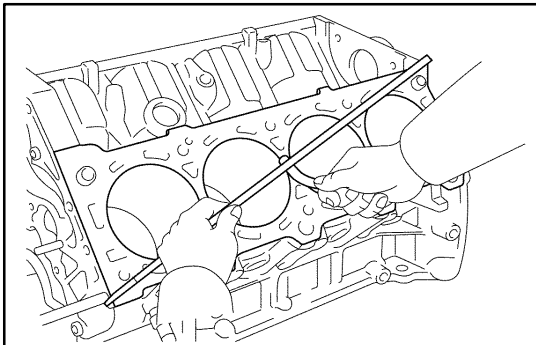
- ★ The piston and the pin are the set.
- ★ Arrange the pistons, the pins, the rings, the connecting rods and the bearings in correct order for installation.



INSPECTION

1. CLEAN CYLINDER BLOCK

- (a) Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
- (b) Using a soft brush and solvent, thoroughly clean the cylinder block.



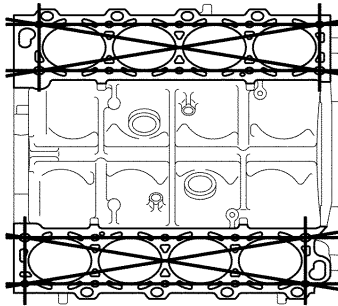
2. INSPECT CYLINDER BLOCK

- (a) Inspect for flatness.
Using a precision straight edge and a feeler gauge, measure the surfaces contacting the cylinder head and main bearing cap for a warp.

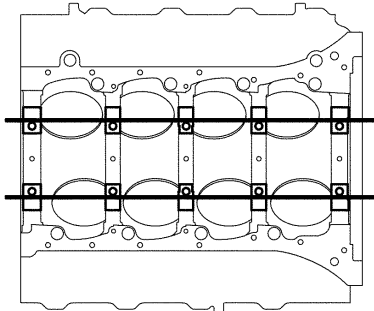
Maximum warp: 0.07 mm (0.0028 in.)

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

Cylinder Block Side

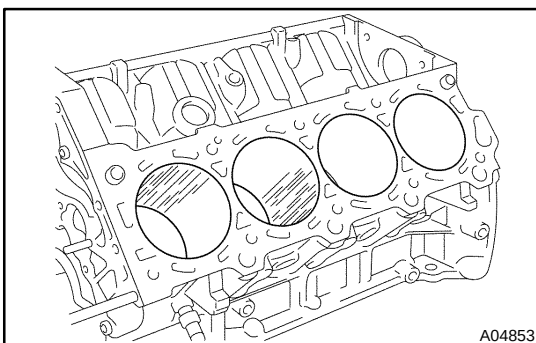


Main Bearing Cap Side

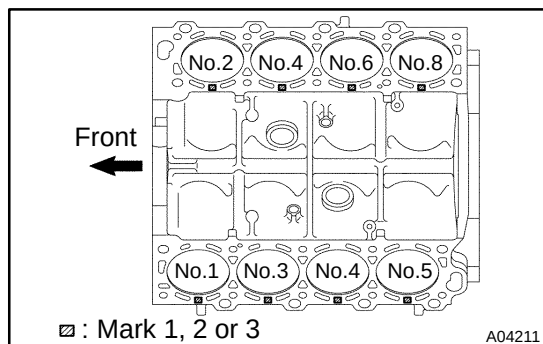


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A04212

A05178



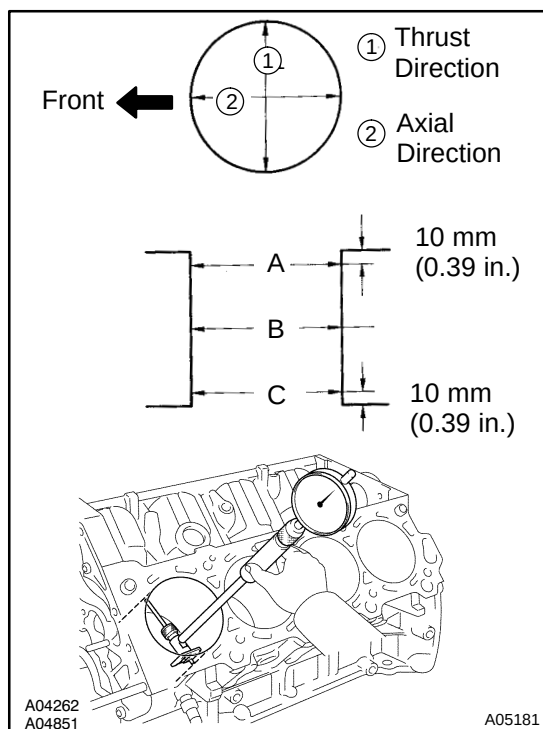
- (b) Visually check the cylinder for vertical scratches.
If deep scratches are found, rebore all the 8 cylinders and replace all the 8 pistons (See page [EM-104](#)). If necessary, replace the cylinder block.



(c) Inspect the cylinder bore diameter.

HINT:

There are 3 sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the cylinder block.



Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

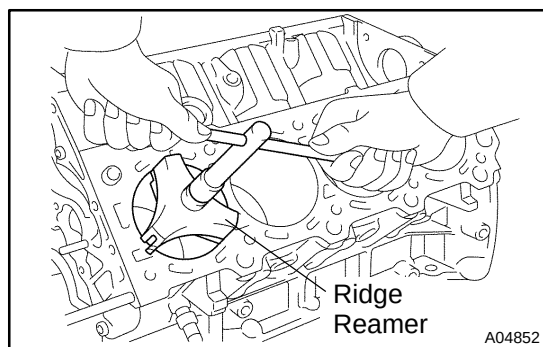
Standard diameter:

STD	Mark "1"	94.002 - 94.010 mm (3.7009 - 3.7012 in.)
	Mark "2"	94.010 - 94.023 mm (3.7012 - 3.7017 in.)
	Mark "3"	94.023 - 94.031 mm (3.7017 - 3.7020 in.)

Maximum diameter: 94.23 mm (3.7098 in.)

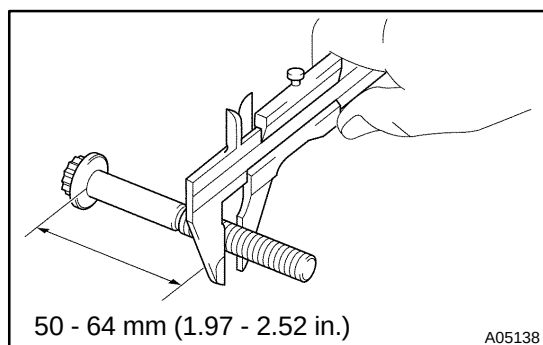
STD	94.231 mm (3.7099 in.)
O/S 0.50	94.731 mm (3.7296 in.)

If the diameter is greater than the maximum, rebore all the 8 cylinders and replace all the 8 pistons (See page [EM-104](#)). If necessary, replace the cylinder block.



(d) Remove the cylinder ridge.

If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.



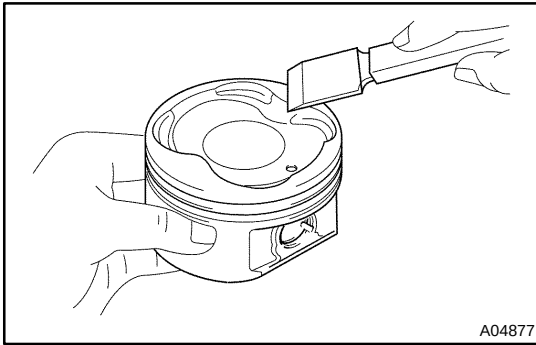
(e) Using vernier calipers, measure the thread outside diameter of the main bearing cap bolt.

Standard diameter:

10.760 - 10.970 mm (0.4236 - 0.4319 in.)

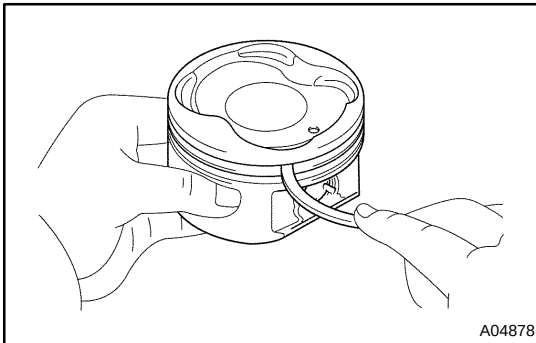
Minimum diameter: 10.40 mm (0.4094 in.)

If the diameter is less than the minimum, replace the cap bolt.

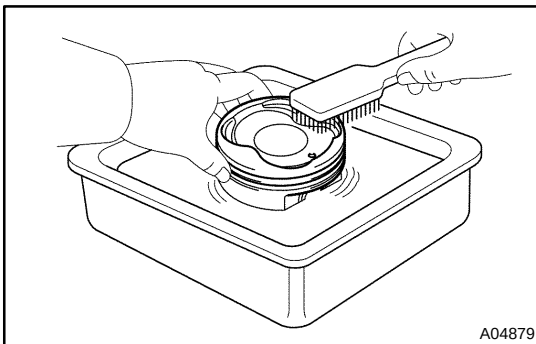


3. CLEAN PISTON

- (a) Using a gasket scraper, remove the carbon from the piston top.



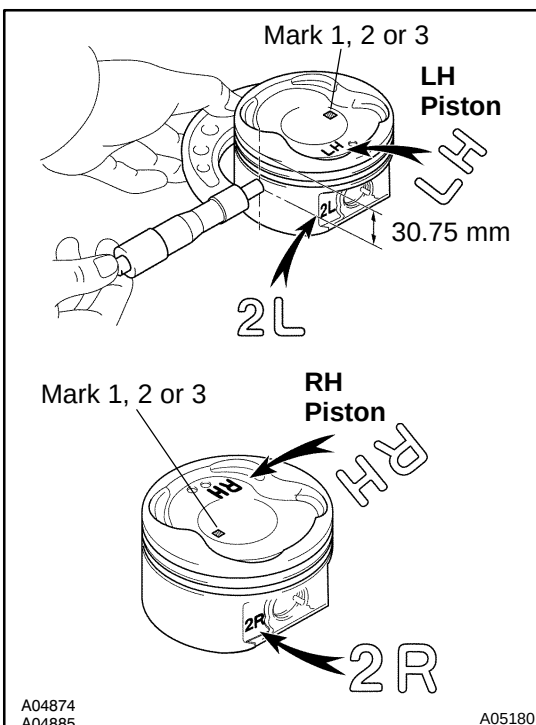
- (b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



- (c) Using solvent and a brush, thoroughly clean the piston.

NOTICE:

Do not use a wire brush.



4. INSPECT PISTON AND CONNECTING ROD

- (a) Inspect the piston oil clearance.

HINT:

There are 3 sizes of the standard piston diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the piston top.

- (1) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 30.75 mm (1.2106 in.) from the piston head.

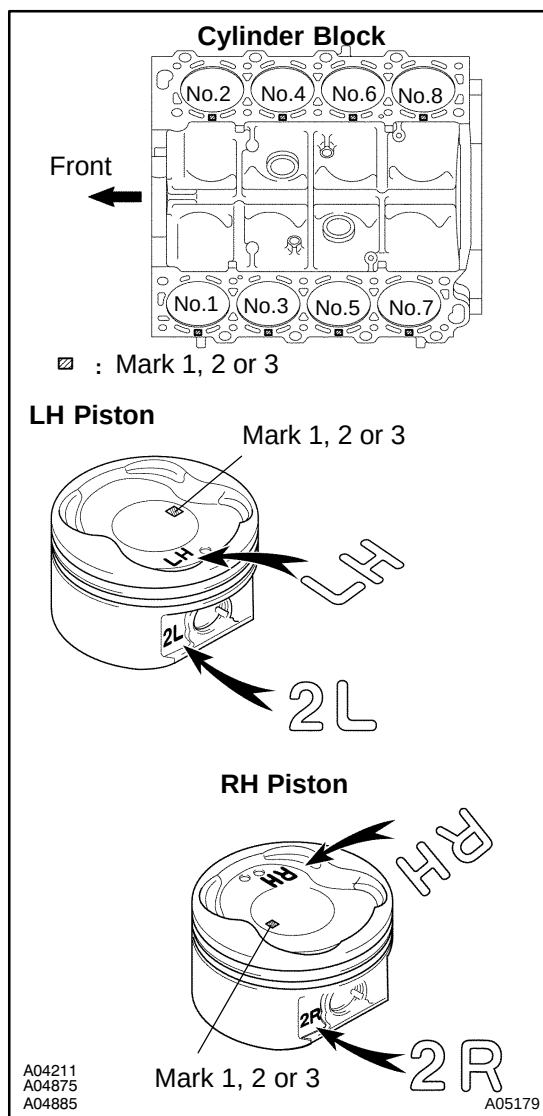
Piston diameter:

STD	Mark "1"	93.902 - 93.912 mm (3.6969 - 3.6973 in.)
	Mark "2"	93.912 - 93.920 mm (3.6973 - 3.6976 in.)
	Mark "3"	93.920 - 93.930 mm (3.6976 - 3.6980 in.)
O/S 0.50		94.402 - 94.430 mm (3.7166 - 3.7177 in.)

- (2) Measure the cylinder bore diameter in the thrust directions. (See step 2 above)
- (3) Subtract the piston diameter from the cylinder bore diameter.

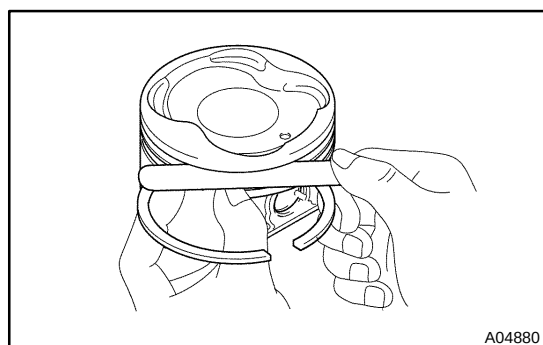
Standard oil clearance:**0.090 - 0.111 mm (0.0035 - 0.0044 in.)****Maximum oil clearance: 0.13 mm (0.0051 in.)**

If the oil clearance is greater than the maximum, replace all the 8 pistons and rebore all the 8 cylinders. (See page [EM-104](#)) If necessary, replace the cylinder block.

**HINT**

Use new cylinder block:

- ★ Use a piston with the same number mark as the cylinder diameter marked on the cylinder block.
- ★ The shape of the piston varies for the LH and the RH banks. The LH piston is marked as "LH" and "2L", and the RH piston as "RH" and "2R".

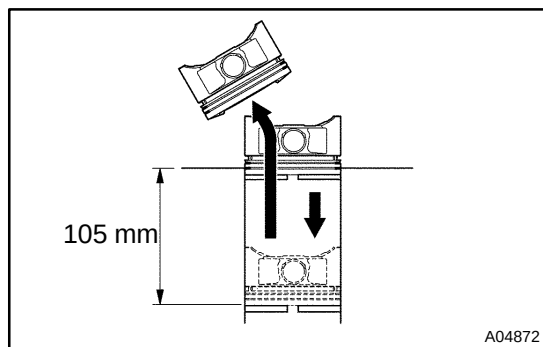


- (b) Inspect the piston ring groove clearance.
Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

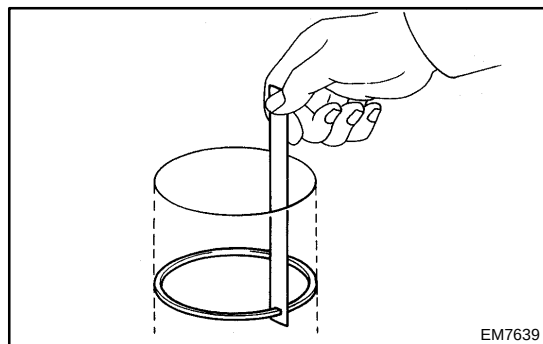
Ring groove clearance:

No.1	0.030 - 0.080 mm (0.0012 - 0.0031 in.)
No.2	0.030 - 0.070 mm (0.0012 - 0.0028 in.)

If the clearance is not as specified, replace the piston.



- (c) Inspect the piston ring end gap.
- (1) Insert the piston ring into the cylinder bore.
 - (2) Using a piston, push the piston ring to a little beyond the bottom of the ring travel, 105 mm (4.13 in.) from the top of the cylinder block.



- (3) Using a feeler gauge, measure the end gap.

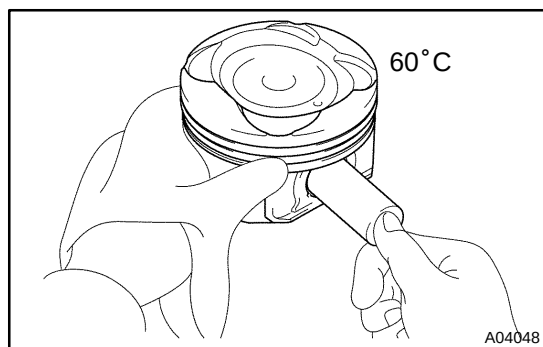
Standard end gap:

No.1	0.300 - 0.500 mm (0.0118 - 0.0197 in.)
No.2	0.400 - 0.650 mm (0.0157 - 0.0256 in.)
Oil (Side rail)	0.130 - 0.480 mm (0.0051 - 0.0189 in.)

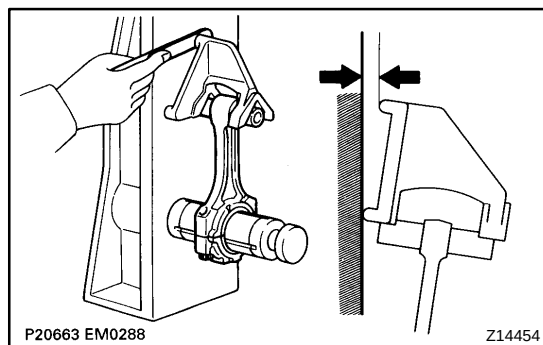
Maximum end gap:

No.1	1.10 mm (0.0433 in.)
No.2	1.20 mm (0.0472 in.)
Oil (Side rail)	1.15 mm (0.0453 in.)

If the end gap is greater than the maximum, replace the piston ring. If the end gap is greater than the maximum, even with a new piston ring, rebore all the 8 cylinders (See page [EM-104](#)) or replace the cylinder block.



- (d) Inspect the piston pin fit.
- At 60°C (140°F), you should be able to push the piston pin into the piston pin hole with your thumb.

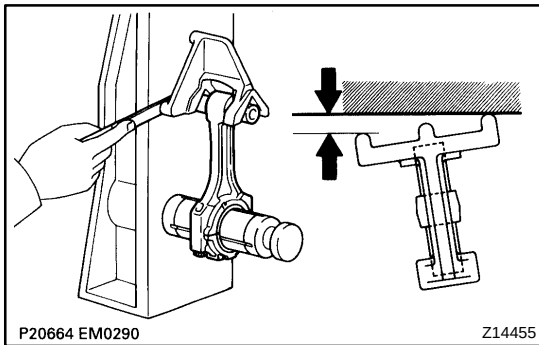


- (e) Using a rod aligner and the feeler gauge, check the connecting rod alignment.
- (1) Check for bend.

Maximum bend:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If bend is greater than maximum, replace the connecting rod assembly.

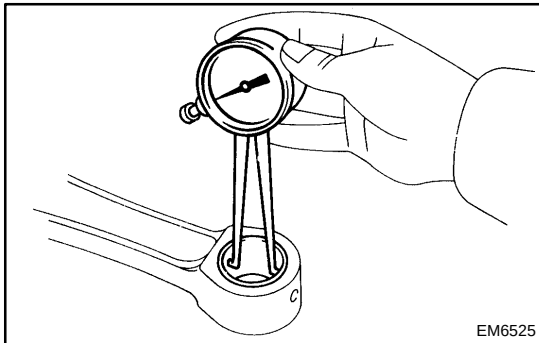


- (2) Check for twist

Maximum twist:

0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

If twist is greater than the maximum, replace the connecting rod assembly.

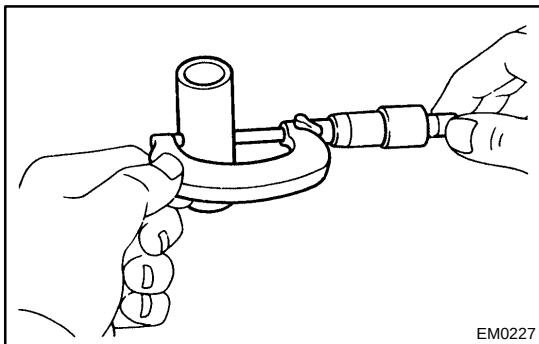


- (f) Inspect the piston pin oil clearance.

- (1) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

Bushing inside diameter:

22.005 - 22.014 mm (0.8663 - 0.8667 in.)



- (2) Using a micrometer, measure the piston pin diameter.

Piston pin diameter:

21.997 - 22.009 mm (0.8660 - 0.8664 in.)

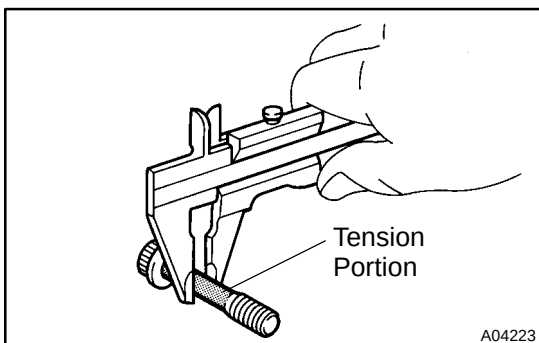
- (3) Subtract the piston pin diameter from the bushing inside diameter.

Standard oil clearance:

0.005 - 0.011 mm (0.0002 - 0.0004 in.)

Maximum oil clearance: 0.05 mm (0.0020 in.)

If the oil clearance is greater than the maximum, replace the bushing. If necessary, replace the piston and the piston pin as a set.



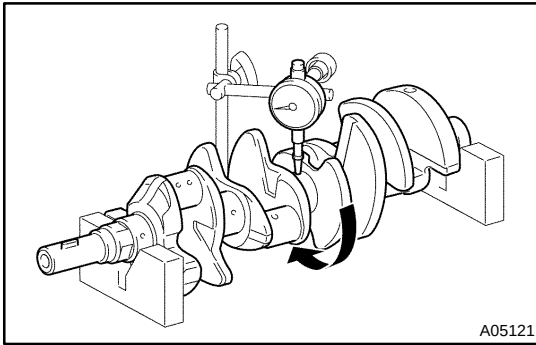
- (g) Using vernier calipers, measure the tension portion of the connecting rod bolt.

Standard diameter:

7.200 - 7.300 mm (0.2835 - 0.2874 in.)

Minimum diameter: 7.00 mm (0.2756 in.)

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



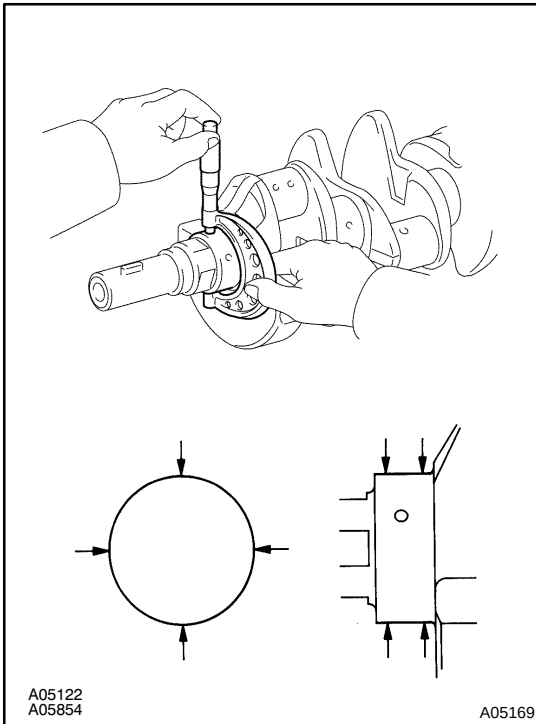
5. INSPECT CRANKSHAFT

(a) Inspect for circle runout.

- (1) Place the crankshaft on V-blocks.
- (2) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.08 mm (0.0031 in.)

If the circle runout is greater than the maximum, replace the crankshaft.



(b) Inspect the main journals and the crank pins.

- (1) Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

66.988 - 67.000 mm (2.6373 - 2.6378 in.)

Crank pin diameter:

51.982 - 52.000 mm (2.0465 - 2.0472 in.)

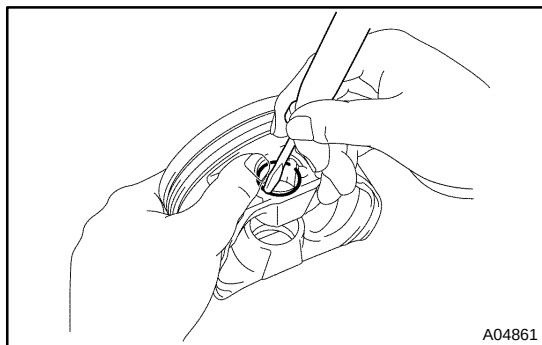
If the diameter is not as specified, check the oil clearance (See page [EM-88](#)). If necessary, replace the crankshaft.

- (2) Check each main journal and crank pin for taper and out-of-round as shown.

Maximum taper and out-of-round:

0.02 mm (0.0008 in.)

If the taper and out-of-round is greater than the maximum, replace the crankshaft.



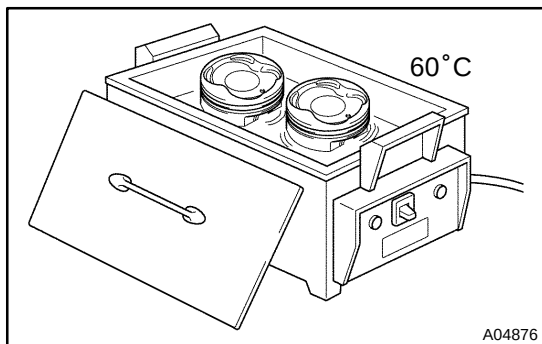
REASSEMBLY

HINT:

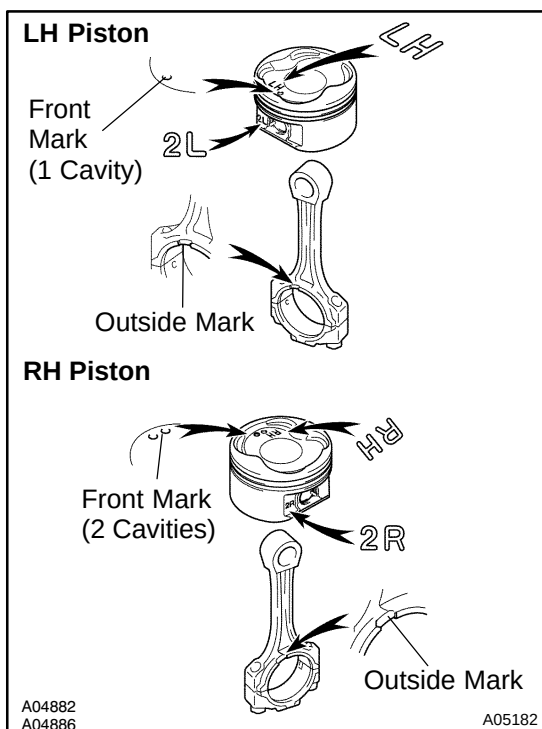
- ★ Thoroughly clean all parts to be assembled.
- ★ Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- ★ Replace all gaskets, O-rings and oil seals with new parts.

1. ASSEMBLE PISTON AND CONNECTING ROD

- (a) Using a small screwdriver, install a new snap ring on one side of the piston pin hole.



- (b) Gradually heat the piston to about 60°C (140°F).

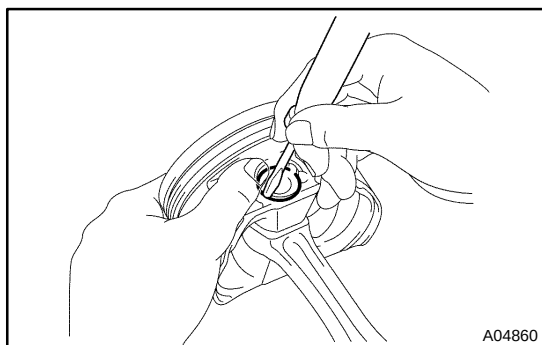


- (c) Coat the piston pin with engine oil.
- (d) Position the piston front mark to the outside mark on the connecting rod as shown in the diagram.

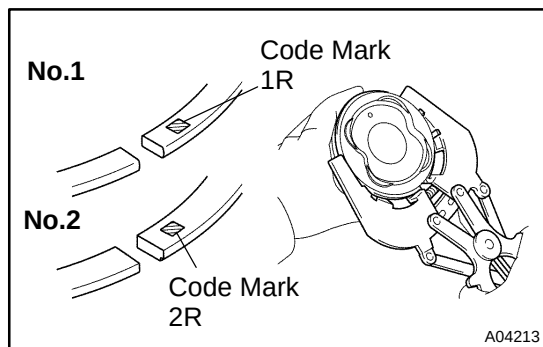
NOTICE:

The installation directions of the piston and connecting rod are different for the LH and RH banks. The LH piston is marked with "LH" and "2L", the RH piston with "RH" and "2R".

- (e) Align the piston pin holes of the piston and connecting rod, and push in the piston pin with your thumb.



- (f) Using a small screwdriver, install a new snap ring on the other side of the piston pin hole.

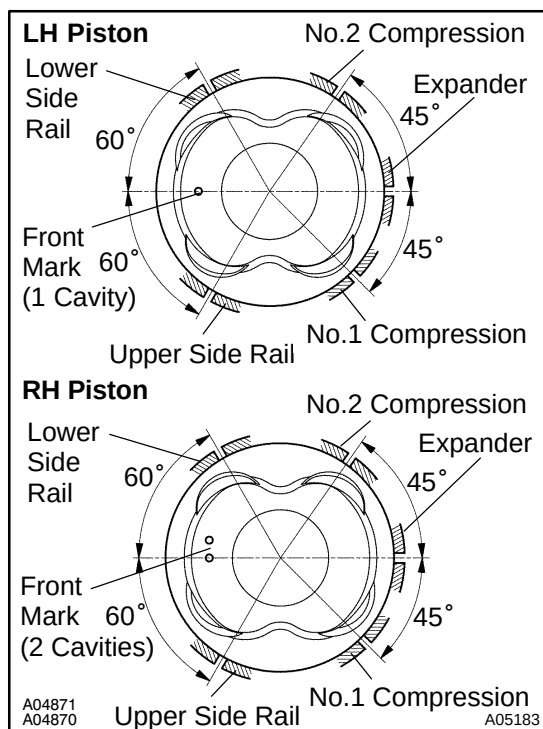


2. INSTALL PISTON RINGS

- Install the oil ring expander and the 2 side rails by hand.
- Using a piston ring expander, install the 2 compression rings with the code mark facing upward.

Code mark:

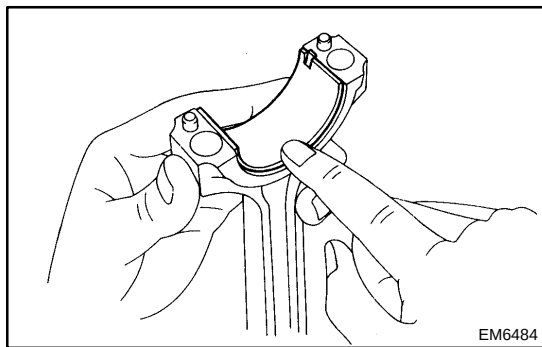
No.1	1R
No.2	2R



- Position the piston rings so that the ring ends are as shown.

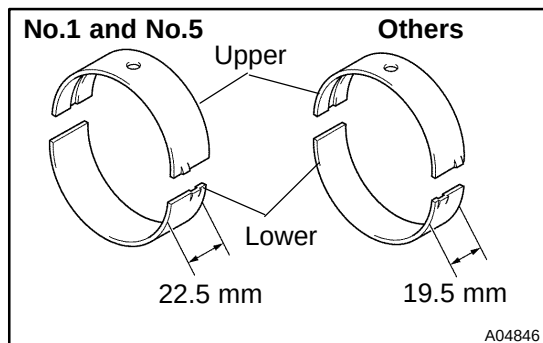
NOTICE:

Do not align the ring ends.



3. INSTALL BEARINGS

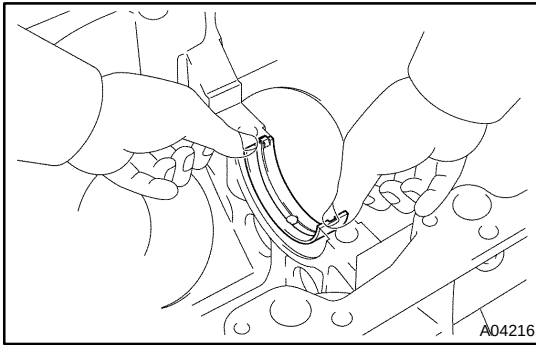
- Align the bearing claw with the groove of the connecting rod or the connecting cap.
- Install the bearings in the connecting rod and the connecting rod cap.



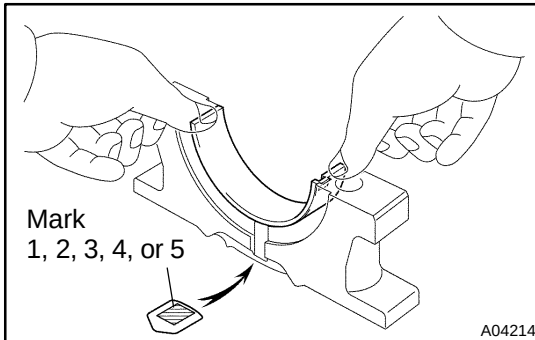
4. INSTALL MAIN BEARINGS

HINT:

- ★ Main bearings come in widths of 19.5 mm (0.768 in.) and 22.5 mm (0.886 in.). Install the 22.5 mm (0.886 in.) bearings in the No.1 and No.5 cylinder block journal positions with the main bearing cap. Install the 19.5 mm (0.768 in.) bearings in the other positions.
- ★ Upper bearings have an oil groove and an oil holes; lower bearings do not.



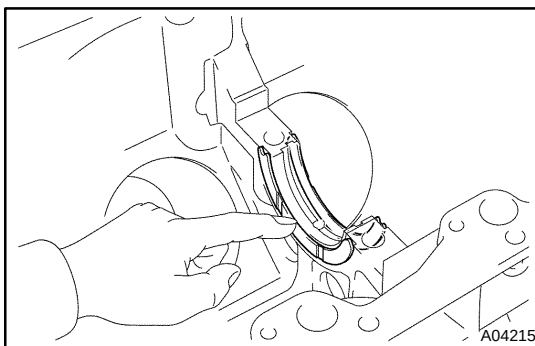
- (a) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings.



- (b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

HINT:

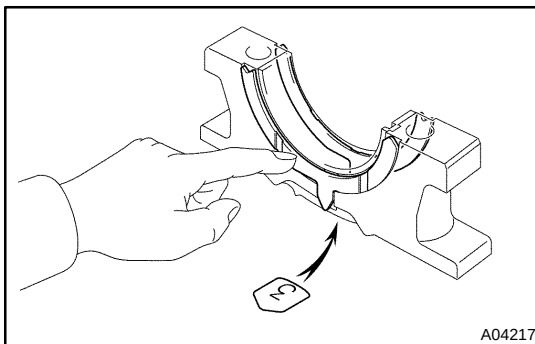
A number is marked on each main bearing cap to indicate the installation position.



5. INSTALL UPPER THRUST WASHERS

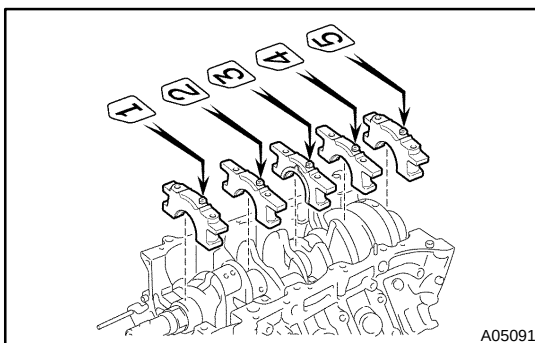
Install the 2 thrust washers under the No.3 journal position of the cylinder block with the oil grooves facing outward.

6. PLACE CRANKSHAFT ON CYLINDER BLOCK



7. PLACE MAIN BEARING CAPS AND LOWER THRUST WASHERS ON CYLINDER BLOCK

- (a) Install the 2 thrust washers on the No.3 bearing cap with the grooves facing outward.

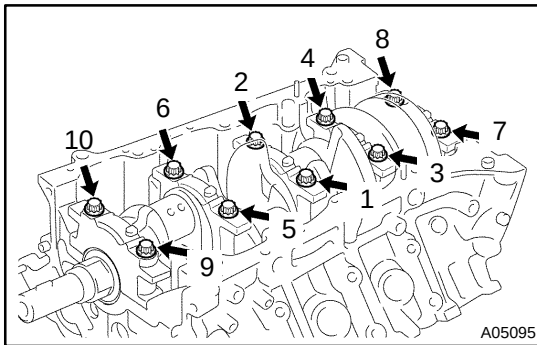


- (b) Install the 5 main bearing caps in their proper locations.

8. INSTALL MAIN BEARING CAP BOLTS

HINT:

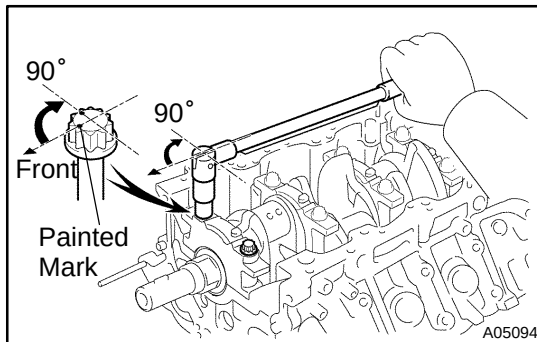
- ★ The main bearing cap bolts are tightened in 2 steps (steps (b) and (d)).
- ★ If any one of the main bearing cap bolts is broken or deformed, replace it.



- (a) Apply a light coat of engine oil on the threads and under the main bearing cap bolts.
- (b) Install and evenly tighten the 10 main bearing cap bolts a little at a time for several times as in the sequence shown.

Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)

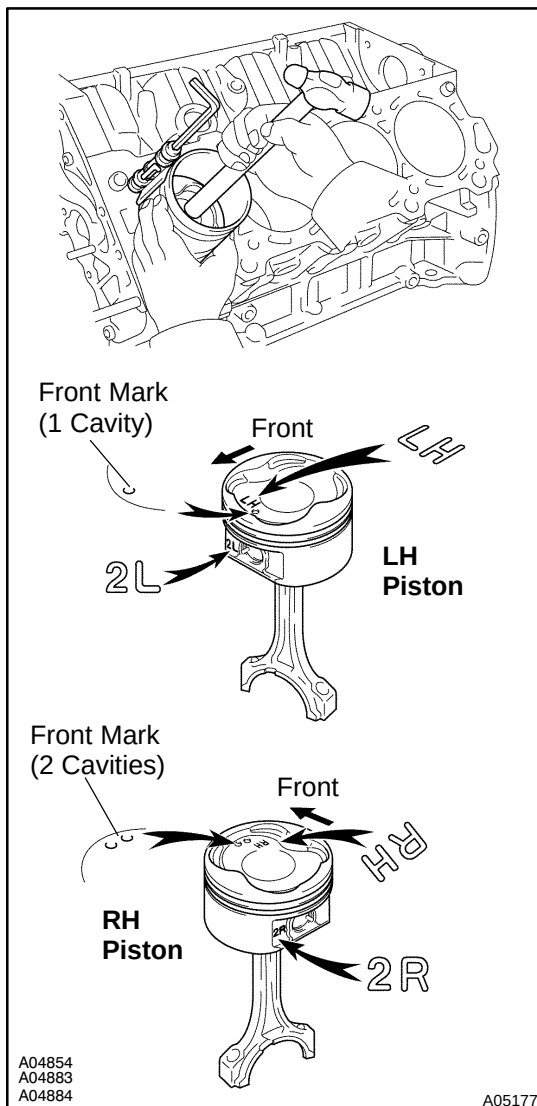
If any one of the main bearing cap bolts does not meet the torque specification, replace the main bearing cap bolt.



- (c) Mark the front of the main bearing cap bolt with paint.
- (d) Retighten the main bearing cap bolts by 90° in the numerical order shown.
- (e) Check that the painted mark is now at a 90° angle to the front.
- (f) Check that the crankshaft turns smoothly.

9. CHECK CRANKSHAFT THRUST CLEARANCE

(See page [EM-88](#))

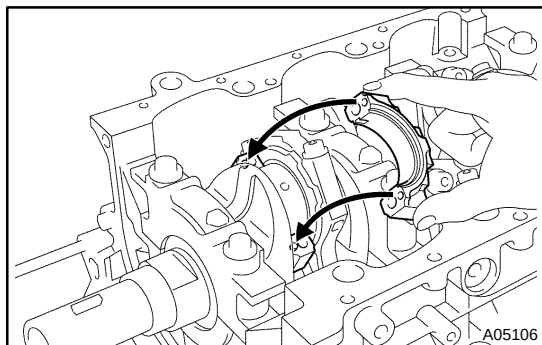


10. INSTALL PISTON AND CONNECTING ROD ASSEMBLES

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

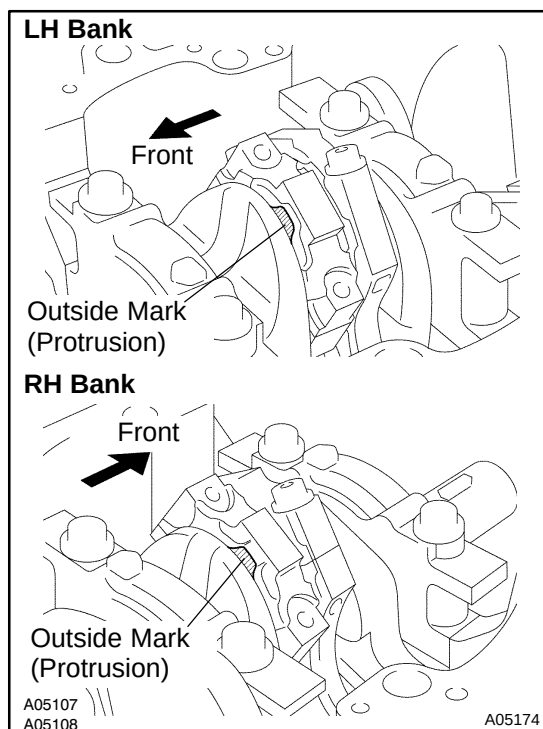
NOTICE:

The shape of the piston varies for the LH and RH banks. The LH piston is marked with "LH" and "2R", the RH piston with "RH" and "2R".



11. PLACE CONNECTING ROD CAP ON CONNECTING ROD

- Match the numbered connecting rod cap with the connecting rod.
- Align the pin groove of the connecting rod cap with the pins of the connecting rod, and install the connecting rod cap.

