

Engine Workshop Manual BP (1.8L)

(Normally aspirated & turbo)

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FOREWORD

This manual explains the disassembly, inspection, repair and reassembly procedures for the above-indicated engine. In order to do these procedures safely, quickly, and correctly, you must first read this manual and any other relevant service materials carefully.

The information in this manual is current up to the time of printing. Any changes that occur after that time will not be reflected in this particular manual. Therefore, the contents of this manual may not exactly match the mechanism that you are currently servicing.

**Mazda Motor Corporation
HIROSHIMA, JAPAN**

GENERAL INFORMATION

00
SECTION

00

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00-00 GENERAL INFORMATION

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HOW TO USE THIS MANUAL

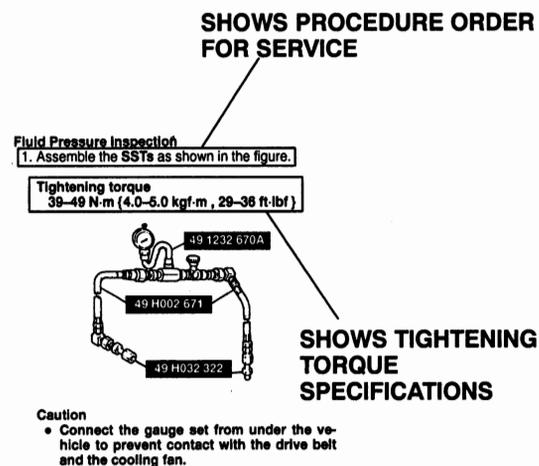
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Range of Topics

- This manual contains procedures for performing all required service operations. The procedures are divided into the following five basic operations:
 - (1) Removal/Installation
 - (2) Disassembly/Assembly
 - (3) Replacement
 - (4) Inspection
 - (5) Adjustment
- Simple operations which can be performed easily just by looking at the vehicle (i.e., removal/installation of parts, jacking, vehicle lifting, cleaning of parts and visual inspection) have been omitted.

Service Procedure Inspection, adjustment

- Inspection and adjustment procedures are divided into steps. Important points regarding the location and contents of the procedures are explained in detail and shown in the illustrations.

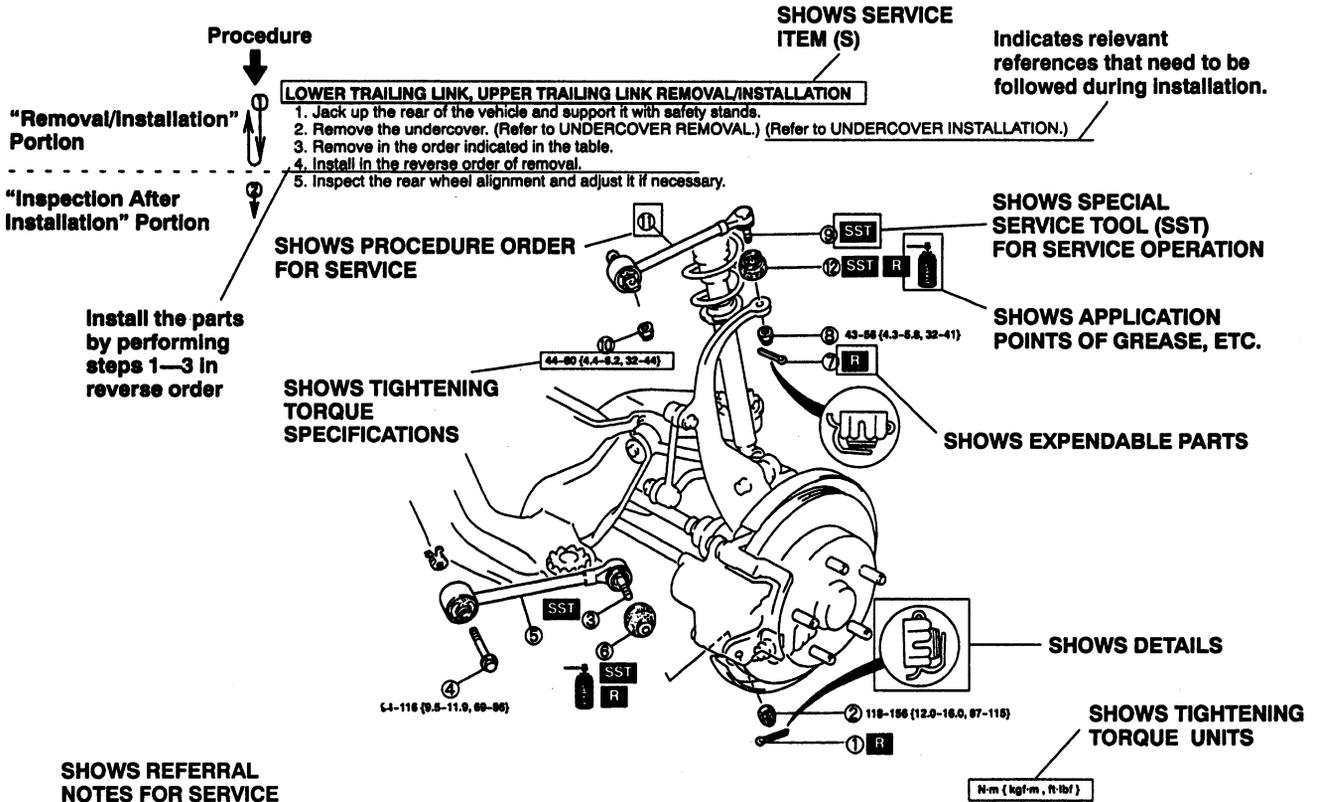


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GENERAL INFORMATION

Repair procedure

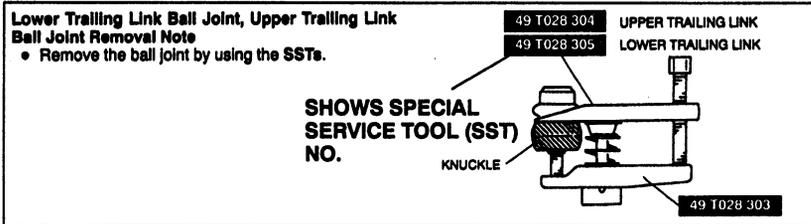
1. Most repair operations begin with an overview illustration. It identifies the components, shows how the parts fit together and describes visual part inspection. However, only removal/installation procedures that need to be performed methodically have written instructions.
2. Expendable parts, tightening torques and symbols for oil, grease, and sealant are shown in the overview illustration. In addition, symbols indicating parts requiring the use of special service tools are also shown.
3. Procedure steps are numbered and the part that is the main point of that procedure is shown in the illustration with the corresponding number. Occasionally, there are important points or additional information concerning a procedure. Refer to this information when servicing the related part.



SHOWS REFERRAL NOTES FOR SERVICE

1	Split pin
2	Nut
3	Lower trailing link ball joint ⇨ Removal Note
4	Bolt
5	Lower trailing link
6	Dust boot (lower trailing link) ⇨ Installation Note
7	Split pin

8	Nut
9	Upper trailing link ball joint ⇨ Removal Note
10	Nut
11	Upper trailing link
12	Dust boot (upper trailing link) ⇨ Removal Note



SHOWS REFERRAL NOTES FOR SERVICE

X5U000EA1

GENERAL INFORMATION

Symbols

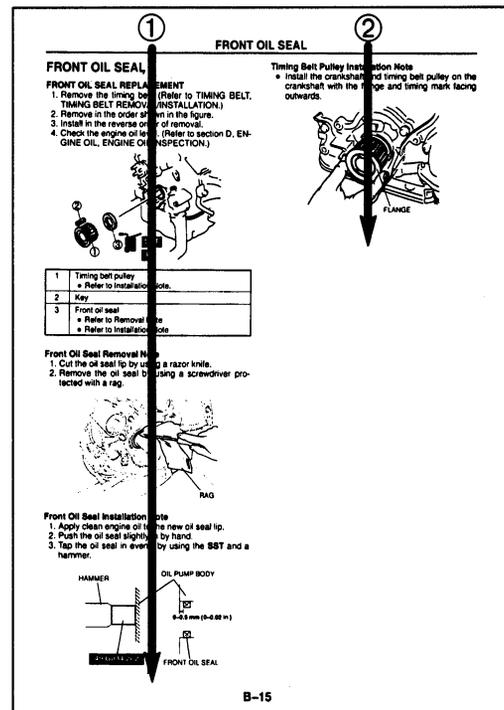
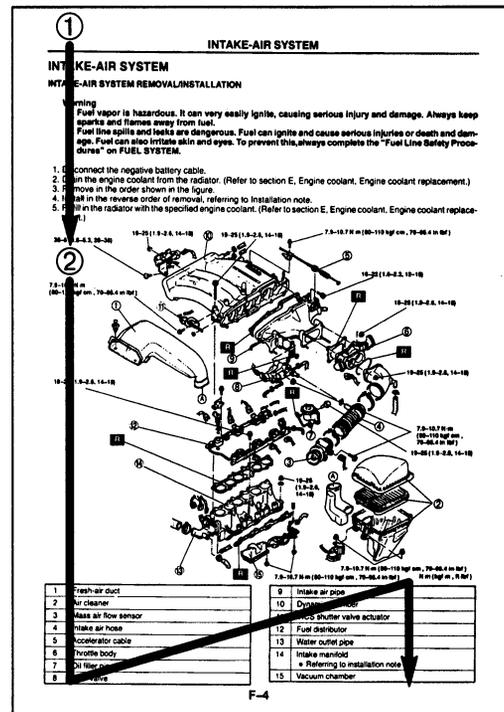
- There are eight symbols indicating oil, grease, fluids, sealant and SST use. These symbols show application points or use of these materials during service.

Symbol	Meaning	Kind
 X5U000EA2	Apply oil	New appropriate engine oil or gear oil
 X5U000EA3	Apply brake fluid	New appropriate brake fluid
 X5U000EA4	Apply automatic transaxle/transmission fluid	New appropriate automatic transaxle/transmission fluid
 X5U000EA5	Apply grease	Appropriate grease
 X5U000EA6	Apply sealant	Appropriate sealant
 X5U000EA7	Apply petroleum jelly	Appropriate petroleum jelly
 X5U000EA8	Replace part	O-ring, gasket, etc.
 X5U000EA9	Use SST	Appropriate SST

Text Sequence

- The text sequence is indicated by the arrows shown below.