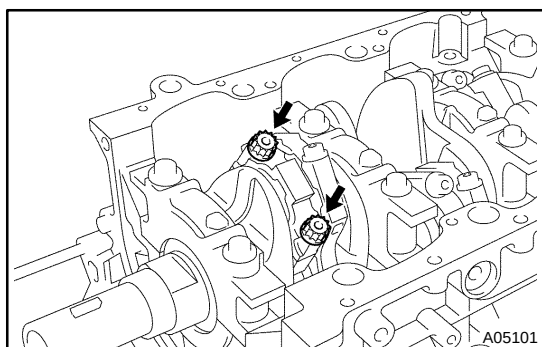


- Check that the outside mark of the connecting rod cap is facing in correct direction.

12. INSTALL CONNECTING ROD CAP BOLTS

HINT:

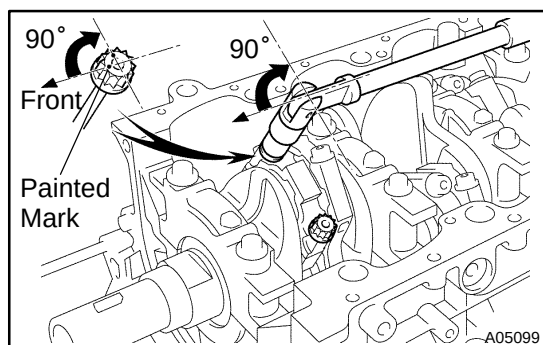
- ★ The connecting rod cap bolts are tightened in 2 steps (steps (b) and (d)).
- ★ If any one of the connecting rod cap bolts is broken or deformed, replace it.



- Apply a light coat of engine oil on the threads and under the heads of the connecting rod cap bolts.
- Install and alternately tighten the 2 connecting rod cap bolts a little at a time for several times.

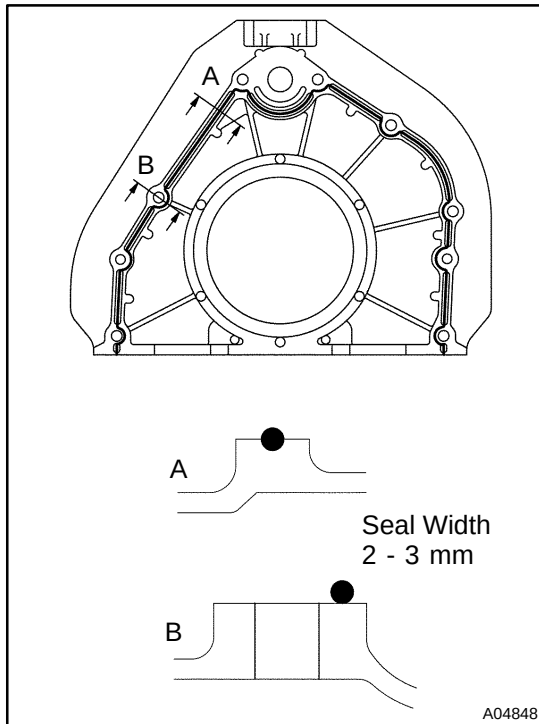
Torque: 24.5 N·m (250 kgf·cm, 18 ft·lbf)

If any one of the connecting rod cap bolts does not meet the torque specification, replace the connecting rod cap bolts.



- Mark the front of the connecting cap bolt with paint.
- Retighten the cap bolts 90° as shown.
- Check that the painted mark is now at a 90° angle to the front.
- Check that the crankshaft turns smoothly.

13. CHECK CONNECTING ROD THRUST CLEARANCE (See page EM-88)

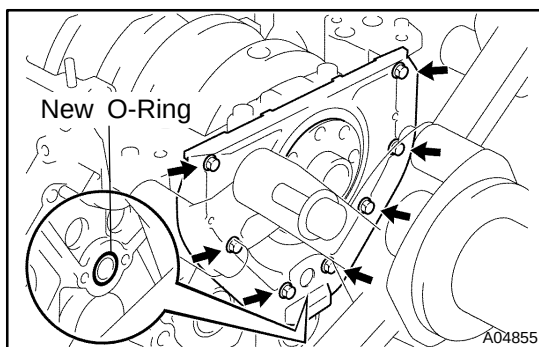


14. INSTALL REAR OIL SEAL RETAINER

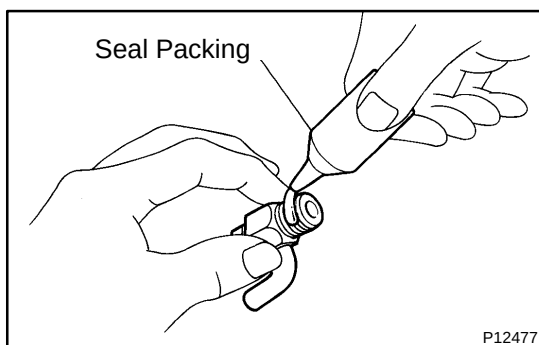
- (a) Remove any old packing (FIPG) material, and be careful not to drop any oil on the contact surfaces of the oil seal retainer and the cylinder block.
- ★ Using a razor blade and a gasket scraper, remove old FIPG from the seal surface.
 - ★ Clean all the components to remove the redundant FIPG completely.
 - ★ Clean sealing surfaces with solvent so that any residue does not remain on the seal.
- (b) Apply seal packing to the oil seal retainer as shown in the illustration.

Seal packing: Part No. 08826-00080 or equivalent

- ★ Install a nozzle that is cut to a 2 - 3 mm (0.08 - 0.12 in.) opening.
- ★ Parts must be assembled within 5 minutes after the seal packing application. Otherwise the material must be removed and the seal packing have to be reapplied.
- ★ Immediately remove the nozzle from the tube and reinstall the cap.



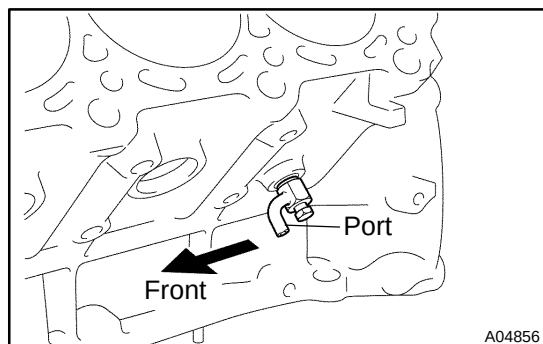
- (c) Install a new O-ring to the cylinder block.
- (d) Install the oil seal retainer with the 7 bolts.
- Torque: 8.0 N·m (80 kgf·cm, 71 in·lbf)**



15. INSTALL ENGINE COOLANT DRAIN UNIONS

- (a) Apply seal packing to 2 or 3 threads from the end of the drain unions.

Seal packing: Part No. 08826-00100 or equivalent



- (b) Install the 2 drain unions.

Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

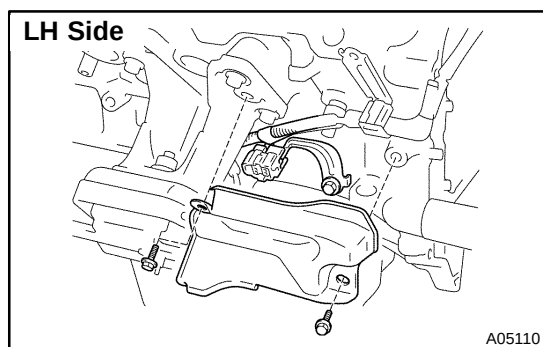
HINT:

After applying the specified torque, rotate the drain union clockwise until the drain port is facing forward.

16. **INSTALL OIL PUMP** (See page [LU-15](#))
17. **INSTALL OIL STRAINER** (See page [LU-15](#))
18. **INSTALL NO.1 OIL PAN** (See page [LU-15](#))
19. **INSTALL OIL PAN BAFFLE PLATE**
(See page [LU-15](#))
20. **INSTALL NO.2 OIL PAN** (See page [LU-15](#))
21. **INSTALL WATER PUMP** (See page [CO-8](#))
22. **INSTALL ENGINE MOUNTING BRACKETS**

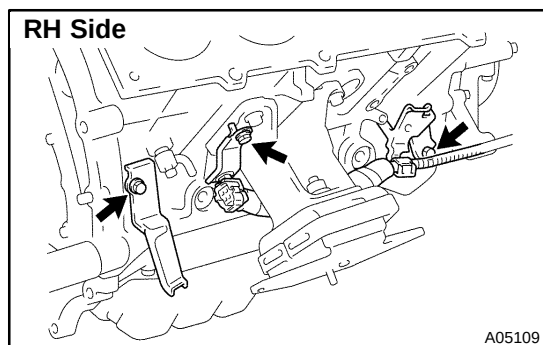
Install the mounting bracket with the 4 bolts. Install the 2 mounting brackets.

Torque: 36 N·m (370 kgf·cm, 27 ft·lbf)



23. INSTALL ENGINE WIRE TO LH SIDE OF CYLINDER BLOCK

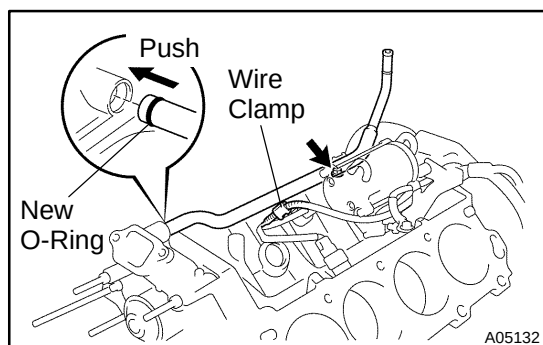
- (a) Install the bracket on the engine wire with the bolt.
- (b) Install the engine wire cover with the 2 bolts.



24. INSTALL ENGINE WIRE TO RH SIDE OF CYLINDER BLOCK

Install the 2 brackets on the engine wire with the 2 bolts.

25. **INSTALL OIL COOLER PIPE BRACKET FOR A/T**
Install the bracket with the bolt.
26. **INSTALL KNOCK SENSORS** (See page [SF-55](#))
27. **INSTALL STARTER** (See page [ST-17](#))

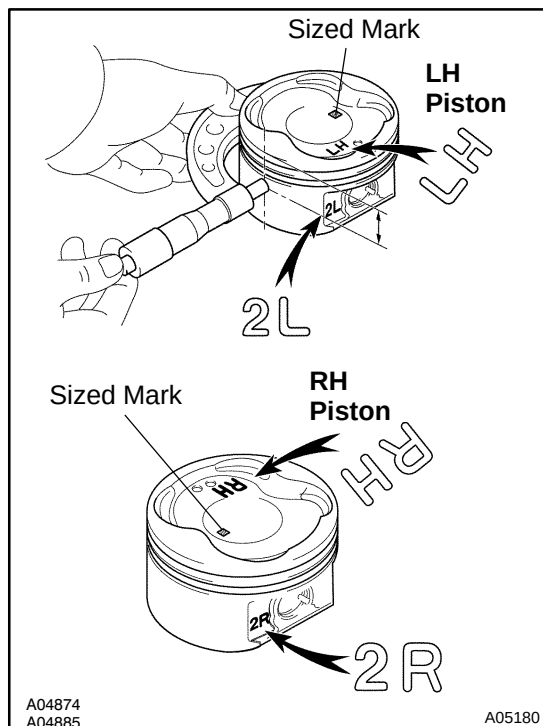


28. INSTALL WATER BYPASS PIPE

- (a) Install a new O-ring to the water bypass pipe.
- (b) Apply soapy water to the O-ring.
- (c) Push the water bypass pipe end into the pipe hole of the water pump.
- (d) Install the water bypass pipe with the bolt.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)
- (e) Install the wire clamp to the bracket of the water bypass pipe.

29. INSTALL CYLINDER HEADS (See page [EM-59](#))

30. INSTALL TIMING BELT AND PULLEYS
(See page [EM-22](#))
31. DISCONNECT ENGINE FROM ENGINE STAND



REPLACEMENT

1. REPLACE OVERSIZED (O/S) PISTONS FOR CYLINDER BORING

HINT:

- ★ Bore all the 8 cylinders to the oversized piston outside diameter.
 - ★ Replace all the piston rings with the ones to match the oversized pistons.
- (a) Keep 8 new O/S pistons.
O/S 0.50 piston diameter:
94.402 - 94.430 mm (3.7166 - 3.7177 in.)

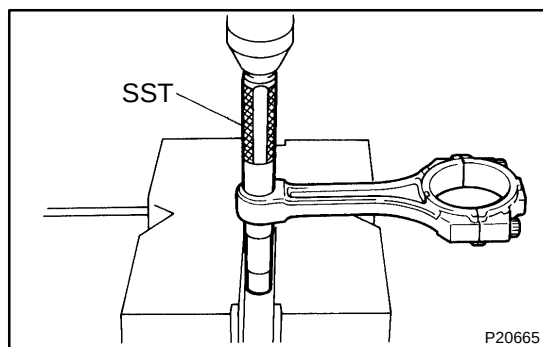
HINT:

The shape of the piston varies for the LH and RH banks. The LH piston is marked with "LH" and "2L", the RH piston with "RH" and "2R".

- (b) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 30.75 mm (1.2106 in.) from the piston head.
- (c) Calculate the amount for each cylinder to be rebored as follows:
Size to be rebored = P + C - H
P = Piston diameter
C = Piston clearance:
0.090 - 0.111 mm (0.0035 - 0.0044 in.)
H = Allowance for honing: 0.02 mm (0.0008 in.) or less
- (d) Bore and hone the cylinders to calculated dimensions.
Maximum honing: 0.02 mm (0.0008 in.)

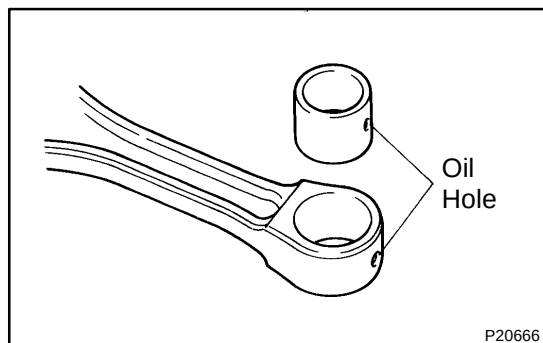
NOTICE:

Excess honing will destroy the finished roundness.

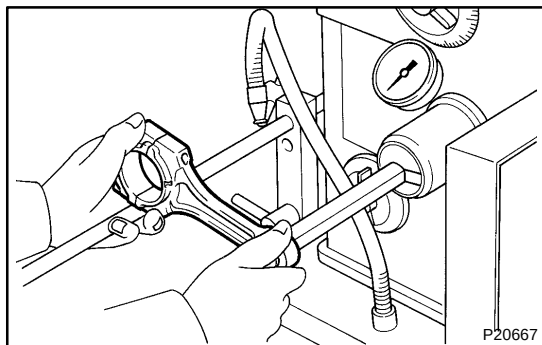


2. REPLACE CONNECTING ROD BUSHINGS

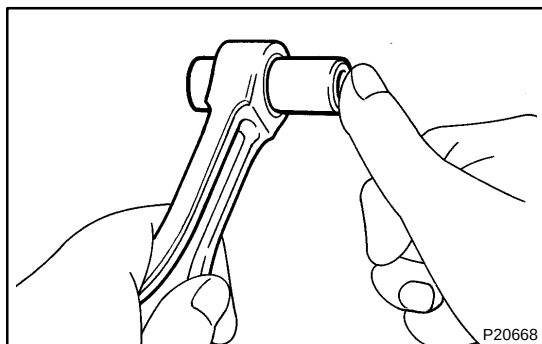
- (a) Using SST and a press, press out the bushing.
 SST 09222-30010



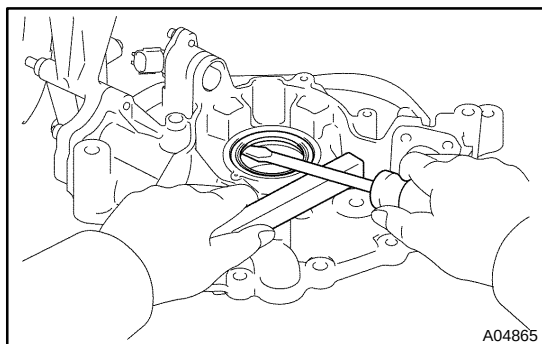
- (b) Align the oil holes of a new bushing and the connecting rod.
- (c) Using SST and a press, press in the bushing.
 SST 09222-30010



- (d) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page [EM-97](#)) between the bushing and piston pin.



- (e) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil, and push it into the connecting rod with your thumb.

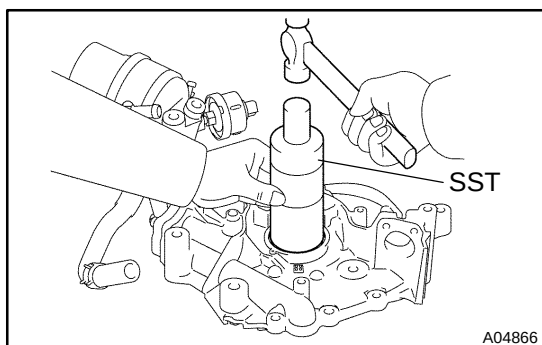


3. REPLACE CRANKSHAFT FRONT OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

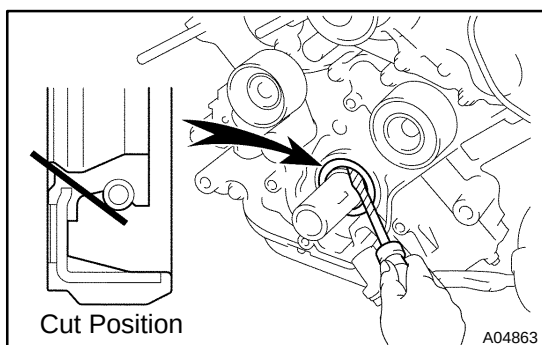
- (a) If the oil pump is removed from the cylinder block:
- (1) Using a screwdriver, pry out the oil seal.



- (2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the oil pump body edge.

SST 09316-6001 1 (09316-00011)

- (3) Apply MP grease to the oil seal lip.

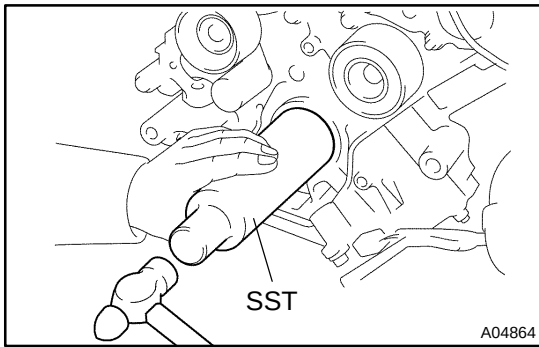


- (b) If the oil pump is installed to the cylinder block:

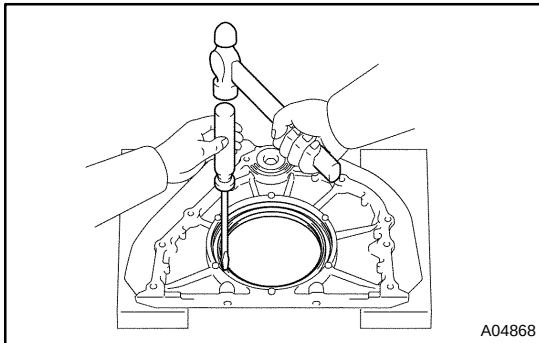
- (1) Using a knife, cut off the oil seal lip.
- (2) Using a screwdriver, pry out the oil seal.

NOTICE:

Be careful not to damage the crankshaft. Tape up the screwdriver tip.



- (3) Apply MP grease to a new oil seal lip.
 - (4) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil pump body edge.
- SST 09316-6001 1 (09316-00011)

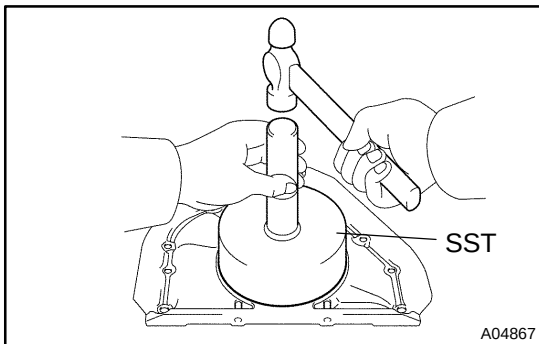


4. REPLACE CRANKSHAFT REAR OIL SEAL

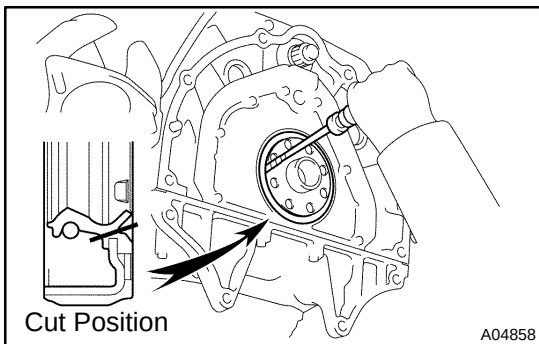
HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

- (a) If the rear oil seal retainer is removed from the cylinder block:
 - (1) Using a screwdriver and hammer, tap out the oil seal.



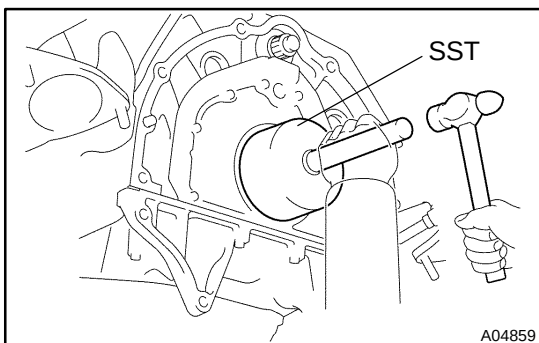
- (2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.
- SST 09223-56010
- (3) Apply MP grease to the oil seal lip.



- (b) If the rear oil seal retainer is installed to the cylinder block:
 - (1) Using a knife, cut off the oil seal lip.
 - (2) Using a screwdriver, pry out the oil seal.

NOTICE:

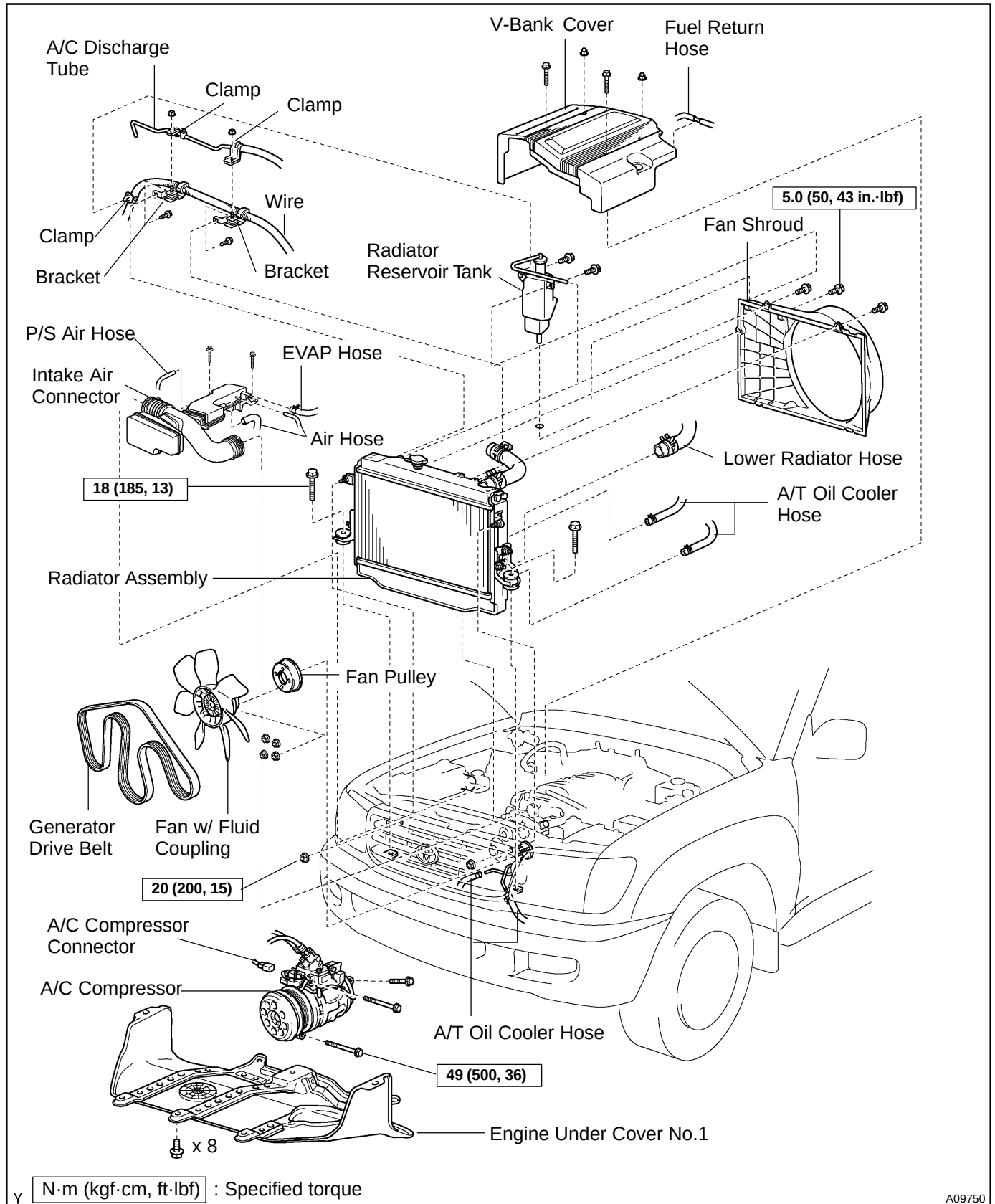
Be careful not to damage the crankshaft. Tape up the screwdriver tip.



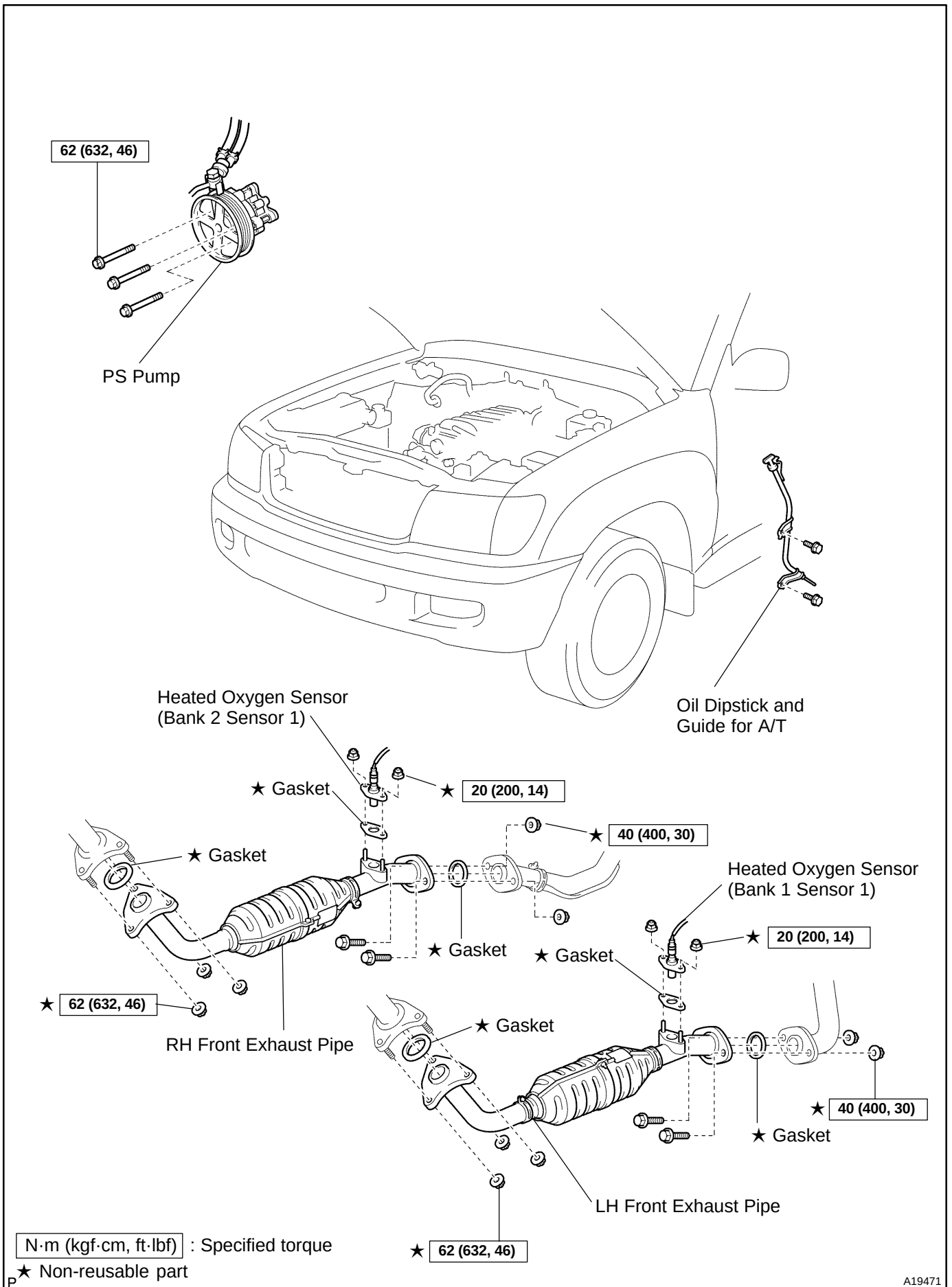
- (3) Apply MP grease to a new oil seal lip.
 - (4) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
- SST 09223-56010

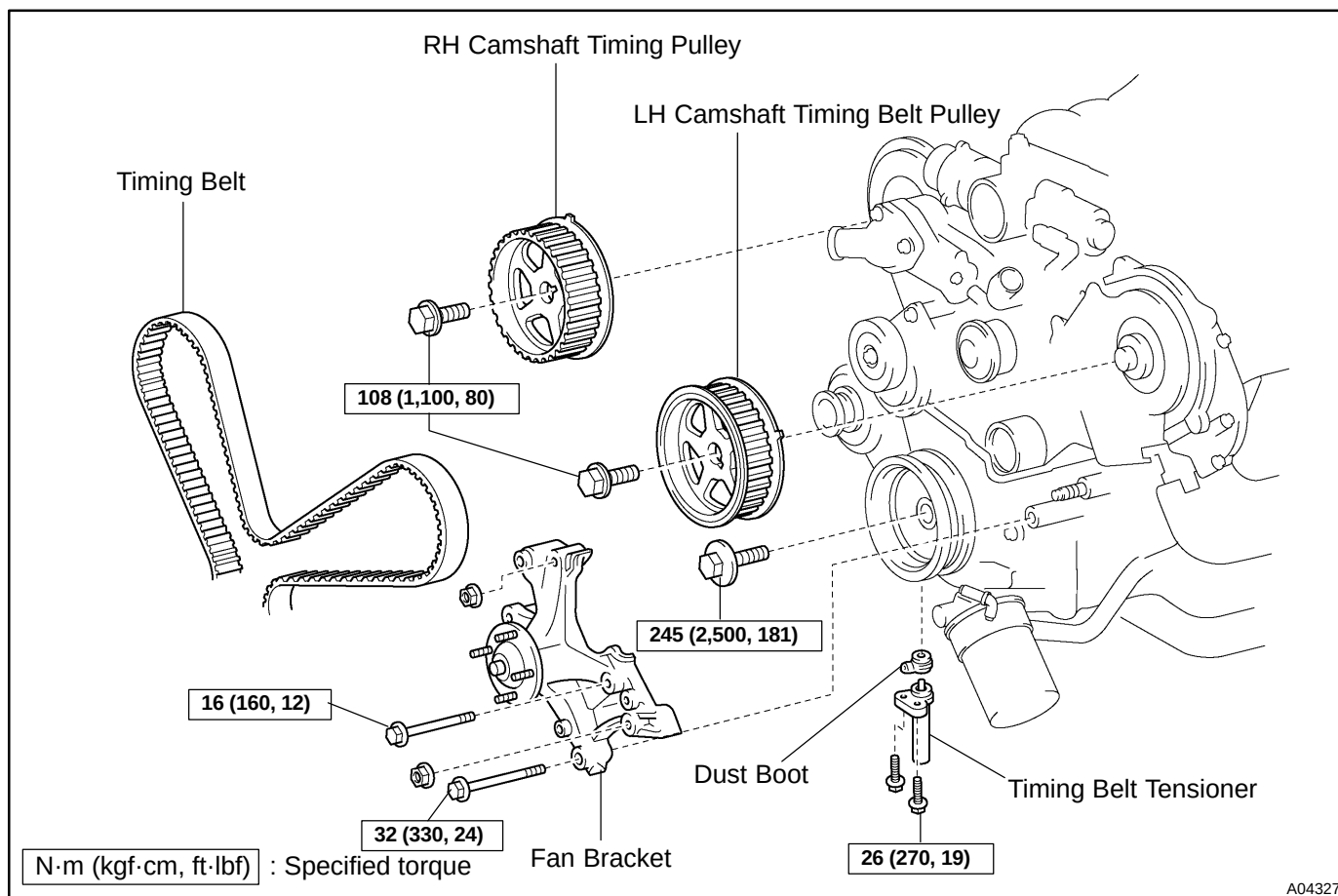
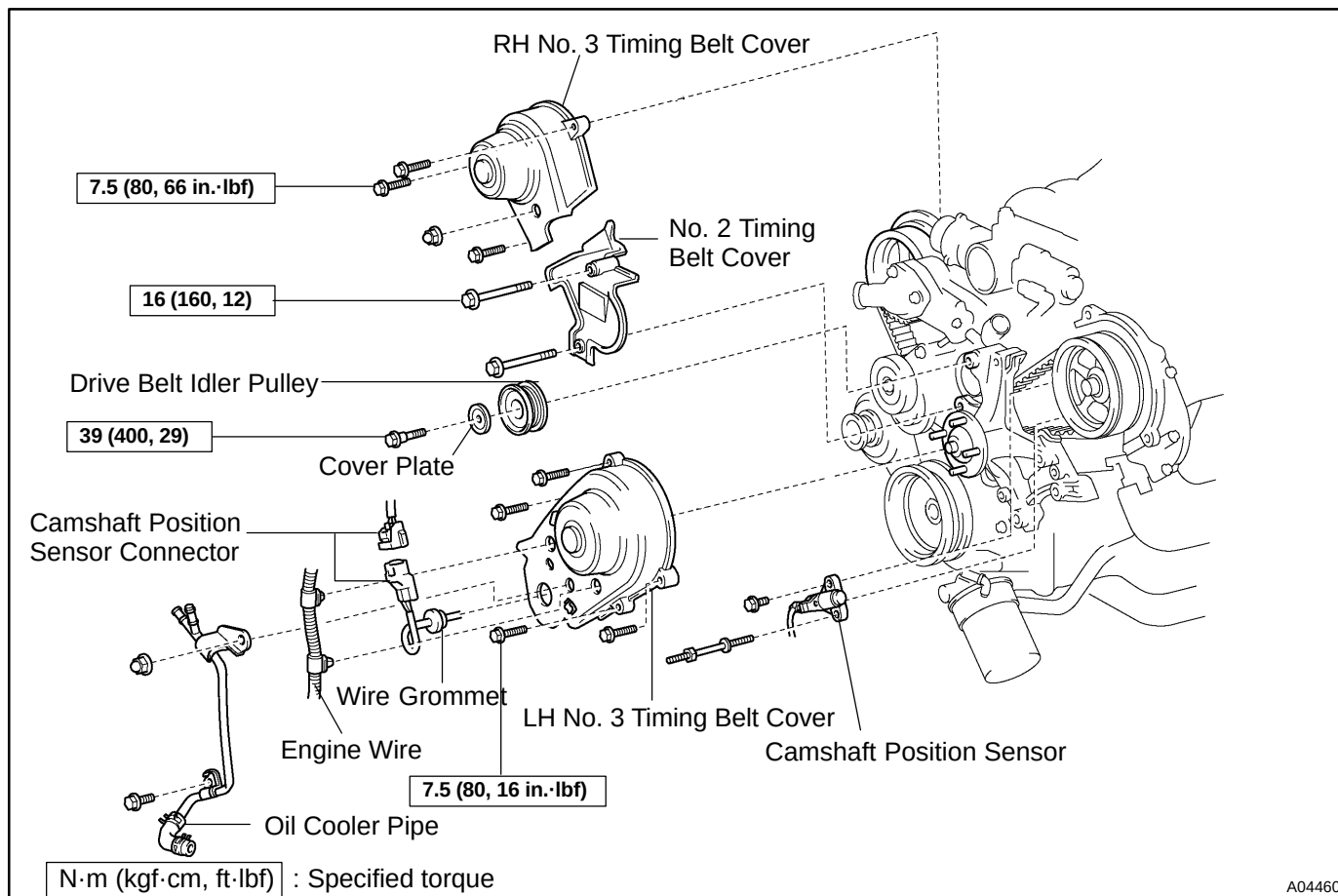
CYLINDER HEAD COMPONENTS