Example:



Advisory Messages

You'll find several **Warnings**, **Cautions**, **Notes**, **Specifications** and **Upper and Lower limits** in this manual.

Warning

- A **Warning** indicates a situation in which serious injury or death could result if the warning is ignored.

Caution

- A **Caution** indicates a situation in which damage to the vehicle could result if the caution is ignored.

Note

- A **Note** provides added information that will help you to complete a particular procedure.

GENERAL INFORMATION

UNITS

X5U000E02

Electrical current	A (ampere)
Electric potential	V (volt)
Electric power	W (watt)
Length	mm (millimeter)
	in (inch)
Negative pressure	kPa (kilo pascal)
	mmHg (millimeters of mercury)
	inHg (inches of mercury)
Positive pressure	kPa (kilo pascal)
	kgf/cm ² (kilogram force per square centimeter)
	psi (pounds per square inch)
Resistance	Ω (ohm)
Torque	N·m (Newton meter)
	kgf·m (kilogram force per meter)
	kgf·cm (kilogram force per centimeter)
	ft·lbf (foot pound)
	in·lbf (inch pound)
Volume	L (liter)
	US qt (U.S. quart)
	Imp qt (Imperial quart)
	ml (milliliter)
	cc (cubic centimeter)
	cu in (cubic inch)
	fl oz (fluid ounce)
Weight	g (gram)
	oz (ounce)

Conversion to SI Units (Système International d'Unités)

- All numerical values in this manual are based on SI units. Numbers shown in conventional units are converted from these values.

Rounding Off

- Converted values are rounded off to the same number of places as the SI unit value. For example, if the SI unit value is 17.2 and the value after conversion is 37.84, the converted value will be rounded off to 37.8.

Upper and Lower Limits

- When the data indicates upper and lower limits, the converted values are rounded down if the SI unit value is an upper limit and rounded up if the SI unit value is a lower limit. Therefore, converted values for the same SI unit value may differ after conversion. For example, consider 2.7 kgf/cm² in the following specifications:

210—260 kPa {2.1—2.7 kgf/cm², 30—38 psi}
270—310 kPa {2.7—3.2 kgf/cm², 39—45 psi}

- The actual converted values for 2.7 kgf/cm² are 264 kPa and 38.4 psi. In the first specification, 2.7 is used as an upper limit, so the converted values are rounded down to 260 and 38. In the second specification, 2.7 is used as a lower limit, so the converted values are rounded up to 270 and 39.

SAE STANDARDS

X5U000E03

- In accordance with new regulations, SAE (Society of Automotive Engineers) standard names and abbreviations are now used in this manual. The table below lists the names and abbreviations that have been used in Mazda manuals up to now and their SAE equivalents.

Previous Standard		New Standard		
Abbr.	Name	Abbr.	Name	Remark
—	Accelerator Pedal	AP	Accelerator Pedal	
—	Air Cleaner	ACL	Air Cleaner	
—	Air Conditioning	A/C	Air Conditioning	
—	Airflow Meter	VAF	Volume Air Flow Sensor	
—	Airflow Sensor	MAF	Mass Air Flow Sensor	
—	Alternator	GEN	Generator	
—	ATF Thermosensor	—	Transmission (Transaxle) Fluid Temperature Sensor	
—	Atmospheric Pressure	BARO	Barometric Pressure	
V _B	Battery Voltage	B+	Battery Positive Voltage	

GENERAL INFORMATION

Previous Standard		New Standard		
Abbr.	Name	Abbr.	Name	Remark
—	Catalytic Converter	OC	Oxidation Catalytic Converter	
		TWC	Three Way Catalytic Converter	
		WU-TWC	Warm Up Three Way Catalytic Converter	Directly connected to exhaust manifold
—	Circuit Opening Relay	FPR	Fuel Pump Relay	In some models, there is a fuel pump relay that controls pump speed. That relay is now called the fuel pump relay (speed).
—	Clutch Position	CPP	Clutch Pedal Position	
—	Crank Angle Sensor	CMP	Camshaft Position Sensor	
—	Crank Angle Sensor 2	CKP	Crankshaft Position Sensor	
—	Diagnosis Connector	DLC	Data Link Connector	
—	Diagnosis/Self-Diagnosis	OBD	On-Board Diagnostic	
—	Direct Ignition	DLI	Distributorless Ignition	
—	EC-AT Control Unit	TCM	Transmission (Transaxle) Control Module	
EGI	Electronic Gasoline Injection System	CIS	Continuous Fuel Injection System	
—	Electronic Spark Ignition	EI	Electronic Ignition	Controlled by the ECM/PCM
ECU	Engine Control Unit	PCM	Powertrain Control Module	Device that controls engine and powertrain
		ECM	Engine Control Module	
—	Engine Modification	EM	Engine Modification	
—	Engine RPM Signal	—	Engine Speed Input Signal	
—	Evaporative Emission	EVAP	Evaporative Emission	
—	Exhaust Gas Recirculation	EGR	Exhaust Gas Recirculation	
—	Fan Control	FC	Fan Control	
—	Feedback System	CLS	Closed Loop System	
—	Flexible Fuel	FF	Flexible Fuel	
—	Fuel Pump	FP	Fuel Pump	
—	Fully Closed	CTP	Closed Throttle Position	
—	Fully Open	WOT	Wide Open Throttle	
—	Ground/Earth	GND	Ground	
—	IC Regulator	VR	Voltage Regulator	
—	Idle Speed Control	IAC	Idle Air Control	
—	Idle Switch	—	Closed Throttle Position Switch	
—	Igniter	ICM	Ignition Control Module	
—	Inhibitor	TR	Transmission (Transaxle) Range	
—	Intake Air Pressure	MAP	Manifold Absolute Pressure	
—	Intake Air Thermo	IAT	Intake Air Temperature	
—	Intercooler	CAC	Charge Air Cooler	
—	Knock Sensor	KS	Knock Sensor	
—	Line Pressure Solenoid Valve	—	Pressure Control Solenoid	
—	Lock-up	TCC	Torque Converter Clutch	
—	Malfunction Indicator Light	MIL	Malfunction Indicator Lamp	
—	Multiport Fuel Injection	MFI	Multiport Fuel Injection	
—	Open Loop	OL	Open Loop	
—	Overdrive	4GR	Fourth Gear	

GENERAL INFORMATION

Previous Standard		New Standard		
Abbr.	Name	Abbr.	Name	Remark
—	Oxygen Sensor	HO2S	Heated Oxygen Sensor	With heater
		O2S	Oxygen Sensor	
—	Park/Neutral Range	PNP	Park/Neutral Position	
—	Power Steering Pressure	PSP	Power Steering Pressure	
—	Pulse Generator	—	Input/Turbine Speed Sensor	
—	Reed Valve	SAPV	Secondary Air Pulse Valve	
—	Secondary Air Injection System	PAIR	Pulsed Secondary Air Injection	Pulsed injection
		AIR	Secondary Air Injection	Inject with compressor
—	Sequential Fuel Injection	SFI	Sequential Multipoint Fuel Injection	
—	Service Code(s)	DTC	Diagnostic Trouble Code(s)	
—	Spark Ignition	DI	Distributor Ignition	
—	Stoplight Switch	—	Brake Switch	
—	Test Mode	DTM	Diagnostic Test Mode	Diagnostic trouble codes depend on the diagnostic test mode
—	Throttle Body	TB	Throttle Body	
—	Throttle Sensor	TP	Throttle Position Sensor	
—	Turbocharger	TC	Turbocharger	
—	Vehicle Speed Sensor	VSS	Vehicle Speed Sensor	
—	Vehicle Speed Sensor 1	—	Output Speed Sensor	
—	Water Thermo	ECT	Engine Coolant Temperature	
—	1-2 Shift Solenoid Valve	—	Shift Solenoid A	
	Shift + A Solenoid Valve			
—	2-3 Shift Solenoid Valve	—	Shift Solenoid B	
	Shift + B Solenoid Valve			
—	3-4 Shift Solenoid Valve	—	Shift Solenoid C	
—	3rd Gear	3GR	Third Gear	
—	—	—	Incorrect Gear Ratio	

FUNDAMENTAL PROCEDURES

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Preparation of Tools and Measuring Equipment

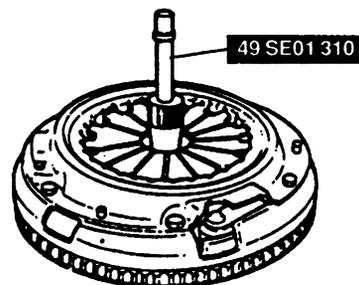
- Be sure that all necessary tools and measuring equipment are available before starting any work.



X5U000EAB

Special Tools

- Use special tools when they are required.

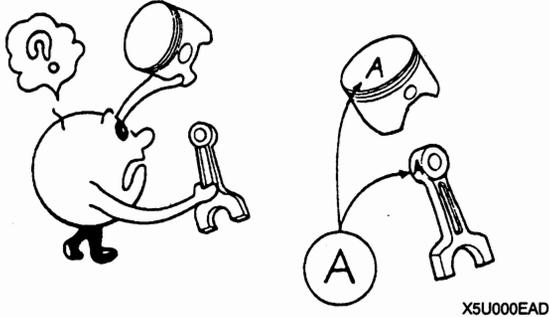


X5U000EAC

GENERAL INFORMATION

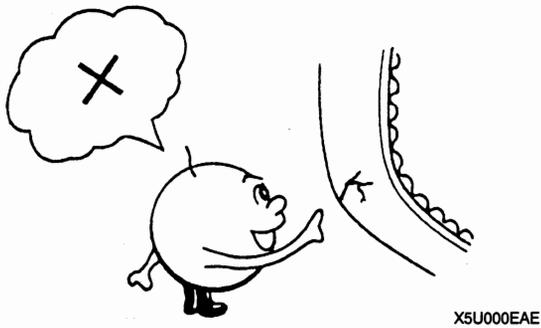
Disassembly

- If the disassembly procedure is complex requiring many parts to be disassembled, all parts should be disassembled in a way that will not affect their performance or external appearance and identified so reassembly can be performed easily and efficiently.



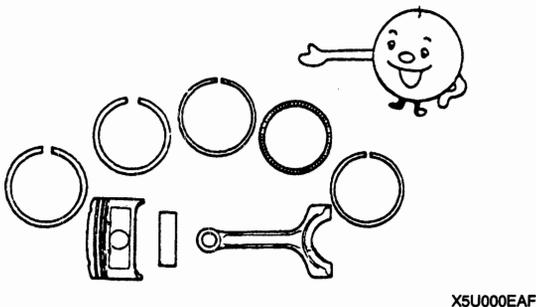
Inspection During Removal, Disassembly

- When removed, each part should be carefully inspected for malfunctioning, deformation, damage and other problems.



Arrangement of Parts

- All disassembled parts should be carefully arranged for reassembly.
- Be sure to separate or otherwise identify the parts to be replaced from those that will be reused.



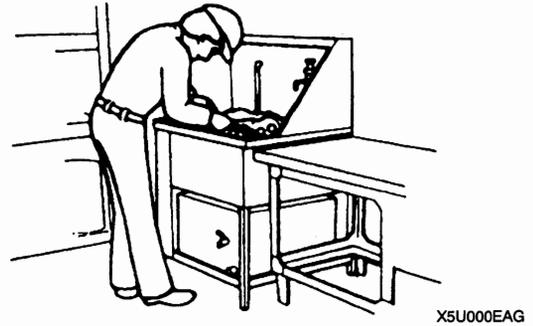
Cleaning of Parts

- All parts to be reused should be carefully and thoroughly cleaned in the appropriate method.

Warning

- Using compressed air can cause dirt and other particles to fly out causing injury to

the eyes. Wear protective eye wear whenever using compressed air.

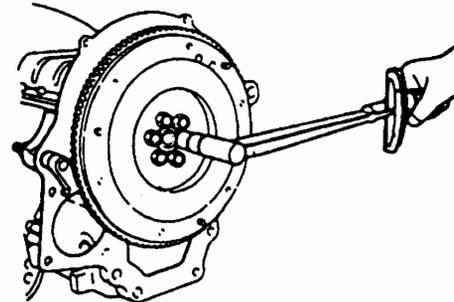


Reassembly

- Standard values, such as torques and certain adjustments, must be strictly observed in the reassembly of all parts.

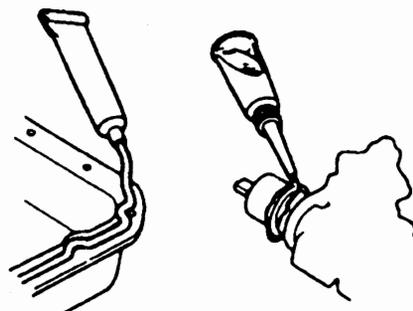
If removed, these parts should be replaced with new ones:

- Oil seals
- Gaskets
- O-rings
- Lockwashers
- Cotter pins
- Nylon nuts



Depending on location:

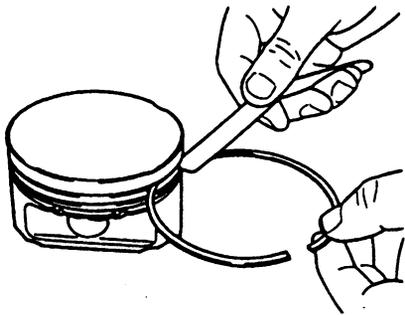
- Sealant and gaskets, or both, should be applied to specified locations. When sealant is applied, parts should be installed before sealant hardens to prevent leaks.
- Oil should be applied to the moving components of parts.
- Specified oil or grease should be applied at the prescribed locations (such as oil seals) before reassembly.



GENERAL INFORMATION

Adjustments

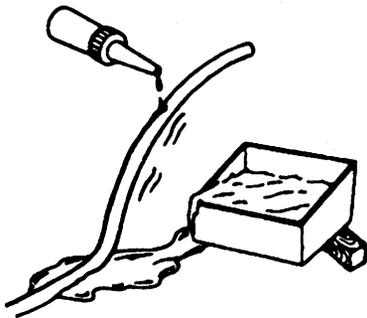
- Use suitable gauges and testers when making adjustments.



X5U000EAK

Rubber Parts and Tubing

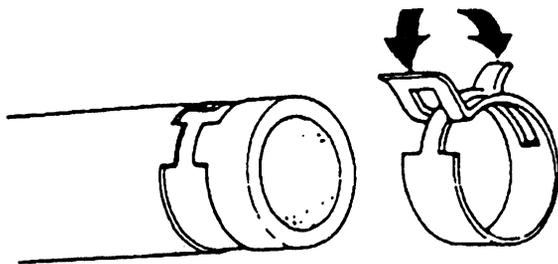
- Prevent gasoline or oil from getting on rubber parts or tubing.



X5U000EAL

Hose Clamps

- When reinstalling, position the hose clamp in the original location on the hose and squeeze the clamp lightly with large pliers to ensure a good fit.



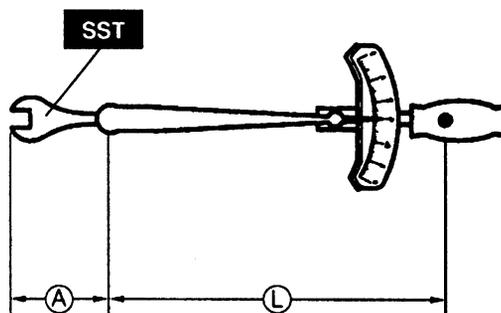
X5U000EAM

Torque Formulas

- When using a torque wrench-SST combination, the written torque must be recalculated due to the extra length that the SST adds to the torque wrench. Recalculate the torque by using the following formulas. Choose the formula that applies to you.

Torque Unit	Formula
N·m	$N \cdot m \times [L / (L + A)]$
kgf·m	$kgf \cdot m \times [L / (L + A)]$
kgf·cm	$kgf \cdot cm \times [L / (L + A)]$
ft·lbf	$ft \cdot lbf \times [L / (L + A)]$
in·lbf	$in \cdot lbf \times [L / (L + A)]$

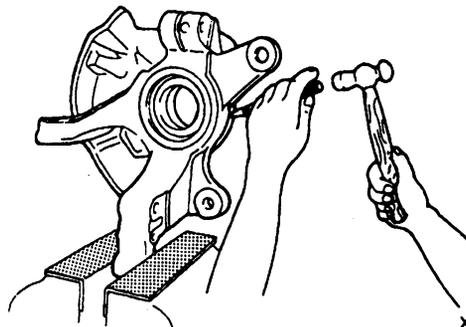
A : The length of the SST past the torque wrench drive.
L : The length of the torque wrench.



X5U000EAN

Vise

- When using a vise, put protective plates in the jaws of the vise to prevent damage to parts.



X5U000EAP

GENERAL INFORMATION

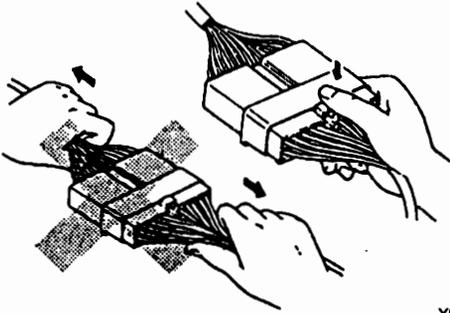
ELECTRICAL SYSTEM

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Connectors

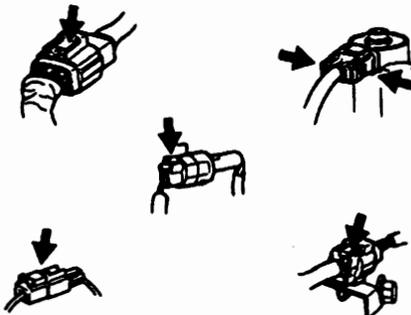
Disconnecting connectors

- When disconnecting two connectors, grasp the connectors, not the wires.



X5U000EAG

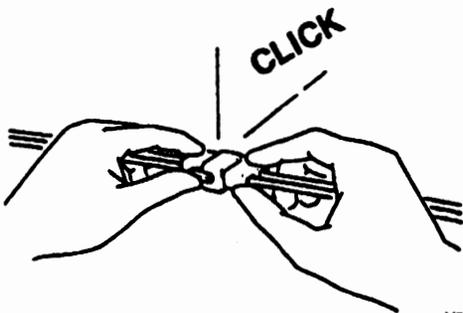
- Connectors can be disconnected by pressing or pulling the lock lever as shown.



X5U000EAR

Locking connector

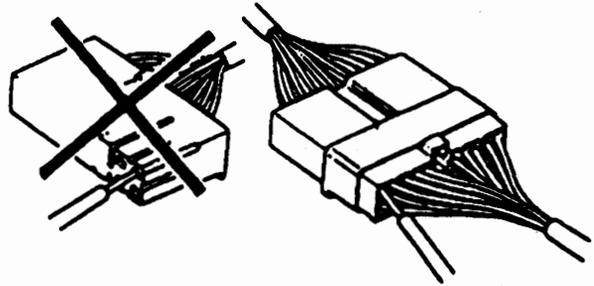
- When locking connectors, listen for a click indicating they are securely locked.



X5U000EAS

Inspection

- When a tester is used for checking continuity or measuring voltage, insert the tester probe from the wiring harness side.

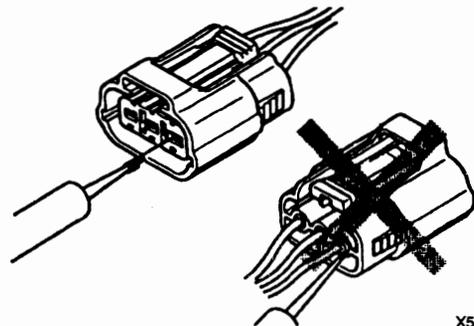


X5U000EAT

- Check the terminals of waterproof connectors from the connector side since they cannot be accessed from the wiring harness side.

Caution

- To prevent damage to the terminal, wrap a thin wire around the lead before inserting into terminal.