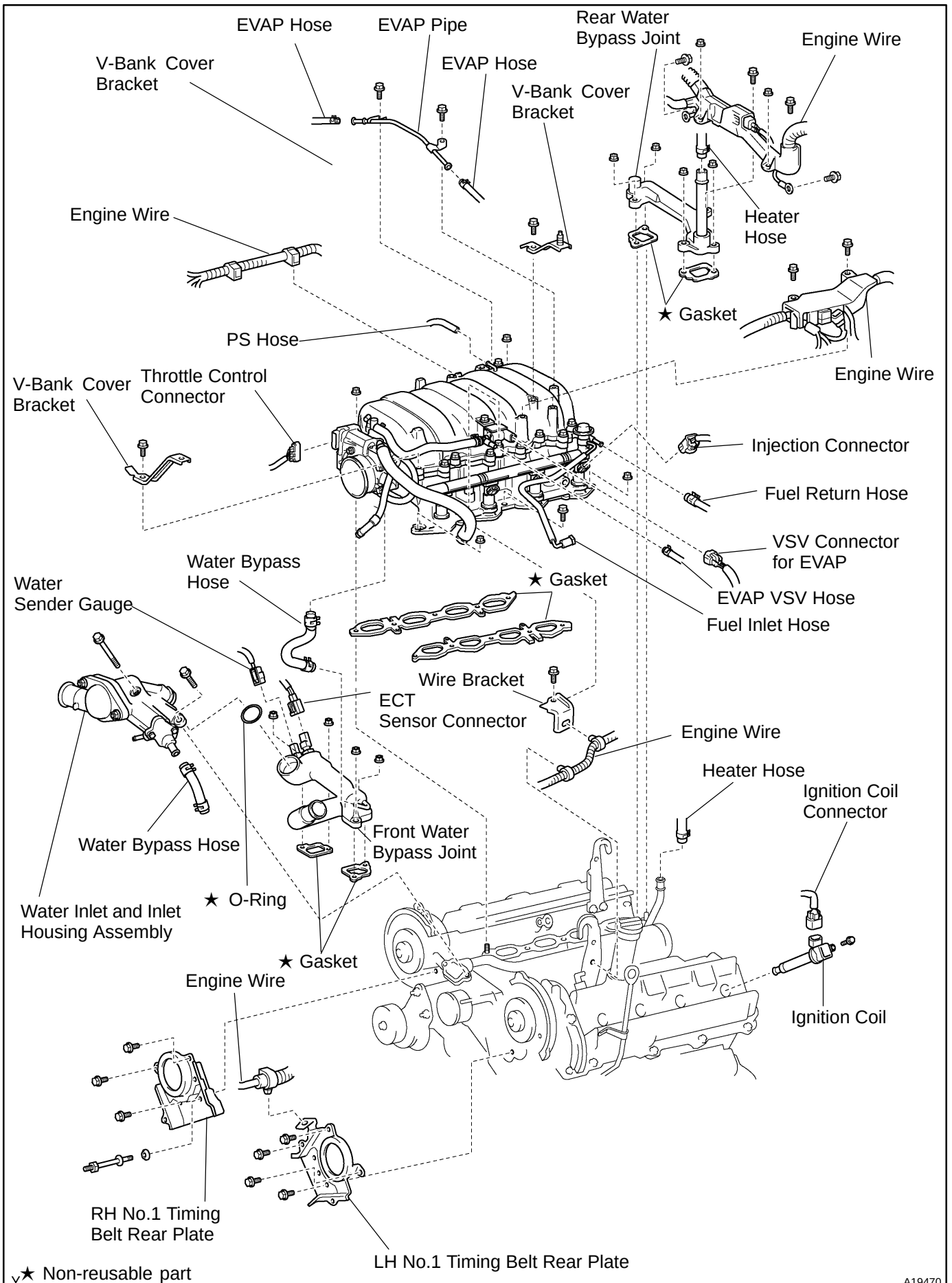
EM1V7-01



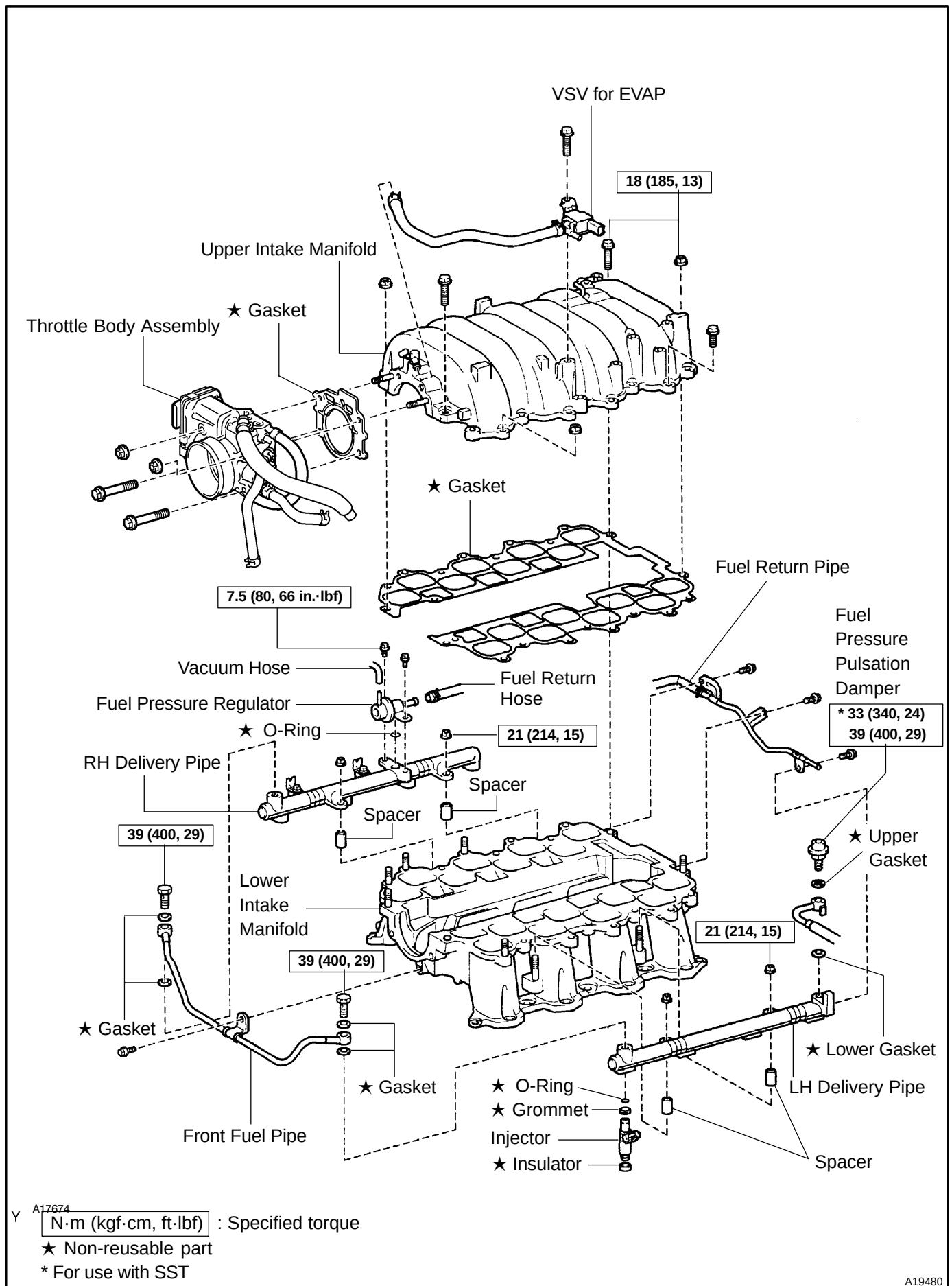
A09750

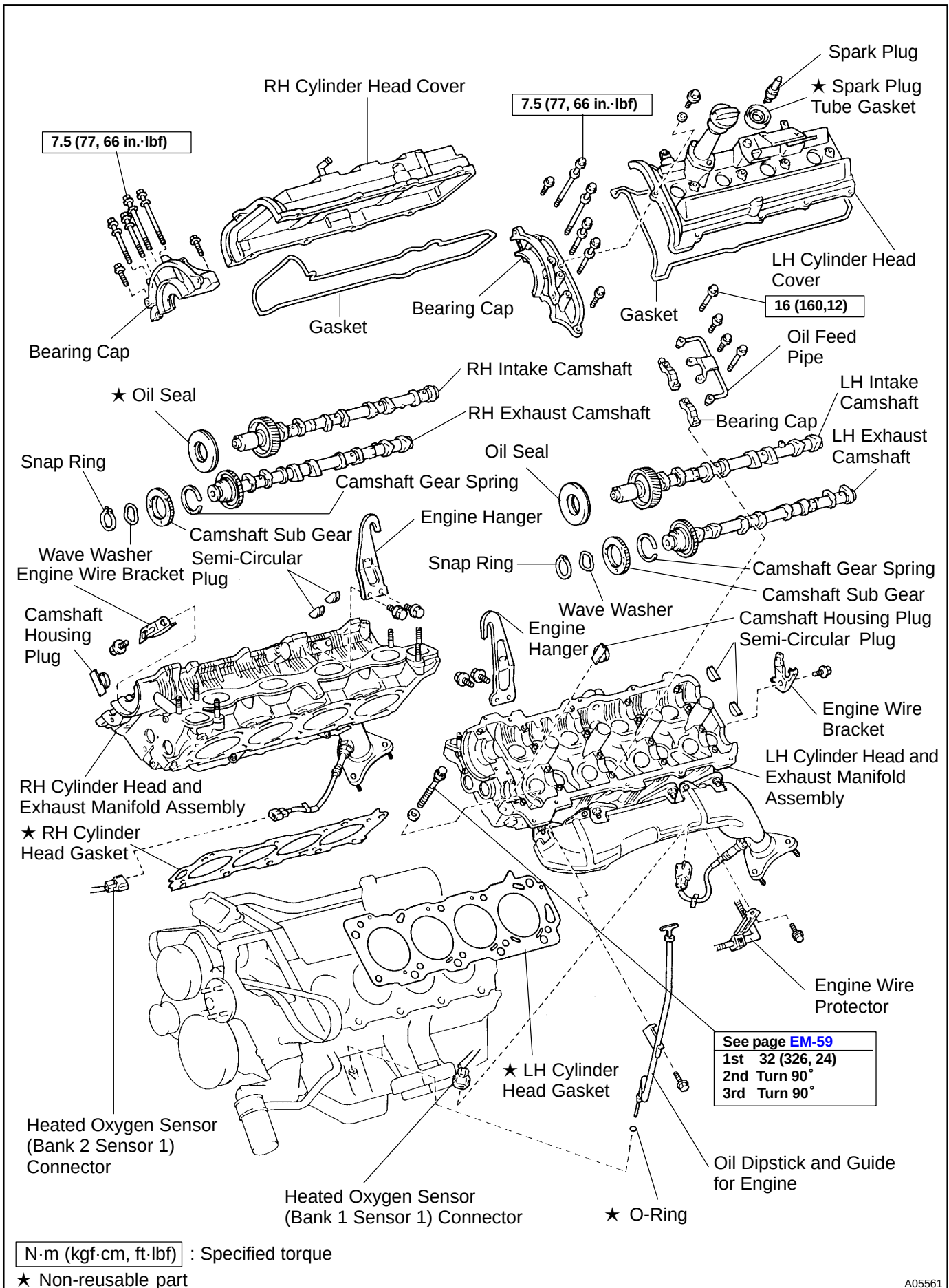




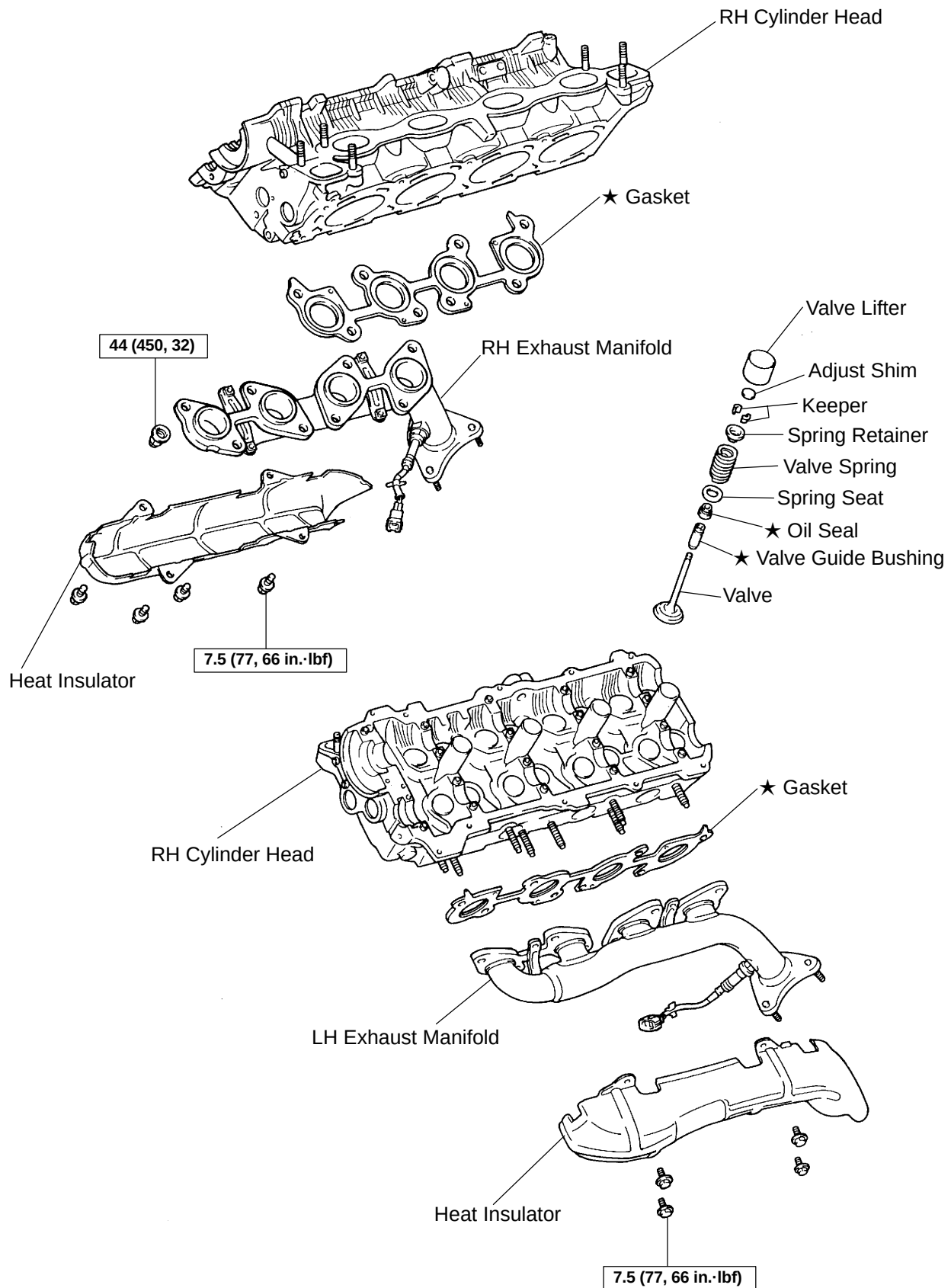


A19470





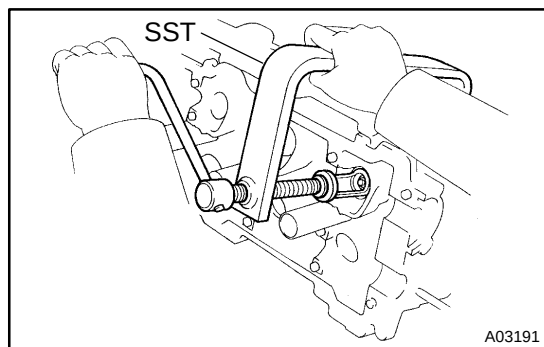
A05561



N·m (kgf·cm, ft·lbf) : Specified torque

★ Non-reusable part

A05527



DISASSEMBLY

1. REMOVE VALVE LIFTERS AND SHIMS

HINT:

Arrange the valve lifters and the shims in correct order.

2. REMOVE VALVES

- (a) Using SST, compress the valve spring and remove the 2 keepers.

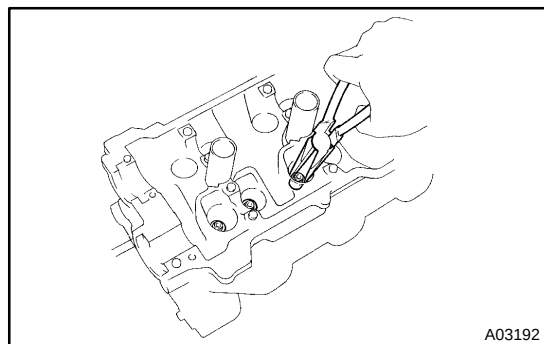
SST 09202-70020

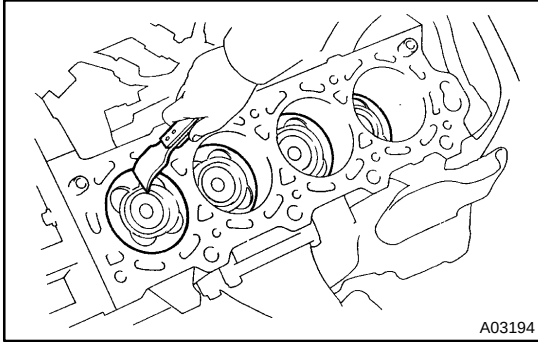
- (b) Remove the spring retainer.
(c) Remove the valve spring.
(d) Remove the valve.
(e) Remove the spring seat.

HINT:

Arrange the valves, the valve springs, the spring seats and the spring retainers in correct order.

- (f) Using needle-nose pliers, remove the oil seal.

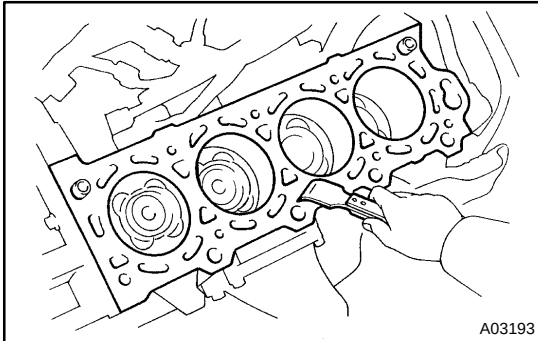




INSPECTION

1. CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK

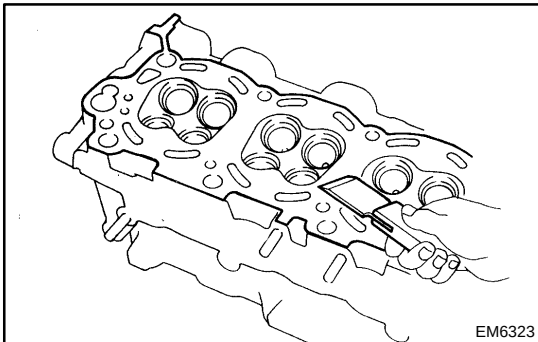
- (a) Turn the crankshaft, and bring each piston to top dead center (TDC). Using a gasket scraper, remove all the carbon from the piston top surface.



- (b) Using a gasket scraper, remove all the gasket material from the cylinder block surface.
- (c) Using compressed air, blow carbon and oil from the bolt holes.

CAUTION:

Protect your eyes when using high pressure compressed air.

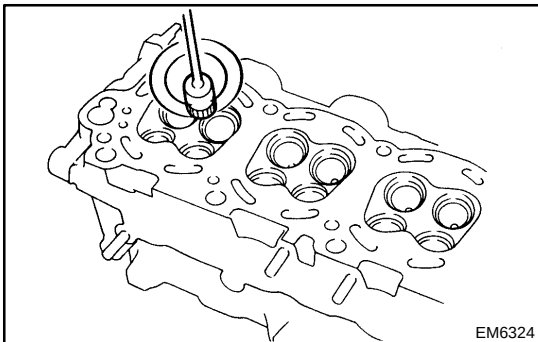


2. REMOVE GASKET MATERIAL

Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.

NOTICE:

Be careful not to scratch the cylinder block contact surface.

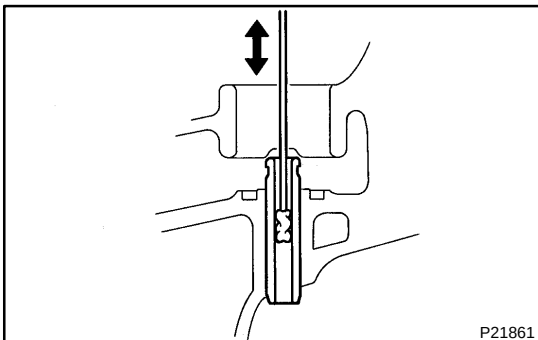


3. CLEAN COMBUSTION CHAMBERS

Using a wire brush, remove all the carbon from the combustion chambers.

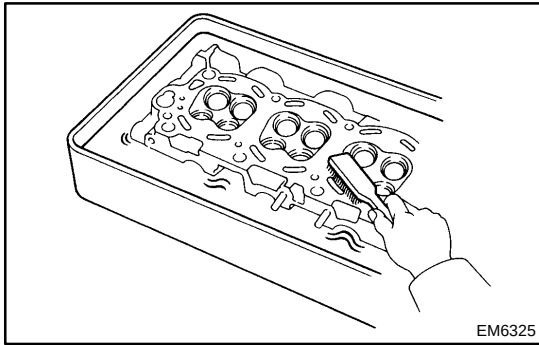
NOTICE:

Be careful not to scratch the cylinder block contact surface.



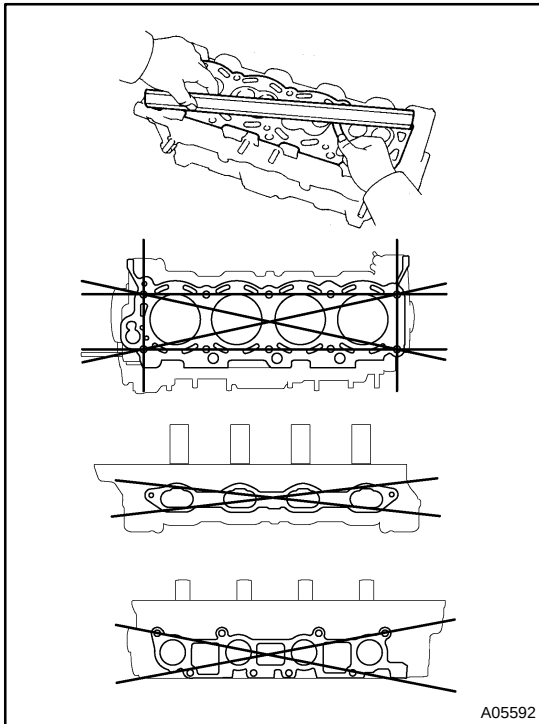
4. CLEAN VALVE GUIDE BUSHINGS

Using a valve guide bushing brush and solvent, clean all the guide bushings.



5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, thoroughly clean the cylinder head.



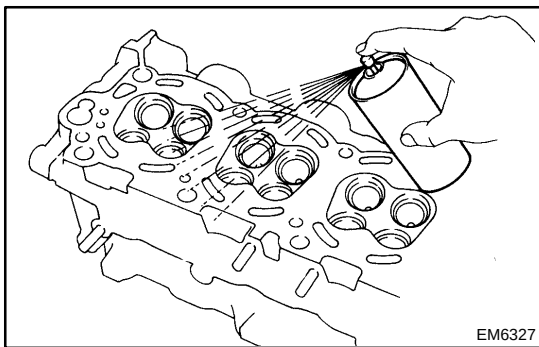
6. INSPECT FOR FLATNESS

Using a precision straight edge and a feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for a warp.

Maximum warpage:

0.10 mm (0.0039 in.)

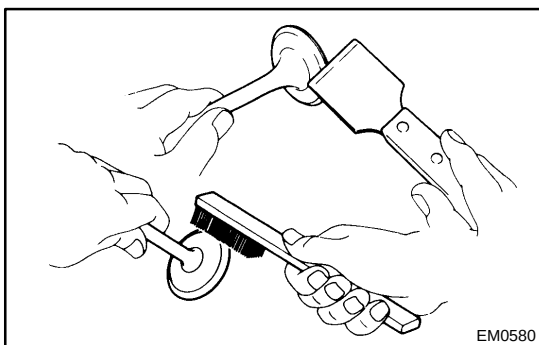
If the warp is greater than maximum, replace the cylinder head.



7. INSPECT FOR CRACKS

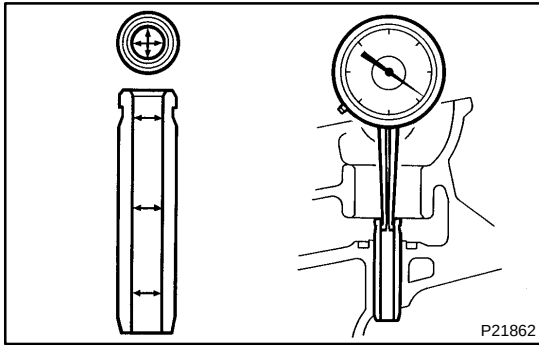
Using a dye penetrate, check the combustion chamber, the intake ports, the exhaust ports and the cylinder head surface for cracks.

If there is a crack, replace the cylinder head.



8. CLEAN VALVES

- (a) Using a gasket scraper, chip off any carbon from the valve head.
- (b) Using a wire brush, thoroughly clean the valve.

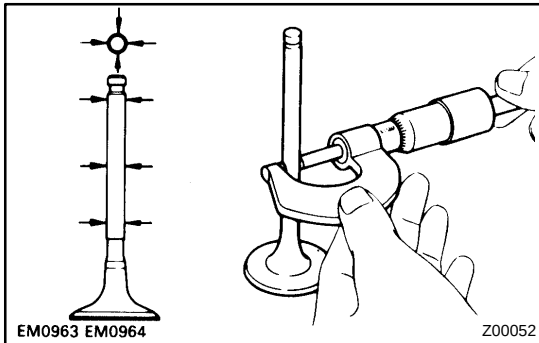


9. INSPECT VALVE STEMS AND GUIDE BUSHINGS

- (a) Using a caliper gauge, measure the inside diameter of the guide bushing.

Bushing inside diameter:

5.510 - 5.530 mm (0.2169 - 0.2177 in.)



- (b) Using a micrometer, measure the diameter of the valve stem.

Valve stem diameter:

Intake

5.470 - 5.485 mm (0.2154 - 0.2159 in.)

Exhaust

5.465 - 5.480 mm (0.2152 - 0.2157 in.)

- (c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.

Standard oil clearance:

Intake

0.025 - 0.060 mm (0.0010 - 0.0024 in.)

Exhaust

0.030 - 0.065 mm (0.0012 - 0.0026 in.)

Maximum oil clearance:

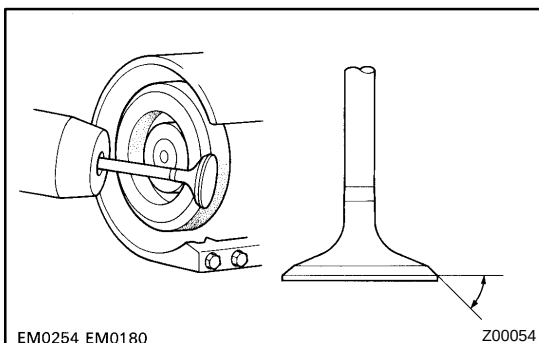
Intake

0.08 mm (0.0031 in.)

Exhaust

0.10 mm (0.0039 in.)

If the clearance is greater than the maximum, replace the valve and the guide bushing. (See Page [EM-55](#))

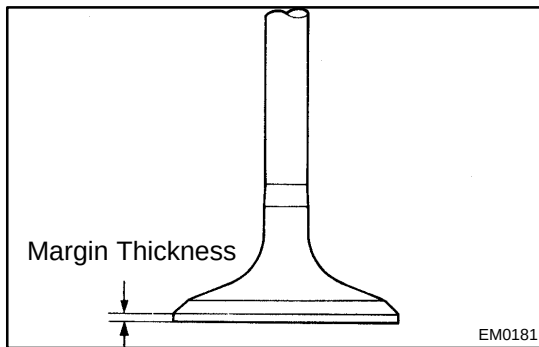


10. INSPECT AND GRIND VALVES

- (a) Grind the valve enough to remove pits and carbon.
(b) Check that the valve is ground to the correct valve face angle.

Valve face angle:

44.5°



- (c) Check the valve head margin thickness.

Standard margin thickness:

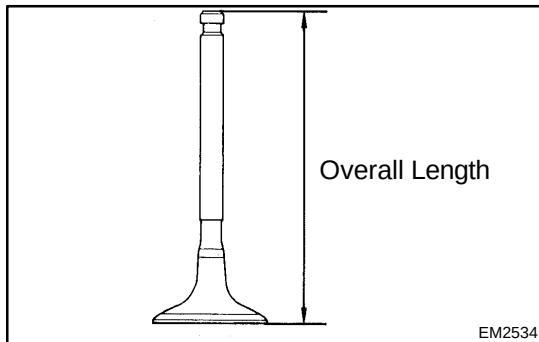
IN 1.25 mm (0.049 in.)

EX 1.40 mm (0.055 in.)

Minimum margin thickness:

0.5 mm (0.020 in.)

If the margin thickness is less than the minimum, replace the valve.



- (d) Check the valve overall length.

Standard overall length:

Intake: 95.05 mm (3.7421 in.)

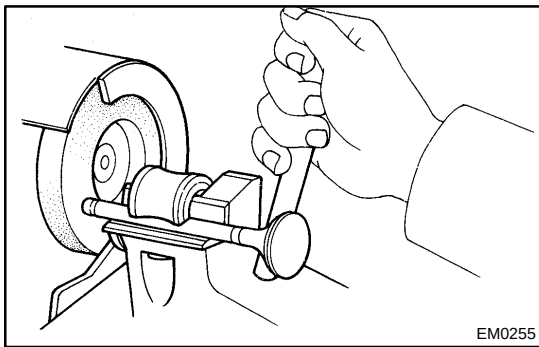
Exhaust: 95.10 mm (3.7441 in.)

Minimum overall length:

Intake: 94.55 mm (3.7224 in.)

Exhaust: 94.60 mm (3.7244 in.)

If the overall length is less than the minimum, replace the valve.

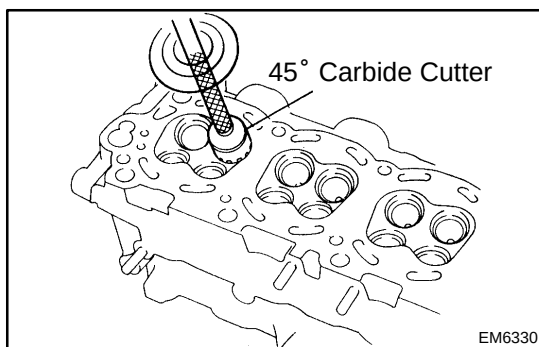


- (e) Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

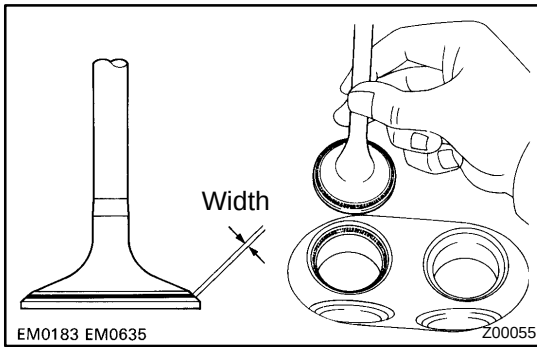
NOTICE:

Do not grind off to below the minimum.



11. INSPECT AND CLEAN VALVE SEATS

- (a) Using a 45° carbide cutter, resurface the valve seats. Remove just enough metal to clean the seats.



- (b) Check the valve seating position.
Apply a light coat of prussian blue (or white lead) to the valve face. Lightly press the valve against the seat. Do not rotate valve.

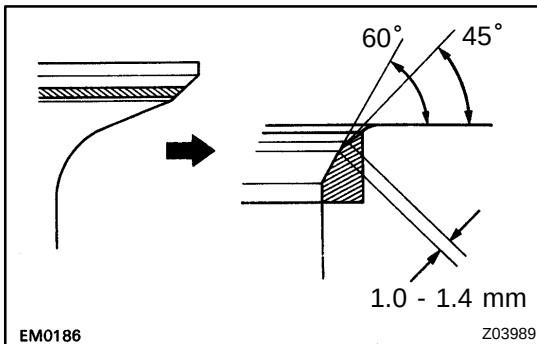
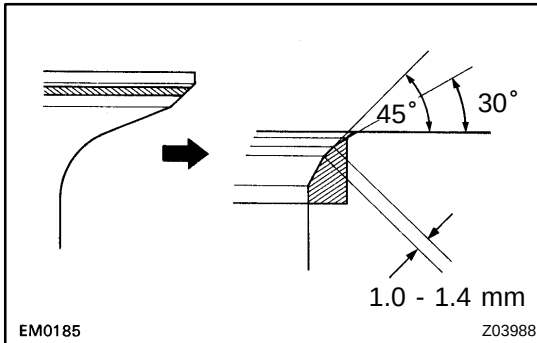
- (c) Check the valve face and seat for the following:

- ★ If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- ★ If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- ★ Check that the seat contact is in the middle of the valve face with the following width:

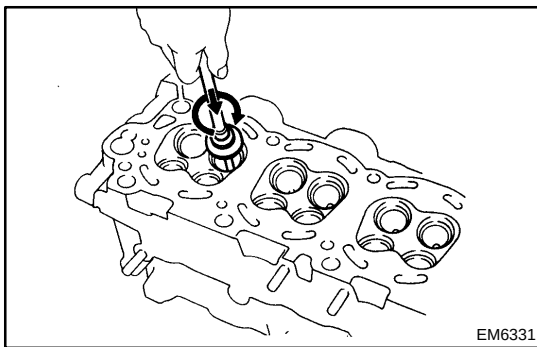
1.0 - 1.4 mm (0.039 - 0.055 in.)

If not, correct the valve seats as follows:

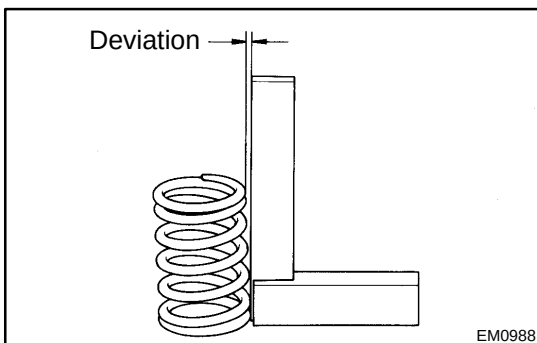
- ★ If the seating is too high on the valve face, use 30° and 45° cutters to correct the seat.



- ★ If the seating is too low on the valve face, use 60° and 45° cutters to correct the seat.



- (d) Hand-lap the valve and valve seat with an abrasive compound.
(e) After hand-lapping, clean the valve and valve seat.



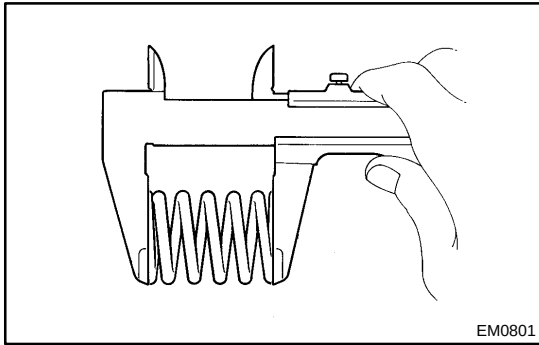
12. INSPECT VALVE SPRINGS

- (a) Using a steel square, measure the deviation of the valve spring.

Maximum deviation:

2.0 mm (0.079 in.)

If the deviation is greater than the maximum, replace the valve spring.

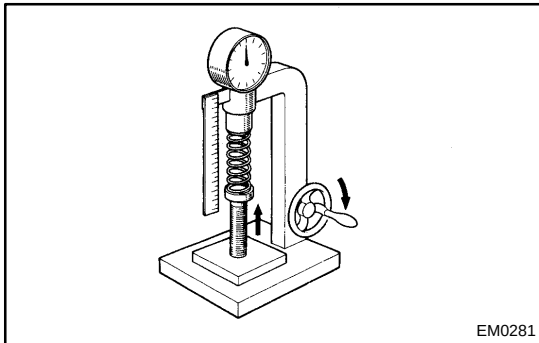


- (b) Using vernier calipers, measure the free length of the valve spring.

Free length:

54.1 mm (2.130 in.)

If the free length is not as specified, replace the valve spring.



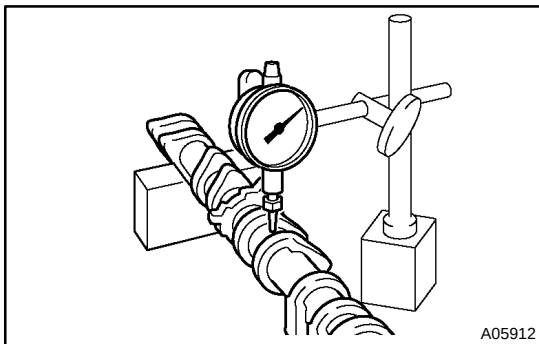
- (c) Using a spring tester, measure the tension of the valve spring at the installed length.

Installed tension:

204 - 226 N (20.8 - 23.0 kgf, 45.9 - 50.7 lbf)

at 35.0 mm (1.378 in.)

If the installed tension is not as specified, replace the valve spring.



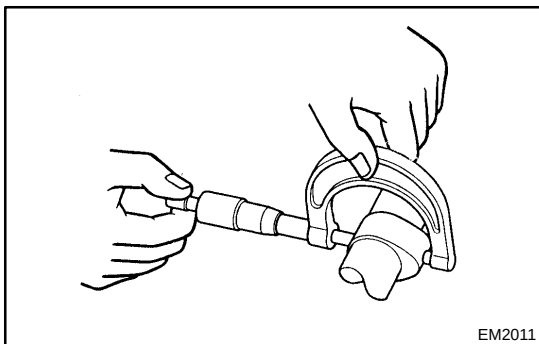
13. INSPECT CAMSHAFT FOR RUNOUT

- (a) Place the camshaft on V-blocks.
(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:

0.08 mm (0.0031 in.)

If the circle runout is greater than the maximum, replace the camshaft.



14. INSPECT CAM LOBES

Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake:

41.94 - 42.04 mm (1.6512 - 1.6551 in.)

Exhaust:

41.96 - 42.06 mm (1.6520 - 1.6559 in.)

Minimum cam lobe height:

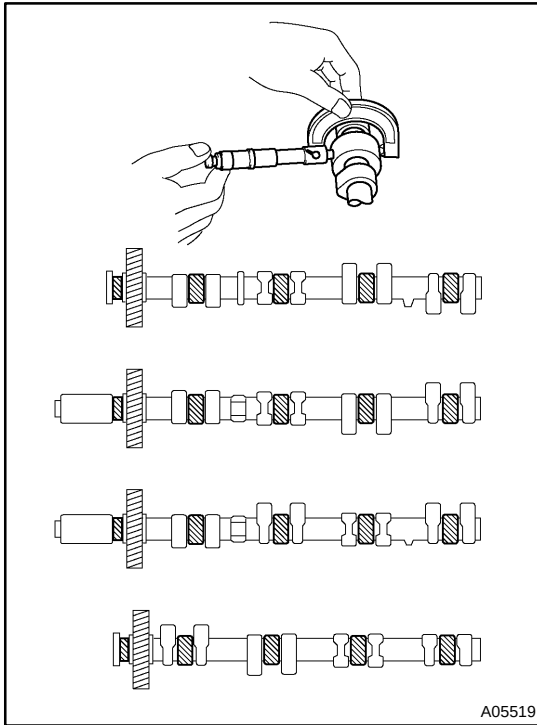
Intake:

41.79 mm (1.6453 in.)

Exhaust:

41.81 mm (1.6461 in.)

If the cam lobe height is less than the minimum, replace the camshaft.



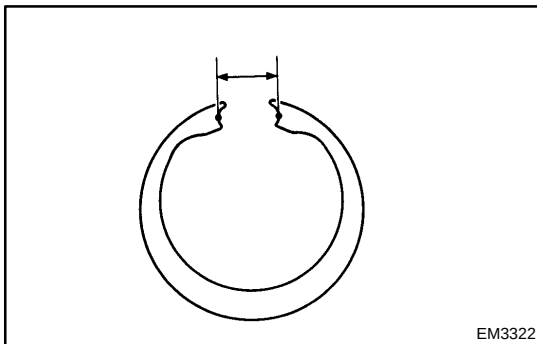
15. INSPECT CAMSHAFT JOURNALS

Using a micrometer, measure the journal diameter.

Journal diameter:

26.954 - 26.970 mm (1.0612 - 1.0618 in.)

If the journal diameter is not as specified, check the oil clearance.



16. INSPECT CAMSHAFT GEAR SPRING

Using vernier calipers, measure the free distance between the spring ends.

Free distance:

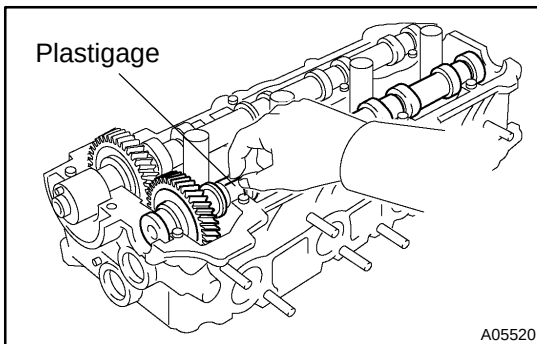
18.2 - 18.8 mm (0.712 - 0.740 in.)

If the free distance is not as specified, replace the gear spring.

17. INSPECT CAMSHAFT BEARINGS

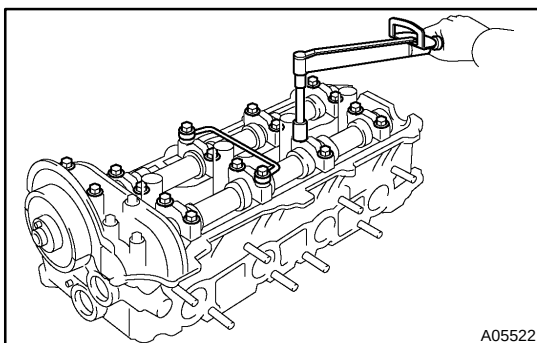
Check that bearings for flaking and scoring.

If the bearings are damaged, replace the bearing caps and cylinder head as a set.



18. INSPECT CAMSHAFT JOURNAL OIL CLEARANCE

- Clean the bearing caps and the camshaft journals.
- Place the camshafts on the cylinder head.
- Lay a strip of plastigage across each of the camshaft journals.



- Install the bearing caps.

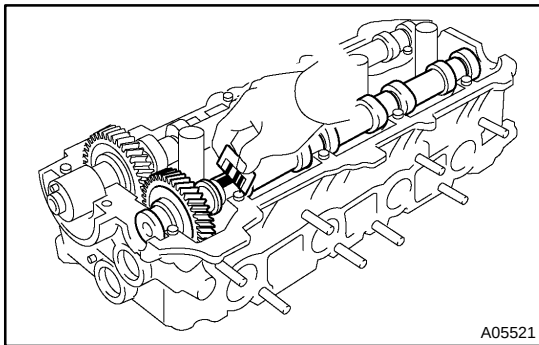
(See page [EM-59](#))

Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

NOTICE:

Do not turn the camshaft.

- Remove the bearing caps.



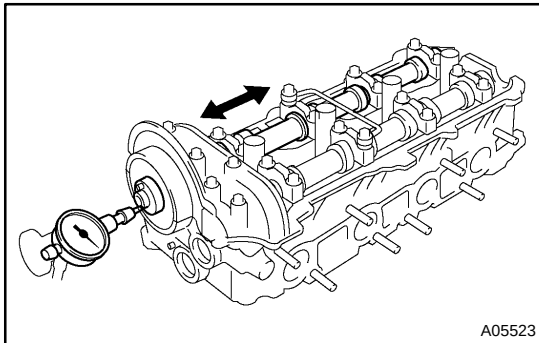
- (f) Measure the Plastigage at its widest point.

Maximum oil clearance:

0.10 mm (0.0039 in.)

If the oil clearance is greater than the maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

- (g) Completely remove the plastigage.
(h) Remove the camshafts.



19. INSPECT CAMSHAFT THRUST CLEARANCE

- (a) Install the camshaft.

(See page [EM-59](#))

- (b) Using a dial indicator, measure the thrust clearance as moving the camshaft back and forth.

Standard thrust clearance:

Intake

0.040 - 0.090 mm (0.0016 - 0.0035 in.)

Exhaust

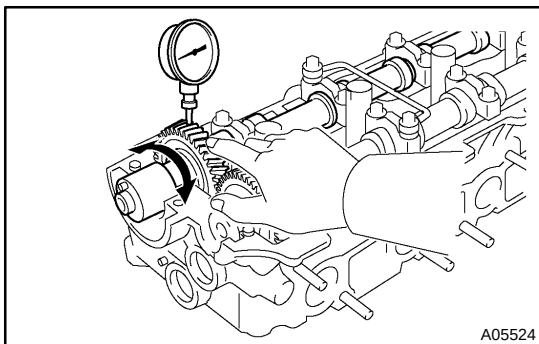
0.040 - 0.085 mm (0.0016 - 0.0033 in.)

Maximum thrust clearance:

0.12 mm (0.0047 in.)

If the thrust clearance is greater than the maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

- (c) Remove the camshafts.



20. INSPECT CAMSHAFT GEAR BACKLASH

- (a) Install the camshafts without installing the exhaust cam sub-gear and the front bearing cap.

(See page [EM-59](#))

- (b) Using a dial indicator, measure the backlash.

Standard backlash:

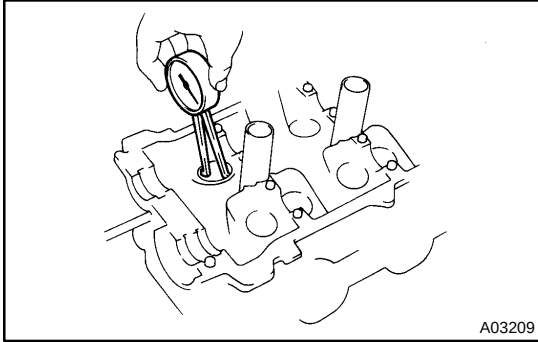
0.020 - 0.200 mm (0.0008 - 0.0079 in.)

Maximum backlash:

0.30 mm (0.0188 in.)

If the backlash is greater than the maximum, replace the camshafts.

- (c) Remove the camshafts.

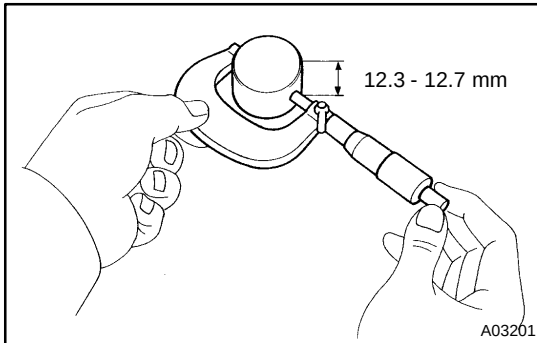


21. INSPECT VALVE LIFTERS AND LIFTER BORES

- (a) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

Lifter bore diameter:

31.000 - 31.016 mm (1.2205 - 1.2211 in.)



- (b) Using a micrometer, measure the lifter diameter at the valve lifter center line, 12.3 - 12.7 mm (0.484 - 0.500 in.) from the valve lifter head.

Lifter diameter:

30.966 - 30.976 mm (1.2191 - 1.2195 in.)

- (c) Subtract the lifter diameter from the lifter bore diameter.

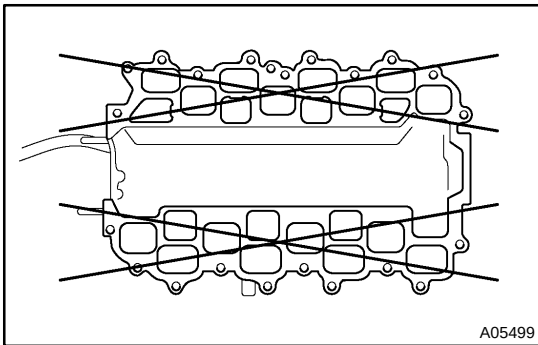
Standard oil clearance:

0.024 - 0.050 mm (0.0009 - 0.0020 in.)

Maximum oil clearance:

0.07 mm (0.0028 in.)