X5U000EAU

ABBREVIATIONS

X5U000E05

AT	Automatic transmisson
EX	Exhaust
IN	Intake
MAX.	Maximum

MIN.	Minimum
MT	Manual transmisson
SST	Special service tool
TDC	Top dead center

ENGINE

01 SECTION

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ENGINE OVERHAUL SERVICE WARNING

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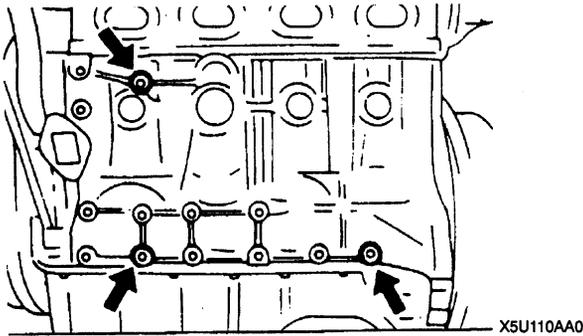
Warning

- Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

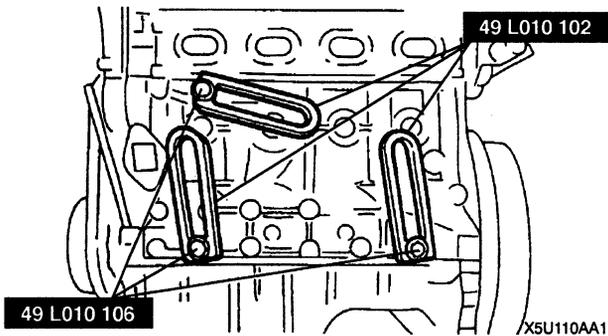
ENGINE MOUNTING / DISMOUNTING

Mounting

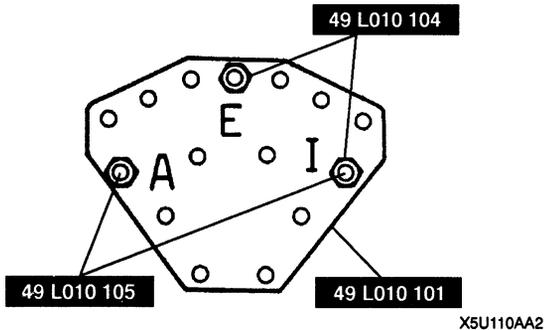
1. Use the holes shown in the figure.



2. Install the SST (arms) to the cylinder block holes as shown, and hand-tighten the SST (bolts).

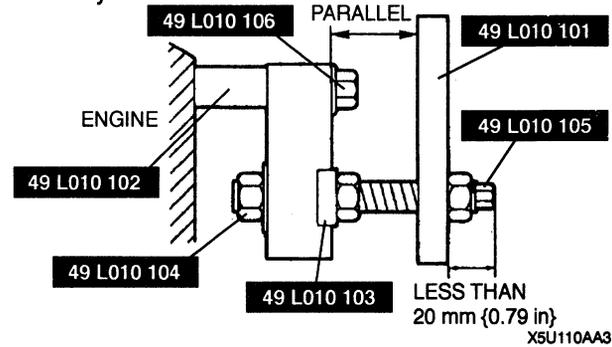


3. Assemble the SST (bolts, nuts, and plate) in the specified positions.



4. Install the SST assembled in step 3 to the respective arms.
5. Adjust the SST (bolts) so that less than 20 mm {0.79 in} of thread is exposed.
6. Make the SST (plate and arms) parallel by adjusting the SST (bolts and nuts).

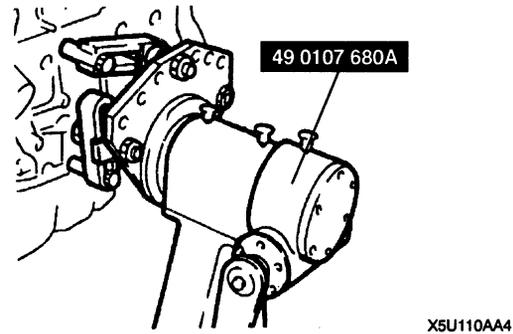
7. Tighten the SST (bolts and nuts) to affix the SST firmly.



Warning

- The self-locking brake system of the engine stand may not be effective when the engine is held in an unbalanced position. This could lead to sudden, rapid movement of the engine and mounting stand handle and cause serious injury. Never keep the engine in an unbalanced position, and always hold the rotation handle firmly turning the engine.

8. Mount the engine on the SST (engine stand).



9. Drain the engine oil.
10. Install the oil drain plug.

Tightening torque

30—41 N·m {3.0—4.2 kgf·m, 22—30 ft·lbf}

Dismounting

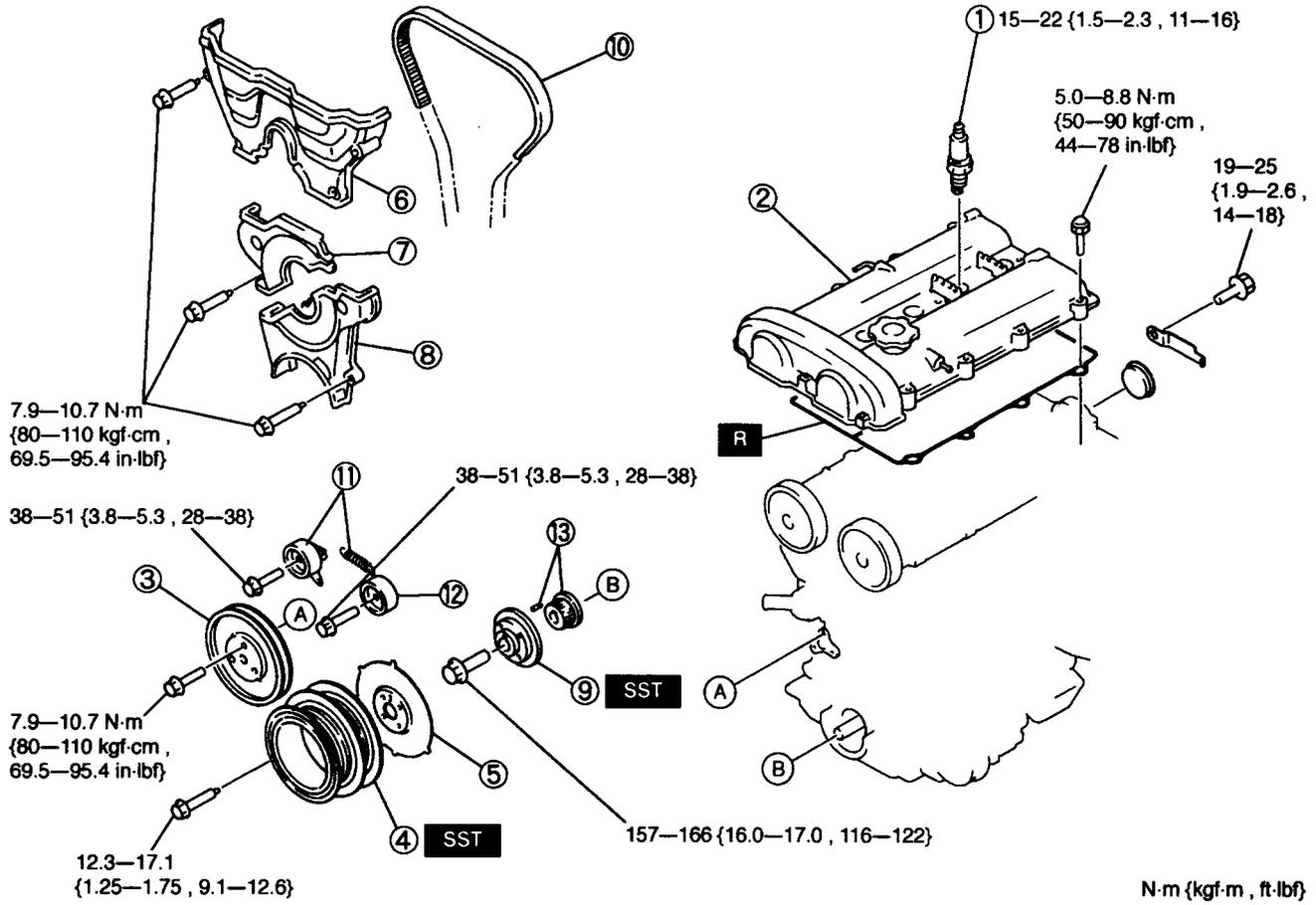
- Dismount in the reverse order of mounting.

Engine Workshop Manual BP (1605-10-97K)
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ENGINE DISASSEMBLY / ASSEMBLY

Timing Belt Disassembly / Assembly

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



X5U110AA5

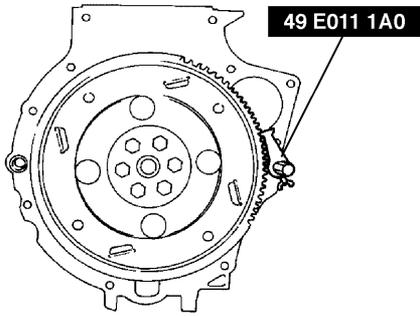
1	Spark plug
2	Cylinder head cover ☞ Assembly Note
3	Water pump pulley
4	Crankshaft pulley ☞ Disassembly Note ☞ Assembly Note
5	Plate
6	Upper timing belt cover
7	Middle timing belt cover
8	Lower timing belt cover

9	Pulley boss ☞ Disassembly Note ☞ Assembly Note
10	Timing belt ☞ Disassembly Note ☞ Assembly Note
11	Tensioner and tensioner spring ☞ Assembly Note
12	Idler
13	Timing belt pulley and key ☞ Assembly Note

**Engine Workshop Manual BP (1605-10-97K)
MECHANICAL**

Crankshaft pulley disassembly note

- Hold the crankshaft using the **SST**.