If the oil clearance is greater than the maximum, replace the lifter. If necessary, replace the cylinder head.



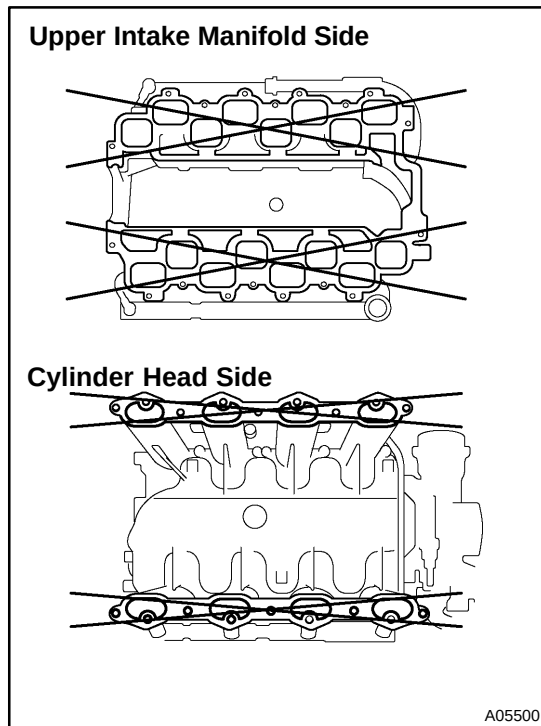
22. INSPECT INTAKE MANIFOLD

- (a) Upper intake manifold:

Using a precision straight edge and a feeler gauge, measure the surface contacting of the lower intake manifold for a warp.

Maximum warp: 0.15 mm (0.0059 in.)

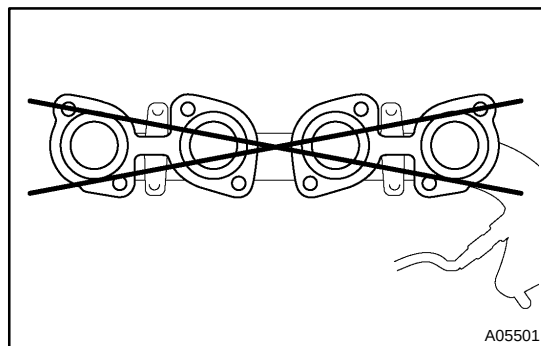
If the warp is greater than the maximum, replace the upper intake manifold.



- (b) Lower intake manifold:
Using a precision straight edge and a feeler gauge, measure the surface contacting of the cylinder head and the upper intake manifold for a warpage.

Maximum warpage:
0.15 mm (0.0059 in.)

If the warp is greater than the maximum, replace the lower intake manifold.

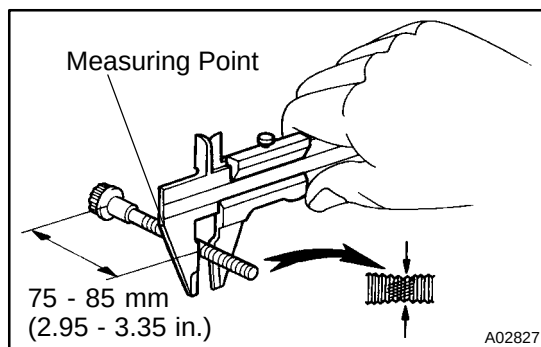


23. INSPECT EXHAUST MANIFOLD

Using a precision straight edge and a feeler gauge, measure the surface contacting of the cylinder head for a warp.

Maximum warpage:
0.50 mm (0.0197 in.)

If the warp is greater than the maximum, replace the manifold.



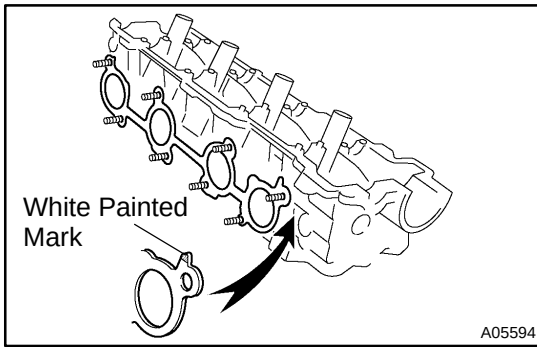
24. INSPECT CYLINDER HEAD BOLTS

Using vernier calipers, measure the thread outside diameter of the bolt.

Standard outside diameter:
9.810 - 9.960 mm (0.3862 - 0.3921 in.)

Minimum outside diameter:
9.700 mm (0.3819 in.)

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



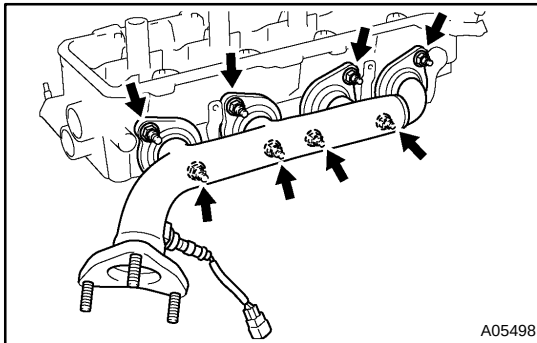
INSTALLATION

1. INSTALL RH EXHAUST MANIFOLD TO CYLINDER HEAD

- (a) Place a new gasket on the cylinder head with the white painted marks facing the manifold side.

NOTICE:

Be careful of the installation direction.

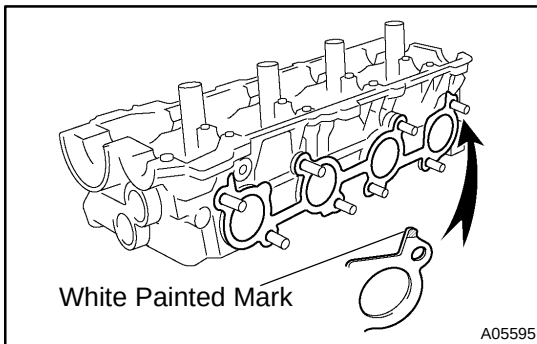


- (b) Install the exhaust manifold with 8 new nuts. Evenly tighten the nuts a little at a time for several times.

Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)

- (c) Install the heat insulator with the 4 bolts.

Torque: 7.5 N·m (77 kgf·cm, 66 in·lbf)

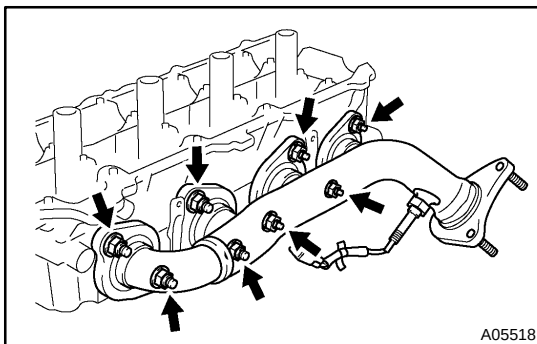


2. INSTALL LH EXHAUST MANIFOLD TO CYLINDER HEAD

- (a) Place a new gasket on the cylinder head with the white painted marks facing the manifold side.

NOTICE:

Be careful of the installation direction.

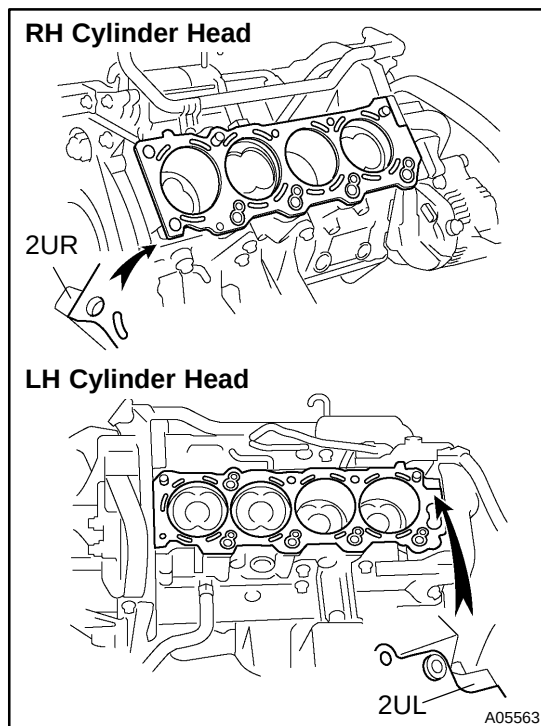


- (b) Install the exhaust manifold with 8 new nuts. Evenly tighten the nuts a little at a time for several times.

Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)

- (c) Install the heat insulator with the 4 bolts.

Torque: 7.5 N·m (77 kgf·cm, 66 in·lbf)



3. PLACE CYLINDER HEAD ON CYLINDER BLOCK

- (a) Place 2 new cylinder head gaskets in position on the cylinder block.

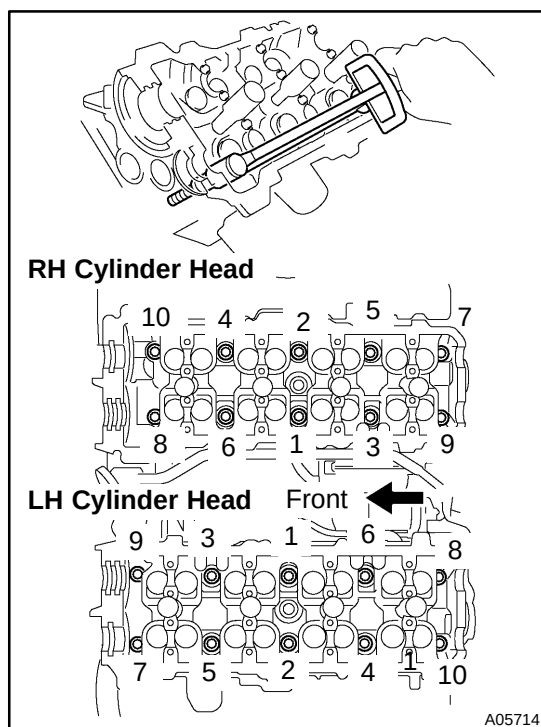
HINT:

On the rear side of the cylinder head gasket, there is a mark to distinguish the LH and RH banks, a "2UR" for the RH bank and a "2UL" for the LH bank.

NOTICE:

Be careful of the installation direction.

- (b) Place the 2 cylinder heads in position on the cylinder head gaskets.



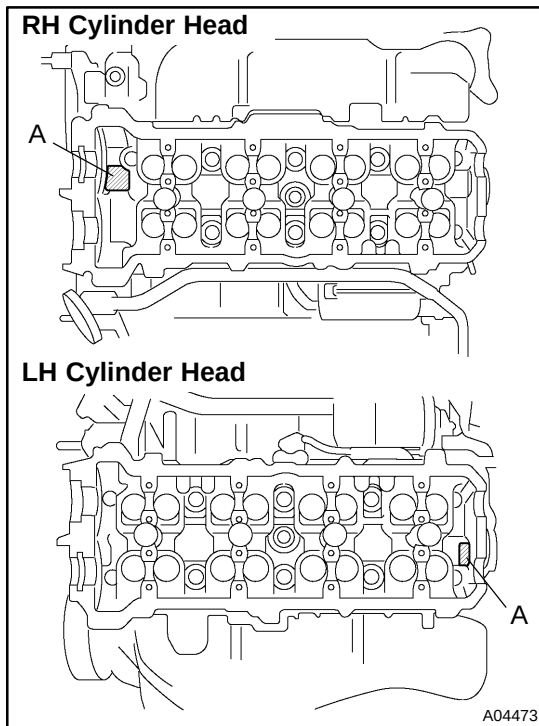
4. INSTALL CYLINDER HEAD BOLTS

HINT:

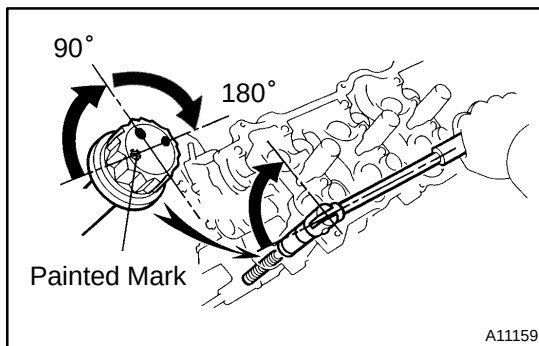
- ★ The cylinder head bolts are tightened in 2 progressive steps (steps (c) and (e)).
 - ★ If any cylinder head bolt is broken or deformed, replace it.
- (a) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.
- (b) Install the plate washer to the cylinder head bolt.
- (c) Install and evenly tighten the 10 cylinder head bolts on one side of the cylinder head a little at a time for several times as in the order shown, then do the other side as shown.

Torque: 32 N·m (325 kgf·cm, 24 ft·lbf)

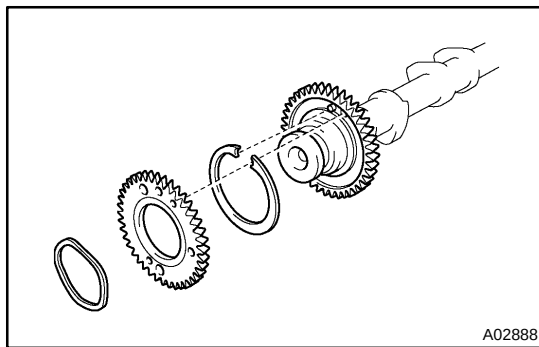
If any one of the cylinder head bolts does not meet the torque specification, replace the cylinder head bolt.

**NOTICE:**

Do not drop the plate washer of the cylinder head bolt into A area in the illustration. It will fall down to the oil pan through the cylinder head and the cylinder block.



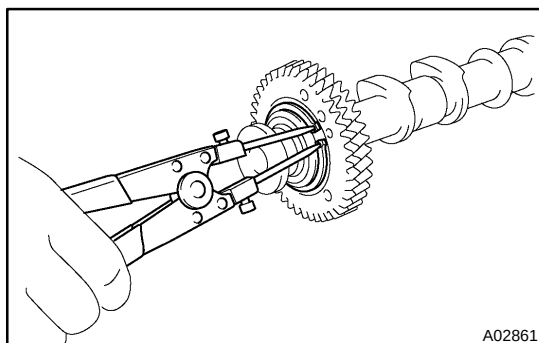
- (d) Mark the front of the cylinder head bolt head with paint.
- (e) Retighten the cylinder head bolts by 90° only for the first time.
- (f) Then retighten them by 90° further for the second time.
- (g) Check that the painted mark is now at a 180° angle to the front.

5. INSTALL SPARK PLUGS**6. ASSEMBLE EXHAUST CAMSHAFT**

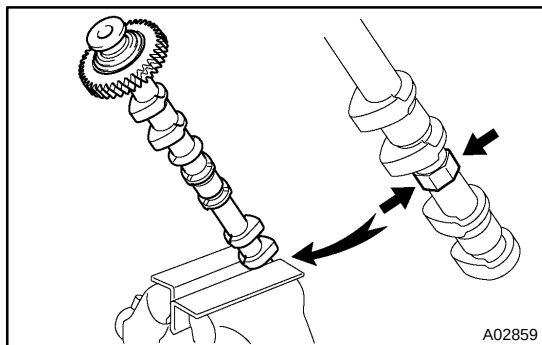
- (a) Install the camshaft gear spring, the camshaft sub-gear and the wave washer.

HINT:

Attach the pins on the gears to the gear spring ends.



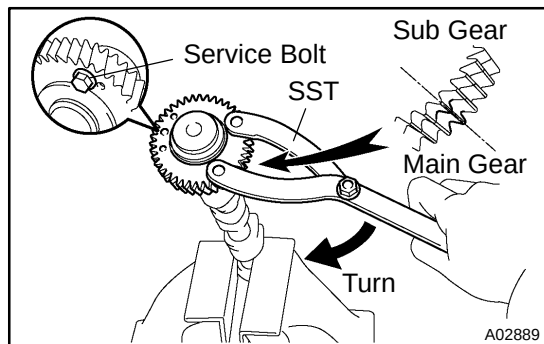
- (b) Using snap ring pliers, install the snap ring.



(c) Mount the hexagon shaped part of the camshaft in a vise.

NOTICE:

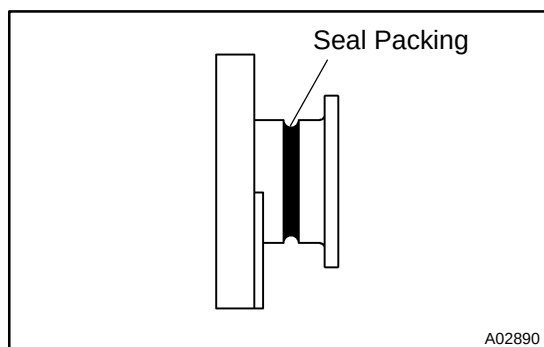
Be careful not to damage the camshaft.



(d) Using SST, align the holes of the camshaft main gear and sub-gear by turning camshaft sub-gear counterclockwise, and temporarily install a service bolt.

SST 09960-10010 (09962-01000, 09963-00500)

(e) Align the gear teeth of the main gear and sub-gear, and tighten the service bolt.



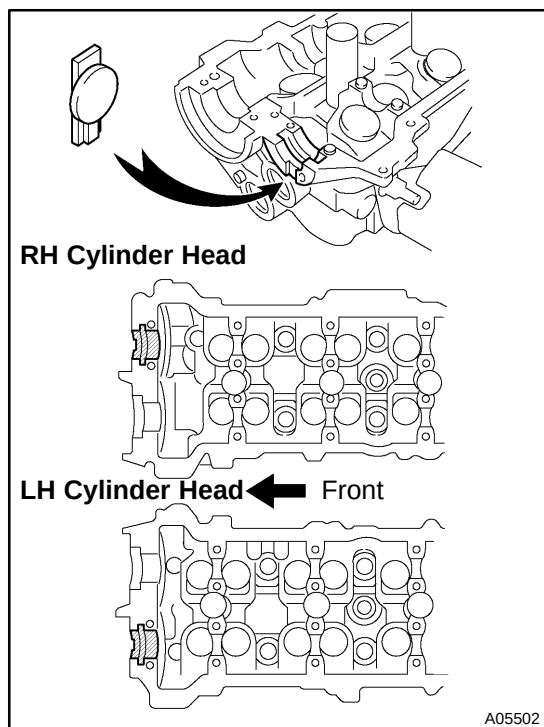
7. INSTALL CAMSHAFT HOUSING PLUGS

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the camshaft housing plug grooves.

Seal packing:

Part No. 08826-00080 or equivalent



(c) Install the 2 camshaft housing plugs to the cylinder heads.

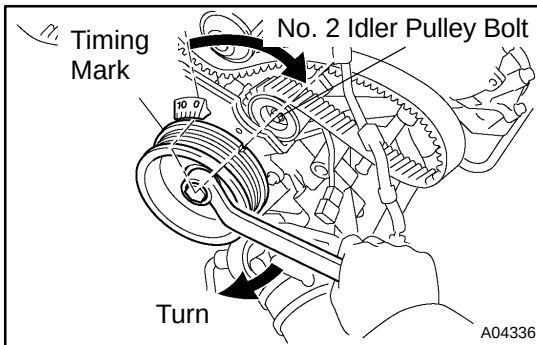
8. INSTALL CAMSHAFTS

NOTICE:

Since the thrust clearance of the camshaft is small, the camshaft must be kept level while it is being removed. Otherwise, excessive pressure is put on the cylinder head journal thrust, causing a burr on the journal and damage on the camshaft. To avoid this, follow the steps below.

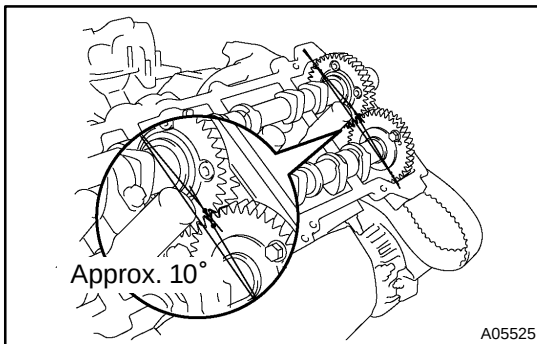
- (a) Set the crankshaft pulley position.

Turn the crankshaft pulley clockwise or counterclockwise, and put the timing mark of the crankshaft pulley in line with the centers of the crankshaft pulley bolt and the idler pulley bolt.



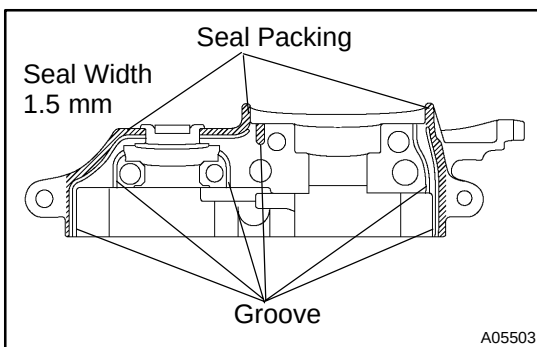
NOTICE:

Having the crankshaft pulley at the wrong angle can cause the piston head and the valve head to come into contact with each other when removing the camshaft, causing damage on them. So always set the crankshaft pulley at the correct angle.



- (b) Install the RH camshafts.

- (1) Apply MP grease to the thrust portion of the intake and exhaust camshafts.
- (2) Place the intake and exhaust camshafts.
- (3) Set the timing mark (1 dot mark) of the camshaft main gear at approx. 10° angle.



- (4) Remove any old packing (FIPG) material from the front bearing cap.
- (5) Apply seal packing to the front bearing cap as shown in the illustration.

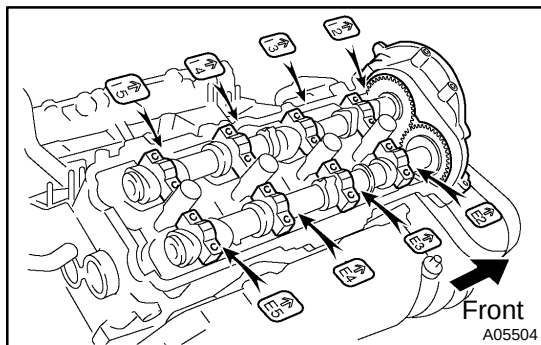
Seal packing:

Part No. 08826-00080 or equivalent

- ★ Install a nozzle that is cut to a 1.5 mm (0.06 in.) opening.
- ★ Parts must be assembled within 5 minutes the seal packing application. Otherwise the material must be removed and the packing have to be reapplied.
- ★ Immediately remove nozzle from the tube and reinstall cap.

NOTICE:

Do not apply seal packing to the front bearing cap grooves.



- (6) Install the front bearing cap.

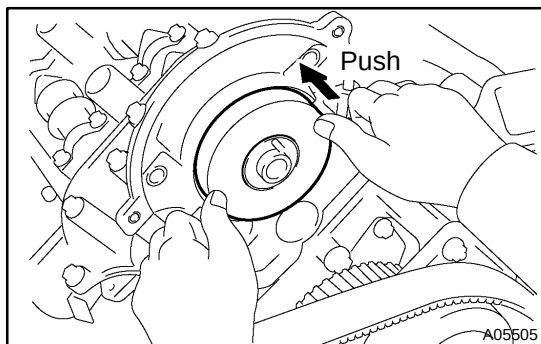
HINT:

Installing the front bearing cap will determine the thrust portion of the camshaft.

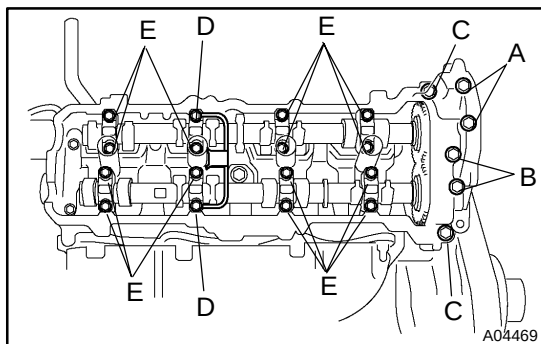
- (7) Install the other bearing cap in the sequence shown with the arrow mark facing forward.

HINT:

Align the arrow marks at the front and rear of the cylinder head with the mark on the bearing cap.



- (8) Push in the camshaft oil seal.



- (9) Apply a light coat of engine oil on the threads and under the heads (D and E) of the bearing cap bolts.

HINT:

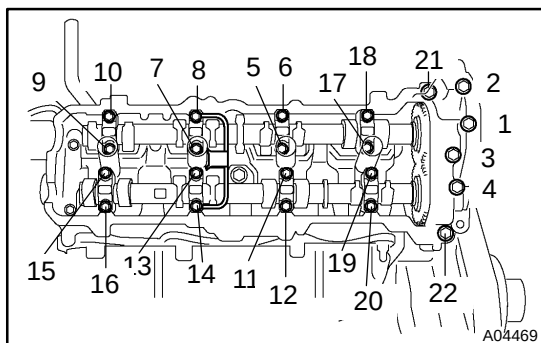
Do not apply engine oil under the heads of the bearing cap bolt (A), (B) and (C).

- (10) Install the oil feed pipe and the 22 bearing cap bolts as shown.

HINT:

Bolt length:

- 94 mm (3.70 in.) for A
- 72 mm (2.83 in.) for B
- 25 mm (0.98 in.) for C
- 52 mm (2.05 in.) for D
- 38 mm (1.50 in.) for E



- (11) Evenly tighten the 22 bearing cap bolts a little at a time for several times as in the sequence shown.

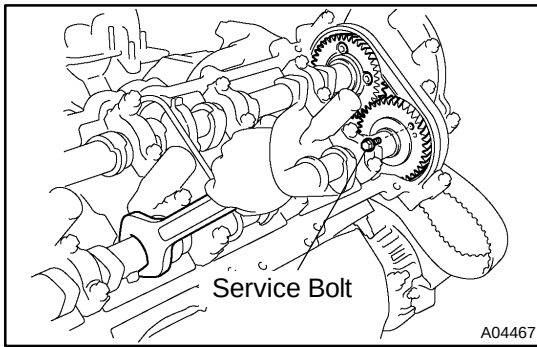
Torque:

Bolt C:

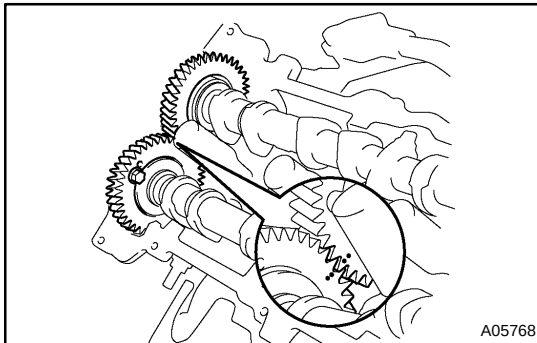
7.5 N·m (80 kgf·cm, 69 in·lbf)

Others

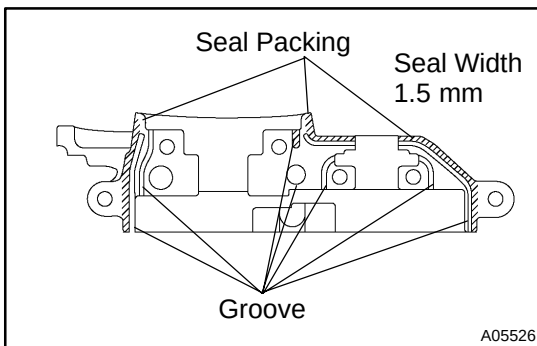
16 N·m (160 kgf·cm, 12 ft·lbf)



- (12) Move a service bolt of the sub-gear upward by turning the hexagon shaped port of the exhaust camshaft with a wrench.
- (13) Remove the service bolt.



- (c) Install the LH camshafts.
 - (1) Apply MP grease to the thrust portion of the intake and exhaust camshafts.
 - (2) Place the intake and exhaust camshafts.
 - (3) Engage the intake to the exhaust gear by putting the timing marks (2 dot marks) on each gear.



- (4) Remove any old packing (FIPG) material.
- (5) Apply seal packing to the front bearing cap.

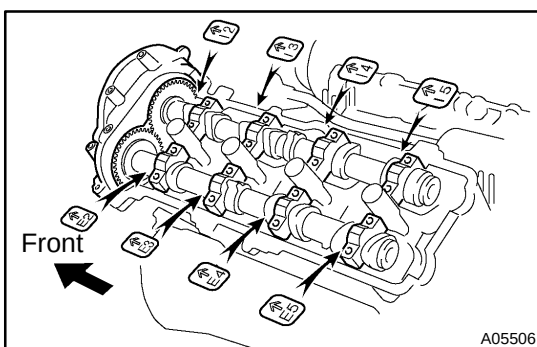
Seal packing:

Part No. 08826-00080 or equivalent

- ★ Install a nozzle that is cut to a 1.5 mm (0.06 in.) opening.
- ★ Parts must be assembled within 5 minutes the seal packing application. Otherwise the material must be removed and the packing have to be reapplied.
- ★ Immediately remove nozzle from the tube and reinstall cap.

NOTICE:

Do not apply seal packing to the front bearing cap grooves.



2004 LAND CRUISER (RM1071U)

- (6) Install the front bearing cap.

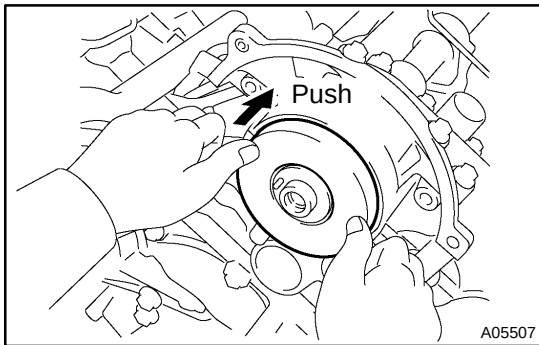
HINT:

Installing the front bearing cap will determine the thrust portion of the camshaft.

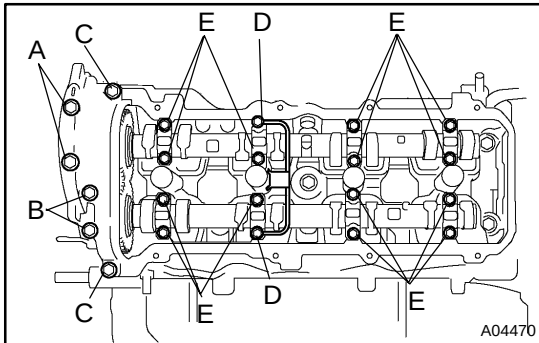
- (7) Install the other bearing cap in the sequence shown with the arrow mark facing forward.

HINT:

Align the arrow marks at the front and rear of the cylinder head with the mark on the bearing cap.



- (8) Push in the camshaft oil seal.



- (9) Apply a light coat of engine oil on the threads and under the heads (D and E) of the bearing cap bolts.

HINT:

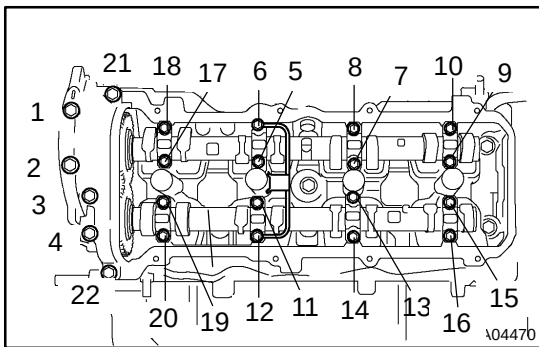
Do not apply engine oil under the heads of the bearing cap bolt (A), (B) and (C).

- (10) Install the oil feed pipe and the 22 bearing cap bolts as shown.

HINT:

Bolt length:

- 94 mm (3.70 in.) for A
- 72 mm (2.83 in.) for B
- 25 mm (0.98 in.) for C
- 52 mm (2.05 in.) for D
- 38 mm (1.50 in.) for E



- (11) Uniformly tighten the 22 bearing cap bolts in several passes, in the sequence shown.

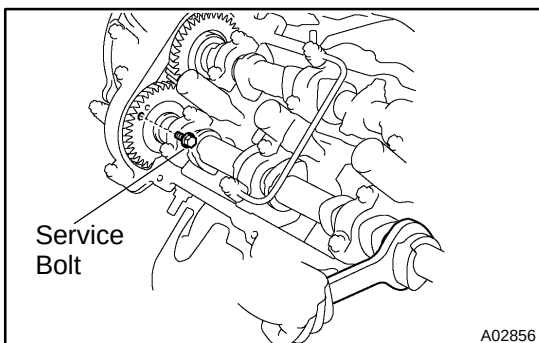
Torque:

Bolt C:

7.5 N·m (80 kgf·cm, 69 in.-lbf)

Others

16 N·m (160 kgf·cm, 12 ft-lbf)

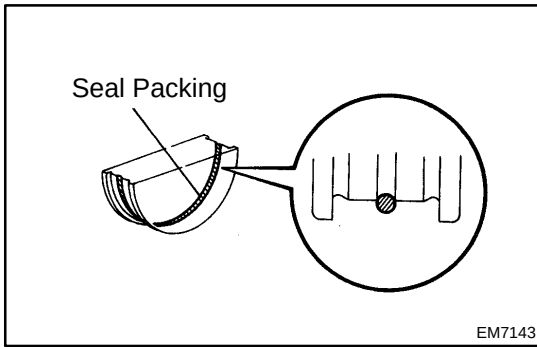


- (12) Move a service bolt of the sub-gear upward by turning the hexagon shaped port of the exhaust camshaft with a wrench.

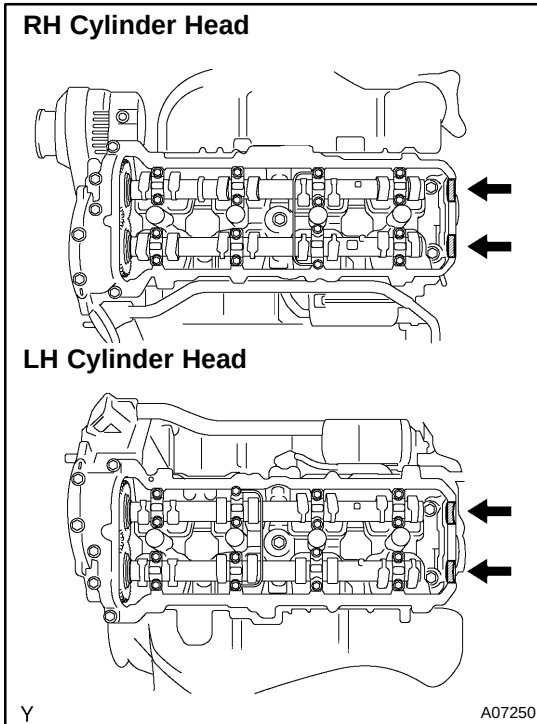
- (13) Remove the service bolt.

9. CHECK AND ADJUST VALVE CLEARANCE (See page EM-4)

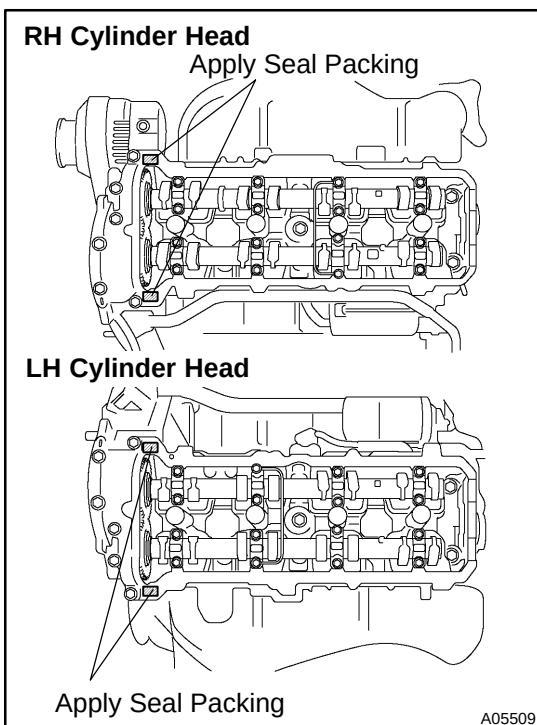
Turn the camshaft and the position the cam lobe upward, and check and adjust the valve clearance.

**10. INSTALL SEMI-CIRCULAR PLUGS**

- (a) Remove any old packing (FIPG) material.
- (b) Apply seal packing to the semi-circular plug grooves.

Seal packing:**Part No. 08826-00080 or equivalent**

- (c) Install the 4 semi-circular plugs to the cylinder heads.

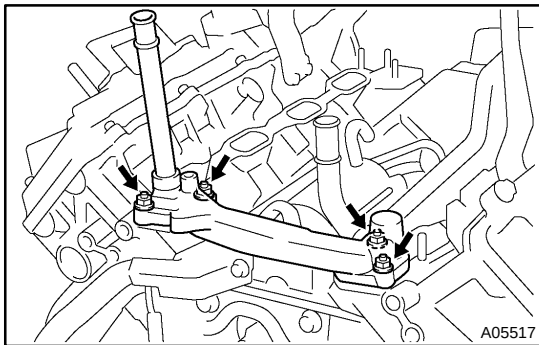
**11. INSTALL CYLINDER HEAD COVER**

- (a) Remove any old packing (FIPG) material.
- (b) Apply seal packing to the cylinder heads as shown in the illustration.

Seal packing:**Part No. 08826-00080 or equivalent**

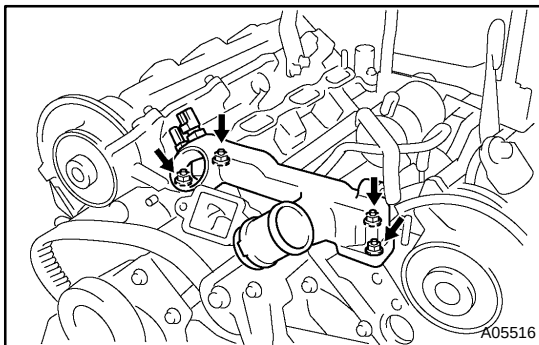
- (c) Install the gasket to the cylinder head cover.
- (d) Install the seal washer to the bolt.
- (e) Install the cylinder head cover with the 18 bolts. Evenly tighten the bolts a little at a time for several times. Install the 2 cylinder head covers.

Torque: 6.0 N·m (60 kgf·cm, 53 in·lbf)**12. INSTALL ENGINE HANGERS****Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)****13. INSTALL OIL DIPSTICK AND GUIDE FOR ENGINE**

**14. INSTALL REAR WATER BYPASS JOINT**

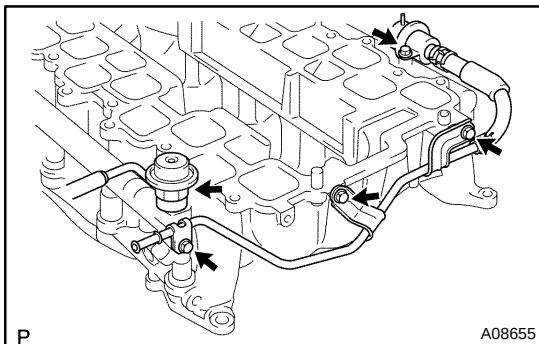
- (a) Install 2 new gaskets to the cylinder head.
- (b) Install the 4 nuts holding the water bypass joint to the cylinder heads. Alternately tighten the nuts.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

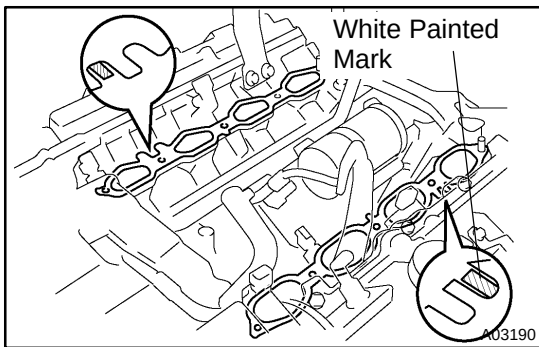
**15. INSTALL FRONT WATER BYPASS JOINT**

Install 2 new gaskets and the water bypass joint with the 4 nuts. Alternately tighten the nuts.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

16. INSTALL WATER INLET AND INLET HOUSING ASSEMBLY (See page CO-8)**17. ASSEMBLE UPPER AND LOWER INTAKE MANIFOLDS**

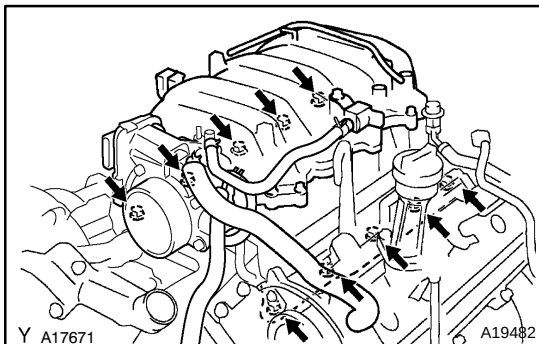
- (a) Install the 2 delivery pipes and the 8 injectors (See page SF-27).
- (b) Install new 2 gaskets, the fuel pressure regulator and the fuel pulsation damper.
- (c) Install the fuel return hose to the lower intake manifold with the 3 bolts.
- (d) Connect the fuel return hose to the fuel pressure regulator.

**18. INSTALL INTAKE MANIFOLD ASSEMBLY**

- (a) Place 2 new gaskets on the cylinder heads with white painted mark facing upward.

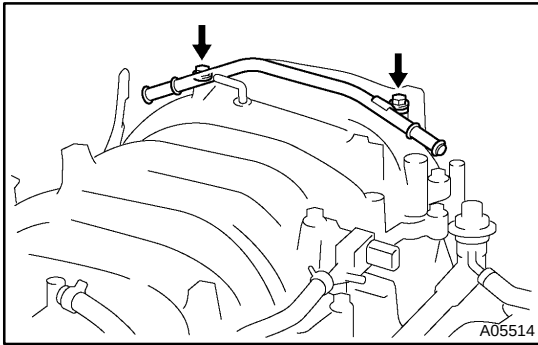
NOTICE:

- ★ Align the port holes of the gasket and cylinder head.
- ★ Be careful of the installation direction.

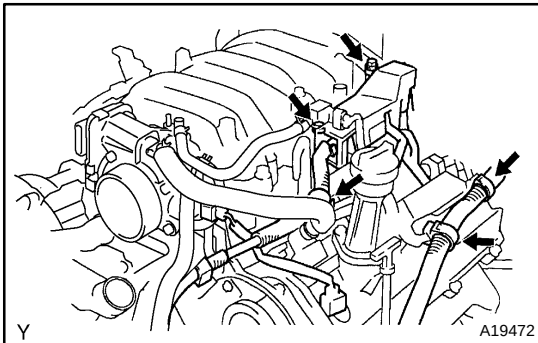


- (b) Place the intake manifold assembly on the cylinder heads.
- (c) Install and uniformly tighten the 6 bolts and the 4 nuts in several passes.

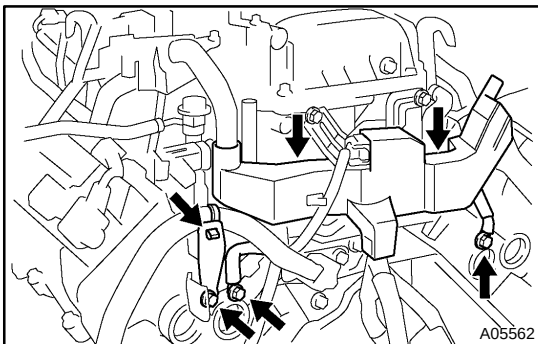
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)



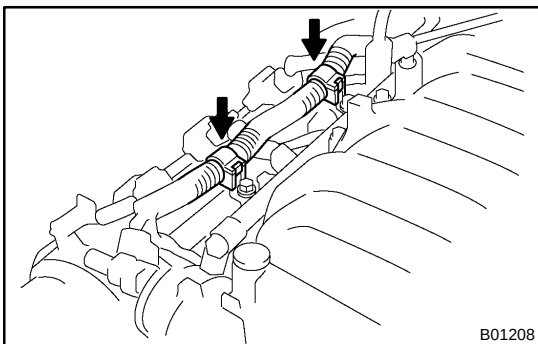
- (d) Install the EVAP pipe to the intake manifold with the 2 bolts.



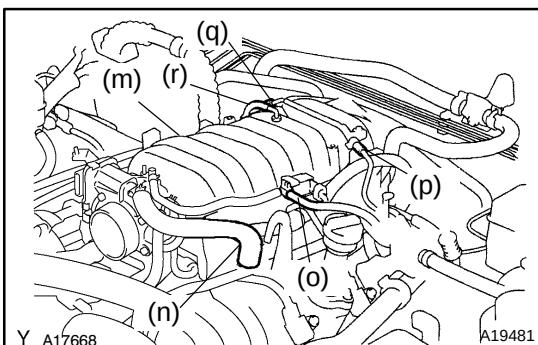
- (e) Connect the wire protector to the intake manifold with the 2 bolts.
 (f) Install the engine wire to the engine hanger.
 (g) Install the engine wire to the LH No.1 timing belt rear plate.
 (h) Install the engine wire to the bracket.



- (i) Connect the wire protector to the rear water bypass joint and RH cylinder head with the 2 bolts.
 (j) Install the 2 ground cables to the RH and LH cylinder head.
 (k) Install the guide for A/T bracket to the LH cylinder head.

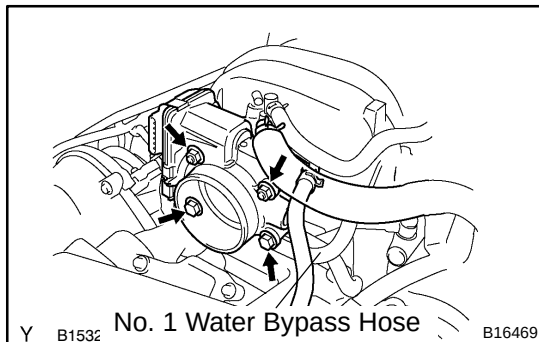


- (l) Connect the 2 wire clamps to the wire clamp bracket on the RH delivery pipe.



- (m) Connect the fuel pressure regulator vacuum hose to the fuel pressure regulator pipe.
 (n) Connect the PCV hose to the PCV valve on the LH cylinder head.
 (o) Connect the EVAP hose (from charcoal canister) to the VSV for EVAP.
 (p) Connect the EVAP hose (from charcoal canister) to the EVAP pipe on the intake manifold.
 (q) Connect the EVAP hose (from intake air connector) to EVAP pipe on the the intake manifold.

- (r) Connect the PS air hose to intake manifold.



- (s) Connect the No.1 water bypass hose (from water inlet housing) to throttle body.
- (t) Connect the throttle control connector.
- (u) Connect the VSV connector for EVAP.
- (v) Connect the 8 injector connectors.
- (w) Connect the ECT sensor.
- (x) Connect the water sender gauge.
- (y) Connect the 8 ignition coil connectors.
- (z) Connect the 2 oxygen sensor connectors.

19. CONNECT FUEL INLET HOSE (See page [SF-24](#))

20. INSTALL TIMING BELT REAR PLATES

- (a) Install the RH timing belt rear plates.
- Install the No.1 timing belt rear plate to the cylinder head with the 3 bolts and the stud bolt.
- Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)**
- (b) Install the LH timing belt rear plates.
- (1) Connect the wire clamp to the No.1 timing belt rear plate.
- (2) Install the No.1 timing belt rear plate to the cylinder head with the 3 bolts.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

21. INSTALL V-BANK COVER

Install the 3 V-bank covers.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

22. INSTALL IGNITION COILS (See page [IG-6](#))

23. INSTALL OIL DIPSTICK AND GUIDE FOR A/T

24. INSTALL FRONT EXHAUST PIPE (See page [EM-115](#))

25. INSTALL PS PUMP (See page [EM-81](#))

26. INSTALL CAMSHAFT POSITION SENSOR (See page [IG-10](#))

27. INSTALL CAMSHAFT TIMING PULLEYS (See page [EM-22](#))

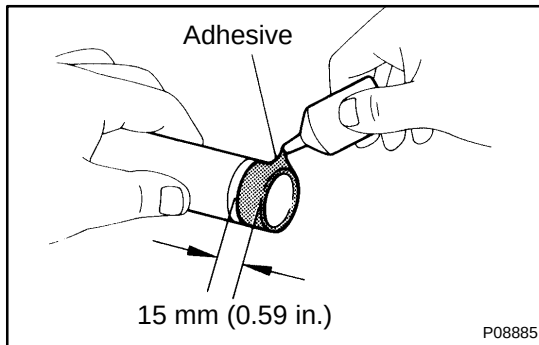
28. CONNECT TIMING BELT TO CAMSHAFT TIMING PULLEYS (See page [EM-22](#))

29. CHECK ENGINE OIL LEVEL

REASSEMBLY

HINT:

- ★ Thoroughly clean all parts to be assembled.
- ★ Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- ★ Replace all gaskets and oil seals with new ones.



1. INSTALL SPARK PLUG TUBES

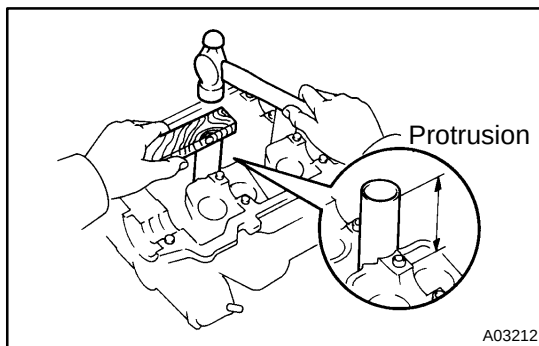
HINT:

When using a new cylinder head, the spark plug tubes must be installed.

- (a) Apply adhesive to the end of the spark plug tube.

Adhesive:

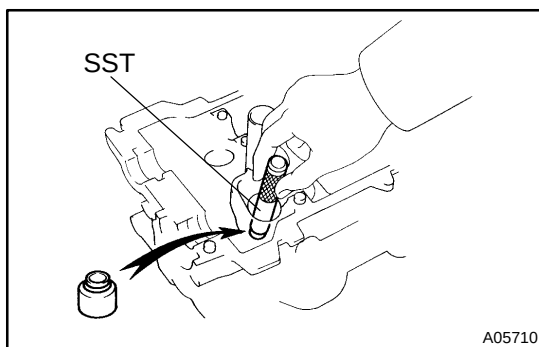
Part No. 08833-00070, THREE BOND 1324 or equivalent



- (b) Using a wooden block and hammer, tap in a new spark tube until the protrusion from the camshaft bearing cap installation surface of the cylinder head becomes 48.4 - 49.6 mm (1.906 - 1.953 in.).

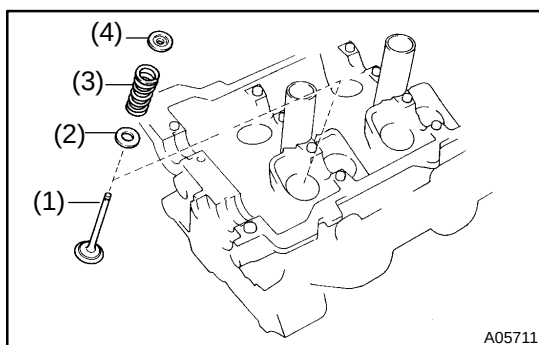
NOTICE:

Avoid tapping a new spark plug tube in too far by measuring the amount of the protrusion as tapping.

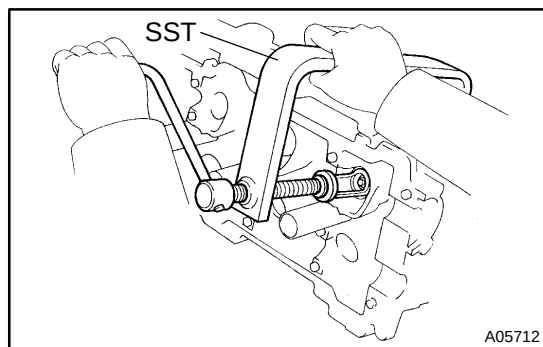


2. INSTALL VALVES

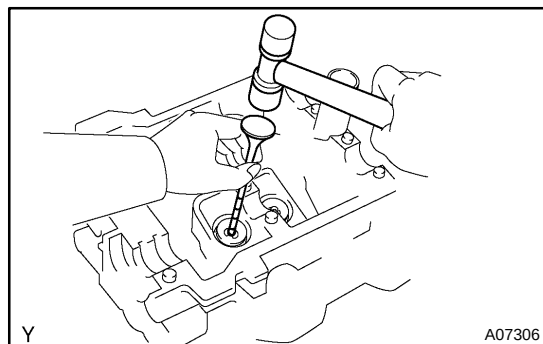
- (a) Using SST, push in a new oil seal.
SST 09201-41020



- (b) Install the valve (1), the spring seat (2), the valve spring (3), and the spring retainer (4).



- (c) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202-70020



- (d) Using a plastic-faced hammer and the valve stem tip taped up with vinyl tape, lightly tap the valve stem tip to assure proper fit.

NOTICE:

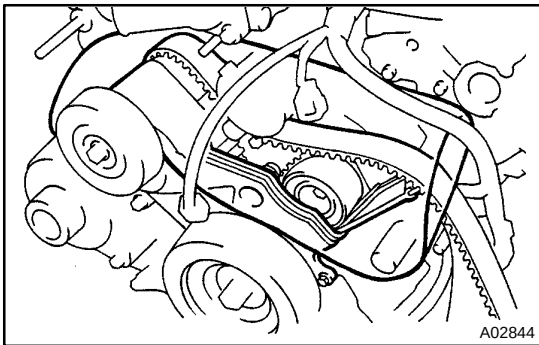
Be careful not to damage the valve stem tip.

3. INSTALL SHIMS AND VALVE LIFTERS

- (a) Install the shim and the valve lifter.
(b) Check that the valve lifter rotates smoothly by hand.

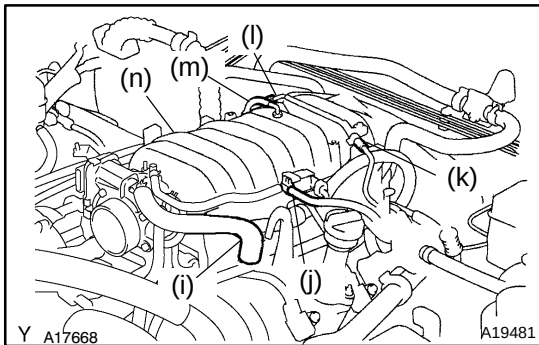
REMOVAL

1. **DRAIN ENGINE COOLANT**
2. **REMOVE V-BANK COVER**
Remove the V-bank covers.
3. **DISCONNECT TIMING BELT FROM CAMSHAFT TIMING PULLEYS (See page EM-15)**
4. **REMOVE CAMSHAFT TIMING PULLEYS (See page EM-15)**
5. **REMOVE CAMSHAFT POSITION SENSOR (See page IG-9)**
6. **DISCONNECT PS PUMP FROM ENGINE (See page EM-77)**
7. **REMOVE FRONT EXHAUST PIPE (See page EM-1 15)**
8. **REMOVE OIL DIPSTICK AND GUIDE FOR A/T**
9. **REMOVE IGNITION COILS (See page IG-6)**
10. **REMOVE TIMING BELT REAR PLATES**
 - (1) Remove the 3 bolts, the stud bolt, and the RH No.1 timing belt rear plates.
 - (2) Disconnect the wire clamp from the LH timing belt rear plate.
 - (3) Remove the 3 bolts, the stud bolt, the LH No.1 and the timing belt rear plates.

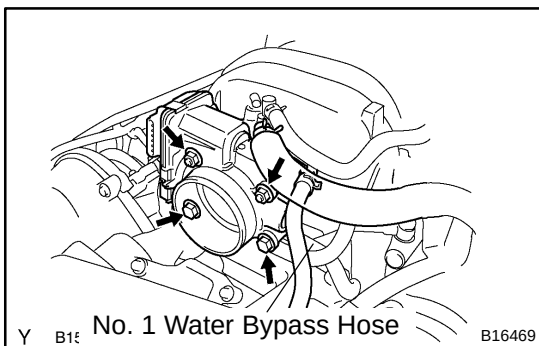


NOTICE:

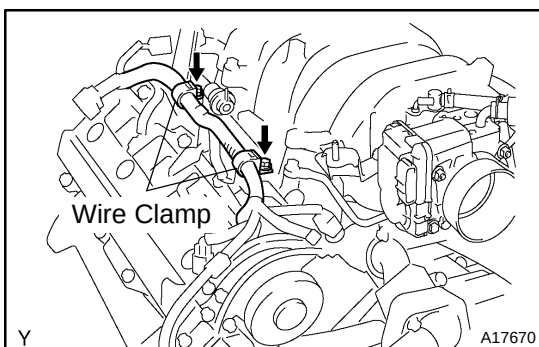
- ★ **Be careful not to drop anything inside the timing belt cover.**
 - ★ **Do not allow the belt to contact correct with oil, water or dust.**
11. **DISCONNECT FUEL INLET HOSE (See page SF-24)**
 12. **REMOVE INTAKE MANIFOLD ASSEMBLY**
 - (a) Disconnect the throttle control connector.
 - (b) Disconnect the VSV connector for EVAP.
 - (c) Disconnect the 8 injector connectors.
 - (d) Disconnect the ECT sensor connector.
 - (e) Disconnect the water sender gauge connector.
 - (f) Disconnect the 8 ignition coil connectors.
 - (g) Disconnect the 2 oxygen sensor connectors.



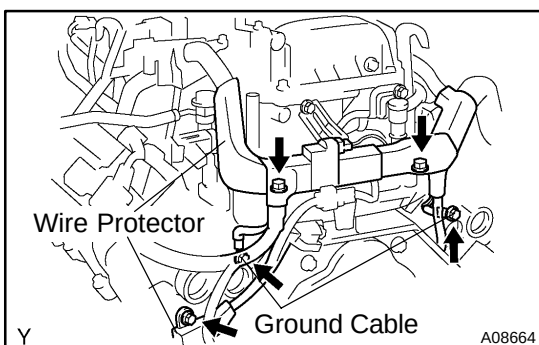
- (h) Disconnect the fuel pressure regulator vacuum hose from the fuel pressure regulator pipe.
- (i) Disconnect the PCV hose from the PCV valve on the LH cylinder head.
- (j) Disconnect the EVAP hose (from charcoal canister) from VSV for EVAP.
- (k) Disconnect the EVAP hose (from charcoal canister) from the EVAP pipe on the intake manifold.
- (l) Disconnect the EVAP hose (from intake air connector) from the EVAP pipe on the intake manifold.
- (m) Disconnect the PS air hose from the intake manifold.



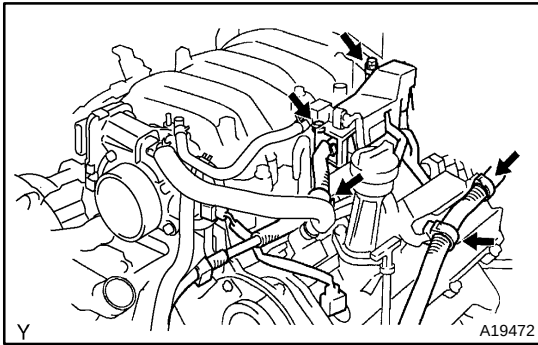
- (n) Disconnect the No.1 water bypass hose from the front water by-pass joint.



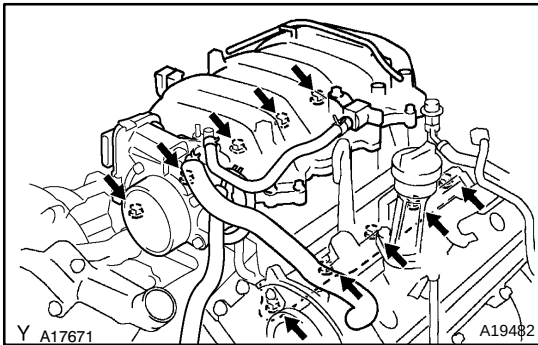
- (o) Disconnect the 2 wire clamps from the wire clamp bracket on the RH delivery pipe.



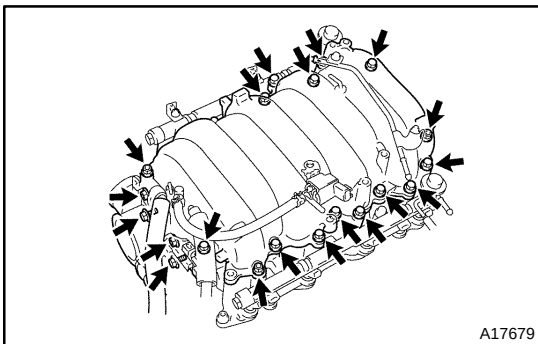
- (p) Remove the 2 bolts and disconnect the engine wire protector from the rear water bypass joint and the RH cylinder head.
- (q) Remove the guide for A/T bracket from the LH cylinder head.
- (r) Remove the 2 ground cables from the RH and LH cylinder head.



- (s) Remove the 2 bolts and disconnect the engine wire protector from the intake manifold.
- (t) Remove the engine wire from the engine hanger.
- (u) Remove the engine wire from the wire bracket.
- (v) Remove the RH rear and the LH front V-bank cover brackets.

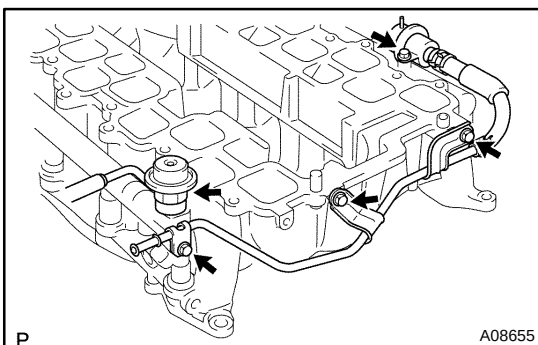
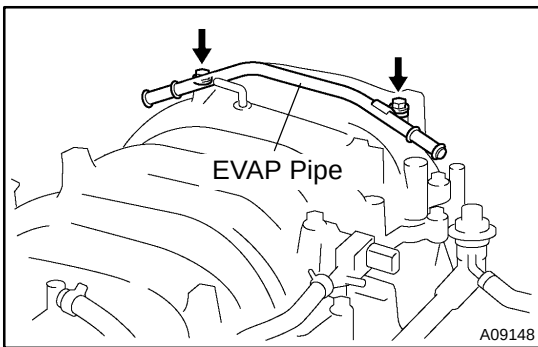


- (w) Remove the 6 bolts, the 4 nuts, the intake manifold assembly and the 2 gaskets.



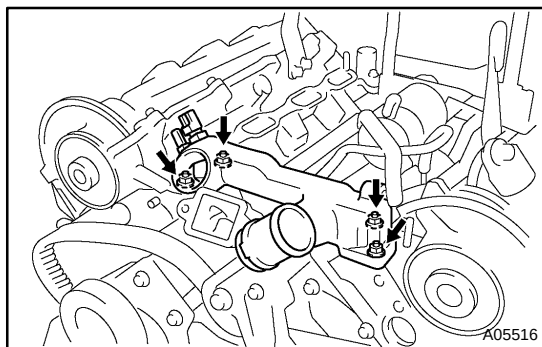
13. DISASSEMBLE UPPER AND LOWER INTAKE MANIFOLDS

- (a) Remove the throttle body (See page [SF-36](#)).
- (b) Remove the 13 bolts, the 3 nuts, the upper intake manifold and the gasket.
- (c) Disconnect the EVAP hose from the upper intake manifold, and remove the accelerator cable clamp and VSV for EVAP.
- (d) Remove the bolt, the union, the 2 gaskets and the brake booster tube from the upper intake manifold.
- (e) Remove the 2 bolts and the EVAP pipe from the intake manifold.



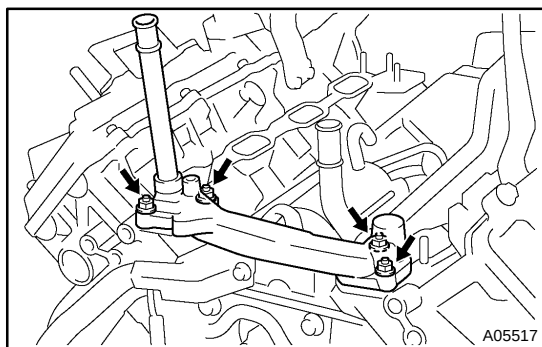
- (f) Disconnect the fuel return hose from the fuel pressure regulator.
- (g) Remove the 3 bolts holding the fuel return hose from the lower intake manifold.
- (h) Remove the fuel pressure regulator, the fuel pressure pulsation damper and the 2 gaskets.
- (i) Remove the bolt and the rear fuel pipe.
- (j) Remove the 2 delivery pipes and the 8 injectors (See page [SF-22](#)).

14. REMOVE WATER INLET AND INLET HOUSING ASSEMBLY (See page [CO-6](#))



15. REMOVE FRONT WATER BYPASS JOINT

Remove the 4 nuts, the water bypass joint and the 2 gaskets.

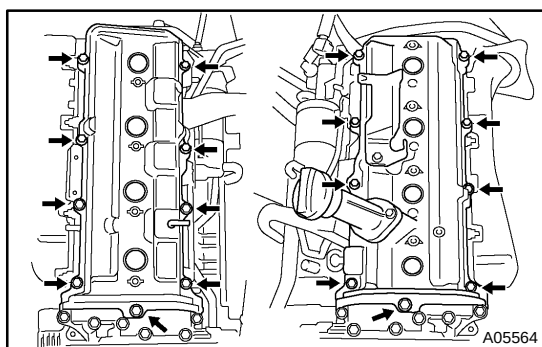


16. REMOVE REAR WATER BYPASS JOINT

Remove the 4 nuts, the water bypass joint and the 2 gaskets.

17. REMOVE ENGINE HANGERS

18. REMOVE OIL DIPSTICK AND GUIDE FOR A/T



19. REMOVE CYLINDER HEAD COVERS

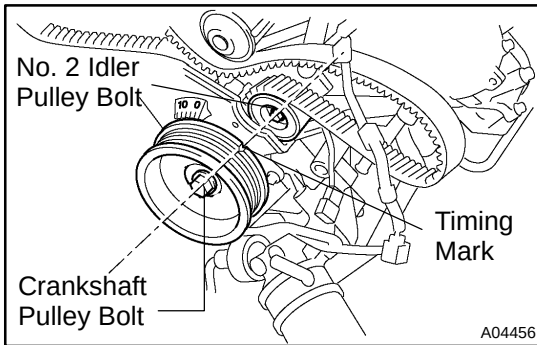
Remove the 18 bolts, the 18 seal washers, the cylinder head cover and gasket. Remove the 2 cylinder head covers.

20. IF NECESSARY, REMOVE SEMI-CIRCULAR PLUGS AND CAMSHAFT HOUSING PLUGS

21. REMOVE CAMSHAFTS

NOTICE:

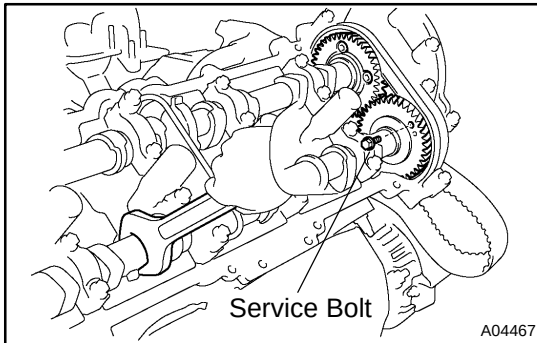
Since the thrust clearance of the camshaft is small, the camshaft must be kept level while it is being removed. Otherwise, excessive pressure is put on the cylinder head journal thrust, causing a burr on the journal and damage on the camshaft. To avoid this, follow the steps below.



- (a) Check the crankshaft pulley position.
Check that the timing mark of the crankshaft pulley is aligned with the centers of the crankshaft pulley bolt and the idler pulley bolt.

NOTICE:

Having the crankshaft pulley at the wrong angle can cause the piston head and the valve head to come into contact with each other when removing the camshaft, causing damage on them. So always set the crankshaft pulley at the correct angle.



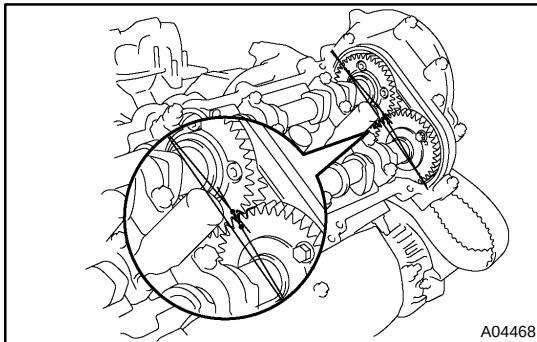
- (b) Remove the RH camshafts.
- (1) Move a service bolt of the sub-gear upward by turning the hexagon shaped port of the exhaust camshaft with a wrench.
 - (2) Secure the sub-gear to the main gear with a service bolt.

Recommended service bolt:

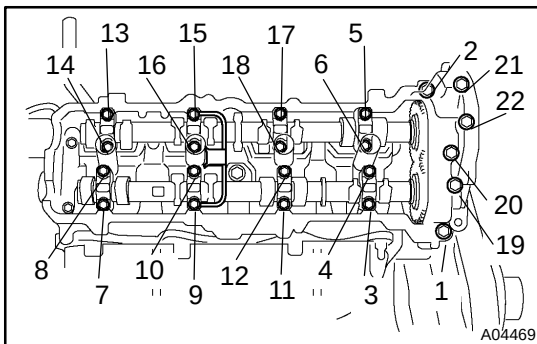
Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	16 - 20 mm

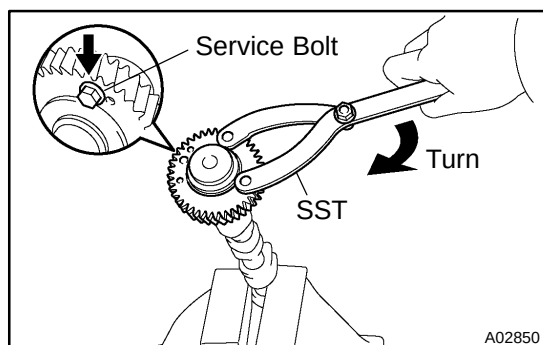
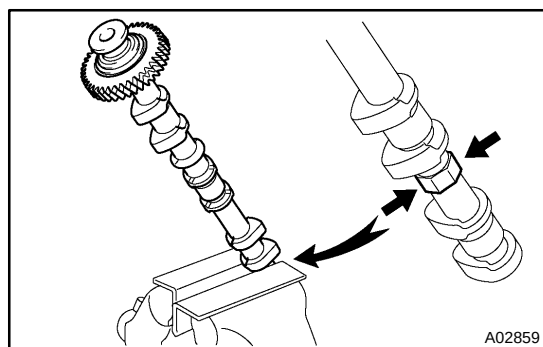
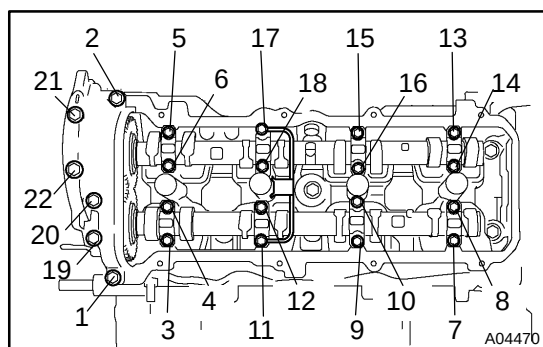
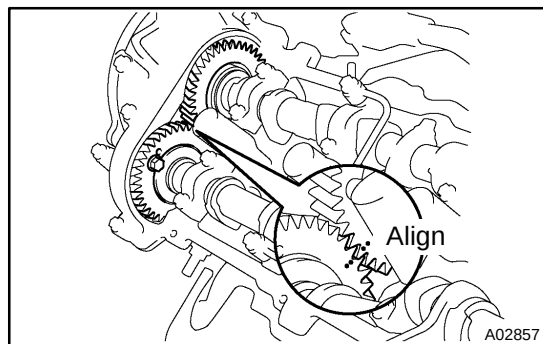
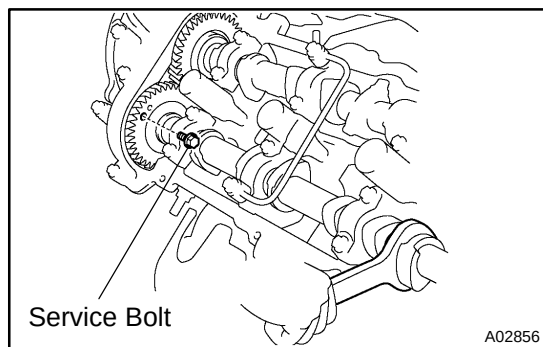
HINT:

When removing the camshafts, make sure that the torsional spring force of the sub-gear is eliminated by the above operation.



- (3) Set the timing mark (1 dot mark) of the camshaft main gear at approx. 10° angle by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.
- (4) Uniformly loosen and remove the 22 bearing cap bolts a little at a time for several times in the sequence shown.
- (5) Remove the oil feed pipe, 9 bearing caps, cam shaft timing oil control valve and camshafts.





- (c) Remove the LH camshafts.
- (1) Move a service bolt of the sub-gear upward by turning the hexagon shaped port of the exhaust camshaft with a wrench.
 - (2) Secure the sub-gear to the main gear with a service bolt.

Recommended service bolt:

Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	16 - 20 mm

HINT:

When removing the camshaft, make sure that the torsional spring force of the sub-gear is eliminated by the above operation.

- (3) Align the timing mark (2 dot marks) of the camshaft drive gear by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.
- (4) Evenly loosen and remove the 22 bearing cap bolts a little at a time for several times as in the sequence shown.
- (5) Remove the oil feed pipe, 9 bearing caps, and camshafts.

HINT:

Arrange the bearing caps in correct order for installation.

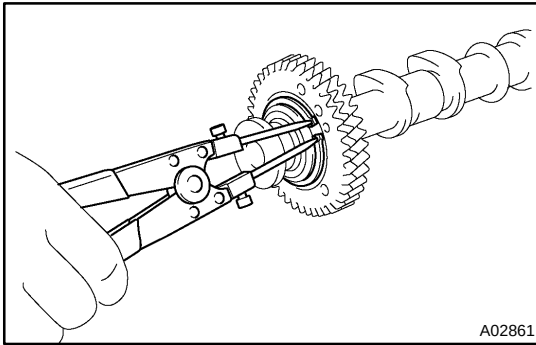
22. DISASSEMBLE EXHAUST CAMSHAFTS

- (a) Mount the hexagon wrench head portion of the camshaft in a vise.

NOTICE:

Be careful not to damage the camshaft.

- (b) Using SST, turn the sub-gear clockwise, and remove the service bolt.
SST 09960-10010 (09962-01000, 09963-00500)



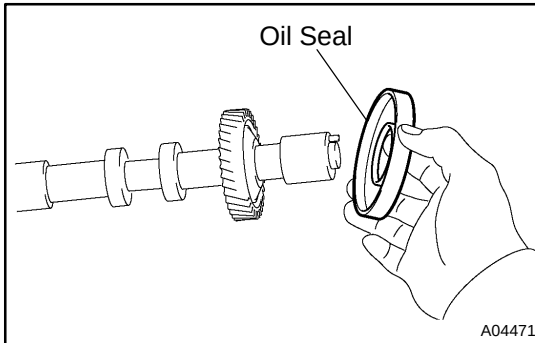
- (c) Using snap ring pliers, remove the snap ring.
- (d) Remove the wave washer.
- (e) Remove the camshaft sub-gear.
- (f) Remove the camshaft gear spring.

HINT:

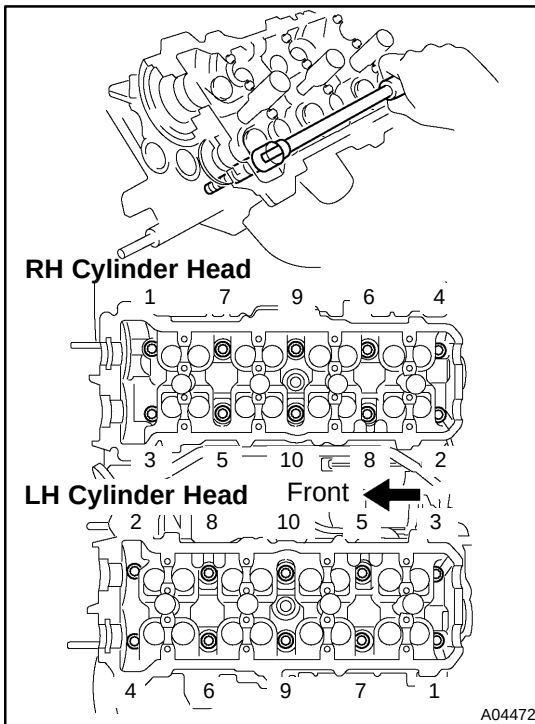
Arrange the camshaft sub-gears and gear spring (RH and LH sides).

NOTICE:

Be careful not to damage the camshaft timing tube.



- 23. REMOVE OIL SEAL FROM INTAKE CAMSHAFT**
- 24. REMOVE SPARK PLUGS**

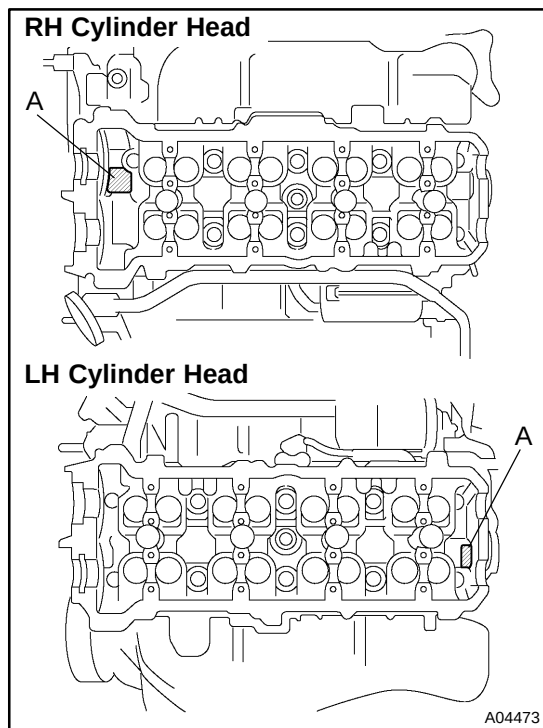


- 25. REMOVE CYLINDER HEAD AND EXHAUST MANIFOLD ASSEMBLIES**

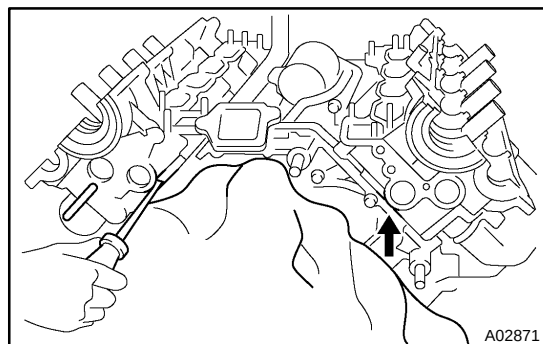
- (a) Uniformly loosen the 10 cylinder head bolts on one side of each cylinder head in a little at a time for several times as in the sequence shown, then do the other side as shown. Remove the 20 cylinder head bolts and the plate washers.

NOTICE:

- ★ Removing the bolts in incorrect order could cause a warp or cracks in the cylinder head.



- ★ Do not drop the plate washer of the cylinder head bolt into A area in the illustration. It will fall down to the oil pan through the cylinder head and the cylinder block.



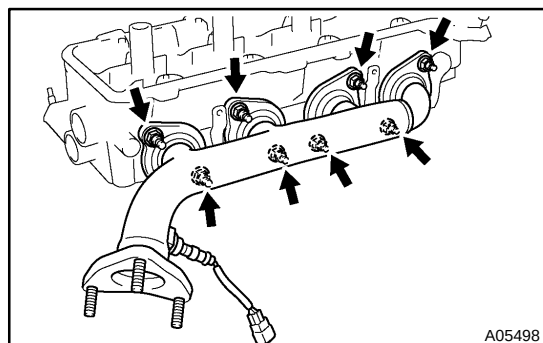
- (b) Lift the cylinder head from the dowels on the cylinder block, and place the 2 cylinder heads on wooden blocks.

HINT:

After lifting off the cylinder head, pry off the cylinder head and the cylinder block with a screwdriver.

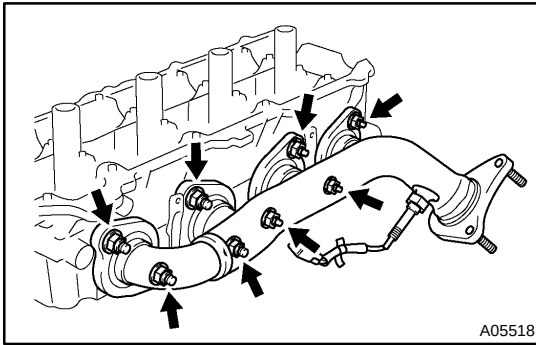
NOTICE:

- ★ Be careful not to damage the contact surfaces of the cylinder head and the cylinder block.
- ★ The cylinder head should not be tilted so to secure the valve lifter. If the cylinder head is tilted, remove the valve lifter and check that the adjusting shim is set correctly.

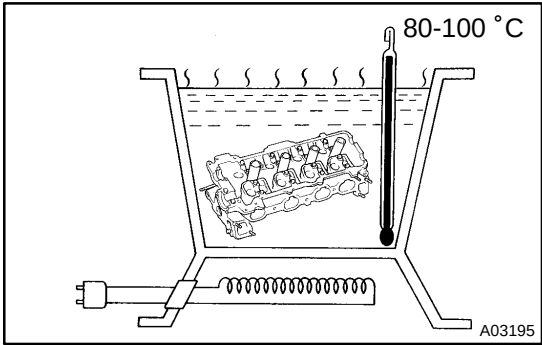


26. REMOVE RH EXHAUST MANIFOLD FROM CYLINDER HEAD

- (a) Remove the 4 bolts and the heat insulator.
- (b) Remove the 8 nuts, the exhaust manifold and the gasket.

**27. REMOVE LH EXHAUST MANIFOLD FROM CYLINDER HEAD**

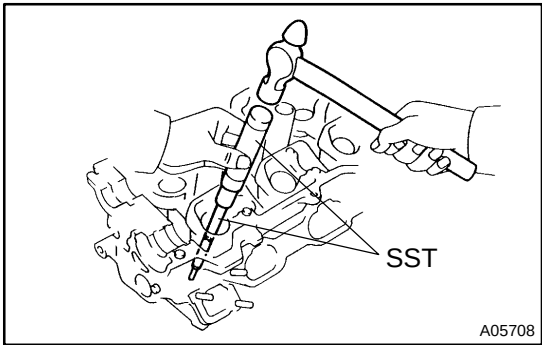
- (a) Remove the 4 bolts and the heat insulator.
- (b) Remove the 8 nuts, the exhaust manifold and the gasket.



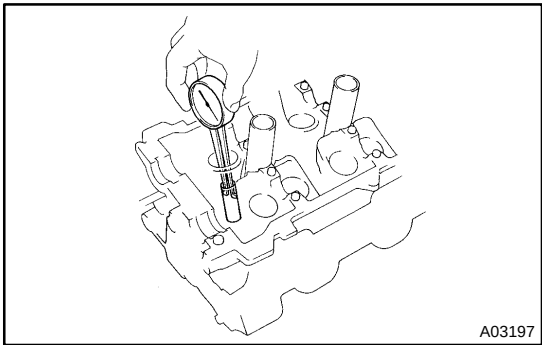
REPLACEMENT

1. REPLACE VALVE GUIDE BUSHINGS

- (a) Gradually heat the cylinder head to 80 - 100°C (176 - 212°F).



- (b) Using SST and a hammer, tap out the guide bushing.
SST 09201-10000 (09201-01060),
09950-70010 (09951-07100)



- (c) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

Both intake and exhaust

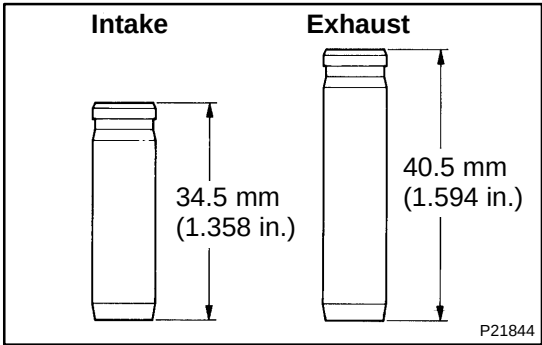
Bushing bore diameter mm (in.)	Bushing size
10.285 - 10.306 (0.4049 - 0.4057)	Use STD
10.335 - 10.356 (0.4069 - 0.4077)	Use O/S STD

- (d) Select a new guide bushing (STD or O/S 0.05).

If the bushing bore diameter of the cylinder head is greater than 10.306 mm (0.4057 in.), machine the bushing bore to the following dimension:

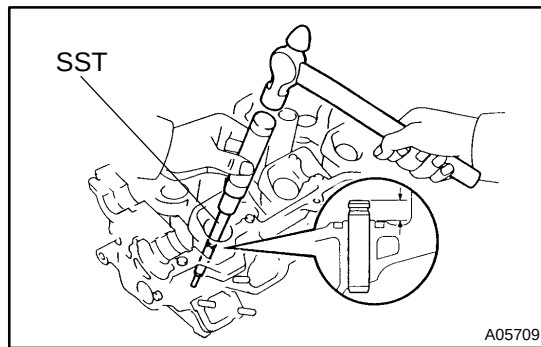
10.335 - 10.356 mm (0.4069 - 0.4077 in.)

If the bushing bore diameter of the cylinder head is greater than 10.356 mm (0.4077 in.), replace the cylinder head.



HINT:

The intake bushing and the exhaust bushing differ in their sizes.