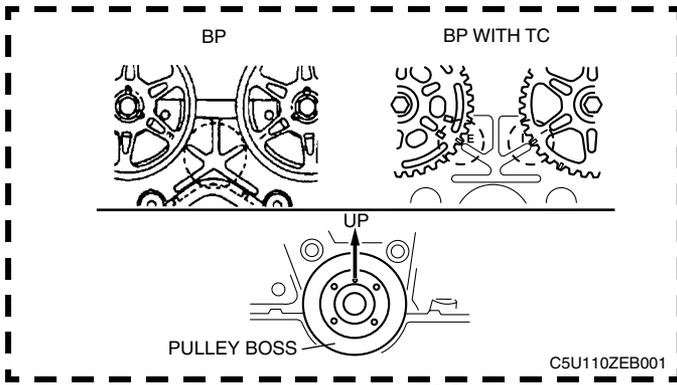
X5U110AA6

Pulley boss disassembly note

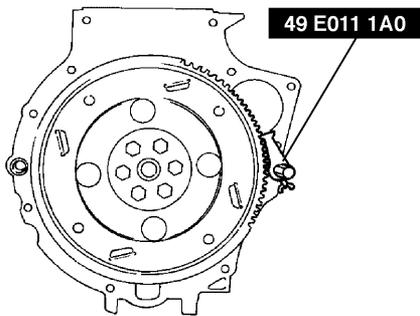
1. Turn the crankshaft clockwise and align the timing marks of the pulleys.

Note

- For the crankshaft side, face the locating pin on the pulley boss straight up.



2. Hold the crankshaft using the **SST**.



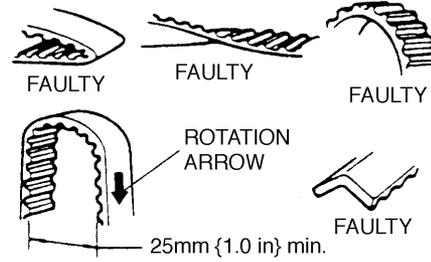
X5U110AA8

Timing belt disassembly note

Caution

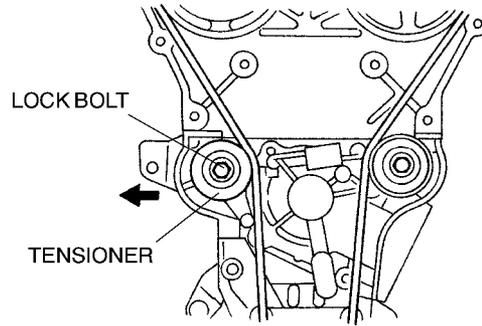
- The following will damage the belt and shorten its life; Forcefully twisting it, turning it inside out, or allowing oil or grease on it.

1. Mark the timing belt rotation on the belt for proper reinstallation.



X5U110AA9

2. Loosen the tensioner lock bolt.
3. Push the tensioner in the direction of the arrow and hand-tighten the lock bolt.

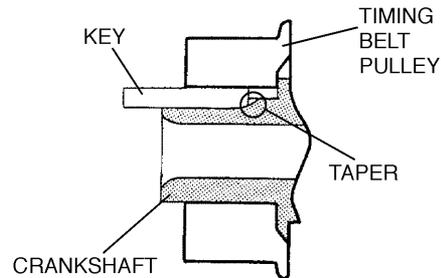


Z5U0110E003

4. Remove the timing belt.

Timing belt pulley and key assembly note

- Insert the key into the timing belt pulley, facing the tapered side downward. Push the key until it stops.

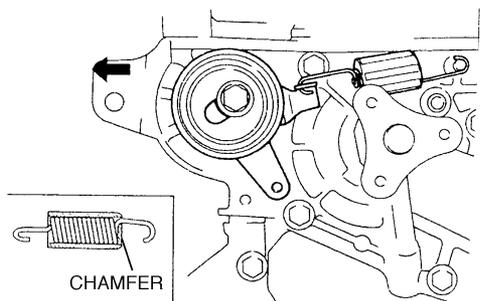


X5U110AAB

**Engine Workshop Manual BP (1605-10-97K)
MECHANICAL**

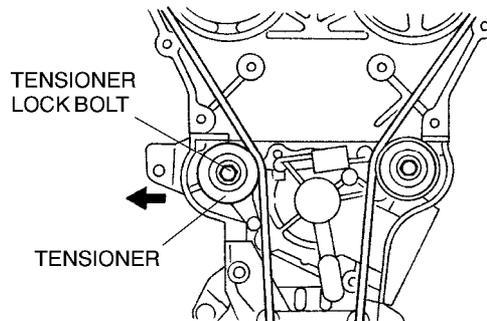
Tensioner and tensioner spring assembly note

1. Install the tensioner spring so that the chamfer of dumping rubber faces the right side as shown.
2. Push the tensioner in the direction of the arrow and hand-tighten the lock bolt.



X5U110AAC

3. Tighten the tensioner lock bolt.



Z5U0110E005

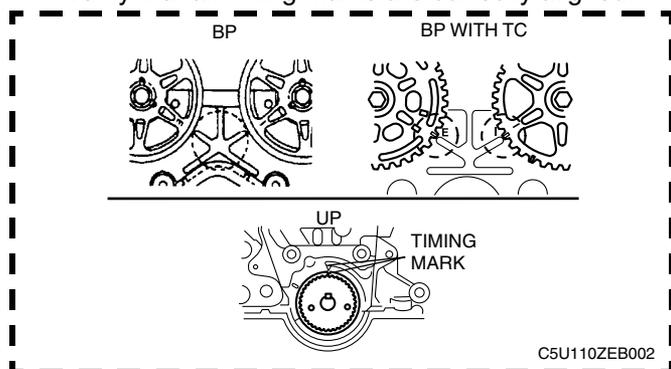
4. Turn the crankshaft clockwise 2 and 1/6 times, and verify that all timing marks are correctly aligned.

Note

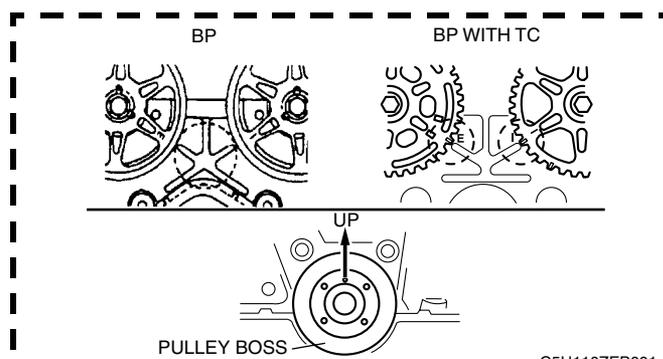
- For the crankshaft side, face the locating pin on the pulley boss straight up.

Timing belt assembly note

- Verify that all timing marks are correctly aligned.



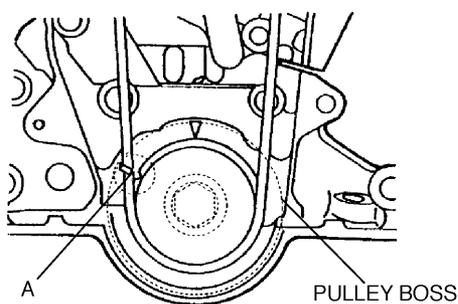
C5U110ZEB002



C5U110ZEB001

Pulley boss assembly note

1. Install the pulley boss and pulley lock bolt. Turn the crankshaft clockwise 1 and 5/6 times, and verify that the timing mark and the tension set mark A are aligned.

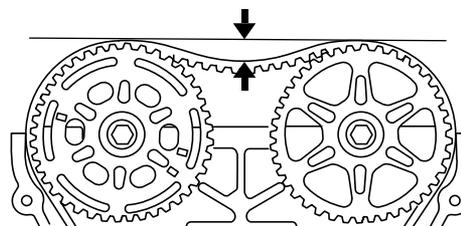


X5U110AAF

5. Inspect for the belt deflection at the point indicated by applying moderate pressure **98 N {10 kgf, 22 lbf}**.

Timing belt deflection
8.5—11.5 mm {0.34—0.45 in}

6. If the timing belt deflection is not as specified, remove the timing belt and repeat from Timing Belt Assembly Note Step 1.

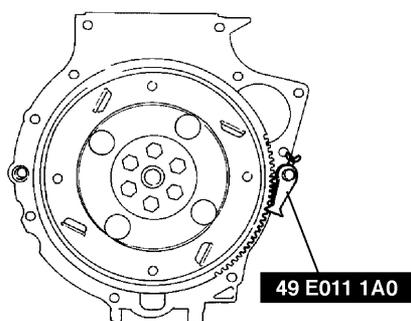


C5U110ZEB003

2. Loosen the tensioner lock bolt to apply tension to the timing belt. Do not apply tension other than that of the tensioner spring.

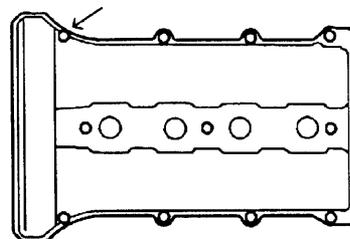
Engine Workshop Manual BP (1605-10-97K)
MECHANICAL

7. Hold the crankshaft by using the **SST**.



X5U110AAK

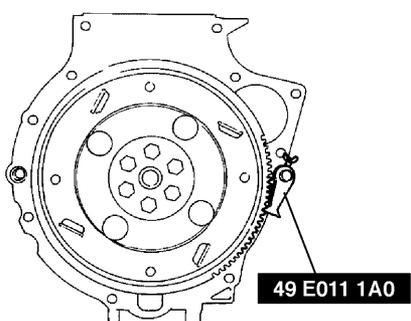
4. Hand-tighten the cylinder head cover bolt as shown.



X5U110AAN

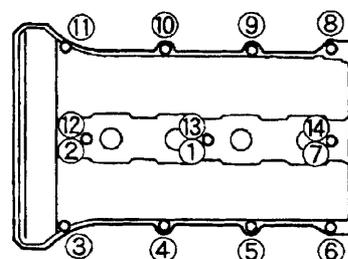
Crankshaft pulley assembly note

- Hold the crankshaft by using the **SST**.



X5U110AAL

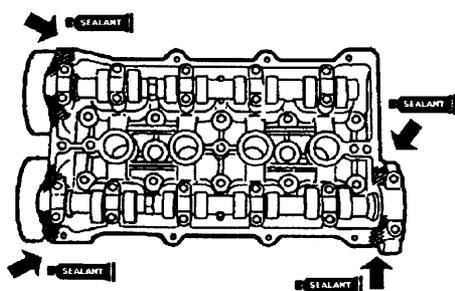
5. Tighten the cylinder head cover bolts in two or three step in the order shown.



X5U110AAP

Cylinder head cover assembly note

1. Verify that the grooves on the cylinder head cover are free of oil, water and other foreign material.
2. Install the cylinder head cover gasket into the cylinder head cover.
3. Apply silicone sealant to the cylinder head as shown.

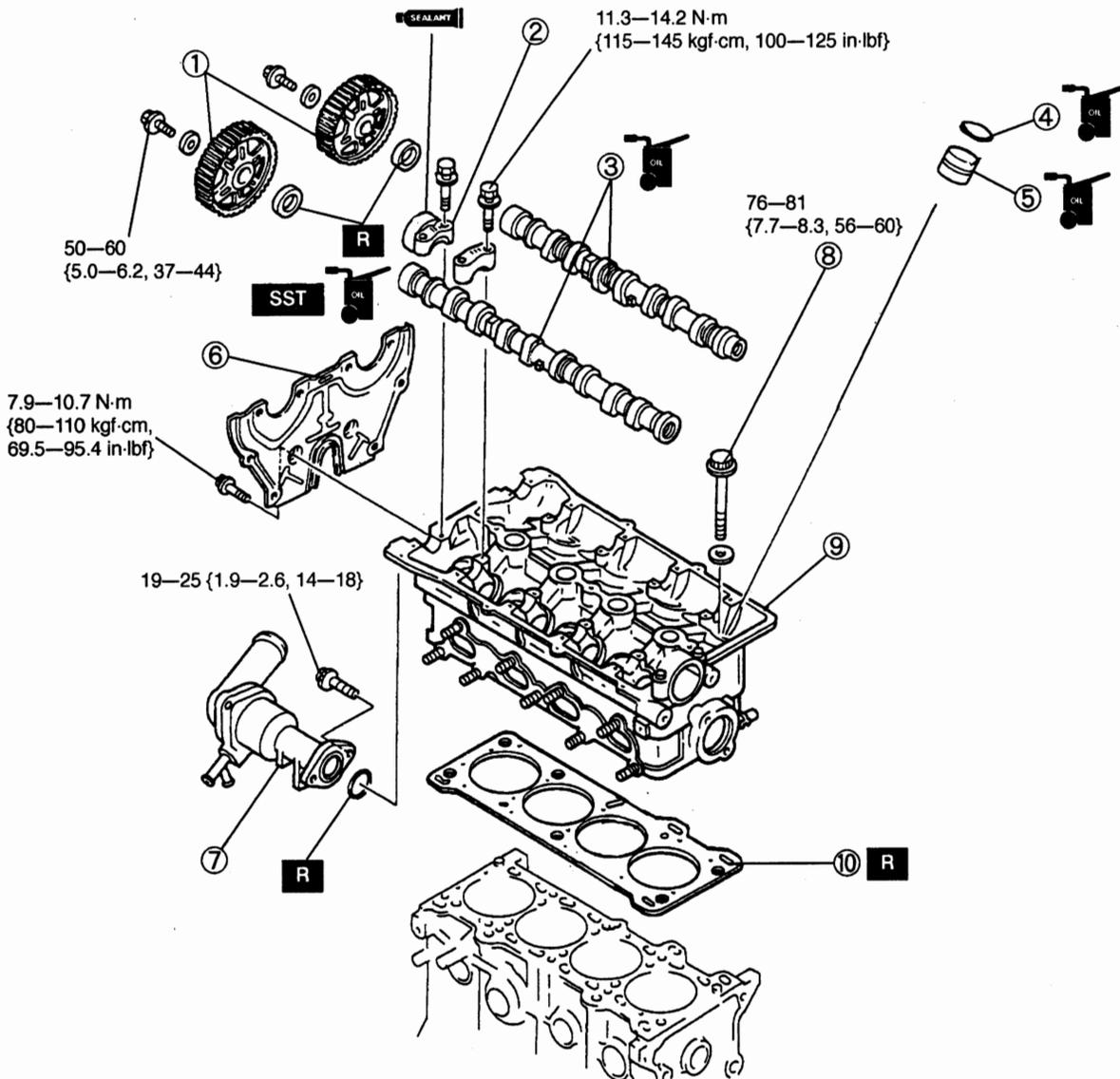


X5U110AAM

MECHANICAL

Cylinder Head Disassembly / Assembly (I)

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



N·m {kgf·m, ft·lbf}

X5U110AAQ

1	Camshaft pulley ☐ Disassembly Note ☐ Assembly Note
2	Camshaft cap ☐ Disassembly Note ☐ Assembly Note
3	Camshaft ☐ Disassembly Note ☐ Assembly Note
4	Adjustment shim
5	Tappet

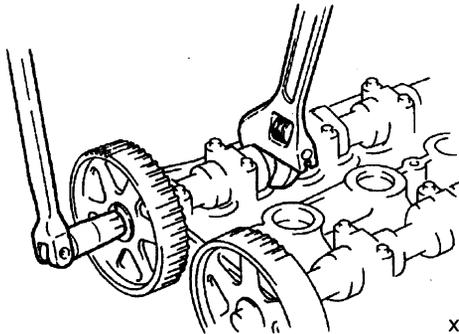
6	Seal plate
7	Thermostat housing
8	Cylinder head bolt ☐ Disassembly Note ☐ Assembly Note
9	Cylinder head ☐ Disassembly Note ☐ Assembly Note
10	Cylinder head gasket

01

MECHANICAL

Camshaft pulley disassembly note

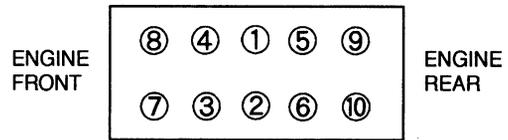
- Hold the camshaft by using a wrench on the cast hexagon as shown, and loosen the camshaft pulley lock bolt.



X5U110AAR

Cylinder head assembly note

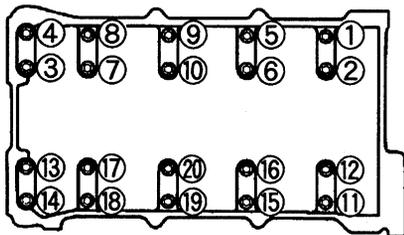
- Install the bolts in two or three steps in the order shown.



X5U110AAU

Camshaft cap disassembly note

- Loosen the camshaft cap bolts in two or three steps in the order shown.



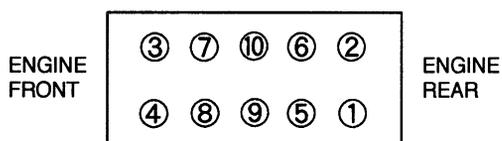
X5U110AAS

Camshaft disassembly note

- Inspect the camshaft end play. (Refer to ENGINE INSPECTION / REPAIR, Camshaft End Play Inspection.)

Cylinder head disassembly note

- Loosen the cylinder head bolts in two or three steps in the order shown.

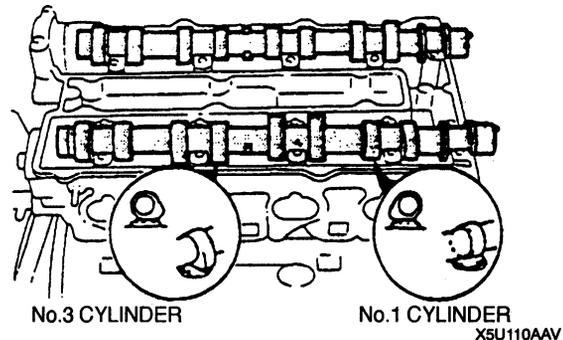


X5U110AAT

Camshaft assembly note

Caution

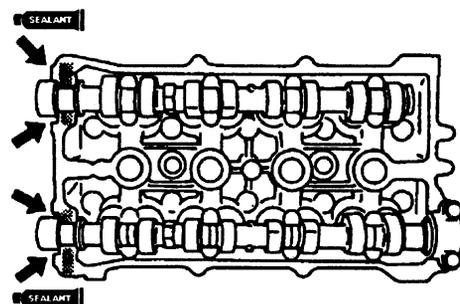
- Because there is little camshaft thrust clearance, the camshaft must be held horizontally while it is installed. Otherwise, excessive force will be applied to the thrust area, causing burr on the thrust receiving area of the cylinder head journal. To avoid this, the following procedure must be observed.
- Assemble the camshaft onto the cylinder head, facing the cam noses at No.1 and No.3 cylinders as shown.



X5U110AAV

Camshaft cap assembly note

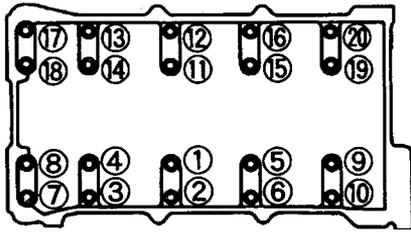
1. Apply silicone sealant to the shaded areas shown in the figure.



X5U110AAW

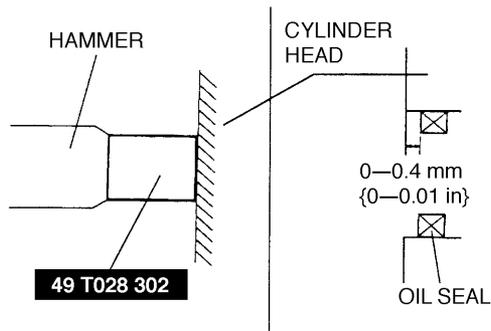
Engine Workshop Manual BP (1605-10-97K)
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2. Install the camshaft caps to the positions from which they were removed.
3. Tighten the camshaft cap bolts in two or three steps in the order shown.



X5U110AAX

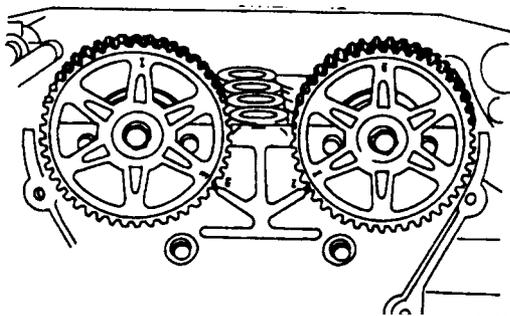
4. Apply clean engine oil to the lip of the new camshaft oil seal.
5. Push the oil seal slightly in by hand.
6. Press the oil seal in evenly by using the **SST**.