- (e) Gradually heat the cylinder head to 80 - 100°C (176 - 212°F).
- (f) Using SST and a hammer, tap in a new guide bushing to the specified protrusion height.

Protrusion height:

Intake

9.2 - 9.8 mm (0.362 - 0.386 in.)

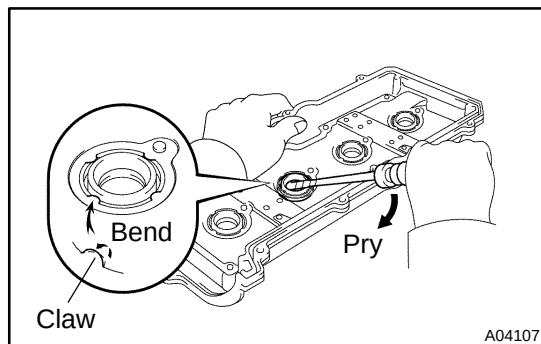
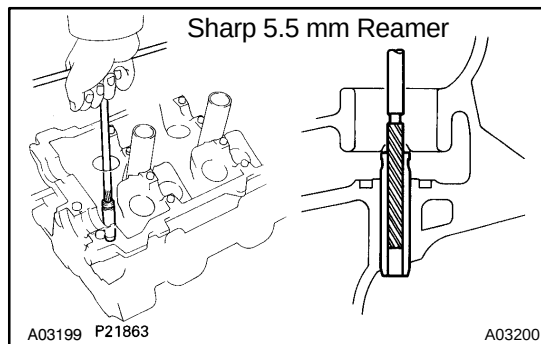
Exhaust

8.2 - 8.8 mm (0.323 - 0.346 in.)

SST 09201-10000 (09201-01060),

09950-70010 (09951-07100)

- (g) Using a sharp 5.5 mm reamer, ream the guide bushing to obtain the standard specified clearance (See page [EM-45](#)) between the guide bushing and the valve stem.

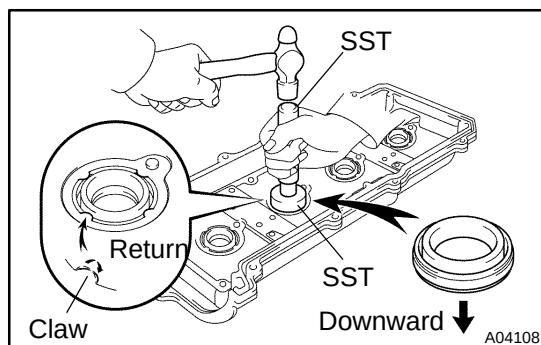


2. REPLACE SPARK PLUG TUBE GASKETS

- (a) Bend the 4 ventilation case claws installed on the cylinder head cover to an angle of 90° or more.
- (b) Using a screwdriver, pry out the gasket.

NOTICE:

Be careful not to damage the cylinder head cover. Tape up the screwdriver tip.



- (c) Using SST and a hammer, tap in a new gasket until its surface is flush with the upper edge of the cylinder head cover.

SST 09950-60010 (09551-00240, 09951-00440,
09952-06010) 09950-70010 (09951-07100)

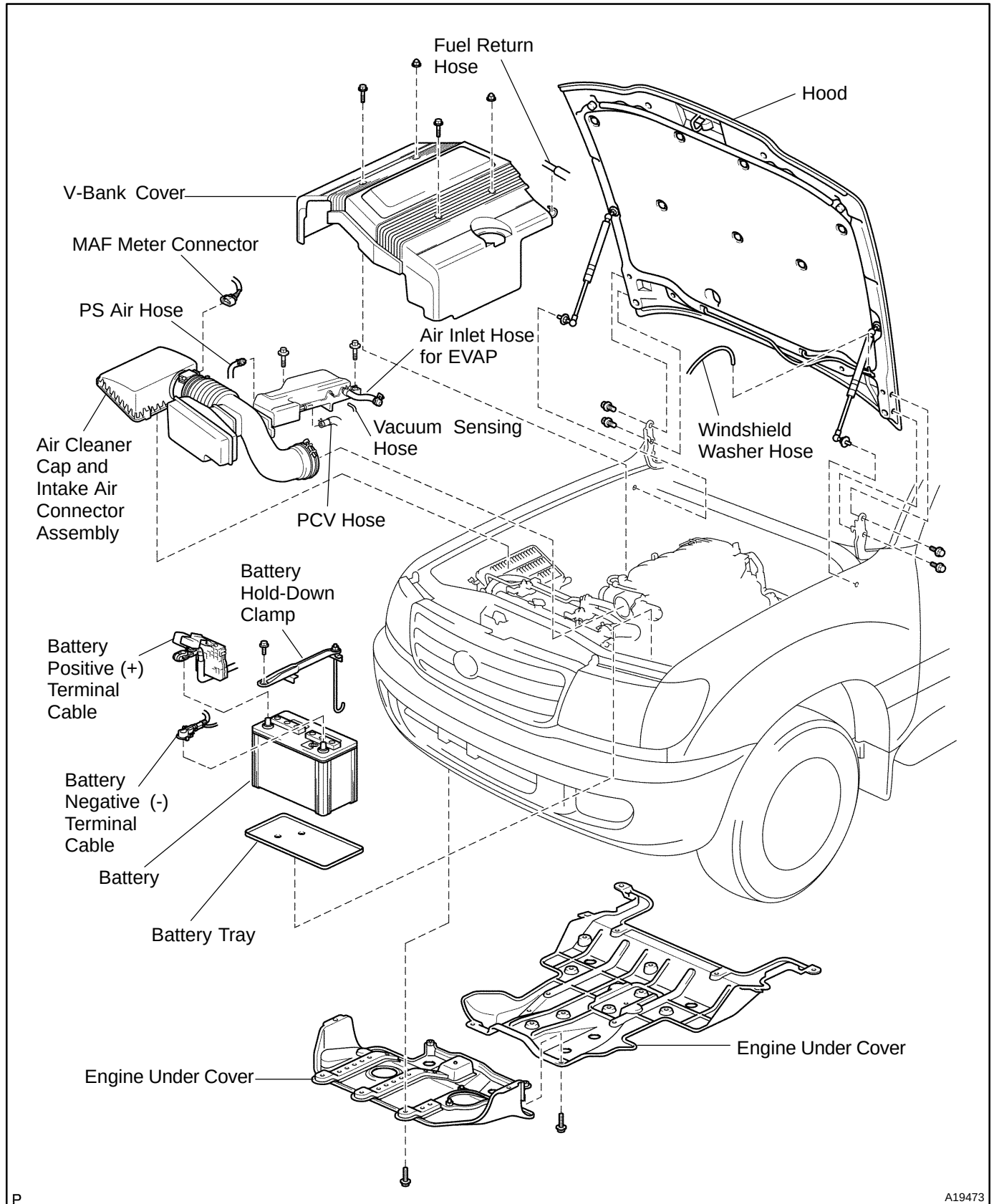
NOTICE:

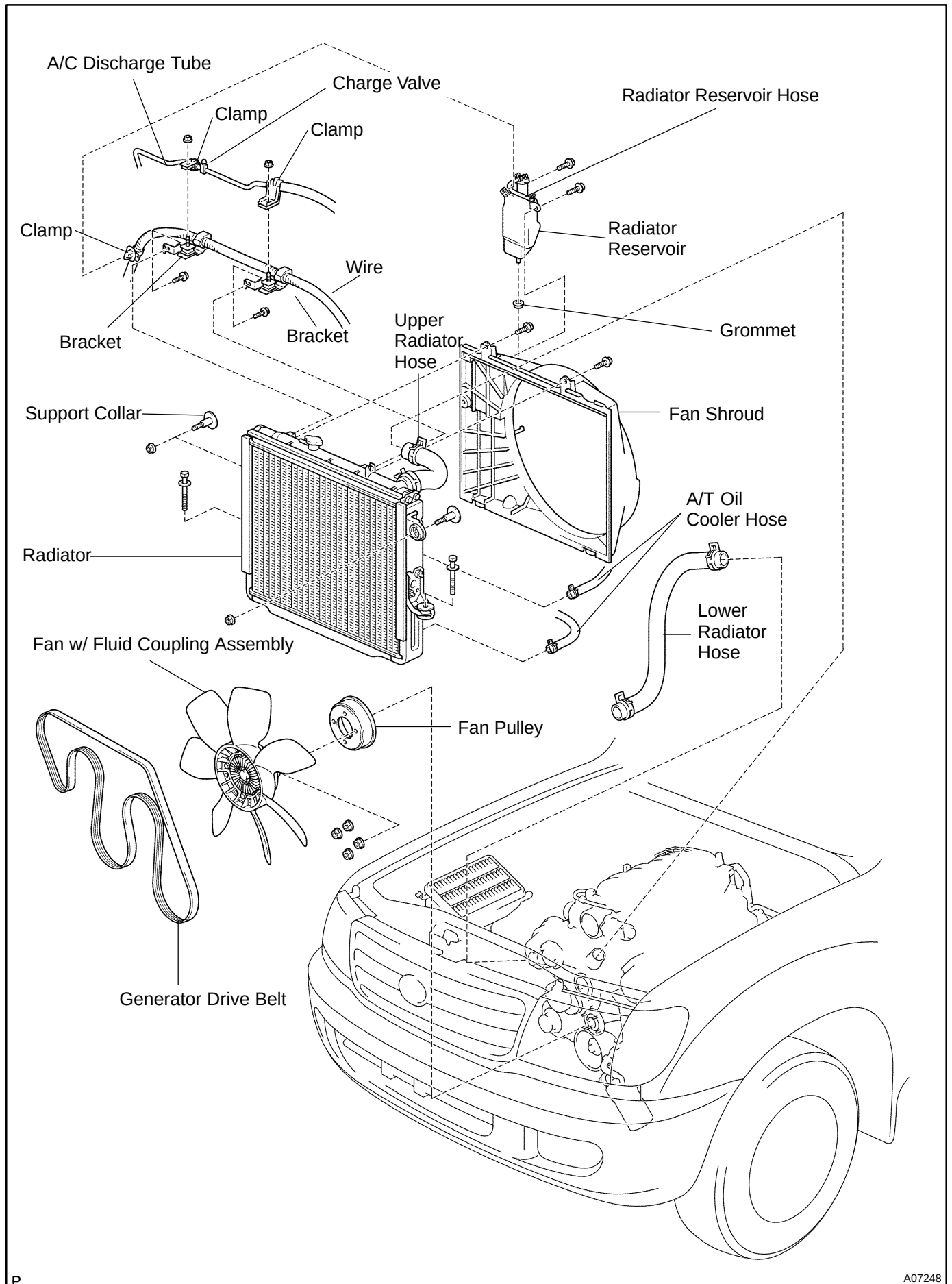
Be careful of the installation direction.

- (d) Apply a light coat of MP grease to the gasket lip.
- (e) Put the 4 ventilation case claws back to its original position.

ENGINE UNIT COMPONENTS

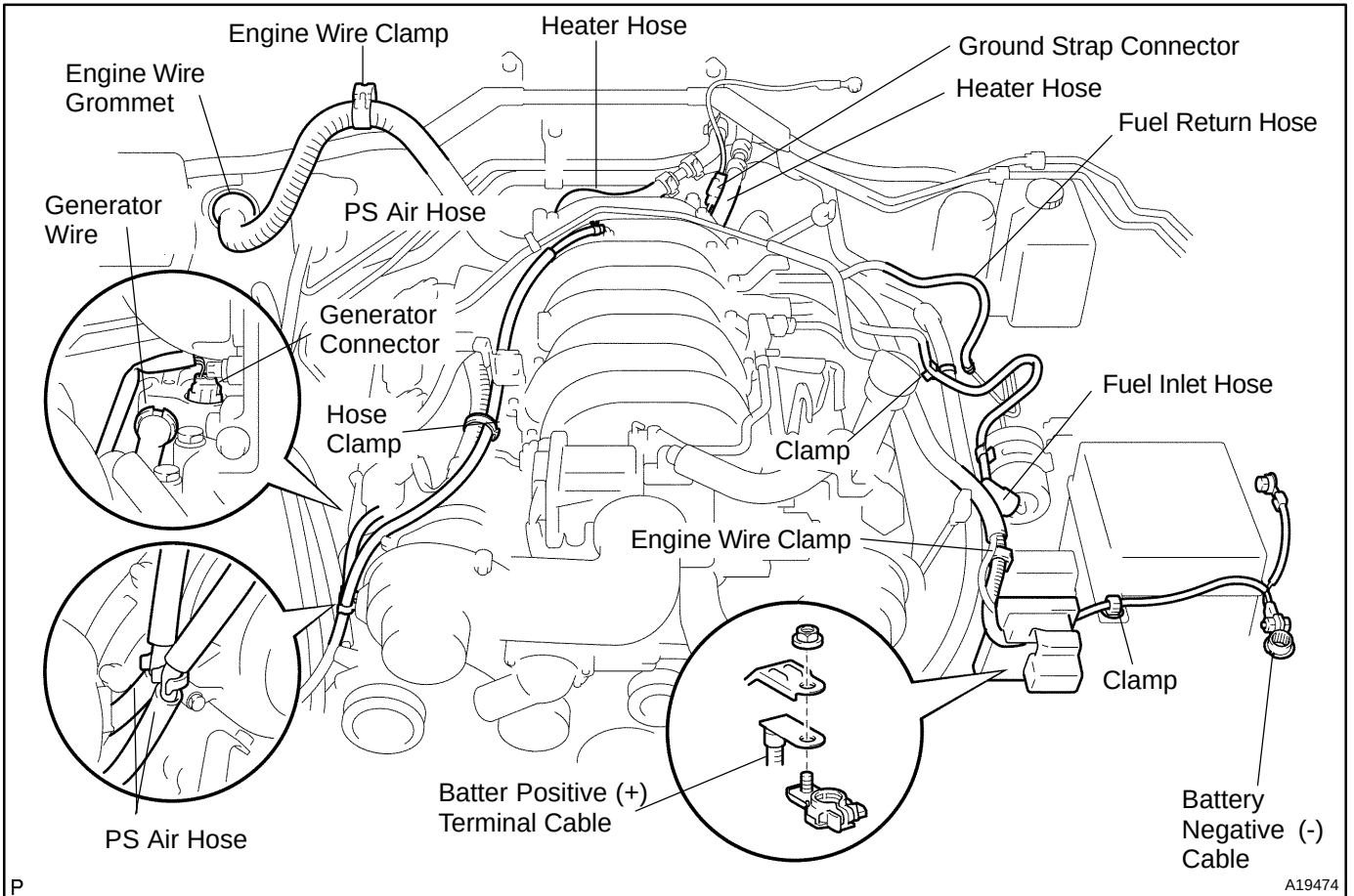
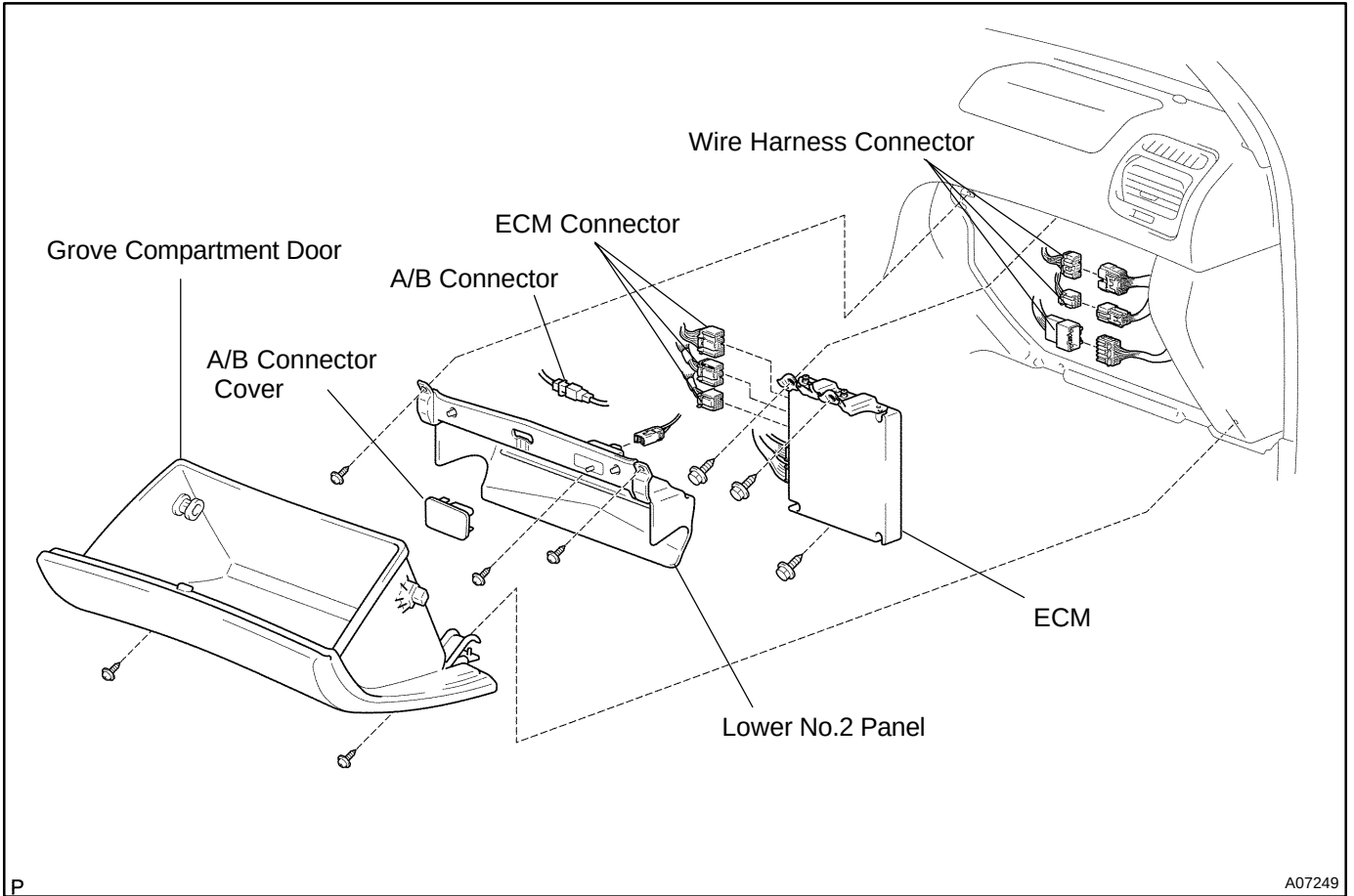
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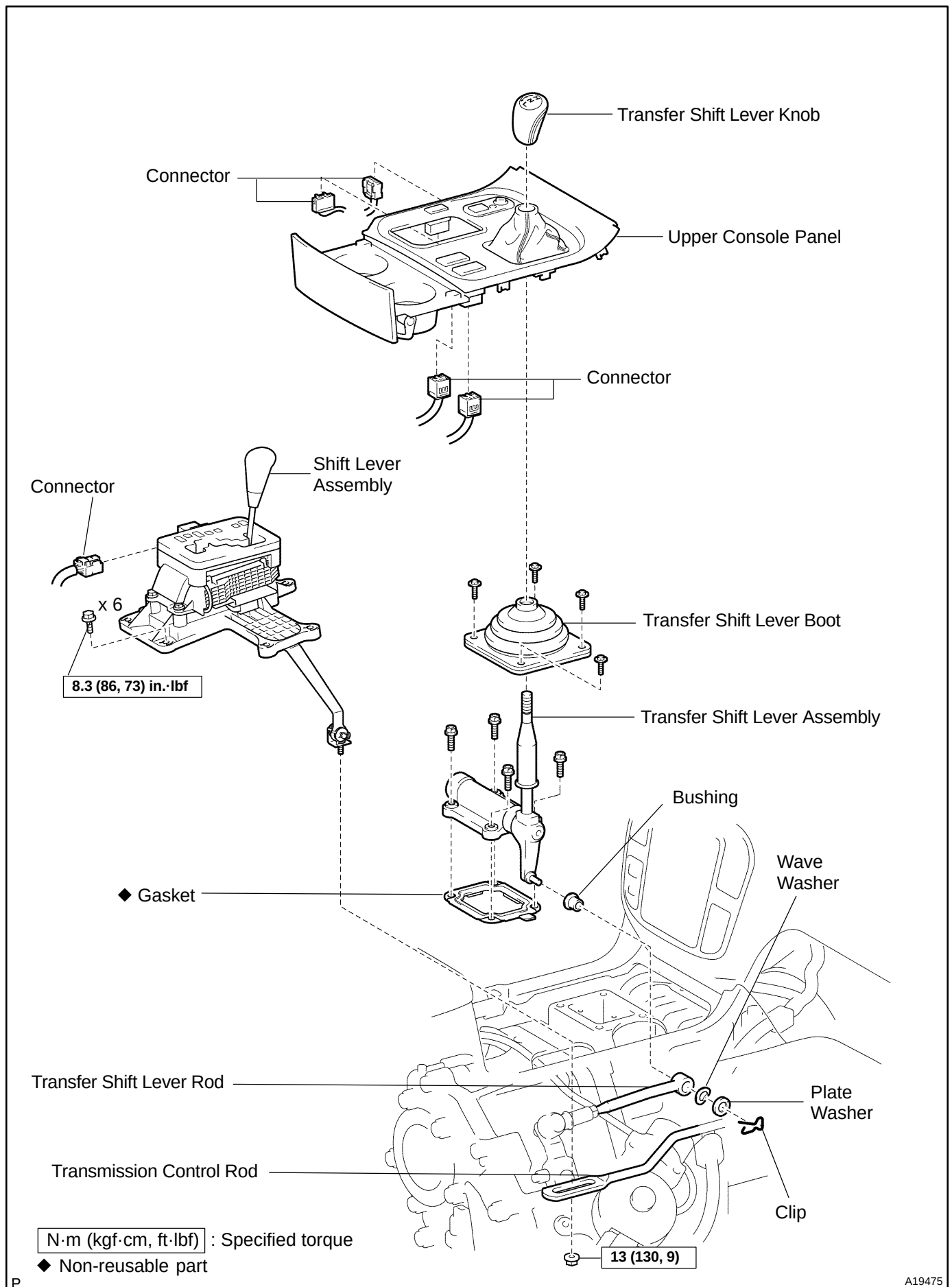




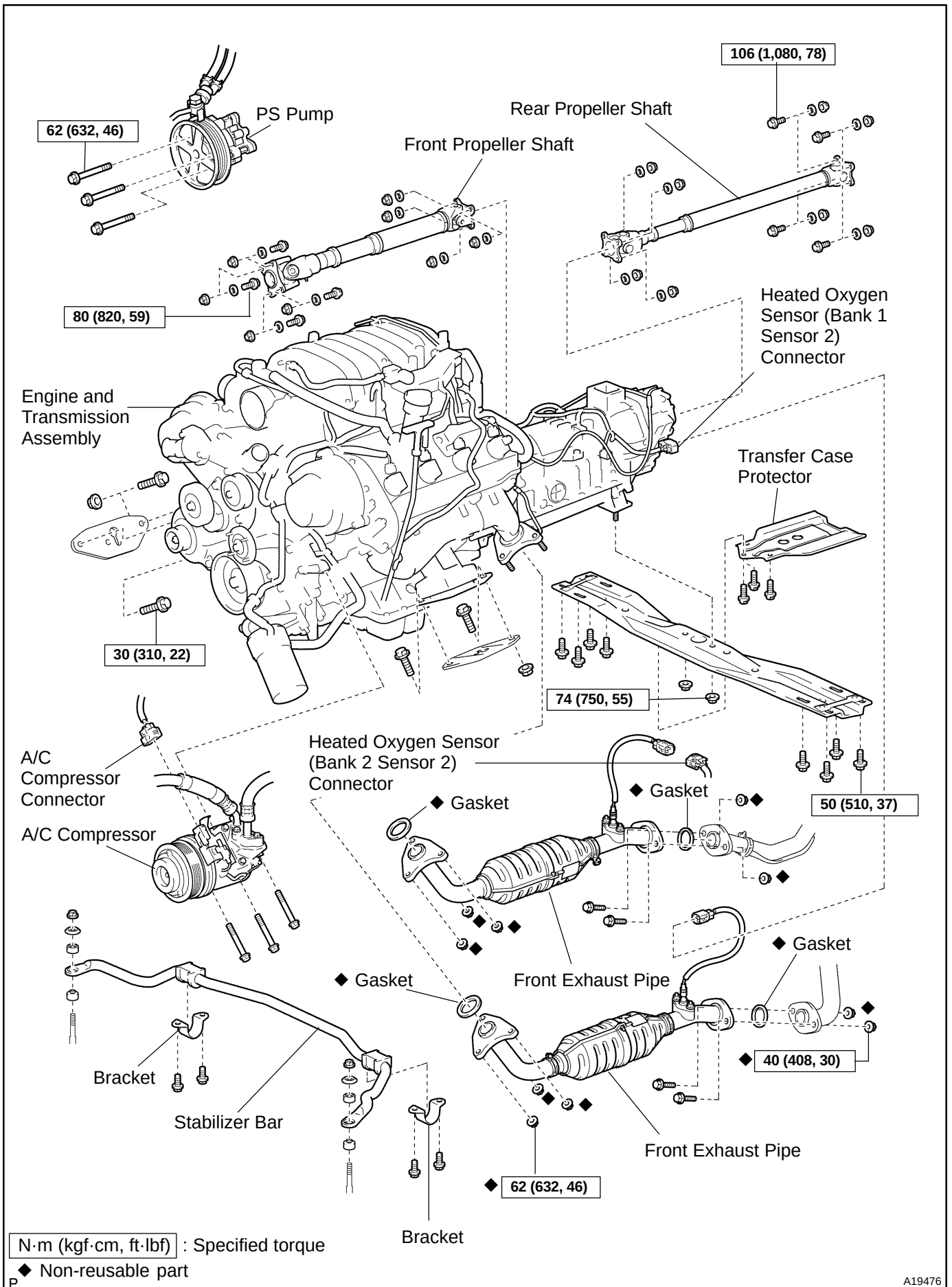
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A07248

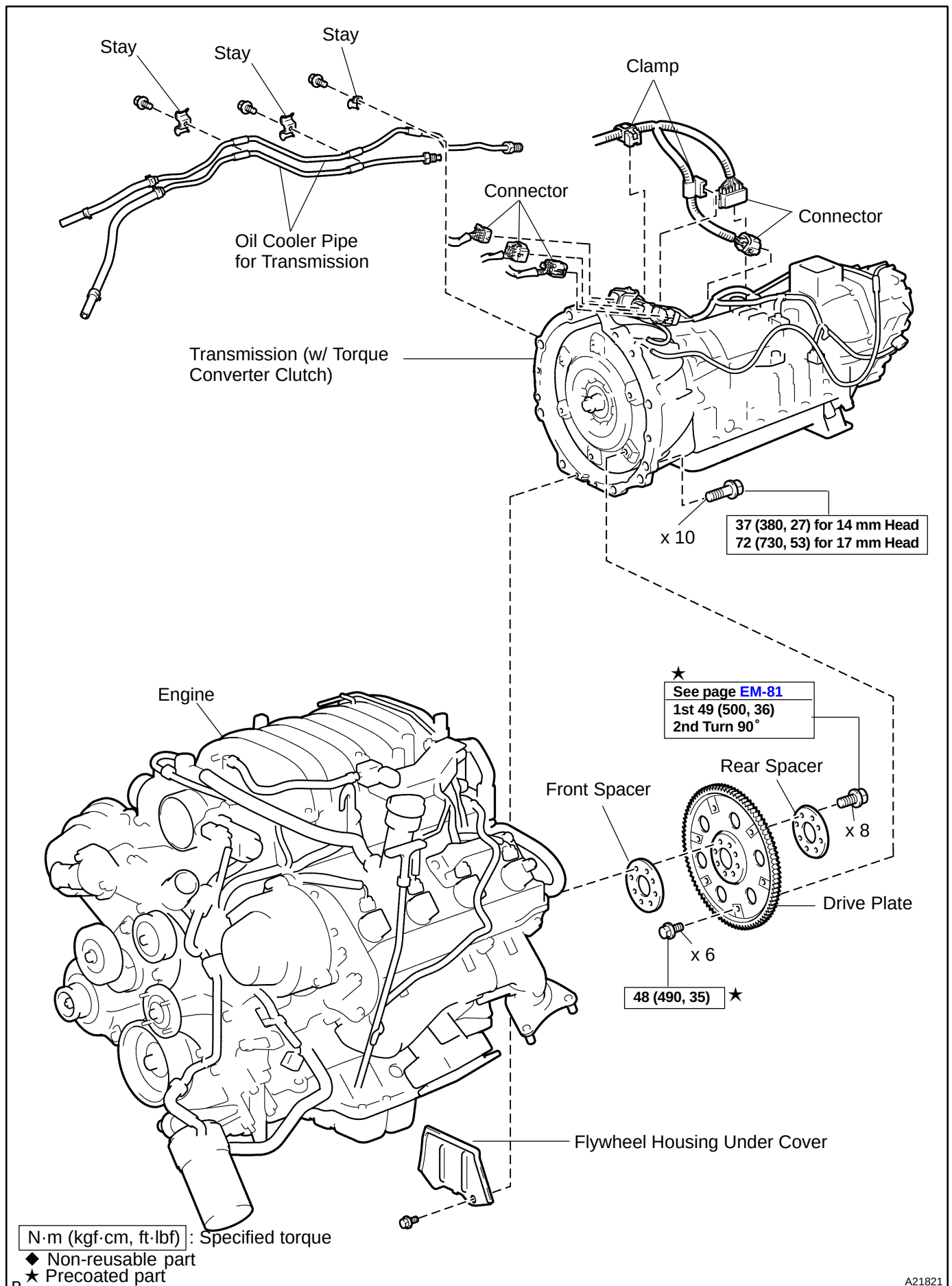




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A19476



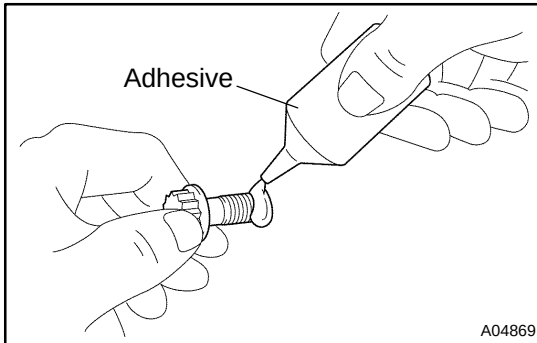
A21821

INSTALLATION

1. INSTALL DRIVE PLATE

HINT:

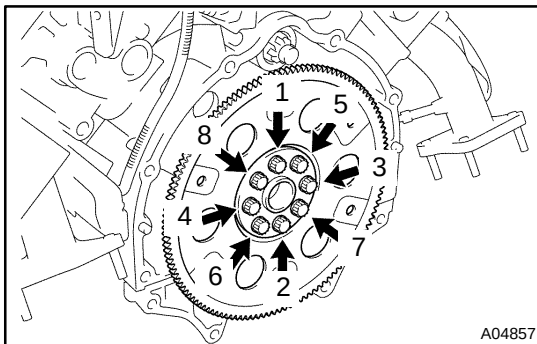
- ★ The mounting bolts are tightened in 2 steps (steps (c) and (e)).
- ★ If any one of the mounting bolts is broken or deformed, replace it.



- (a) Apply adhesive to 2 or 3 threads of the mounting bolt end.

Adhesive:

Part No. 08833-00070, THREE BOND 1324 or equivalent

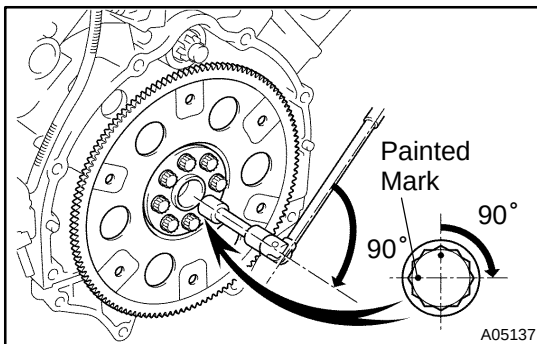


- (b) Install the front spacer, the drive plate and the rear spacer on the crankshaft.

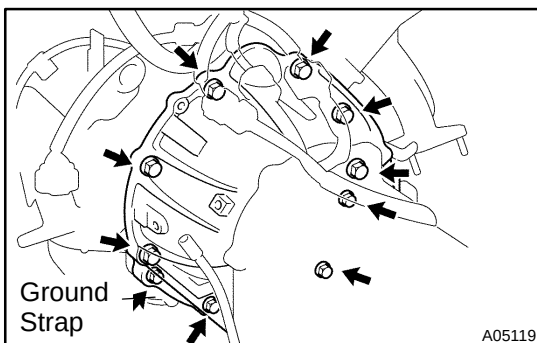
- (c) Hold the crankshaft pulley bolt with a wrench, and install and evenly tighten the 8 mounting bolts, a little at a time for several times as in the sequence shown.

Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

If any one of the mounting bolts does not meet the torque specification, replace the mounting bolt.



- (d) Mark the mounting bolt with paint.
- (e) Retighten the mounting bolts by 90° in the numerical order shown.
- (f) Check that the painted mark is now at a 90° angle to (e).



2. INSTALL TRANSMISSION TO ENGINE

- (a) Check the torque converter clutch installation.
(See page [AT-33](#))

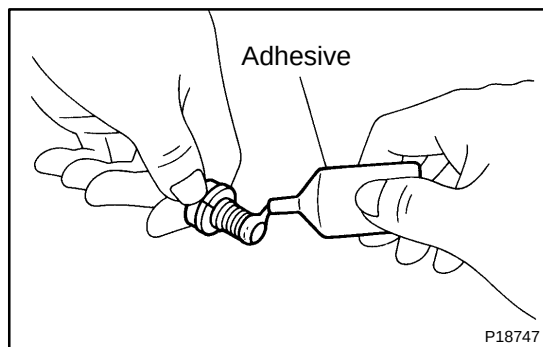
- (b) Attach the transmission to the engine.

- (c) Install the ground strap and 10 bolts.

Torque:

37 N·m (380 kgf·cm, 27 ft·lbf) for 14 mm head

72 N·m (730 kgf·cm, 53 ft·lbf) for 17 mm head

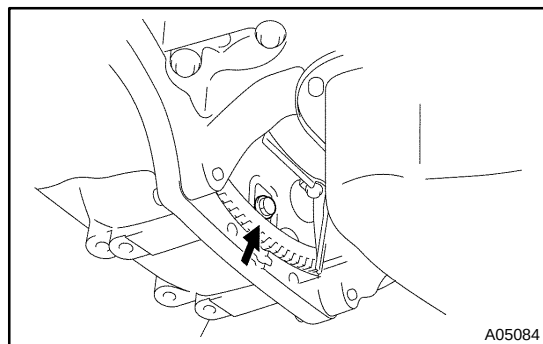


3. INSTALL TORQUE CONVERTER CLUTCH BOLTS

- (a) Apply adhesive to 2 or 3 threads from the bolt end.

Adhesive:

Part No. 08833-00070, THREE BOND 1324 or equivalent

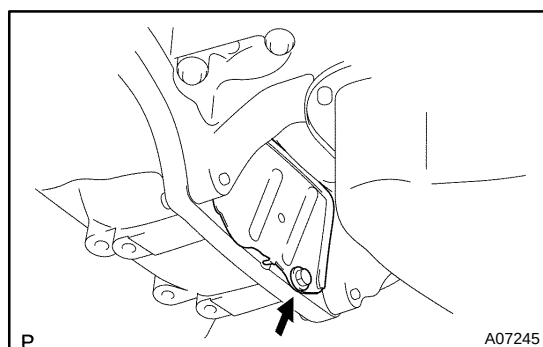


- (b) Hold the crankshaft pulley bolt with a wrench, and install the 6 bolts evenly.

Torque: 48 N·m (490 kgf·cm, 35 ft·lbf)

HINT:

First install the black colored bolt, install the other bolts.



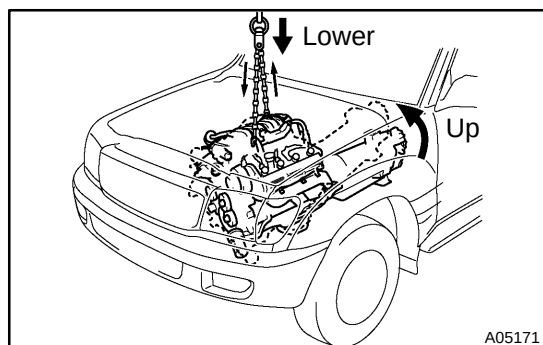
- (c) Install the flywheel housing under cover with the bolt.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

4. INSTALL OIL COOLER PIPE FOR TRANSMISSION

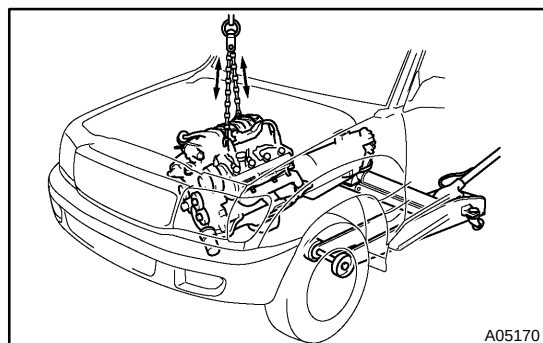
5. CONNECT ENGINE WIRE TO TRANSMISSION

- (a) Connect the 5 connectors.
(b) Connect the 2 wire clamps.

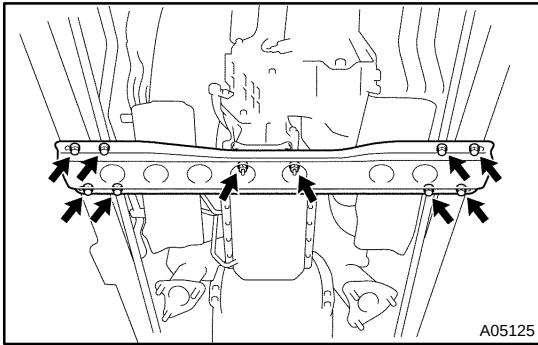


6. INSTALL ENGINE AND TRANSMISSION ASSEMBLY IN VEHICLE

- (a) Attach the engine chain hoist to the engine hangers.
(b) Slowly lower the engine and the transmission assembly into the engine compartment.
(c) Attach the engine mounting brackets to the frame brackets.



- (d) Keep the engine level with a jack.



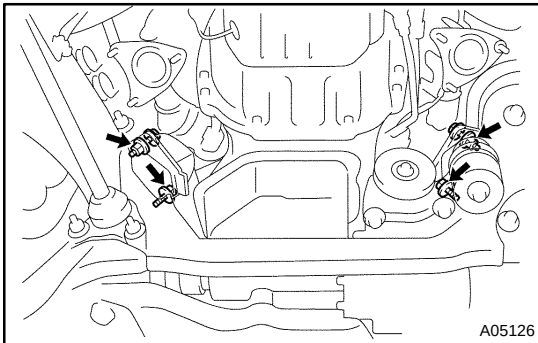
- (e) Install the frame crossmember with the 8 bolts and the 4 nuts.

Torque:

50 N·m (510 kgf·cm, 37 ft·lbf) for bolts

74 N·m (750 kgf·cm, 55 ft·lbf) for nuts

- (f) Install the transfer case protector with the 3 bolts.



- (g) Install the 2 nuts and the 4 bolts holding the engine mounting brackets to the frame brackets.

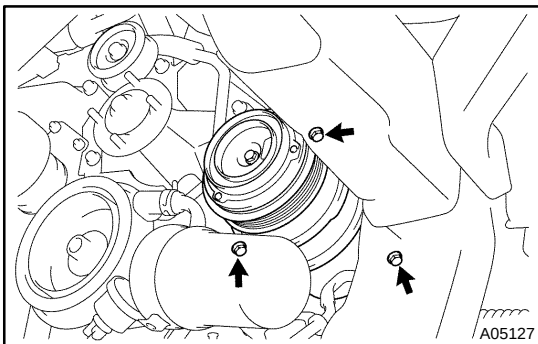
Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)

- (h) Remove the engine chain hoist.

7. INSTALL PS PUMP

Install the PS pump with the 3 bolts.

Torque: 62 N·m (632 kgf·cm, 46 ft·lbf)



8. INSTALL A/C COMPRESSOR

- (a) Install the A/C compressor with the 3 bolts.

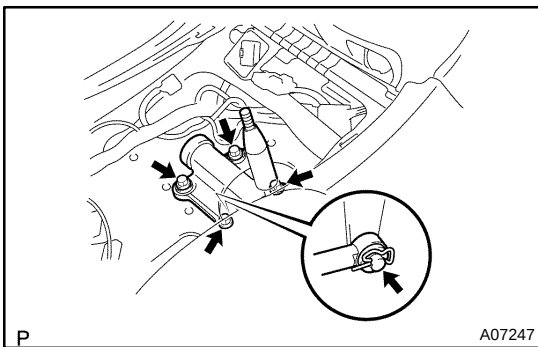
Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

- (b) Connect the A/C compressor connector.

9. INSTALL STABILIZER BAR (See page SA-82)

10. INSTALL PROPELLER SHAFT (See page PR-7)

11. INSTALL FRONT EXHAUST PIPES



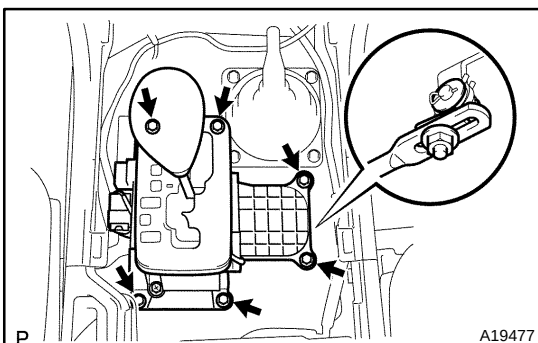
12. INSTALL SHIFT LEVER ASSEMBLY AND TRANSFER SHIFT LEVER ASSEMBLY

- (a) Install the transfer shift lever.

- (1) Install a new gasket and the shift lever with the 4 bolts.

- (2) Connect the transfer shift lever rod to the shift lever with the bushing, the wave washer, the plate washer and the clip.

- (b) Install the transfer shift lever boot with the 4 bolts.



- (c) Install the shift lever assembly.

- (1) Connect the transmission control rod to the shift lever assembly with the nut.

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

- (2) Install the shift lever assembly with the 6 bolts.

Torque: 8.3 N·m (86 kgf·cm, 73 in·lbf)

- (3) Connect the connector.

- (d) Install the console upper cover.

- (e) Install the transfer shift lever knob.