X5U110AAY

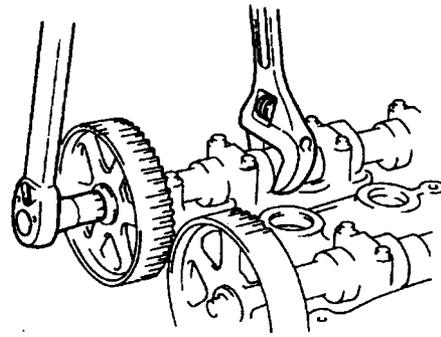
Camshaft pulley

1. Install the camshaft pulleys with the "I" mark (intake side) or the "E" mark (exhaust side) straight up.



X5U110AAZ

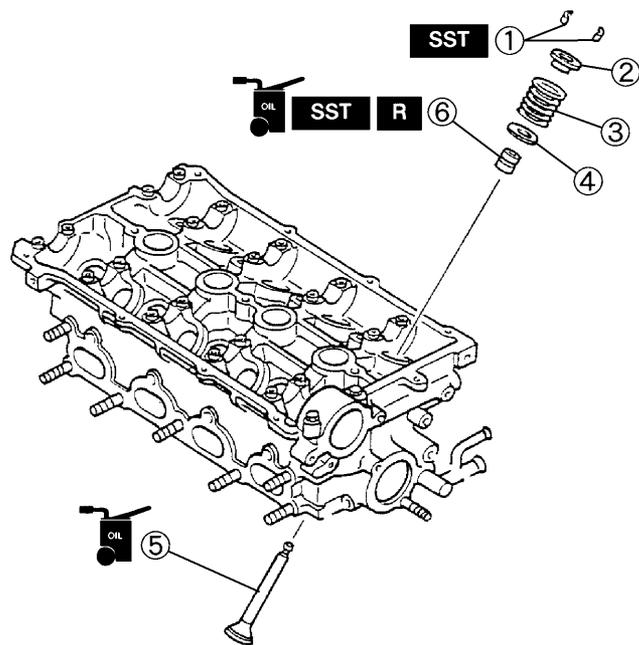
2. Hold the camshaft by using a wrench on the cast hexagon, and tighten the camshaft pulley lock bolt.



X5U110AB0

Cylinder Head Disassembly/Assembly (II)

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



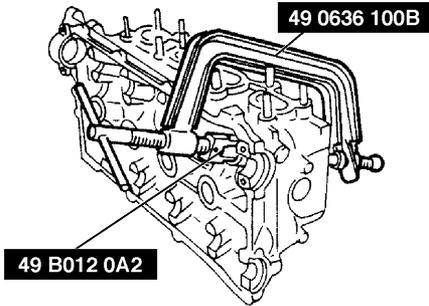
X5U110AB1

1	Valve keeper <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note
2	Valve spring seat, upper
3	Valve spring <ul style="list-style-type: none"> ☞ Assembly Note
4	Valve spring seat, lower
5	Valve
6	Valve seal <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note

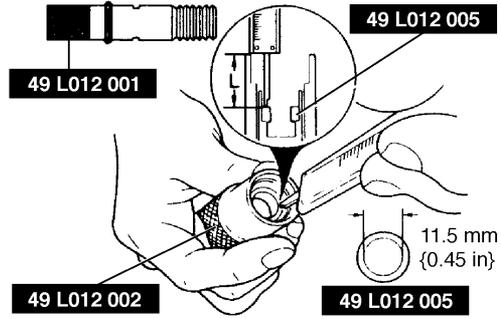
Engine Workshop Manual BP (1605-10-97K)
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Valve keeper disassembly note

- Remove the valve keeper using the SST.



X5U110AB2

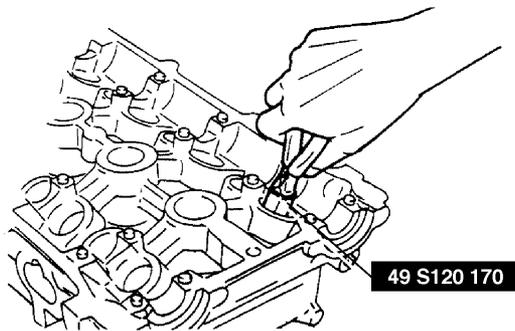


X5U110AB6

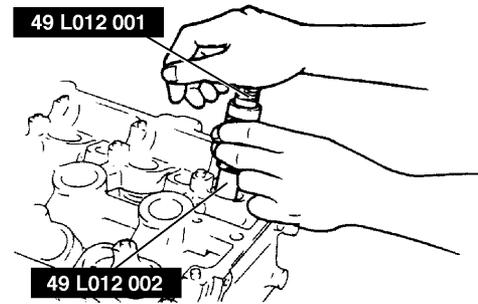
- Press the valve seal onto the valve guide by hand.
- Tap the **SST** by using a plastic hammer until its lower end touches the cylinder head.

Valve seal disassembly note

- Remove the valve seal using the SST.



X5U110AB3

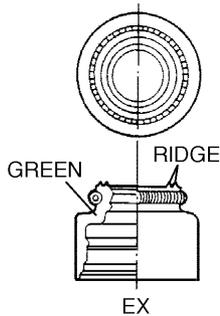


X5U110AB7

Valve seal assembly note

Note

- The intake and exhaust valve seals are different as shown.



X5U110ADK

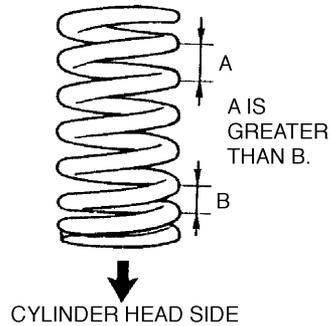
	Ridge		Color
	BP	BP with TC	
Intake	One	Non	Gray
Exhaust	Two		Green

- Assemble the **SST** so that depth L is as specified.

Depth L
19.9 mm {0.783 in}

Valve spring assembly note

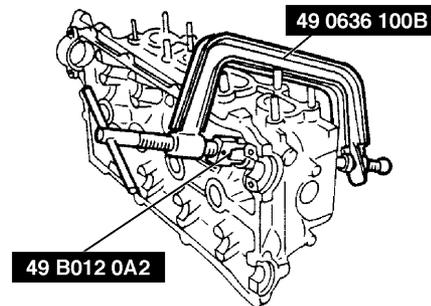
- Install the valve spring with the closer pitch toward the cylinder head.



X5U110AB8

Valve keeper assembly note

- Install the valve keeper by using the **SST**.

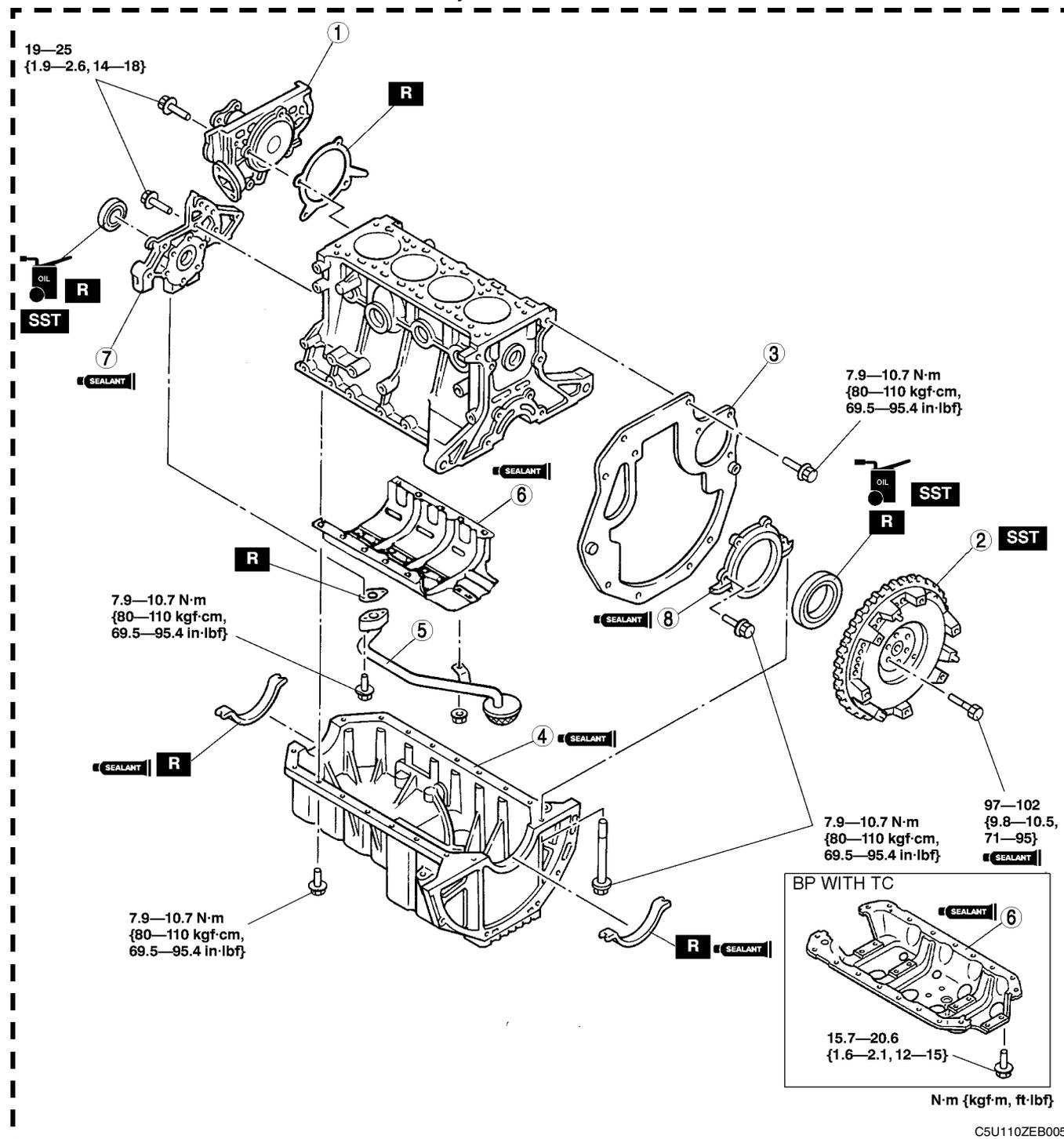


X5U110AB9

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Cylinder Block Disassembly / Assembly (I)