13. CONNECT HOSES, WIRES, CONNECTORS, CLAMPS, GROMMET AND CABLES

- (a) Connect the 2 PS air hoses to the hose clamp on the No.3 RH timing belt cover.
- (b) Connect the generator wire.
- (c) Connect the generator connector.
- (d) Connect the hose clamp for the PS air hose.
- (e) Connect the PS air hose to upper intake manifold.
- (f) Connect the 2 heater hoses.
- (g) Connect the engine wire clamp to the bracket on the cowl panel.
- (h) Connect the engine wire grommet to the cowl panel.
- (i) Connect the ground strap connector.
- (j) Connect the fuel main hose and the clamps.
- (k) Connect the fuel return hose and the clamp.
- (l) Connect the air inlet hose to the charcoal canister.
- (m) Connect the EVAP hose to the charcoal canister.
- (n) Connect the engine wire to the clamp on the right fender apron.
- (o) Connect the clamp on battery negative (-) cable to the relay box.
- (p) Connect the battery negative (-) cable to the right fender apron.
- (q) Connect the battery positive (+) terminal cable.

14. CONNECT ENGINE WIRE TO CABIN

- (a) Connect the 3 wire harness connectors.
- (b) Install the ECM with the 3 screws.
- (c) Connect the 3 connectors to the ECM.
- (d) Install the glove compartment door.
- (e) Install the lower No.2 panel.

15. INSTALL FAN PULLEY, FAN, FLUID COUPLING AND GENERATOR DRIVE BELT

- (a) Temporarily install the fan pulley, the fan and the fluid coupling assembly with the 4 nuts.
- (b) Install the generator drive belt. (See page [CH-16](#))
- (c) Tighten the 4 nuts holding the fluid coupling to the fan bracket.

16. INSTALL RADIATOR AND FAN SHROUD

- (a) Place the fan shroud in the installation position.
- (b) Install the radiator with the 2 support collars, the 2 nuts and the 2 bolts.
- (c) Connect the 2 A/T oil cooler hoses to the radiator.
- (d) Install the lower radiator hose.
- (e) Attach the lower side of the fan shroud to the brackets of the radiator, and install the fan shroud with the 2 bolts.
- (f) Install the 2 brackets on the wire to the radiator with the 2 bolts.
- (g) Install the 2 clamps on the A/C discharge tube to the brackets on the wire with the 2 nuts.

- (h) Connect the upper radiator hose to the front water bypass joint.

17. INSTALL RADIATOR RESERVOIR

- (a) Install the grommet to the reservoir.
- (b) Attach the lower side of the reservoir to the fan shroud.
- (c) Install the reservoir with the 2 bolts.
- (d) Connect the reservoir hose to the radiator.
- (e) Install the clamp on the wire to the reservoir.

18. INSTALL AIR CLEANER CAP AND INTAKE AIR CONNECTOR PIPE ASSEMBLY

19. INSTALL BATTERY

20. FILL WITH ENGINE COOLANT (See page [CO-2](#))

21. FILL WITH ENGINE OIL (See page [LU-2](#))

22. START ENGINE AND CHECK FOR LEAKS

23. INSTALL V-BANK COVER

24. INSTALL ENGINE UNDER COVERS

25. INSTALL HOOD

26. PERFORM ROAD TEST

Check for abnormal noise, shock, slippage, and make sure the shift points is correct and operation is smooth.

27. RECHECK ENGINE COOLANT AND OIL LEVELS

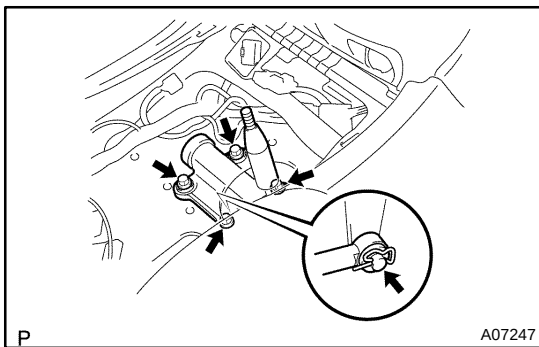
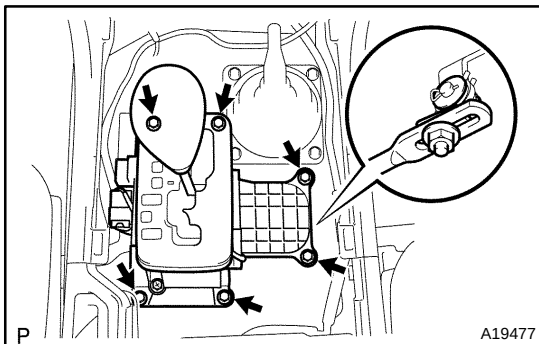
REMOVAL

- 1. REMOVE HOOD**
- 2. REMOVE ENGINE UNDER COVERS**
- 3. DRAIN ENGINE COOLANT**
- 4. DRAIN ENGINE OIL**
- 5. REMOVE V-BANK COVER**
- 6. REMOVE BATTERY**
- 7. REMOVE AIR CLEANER CAP AND INTAKE AIR CONNECTOR PIPE ASSEMBLY**
- 8. REMOVE RADIATOR RESERVOIR**
 - (a) Disconnect the clamp on the wire from the reservoir.
 - (b) Disconnect the reservoir hose from the radiator.
 - (c) Remove the 2 bolts, the reservoir and the grommet.
- 9. REMOVE RADIATOR AND FAN SHROUD**
 - (a) Disconnect the upper radiator hose from the front water bypass joint.
 - (b) Remove the 2 nuts, and disconnect the 2 clamps on the A/C discharge tube from the bracket.
 - (c) Remove the 2 bolts, and disconnect the 2 brackets on the wire from the radiator.
 - (d) Remove the 3 bolts, and disconnect the fan shroud from the radiator.
 - (e) Remove the lower radiator hose.
 - (f) Disconnect the 2 A/T oil cooler hoses from the radiator.
 - (g) Remove the 2 bolts, the 2 nuts, the 2 support collars and the radiator.
 - (h) Remove the fan shroud.
- 10. REMOVE GENERATOR DRIVE BELT, FAN, FLUID COUPLING AND FAN PULLEY**
 - (a) Loosen the 4 nuts holding the fluid coupling to the fan bracket.
 - (b) Remove the generator drive belt. (See page [CH-7](#))
 - (c) Remove the 4 nuts, the fan, the fluid coupling assembly and the fan pulley.
- 11. DISCONNECT ENGINE WIRE FROM CABIN**
 - (a) Remove the glove compartment door.
 - (b) Remove the lower No.2 panel.
 - (c) Disconnect the 3 connectors from the ECM.
 - (d) Remove the 3 screws, and disconnect ECM from the body bracket.
 - (e) Disconnect the 3 wire harness connectors.
- 12. DISCONNECT HOSES, WIRES, CONNECTORS, CLAMPS, GROMMET AND CABLES**
 - (a) Disconnect the 2 PS air hoses from the hose clamp on the No.3 RH timing belt cover.
 - (b) Disconnect the generator wire.
 - (c) Disconnect the generator connector.
 - (d) Disconnect the hose clamp for PS air hose.
 - (e) Disconnect the PS air hose from upper intake manifold.

- (f) Disconnect the 2 heater hoses.
- (g) Disconnect the engine wire clamp from the bracket on the cowl panel.
- (h) Disconnect the engine wire grommet from cowl panel.
- (i) Disconnect the ground strap connector.
- (j) Disconnect the fuel main hose and the clamps.
- (k) Disconnect the fuel return hose and the clamp.
- (l) Disconnect the air inlet hose from the charcoal canister.
- (m) Disconnect the EVAP hose from the charcoal canister.
- (n) Disconnect the engine wire from the clamp on the right fender apron.
- (o) Disconnect the clamp on battery negative (-) cable from the relay box.
- (p) Disconnect the battery negative (-) cable from the right fender apron.
- (q) Disconnect the battery positive (+) terminal cable.

13. REMOVE SHIFT LEVER ASSEMBLY AND TRANSFER SHIFT LEVER ASSEMBLY

- (a) Remove the transfer shift lever knob.
- (b) Remove the upper console panel.
- (c) Remove the shift lever assembly.
 - (1) Disconnect the connector.
 - (2) Remove the 6 bolts.
 - (3) Remove the nut and disconnect the transmission control rod from the shift lever assembly.
 - (4) Remove the shift lever assembly.
- (d) Remove the 4 bolts and the transfer shift lever boot.



- (e) Remove the transfer shift lever assembly.
 - (1) Remove the clip, the plate washer and the wave washer, and disconnect the transfer rod from the shift lever.
 - (2) Remove the bushing.
 - (3) Remove the 4 bolts, the shift lever and the gasket.

14. REMOVE FRONT EXHAUST PIPES

15. REMOVE PROPELLER SHAFT (See page [PR-4](#))

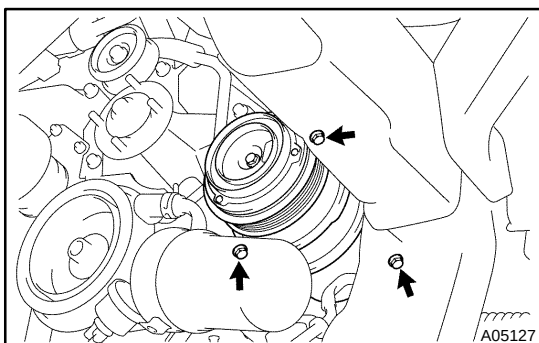
16. REMOVE STABILIZER BAR (See page [SA-81](#))

17. DISCONNECT A/C COMPRESSOR FROM ENGINE

- (a) Disconnect the A/C compressor connector.
- (b) Remove the 3 bolts, and disconnect the A/C compressor from the engine.

HINT:

Suspend the A/C compressor securely.

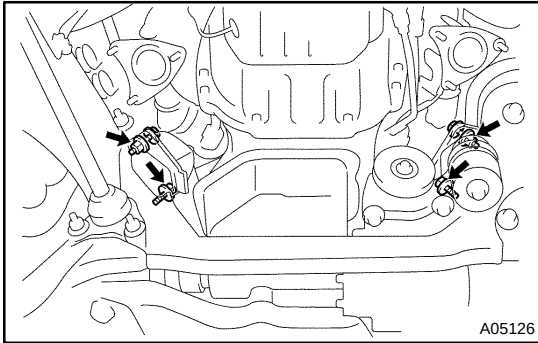


18. DISCONNECT PS PUMP FROM ENGINE

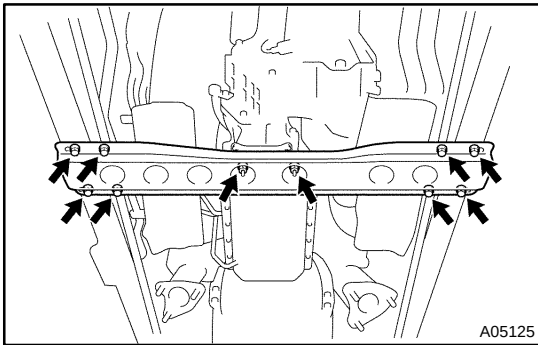
Remove the 3 bolts, and disconnect the PS pump from the engine.

HINT:

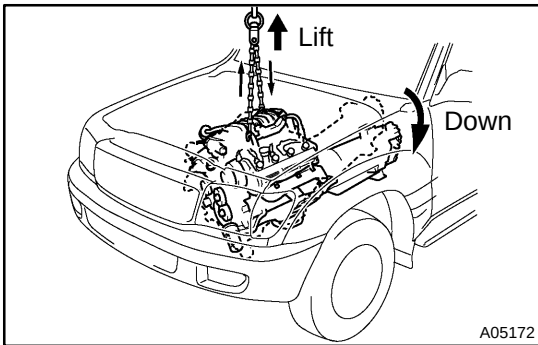
Suspend the PS pump securely.

**19. REMOVE ENGINE AND TRANSMISSION ASSEMBLY FROM VEHICLE**

- (a) Attach the engine chain hoist to the engine hangers.
- (b) Remove the 2 nuts and the 4 bolts holding the engine mounting brackets to the frame brackets.
- (c) Remove the 3 bolts and the transfer case protector.



- (d) Remove the 8 bolts, the 2 nuts and the frame crossmember.



- (e) Lift the engine and take out from the vehicle slowly and carefully.

HINT:

Make sure the engine is clear of all wiring, hoses and cables.

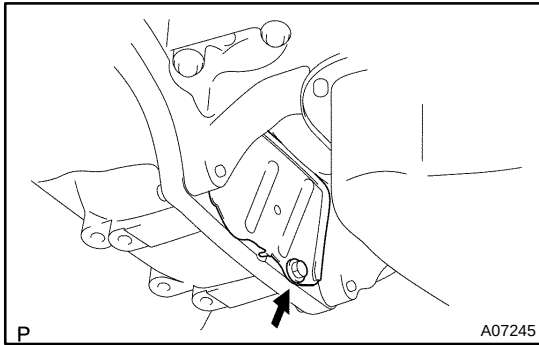
- (f) Place the engine and transmission assembly onto a stand.

20. DISCONNECT ENGINE WIRE FROM TRANSMISSION

- (a) Disconnect the 5 connectors.
- (b) Disconnect the 2 wire clamps.

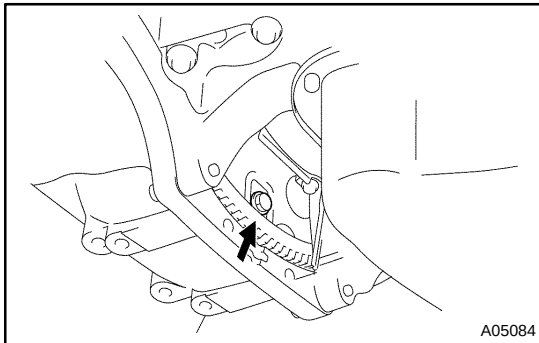
21. REMOVE OIL COOLER PIPES FOR TRANSMISSION

- (a) Remove the 3 bolts and the 3 stays.
- (b) Loosen the 2 union nuts, and remove the 2 oil cooler pipes.

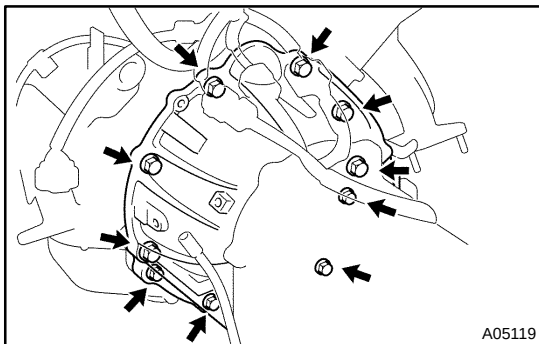


22. REMOVE TORQUE CONVERTER CLUTCH BOLTS

- (a) Remove the bolt and the flywheel housing under cover.

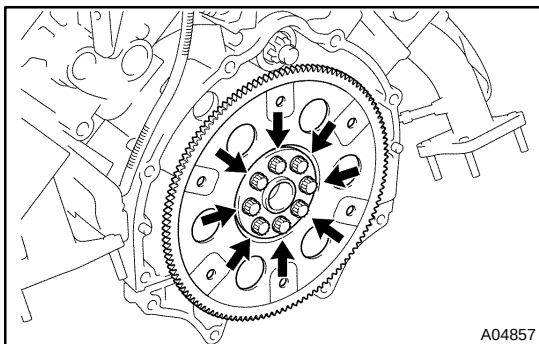


- (b) Turn the crankshaft pulley bolt to gain access to each bolt.
(c) Hold the crankshaft pulley bolt with a wrench, and remove the 6 bolts.



23. REMOVE TRANSMISSION

- (a) Remove the 10 bolts.
(b) Remove the transmission together with the torque converter clutch from the engine.



24. REMOVE DRIVE PLATE

Hold the crankshaft pulley bolt with a wrench, and remove the 8 bolts, the front spacer, the drive plate and the rear spacer.

EM0EE-18



IDLE SPEED

INSPECTION

EMOKU-10

1. INITIAL CONDITIONS

- (a) Engine is at normal operating temperature
- (b) Air cleaner is installed
- (c) All pipes and hoses of air induction systems are connected
- (d) All accessories are switched OFF
- (e) All vacuum lines are properly connected

HINT:

All vacuum hoses should be properly connected.

- (f) SFI system wiring connectors are fully plugged
- (g) Ignition timing is set correctly
- (h) Transmission is in neutral position
- (i) Air conditioning switches are OFF

2. CONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL (See page [EM-9](#))

3. INSPECT IDLE SPEED

- (a) Race the engine speed at 2,500 rpm for approx. 90 seconds.
- (b) Check the idle speed.

Idle speed: 700 ± 50 rpm

If the idle speed is not as specified, check the air intake system.

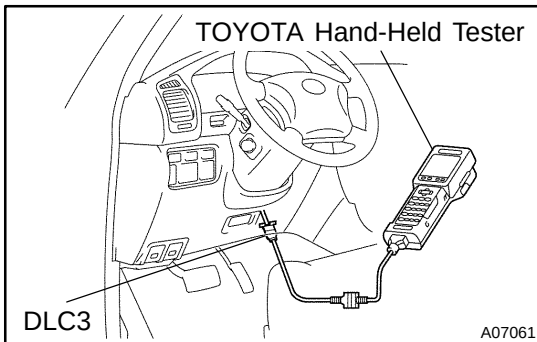
4. DISCONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

IGNITION TIMING INSPECTION

EMOKT-10

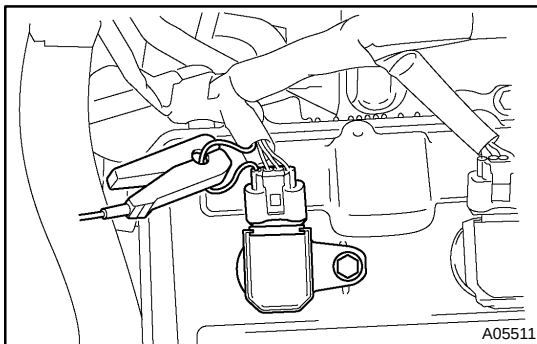
1. REMOVE BATTERY CLAMP COVER
2. REMOVE INTAKE AIR CONNECTOR
3. REMOVE V-BANK COVER
4. WARM UP ENGINE

Allow the engine to warm up to the normal operating temperature.



5. **CONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL**

- (a) Connect the TOYOTA hand-held tester or OBD II scan tool to the DLC3.
- (b) Please refer to the TOYOTA hand-held tester or OBD II scan tool operator's manual for further details.



6. **CONNECT TIMING LIGHT TO ENGINE**

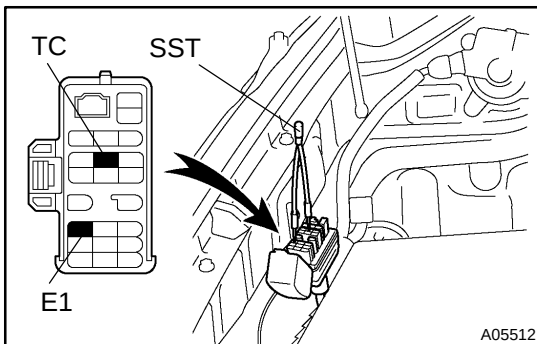
Connect the tester probe of a timing light to the wire of the ignition coil connector for No.1 cylinder.

7. **CHECK IDLE SPEED**

- (a) Race the engine speed at 2,500 rpm for approx. 90 seconds.
- (b) Check the idle speed.

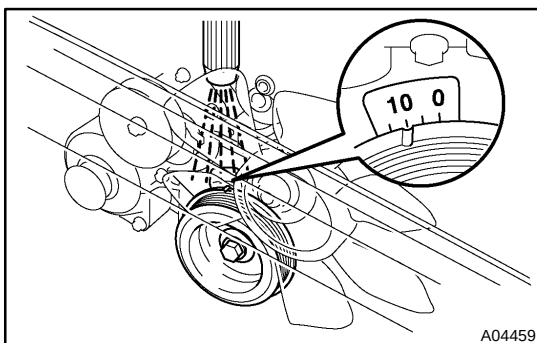
Idle speed:

700 ± 50 rpm



8. **INSPECT IGNITION TIMING**

- (a) Using SST, connect terminal TC and E1 of the DLC1.
SST 09843-18020



- (b) Using a timing light, check the ignition timing.

Ignition timing:

5 - 15° BTDC @ idle

(Transmission in neutral position)

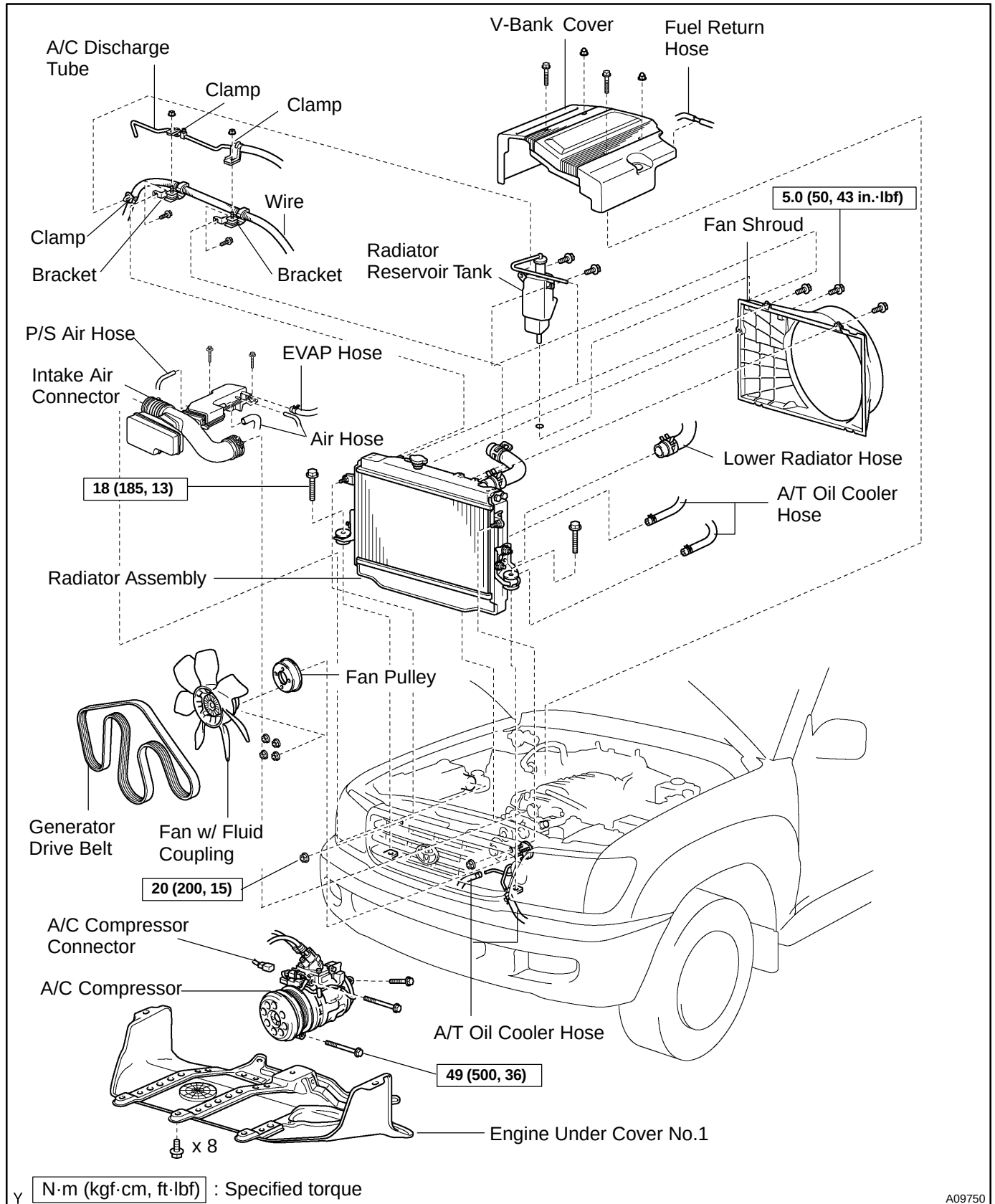
- (c) Remove SST from the DLC1.
SST 09843-18020

9. **DISCONNECT TIMING LIGHT FROM ENGINE**
10. **DISCONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL**

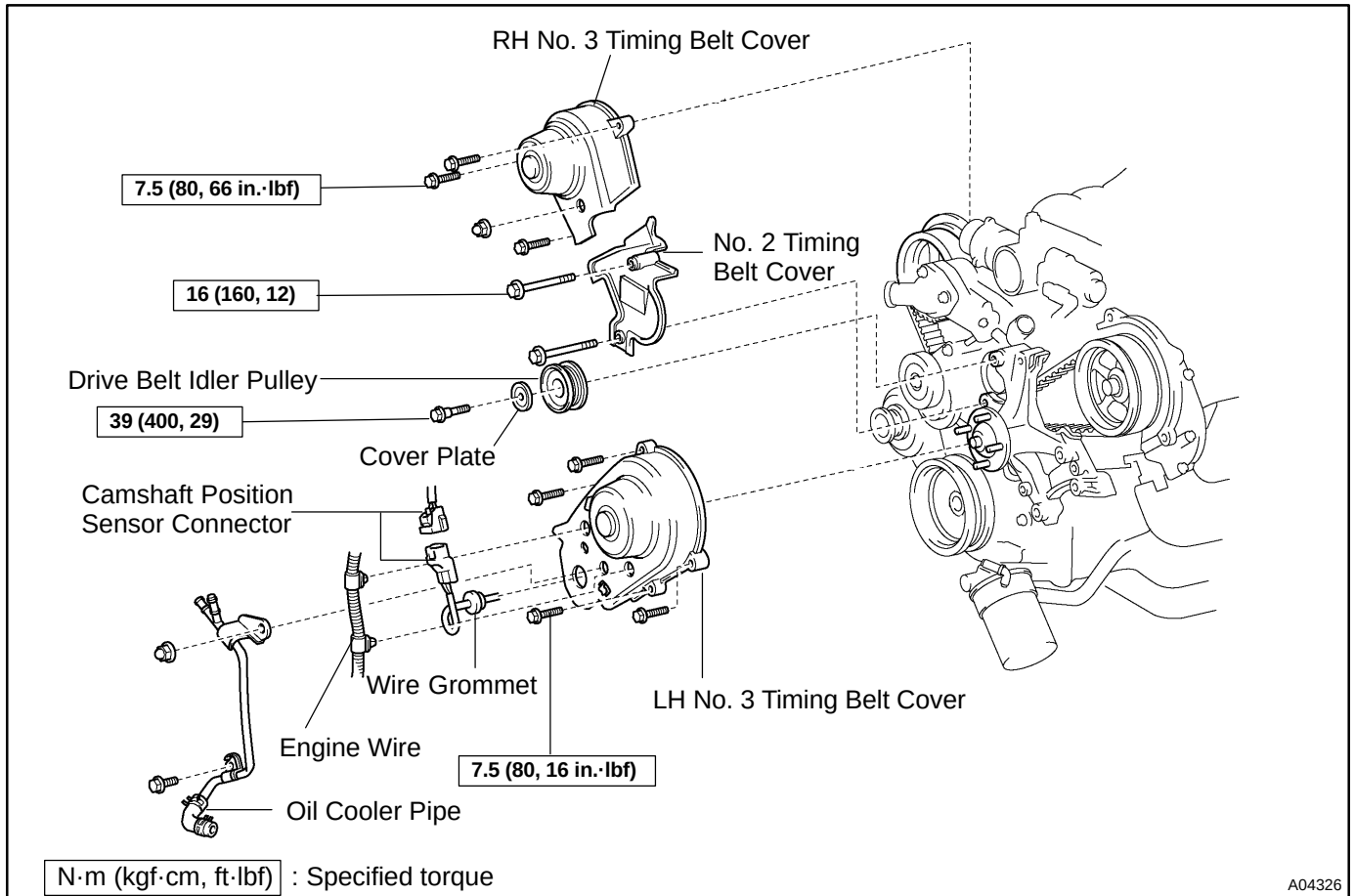
11. REINSTALL V-BANK COVER
12. REINSTALL INTAKE AIR CONNECTOR
13. REINSTALL BATTERY CLAMP COVER

TIMING BELT COMPONENTS

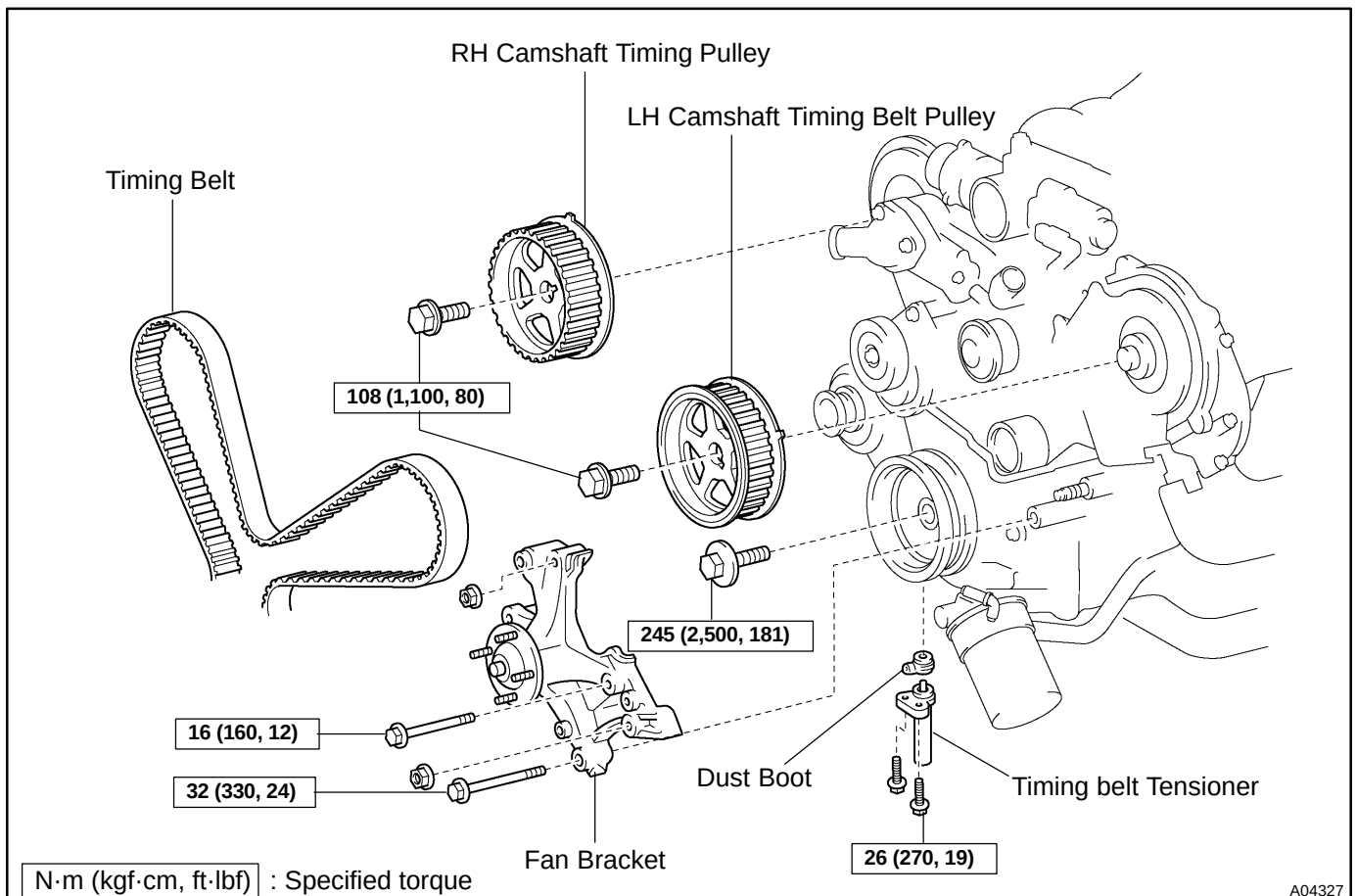
EMOKV-11



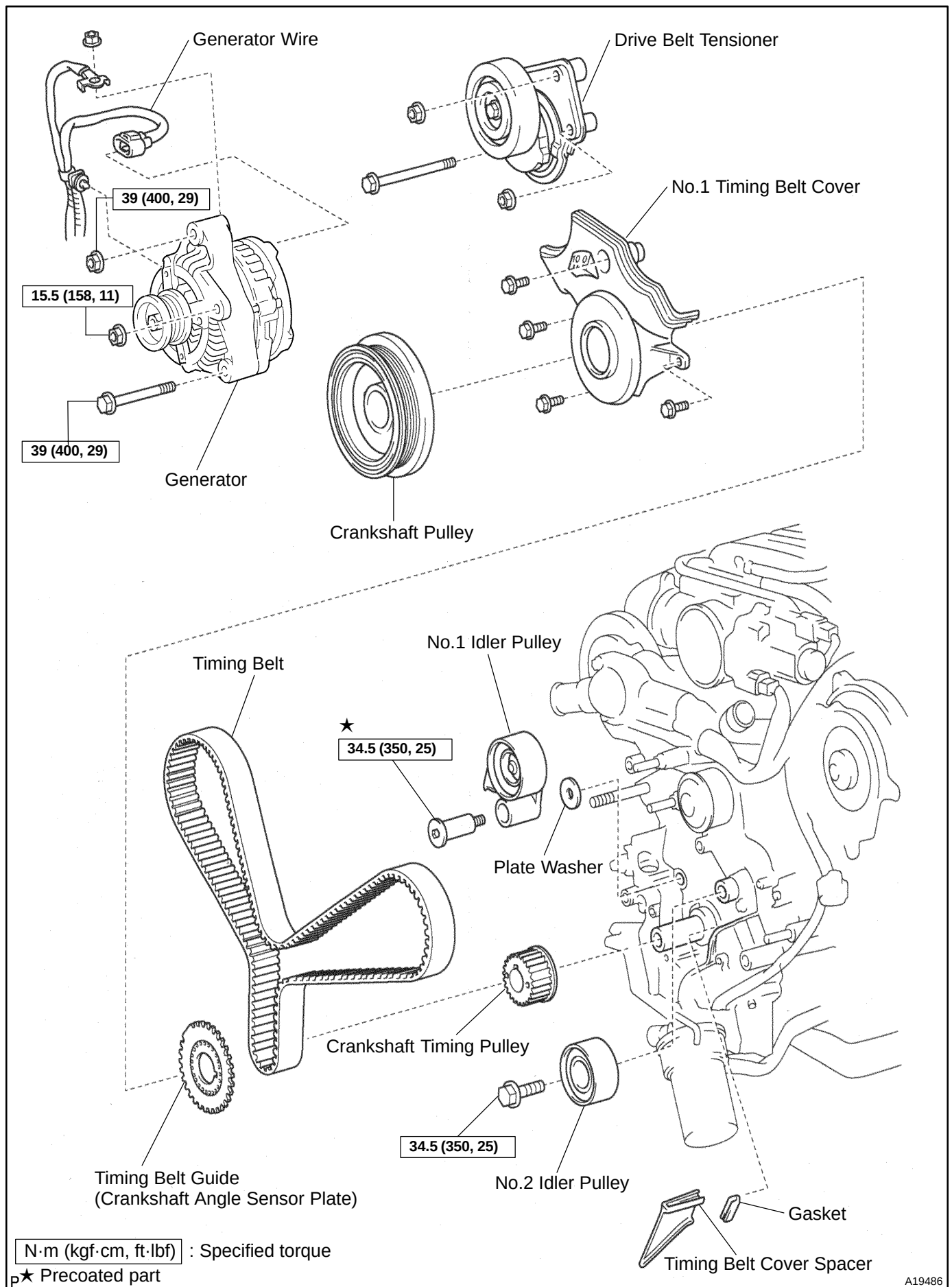
A09750



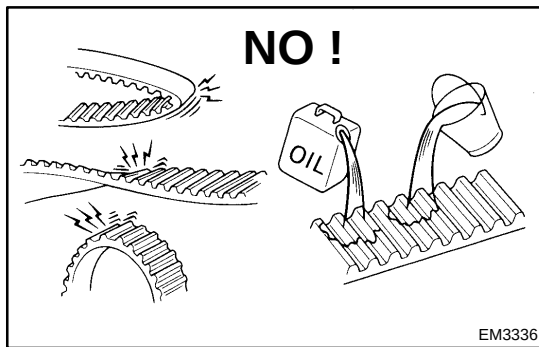
A04326



A04327



A19486



INSPECTION

1. INSPECT TIMING BELT

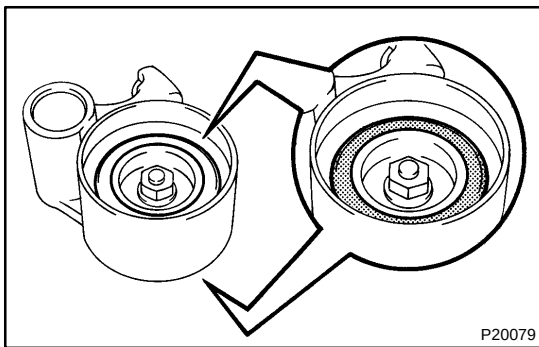
NOTICE:

- ★ Do not bend, twist or turn the timing belt inside out.
- ★ Do not allow the timing belt to contact with oil, water or steam.
- ★ Do not utilize timing belt tension when installing or removing the mount bolt of the camshaft timing pulley.

If there any defects as shown in the illustrations, check these points:

- (a) Premature parting
 - ★ Check for proper installation.
 - ★ Check the timing cover gasket for damage and proper installation.
- (b) If the belt teeth are cracked or damaged, check if either camshaft is locked.
- (c) If there is noticeable wear or cracks on the belt face, check if there are nicks on the side of the idler pulley lock and the water pump.
- (d) Even if there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.
- (e) If there is noticeable wear on the belt teeth, check timing cover for damage and for foreign materials on the pulley teeth.

If necessary, replace the timing belt.



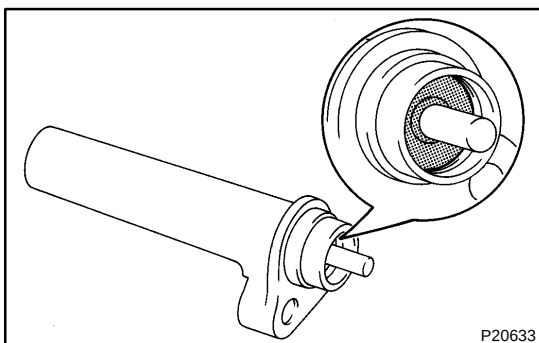
2. INSPECT IDLER PULLEYS

- (a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.

- (b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.



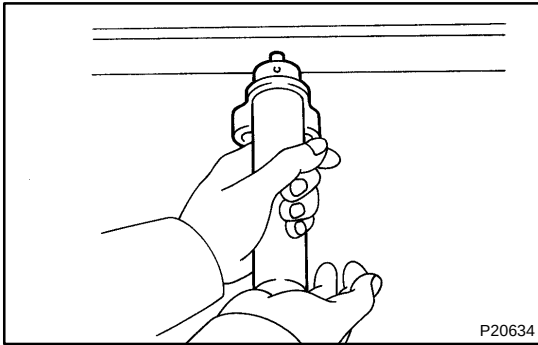
3. INSPECT TIMING BELT TENSIONER

- (a) Visually check the seal portion of the tensioner for oil leakage.

HINT:

If there is only the faintest trace of oil on the seal on the push rod side, the tensioner is all right.

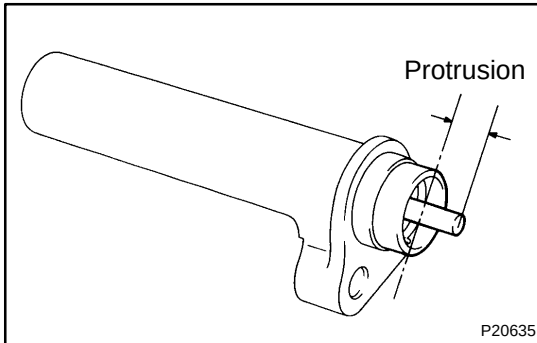
If leakage is found, replace the tensioner.



- (b) Hold the tensioner with both hands, and push the push rod strongly to check that it doesn't move. If the push rod moves, replace the tensioner.

NOTICE:

Never hold the tensioner push rod facing downward.



- (c) Measure the protrusion of the push rod from the housing end.

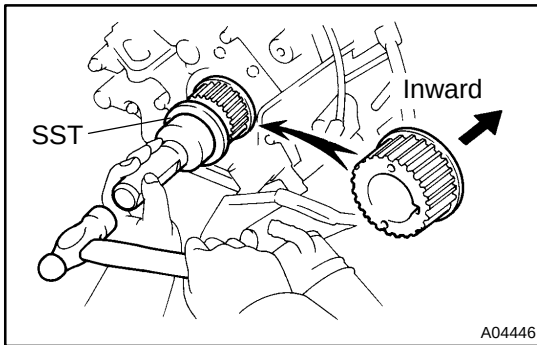
Protrusion:

10.5 - 11.5 mm (0.413 - 0.453 in.)

If the protrusion is not as specified, replace the tensioner.

4. INSPECT WATER PUMP

(See page [CO-7](#))

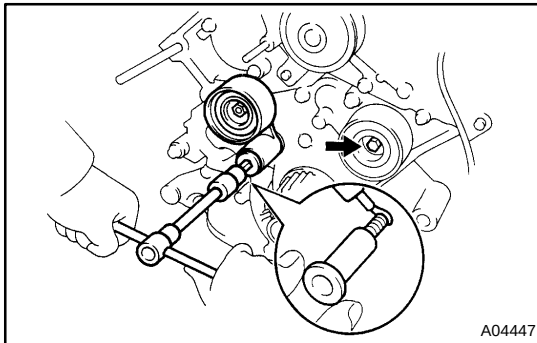


INSTALLATION

1. INSTALL CRANKSHAFT TIMING PULLEY

- Align the timing pulley set key with the key groove of the pulley.
- Using SST and a hammer, tap in the timing pulley, facing the flange side inward.

SST 09223-4601 1



2. INSTALL NO.1 IDLER PULLEY AND NO.2 IDLER PULLEY

- Apply adhesive 2 or 3 threads from the end of the pivot bolt.

Adhesive:

Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent

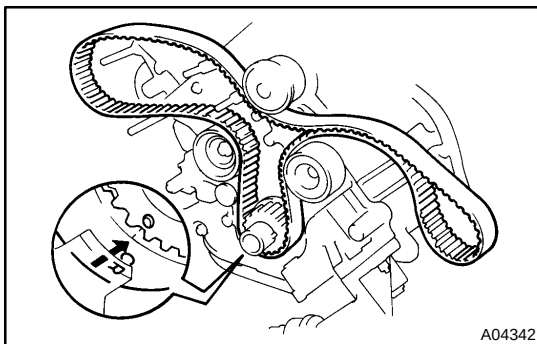
- Using a 10 mm hexagon wrench, install the plate washer and the No.1 idler pulley with the pivot bolt.

Torque: 34.5 N·m (350 kgf·cm, 25 ft·lbf)

- Install the No.2 idler pulley with the bolt.

Torque: 34.5 N·m (350 kgf·cm, 25 ft·lbf)

- Check that the No.1 and No.2 idler pulley moves smoothly.



3. TEMPORARILY INSTALL TIMING BELT

NOTICE:

The engine should be cold.

- Remove any oil or water on and clean the crankshaft pulley, the oil pump pulley, the water pump pulley, the No.1 idler pulley and the No.2 idler pulley.

NOTICE:

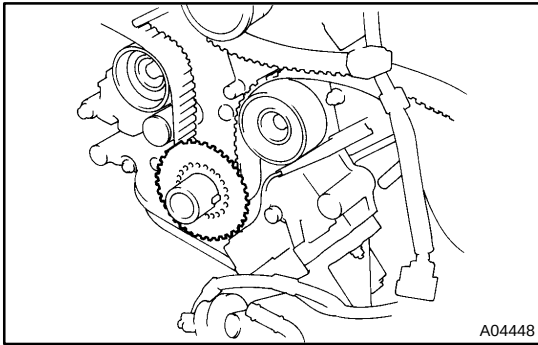
Only wipe the pulleys; do not use any cleansing agent.

- Align the installation mark on the timing belt with the timing mark of the crankshaft timing pulley.

- Install the timing belt on the crankshaft timing pulley, the No.1 idler pulley and the No.2 idler pulley.

4. INSTALL TIMING BELT COVER SPACER

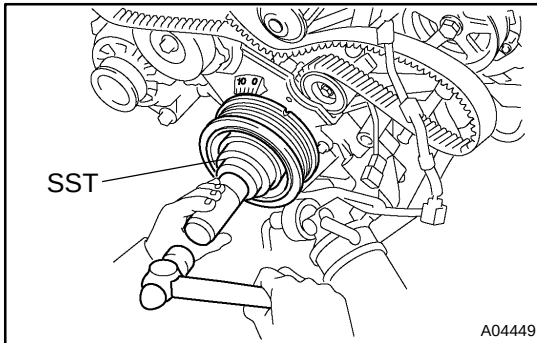
- Install the gasket to the cover spacer.
- Install the cover spacer.

**5. INSTALL TIMING BELT GUIDE**

Install the belt guide, facing the cup side outward.

6. INSTALL NO.1 TIMING BELT COVER

Install the timing belt cover with the 4 bolts.

**7. INSTALL CRANKSHAFT PULLEY**

(a) Align the pulley set key with the key groove of the crankshaft pulley.

(b) Using SST and a hammer, tap in the crankshaft pulley.
SST 09223-4601 1

8. INSTALL DRIVE BELT TENSIONER

Install the belt tensioner with the bolt and the 2 nuts.

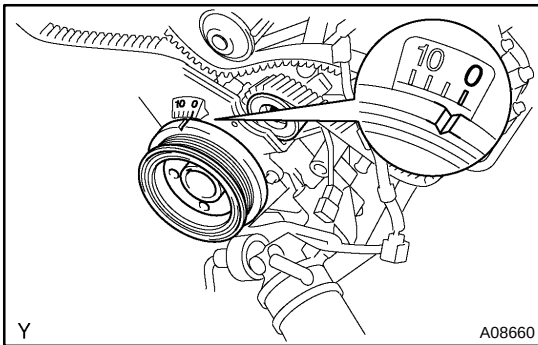
Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

HINT:

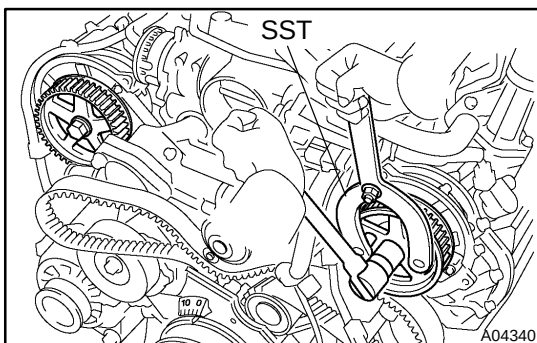
Use a bolt of 106 mm (4.18 in.) in length.

9. INSTALL GENERATOR

(See page [CH-16](#))

**10. CHECK CRANKSHAFT PULLEY POSITION**

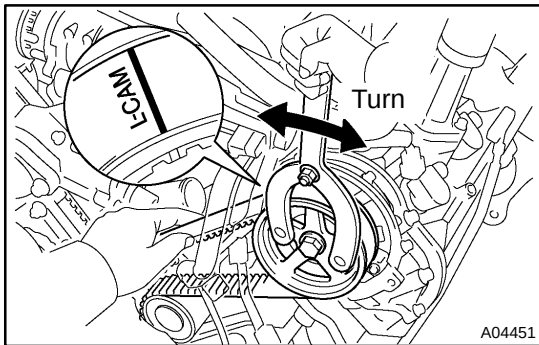
Check that the timing mark of the crankshaft pulley is aligned with the timing mark "0" of the No.1 timing belt cover.

**11. INSTALL RH, LH CAMSHAFT TIMING PULLEYS**

(a) Align the camshaft knock pin with the knock pin groove of the timing pulley, and slide on the timing pulley.

(b) Using SST, install the pulley bolt.
SST 09960-10010 (09962-01000, 09963-01000)

Torque: 108 N·m (1,100 kgf·cm, 80 ft·lbf)



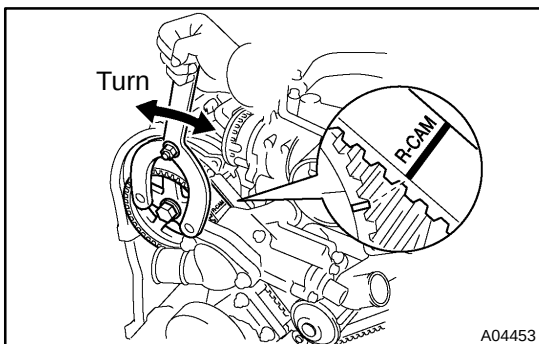
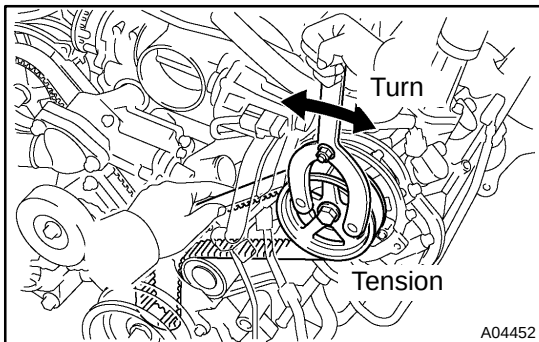
12. CONNECT TIMING BELT TO LH CAMSHAFT TIMING PULLEY

- (a) Remove any oil or water on the LH camshaft timing pulley, and clean it up.

NOTICE:

Only wipe the pulleys; do not use any cleansing agent.

- (b) Turn the LH camshaft timing pulley. Align the installation mark on the timing belt with the timing mark of the camshaft timing pulley, and hang the timing belt on the LH camshaft timing pulley.
- (c) Turn the LH camshaft timing pulley counterclockwise until there is tension between the crankshaft timing pulley and the LH camshaft timing pulley.



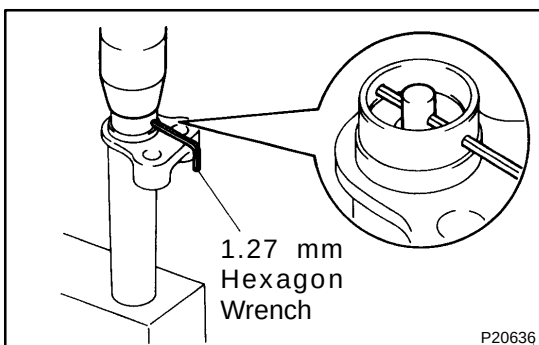
13. CONNECT TIMING BELT TO RH CAMSHAFT TIMING PULLEY

- (a) Remove any oil or water on the RH camshaft timing pulley and water pump pulley, and clean them up.

NOTICE:

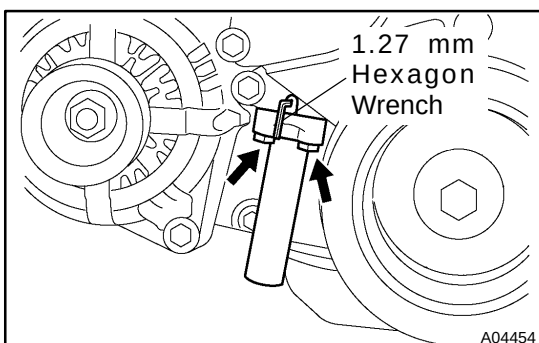
Only wipe the pulleys; do not use any cleansing agent.

- (b) Turn the RH camshaft timing pulley. Align the installation mark on the timing belt with the timing mark of the camshaft timing pulley, and hang the timing belt on the RH camshaft timing pulley.



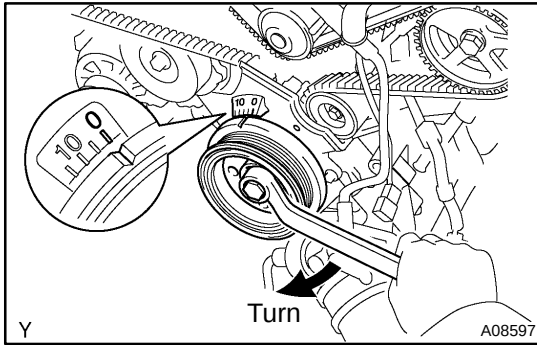
14. SET TIMING BELT TENSIONER

- (a) Using a press, slowly press in the push rod using 981 - 9,807 N (100 - 1,000 kgf, 220 - 2,205 lbf) of pressure.
- (b) Align the holes of the push rod and the housing, pass a 1.27 mm (0.050 in.) hexagon wrench through the holes to keep the setting position of the push rod.
- (c) Release the press.
- (d) Install the dust boot to the belt tensioner.



15. INSTALL TIMING BELT TENSIONER

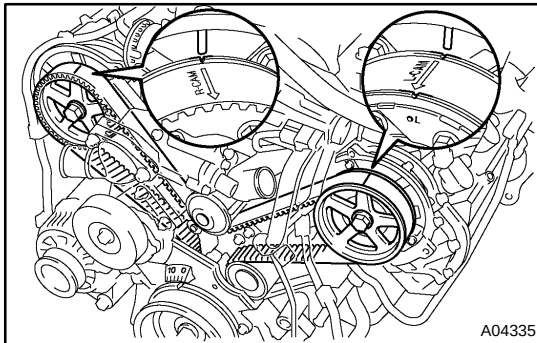
- (a) Temporarily install the belt tensioner with the 2 bolts.
- (b) Alternately tighten the 2 bolts.
Torque: 26 N·m (270 kgf·cm, 19 ft·lbf)
- (c) Using pliers, remove the 1.27 mm (0.050 in.) hexagon wrench from the belt tensioner.

**16. CHECK VALVE TIMING**

- (a) Temporarily install the crankshaft pulley bolt.
- (b) Slowly turn the crankshaft pulley 2 revolutions from TDC to TDC.

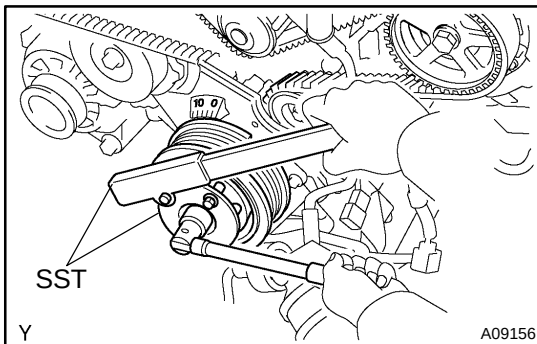
NOTICE:

Always turn the crankshaft pulley clockwise.



- (c) Check that each pulley aligns with the timing marks as shown in the illustration.

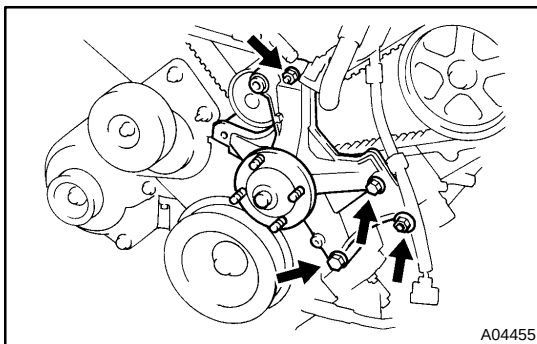
If the timing marks do not align, remove the timing belt and reinstall it.

**17. TIGHTEN CRANKSHAFT PULLEY BOLT**

Using SST, install the pulley bolt.

SST 09213-7001 1 (90105-70020),
09330-00021

Torque: 245 N·m (2,500 kgf·cm, 181 ft·lbf)

**18. INSTALL FAN BRACKET**

Install the fan bracket with the 2 bolts and the 2 nuts.

Torque:

12 mm head

16 N·m (160 kgf·cm, 12 ft·lbf)

14 mm head

32 N·m (330 kgf·cm, 24 ft·lbf)

HINT:

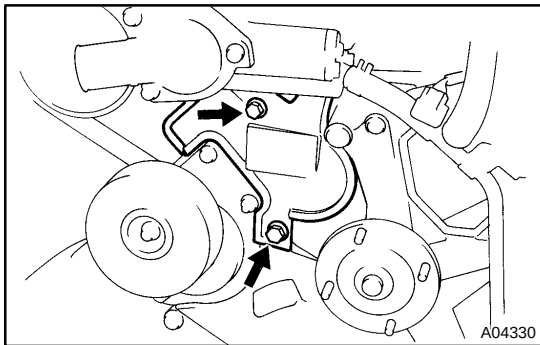
Bolt Length:

106 mm (4.17 in.) for 12 mm head (A)

114 mm (4.49 in.) for 14 mm head (B)

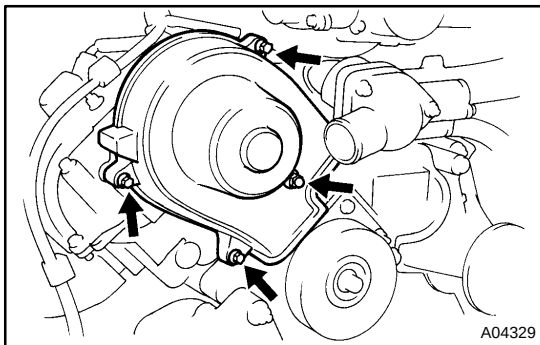
19. INSTALL A/C COMPRESSOR

(See page [EM-81](#))

**20. INSTALL NO.2 TIMING BELT COVER**

Install the No.2 timing belt cover with the 2 bolts.

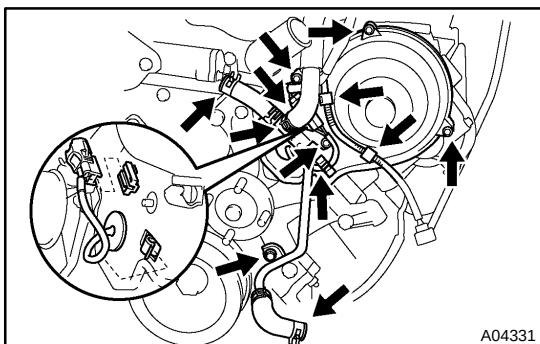
Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

**21. INSTALL RH NO.3 TIMING BELT COVER**

(a) Fit the RH No.3 timing belt cover, matching it with the fan bracket.

(b) Install the RH No.3 timing belt cover with the 3 bolts and nut.

Torque: 7.5 N·m (80 kgf·cm, 66 in·lbf)

**22. INSTALL LH NO.3 TIMING BELT COVER**

(a) Install the oil cooler pipe and the bolt.

(b) Run the camshaft position sensor wire through the LH No.3 timing belt cover hole.

(c) Fit the LH No.3 timing belt cover, matching it with the fan bracket.

(d) Install the LH No.3 timing belt cover with the 4 bolts and the nut.

Torque: 7.5 N·m (80 kgf·cm, 66 in·lbf)

(e) Install the wire grommet to the LH No.3 timing belt cover.

(f) Install the sensor connector to the connector bracket.

(g) Connect the sensor connector.

(h) Install the sensor wire to the wire clamp on the LH No.3 timing belt cover.

(i) Install the engine wire to the 2 wire clamps on the LH No.3 timing belt cover.

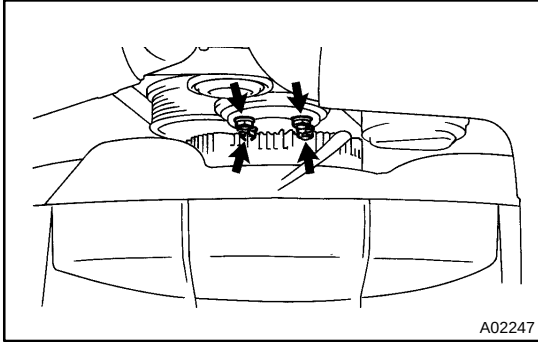
23. INSTALL DRIVE BELT IDLER PULLEY

Install the idler pulley and the cover plate with the bolt.

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)

24. INSTALL RADIATOR ASSEMBLY

(See page [CO-19](#))

**25. INSTALL FAN PULLEY, FAN, FLUID COUPLING AND DRIVE BELT**

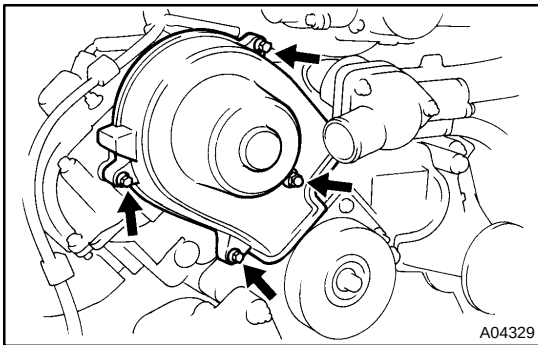
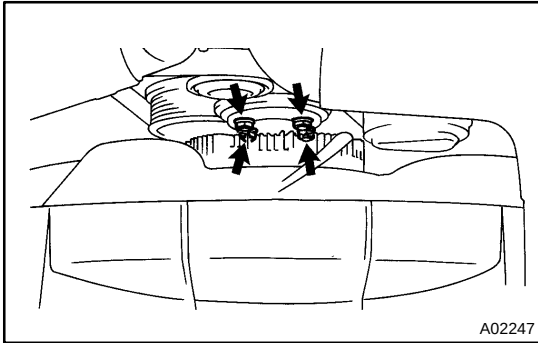
- (a) Temporarily install the fan pulley, the fan, fluid coupling assembly with the 4 nuts.
- (b) Install the generator drive belt.
(See page [CH-16](#))
- (c) Tighten the 4 nuts holding the fluid coupling to the fan bracket.

Torque: 21 N·m (215 kgf·cm, 16 ft·lbf)

26. INSTALL AIR CLEANER AND INTAKE AIR CONNECTOR ASSEMBLY**27. INSTALL V-BANK COVER****28. FILL WITH ENGINE COOLANT****29. START ENGINE AND CHECK FOR LEAKS****30. RECHECK ENGINE COOLANT LEVEL****31. INSTALL BATTERY CLAMP COVER****32. INSTALL ENGINE UNDER COVER****33. INSTALL OIL PAN PROTECTOR**

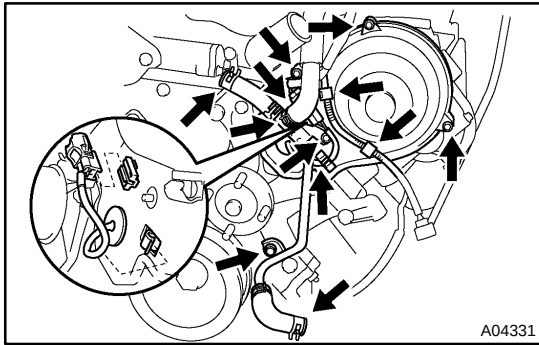
REMOVAL

1. REMOVE OIL PAN PROTECTOR
2. REMOVE ENGINE UNDER COVER
3. DRAIN ENGINE COOLANT
4. REMOVE BATTERY CLAMP COVER
5. REMOVE V-BANK COVER
 - (a) Remove the fuel return hose from the V-bank cover.
 - (b) Remove the 2 bolt, 2 cap nuts and V-bank cover.
6. REMOVE AIR CLEANER AND INTAKE AIR CONNECTOR ASSEMBLY
7. REMOVE DRIVE BELT, FAN, FLUID COUPLING AND FAN PULLEY
 - (a) Loosen the 4 nuts holding the fluid coupling to the fan bracket.
 - (b) Remove the generator drive belt.
(See page [CH-7](#))
 - (c) Remove the 4 nuts, the fan, the fluid coupling assembly and the fan pulley.
8. REMOVE RADIATOR ASSEMBLY
(See page [CO-17](#))
9. REMOVE DRIVE BELT IDLER PULLEY
Remove the pulley bolt, the cover plate and the idler pulley.

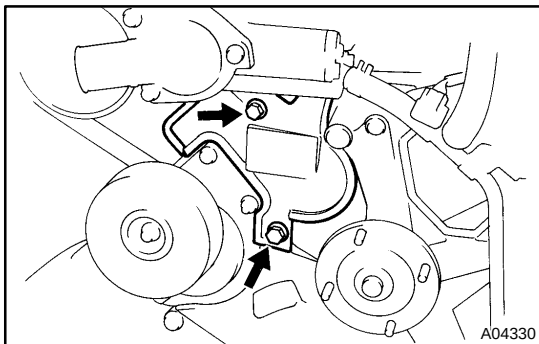


10. REMOVE RH NO.3 TIMING BELT COVER

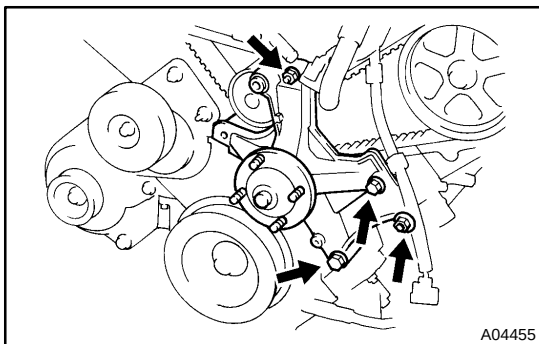
Remove the 3 bolts, the nut and the RH No.3 timing belt cover.

**11. REMOVE LH NO.3 TIMING BELT COVER**

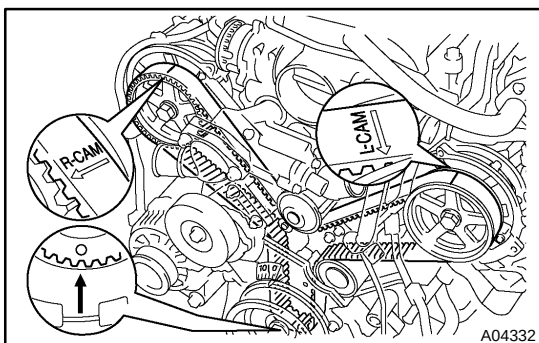
- (a) Disconnect the engine wire from the 2 wire clamps.
- (b) Remove the 4 bolts and the nut.
- (c) Disconnect the camshaft position sensor wire from the wire clamp on the LH No.3 timing belt cover.
- (d) Disconnect the sensor connector from the connector bracket.
- (e) Disconnect the camshaft position sensor connector.
- (f) Remove the wire grommet from the LH No.3 timing belt cover.
- (g) Remove the LH No.3 timing belt cover.
- (h) Remove the oil cooler pipe and the 2 bolts.

**12. REMOVE NO.2 TIMING BELT COVER**

Remove the 2 bolts and the No.2 timing belt cover.

13. DISCONNECT A/C COMPRESSOR FROM ENGINE
(See page [EM-77](#))**14. REMOVE FAN BRACKET**

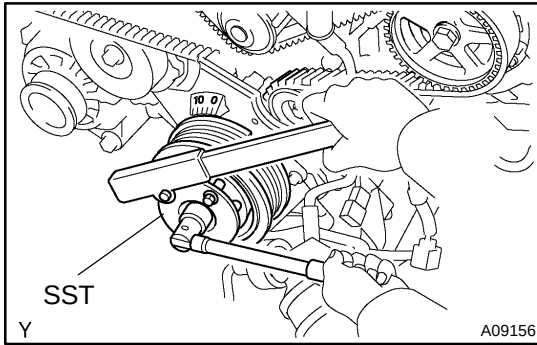
Remove the 2 bolts, the 2 nuts and the fan bracket.

**15. IF RE-USING TIMING BELT, CHECK INSTALLATION MARKS ON TIMING BELT**

Check that there are 3 installation marks on the timing belt as turning the crankshaft pulley as shown in the illustration.

HINT:

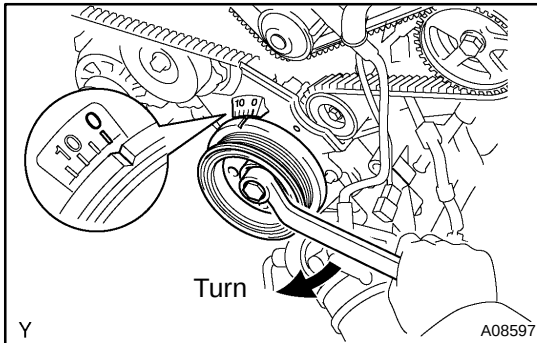
If the installation marks are disappeared, place a new installation mark on the timing belt before removing each part.



16. LOOSEN CRANKSHAFT PULLEY BOLT

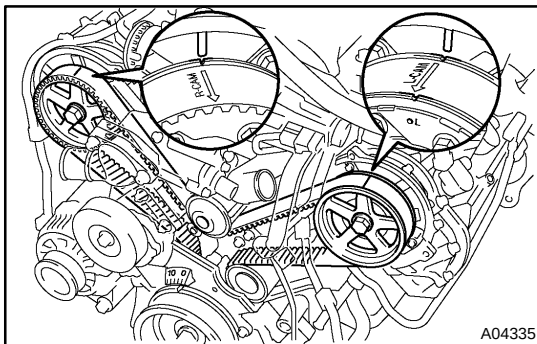
Using SST, loosen the pulley bolt.

SST 09213-7001 1 (90105-70020),
09330-00021



17. SET NO.1 CYLINDER TO TDC/COMPRESSION

- (a) Turn the crankshaft pulley and align its groove with the timing mark "0" of the No.1 timing belt cover.



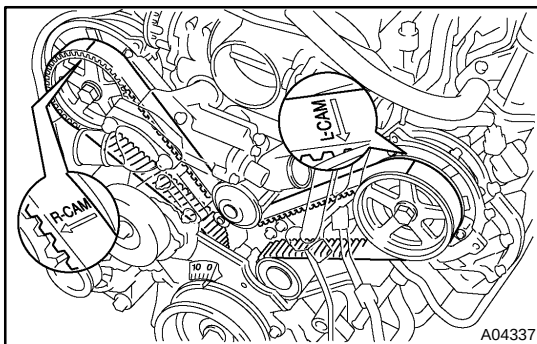
- (b) Check that the timing marks of the camshaft timing pulleys and that of the timing belt rear plates aligned.

If not, turn the crankshaft 1 revolution (360°).

- (c) Remove the crankshaft pulley bolt.

NOTICE:

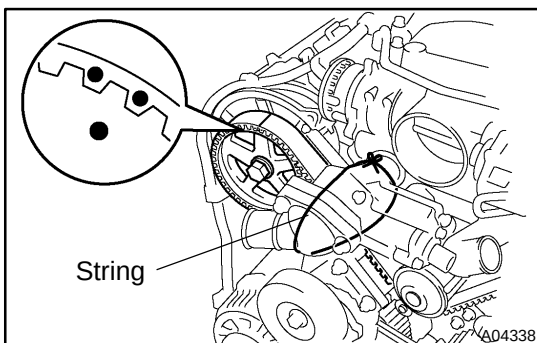
Do not turn the crankshaft pulley.



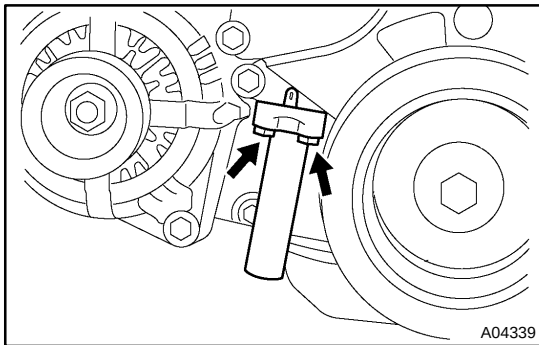
18. REMOVE TIMING BELT TENSIONER

HINT:

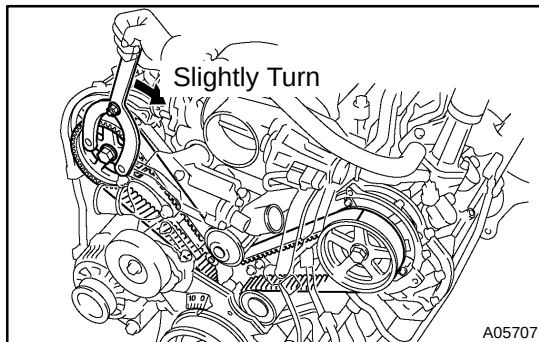
- ★ When re-using timing belt:
If the installation marks are disappeared, place 2 new installation marks on the timing belt to match the timing marks of the camshaft timing pulleys before the removal.



- ★ When replacing timing belt tensioner only:
To avoid meshing of the timing pulley and the timing belt, secure one of them with string, and then place match-marks on the timing belt and the RH camshaft timing pulley.

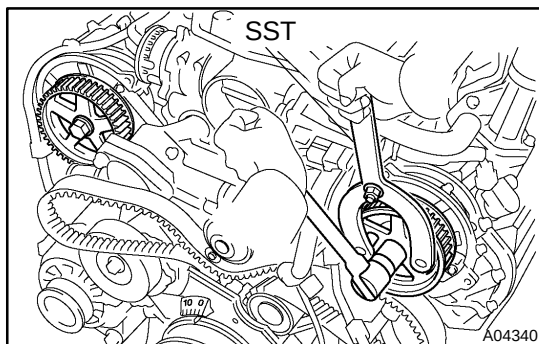


Alternately loosen the 2 bolts, and remove the belt tensioner and the dust boot.



19. DISCONNECT TIMING BELT FROM CAMSHAFT TIMING PULLEYS

- (a) Using SST, loosen the tension spring between the LH and RH camshaft timing pulleys by slightly turning the LH camshaft timing pulley clockwise.
SST 09960-10010 (09962-01000, 09963-01000)
- (b) Disconnect the timing belt from the camshaft timing pulleys.



20. REMOVE CAMSHAFT TIMING PULLEYS

Using SST, remove the bolt and the timing pulley. Remove the 2 timing pulleys.

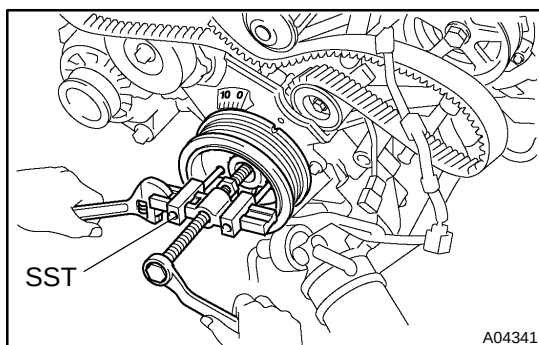
SST 09960-10010 (09962-01000, 09963-01000)

21. REMOVE GENERATOR

(See page [CH-7](#))

22. REMOVE DRIVE BELT TENSIONER

Remove the bolt, 2 nuts and the belt tensioner.



23. REMOVE CRANKSHAFT PULLEY

Using SST, remove the crankshaft pulley.

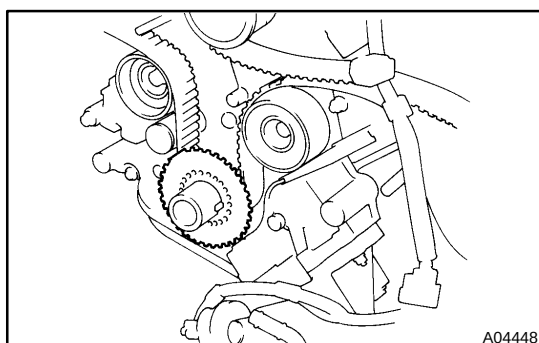
SST 09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011, 09953-05020, 09954-05021)

NOTICE:

Do not turn the crankshaft pulley.

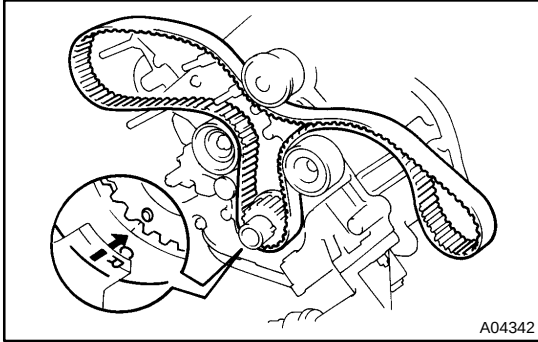
24. REMOVE NO.1 TIMING BELT COVER

Remove the 4 bolts and the timing belt cover.



25. REMOVE TIMING BELT GUIDE

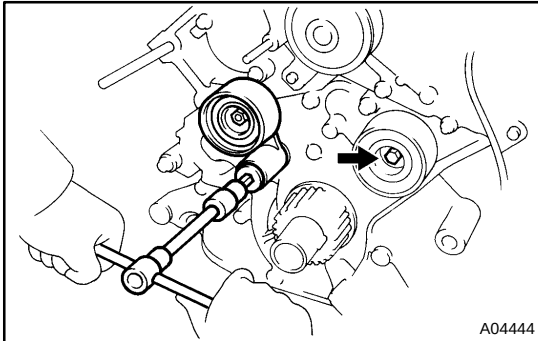
26. REMOVE TIMING BELT COVER SPACER



27. REMOVE TIMING BELT

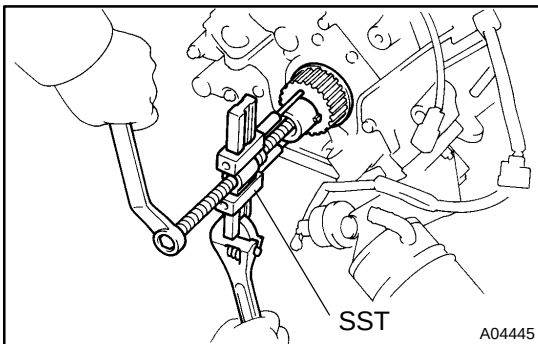
HINT:

If re-using the belt and the installation mark is disappeared from it, place a new installation mark on the timing belt to the match the dot mark on the crankshaft timing pulley.



28. REMOVE NO.1 IDLER PULLEY AND NO.2 IDLER PULLEY

- (a) Using a 10 mm hexagon wrench, remove the bolt, the No.1 idler pulley and the plate washer.
- (b) Remove the bolt and the No.2 idler pulley.



29. REMOVE CRANKSHAFT TIMING PULLEY

Using SST, remove the timing pulley.

SST 09950-50013 (09951-05010, 09952-05010, 09953-05010, 09953-05020, 09954-05011, 09954-05021)

NOTICE:

Do not turn the timing pulley.

VALVE CLEARANCE INSPECTION

EMOKS-08

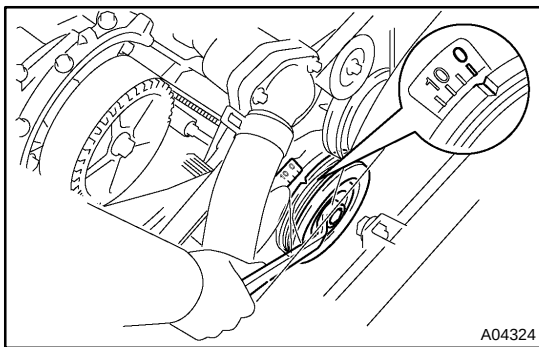
HINT:

Inspect and adjust the valve clearance when the engine is cold.

1. **DRAIN ENGINE COOLANT**
2. **REMOVE BATTERY CLAMP COVER**
3. **REMOVE V-BANK COVER**
4. **REMOVE AIR CLEANER AND INTAKE AIR CONNECTOR ASSEMBLY**
5. **REMOVE NO.3 TIMING BELT COVERS**
(See page [EM-15](#))
6. **REMOVE IGNITION COILS** (See page [IG-6](#))
7. **REMOVE RH CYLINDER HEAD COVER**

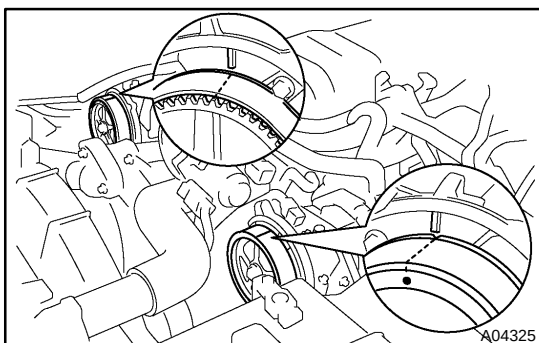
Remove the 9 bolts, the 9 seal washers and the cylinder head cover.

8. **REMOVE LH CYLINDER HEAD COVER**
 - (a) Remove the oil dipstick for the transmission.
 - (b) Disconnect the PCV hose.
 - (c) Disconnect the engine wire clamp from the wire bracket on the cylinder head cover.
 - (d) Remove the 9 bolts, the 9 seal washers and the cylinder head cover.

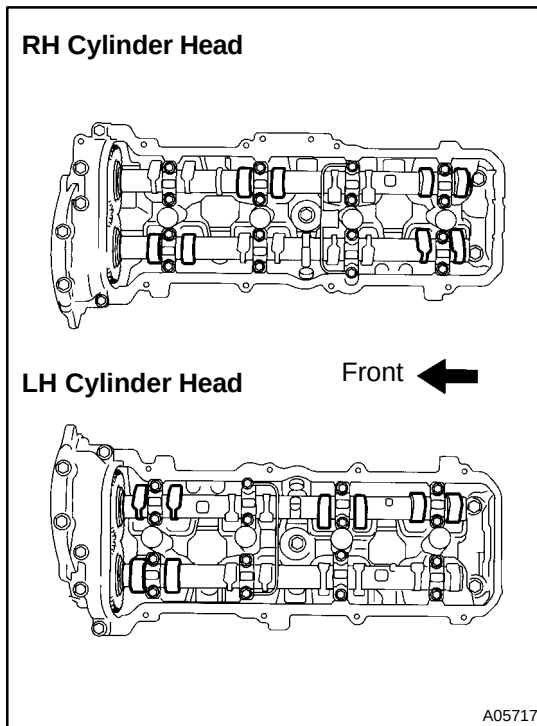


9. SET NO.1 CYLINDER TO TDC/COMPRESSION

- (a) Turn the crankshaft pulley, and align its groove with timing mark "0" of the No.1 timing belt cover.



- (b) Check that the timing marks of the camshaft timing pulleys and that of the timing belt rear plates are aligned. If not, turn the crankshaft 1 revolution (360°) and align the mark as above.

**10. INSPECT VALVE CLEARANCE**

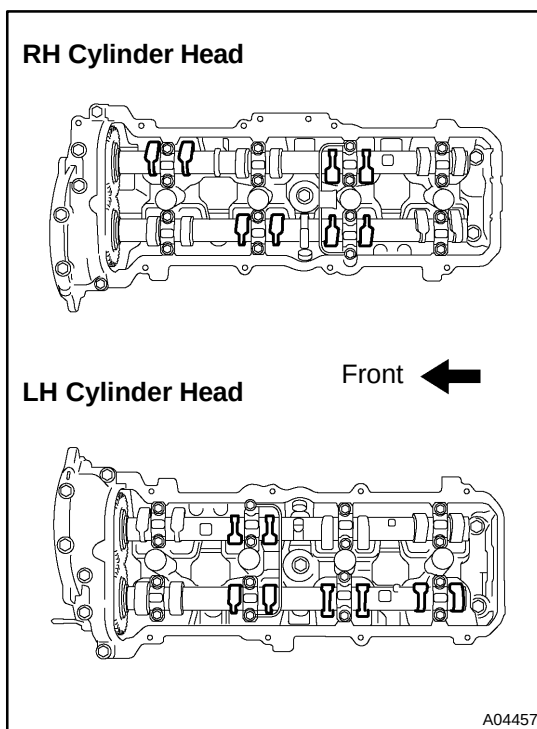
- (a) Check only the valves indicated.
- ★ Using a feeler gauge, measure the clearance between the valve lifter and the camshaft.
 - ★ Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting shim.

Valve clearance (Cold):**Intake**

0.15 - 0.25 mm (0.006 - 0.010 in.)

Exhaust

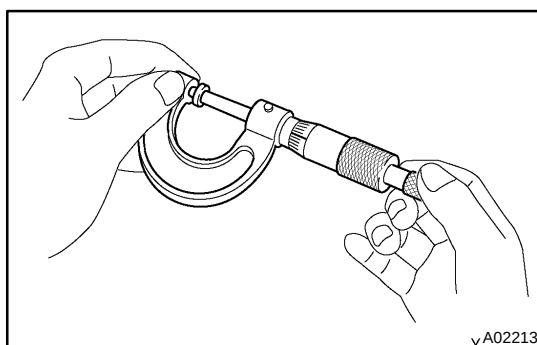
0.25 - 0.35 mm (0.010 - 0.014 in.)



- (b) Turn the crankshaft 1 revolution (360°) and align the mark as above (See procedure in step 9).
- (c) Check only the valves indicated as shown. Measure the valve clearance. (See procedure in step (a))

11. ADJUST VALVE CLEARANCE

- (a) Remove the timing belt (See page [EM-15](#)).
- (b) Remove the camshafts (See page [EM-35](#)).
- (c) Remove the valve lifter and adjusting shim.



- (d) Determine the replacement adjusting shim size according to the following Formula and Charts:
- ★ Using a micrometer, measure the thickness of the removed shim.
 - ★ Calculate the thickness of a new shim so that the valve clearance comes within the specified value.

T Thickness of removed shim

A Measured valve clearance

N Thickness of new shim

Intake:

$$N = T + (A - 0.20 \text{ mm (0.008 in.)})$$

Exhaust:

$$N = T + (A - 0.30 \text{ mm (0.012 in.)})$$

- ★ Select a new shim with the closest thickness as close as possible to the calculated value.

HINT:

Shims are available in 41 increments of 0.020 mm (0.0008 in.), from 2.00 mm (0.0787 in.) to 2.80 mm (0.1102 in.).

- (e) Place a new adjusting shim on the valve.
- (f) Place the valve lifter.
- (g) Reinstall the camshafts (See page [EM-57](#)).
- (h) Reinstall the timing belt (See page [EM-22](#)).
- (i) Recheck the valve clearance.

12. REINSTALL CYLINDER HEAD COVERS**13. REINSTALL IGNITION COILS****14. REINSTALL NO.3 TIMING BELT COVERS (See page [EM-22](#))****15. REINSTALL AIR CLEANER AND INTAKE AIR CONNECTOR ASSEMBLY****16. REFILL WITH ENGINE COOLANT****17. START ENGINE AND CHECK FOR LEAKS****18. RECHECK ENGINE COOLANT LEVEL****19. REINSTALL V-BANK COVER****20. REINSTALL BATTERY CLAMP COVER**