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



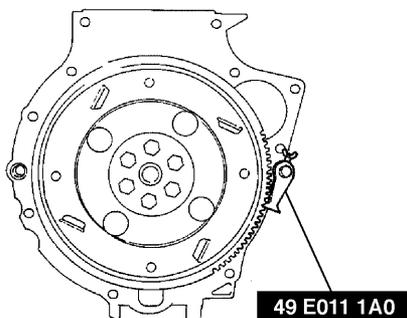
1	Water pump
2	Flywheel (MT), drive plate (AT) <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note
3	End plate
4	Oil pan <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note
5	Oil strainer <ul style="list-style-type: none"> ☞ Assembly Note

6	Oil baffle (BP), MBSP (BP with TC) <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note
7	Oil pump <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note
8	Rear cover <ul style="list-style-type: none"> ☞ Disassembly Note ☞ Assembly Note

**Engine Workshop Manual BP (1605-10-97K)
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Flywheel (MT), drive plate (AT) disassembly note

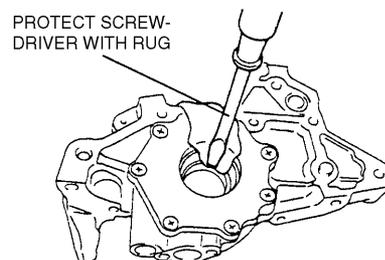
- Hold the crankshaft by using the **SST**.



X5U110ABB

Oil pump disassembly note

- Remove the oil seal by using a screwdriver protected with a rag.



X5U110ABD

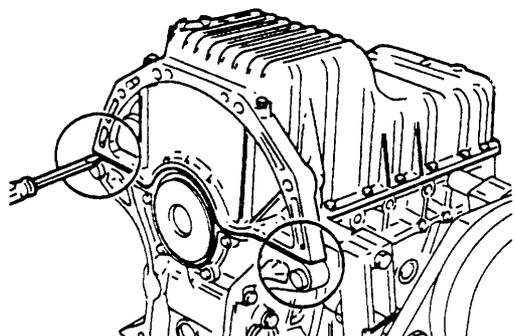
Oil pan disassembly note

1. Remove the oil pan mounting bolts.

Caution

- Pry tools can easily scratch the cylinder block and oil pan contact surfaces.

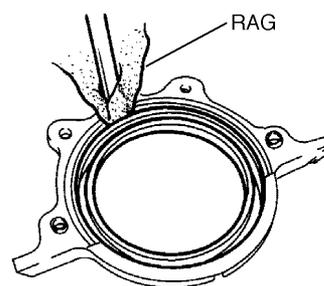
2. Insert a screwdriver only at the points shown.



X5U110ABC

Rear cover disassembly note

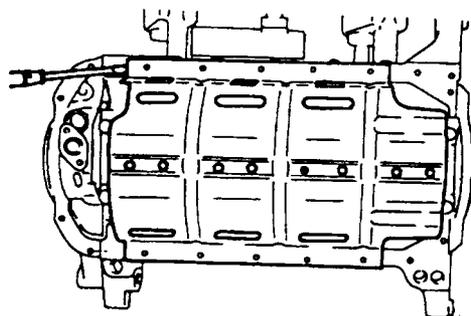
- Remove the oil seal by using a screwdriver protected with a rag.



X5U110ABE

Oil baffle disassembly note

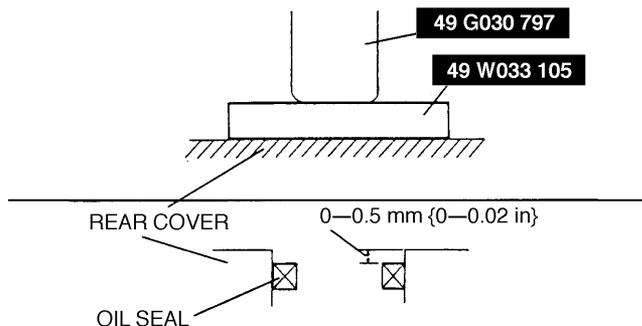
1. Insert a screwdriver between the cylinder block and the oil baffle to separate them.
2. Remove the oil baffle.



X5U110AEA

Rear cover assembly note

1. Apply clean engine oil to the new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly by using the **SST**.



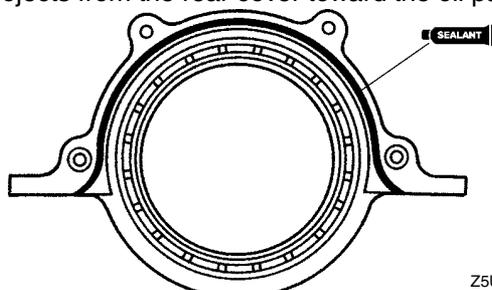
X5U110ABF

4. Apply silicone sealant to the rear cover as shown.

Thickness
ø2 mm {0.079 in}

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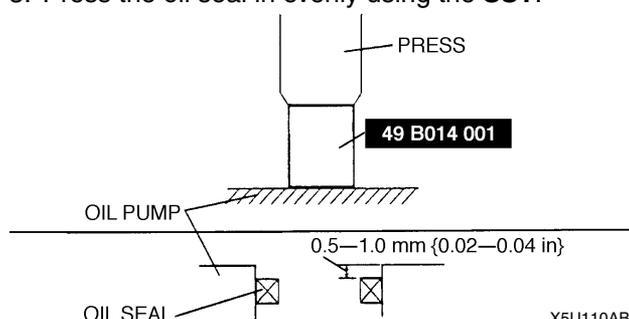
5. Install the rear cover.
6. Cut away the portion of the silicone sealant that projects from the rear cover toward the oil pan side.



Z5U0110E027

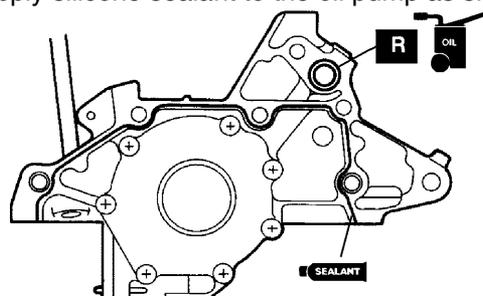
Oil pump assembly note

1. Apply clean engine oil to a new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly using the SST.



X5U110ABH

4. Install the new O-ring.
5. Apply silicone sealant to the oil pump as shown.



X5U110ABJ

Thickness

φ 1—2 mm {0.040—0.078 in}

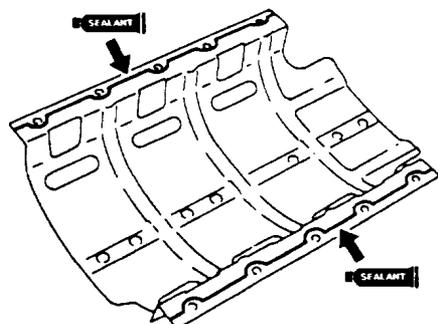
6. Install the oil pump.
7. Cut away the portion of the silicone sealant that projects from the body toward the oil pan side.

Oil baffle assembly note (BP)

1. Remove all foreign material from the contact surfaces.
2. Apply silicone sealant to the oil baffle along the inside of the bolt holes, and install within five minutes.

Thickness

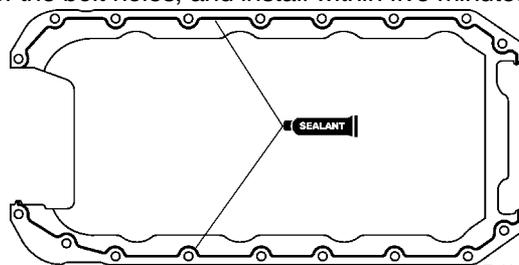
φ 2.5—3.5 mm {0.099—0.137 in}



C5U110ZEB004

MBSP assembly note (BP with TC)

1. Apply silicone sealant to the MBSP along the inside of the bolt holes, and install within five minutes.

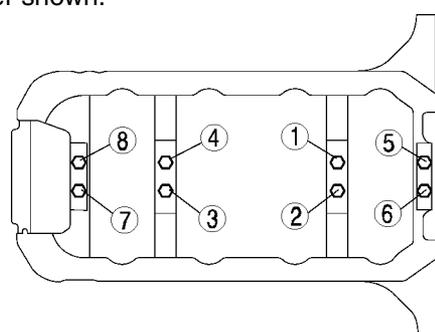


Z5U0110E030

Thickness

φ 2.5—3.5 mm {0.099—0.137 in}

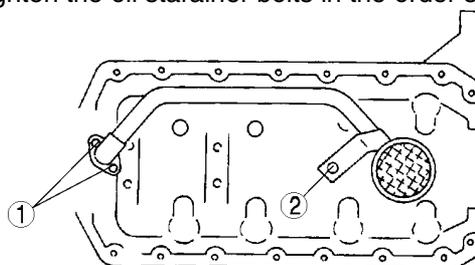
2. Tighten the MBSP bolts in two or three steps in the order shown.



Z5U0110E031

Oil Strainer Assembly Note (BP with TC)

1. Install a new oil strainer gasket onto the oil pump body.
2. Tighten the oil strainer bolts in the order shown.



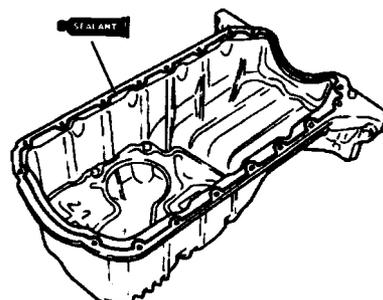
Z5U0110E033

Oil pan assembly note (BP)

1. Apply silicone sealant to the oil pan as shown.

Thickness

φ 2.5—3.5 mm {0.099—0.137 in}

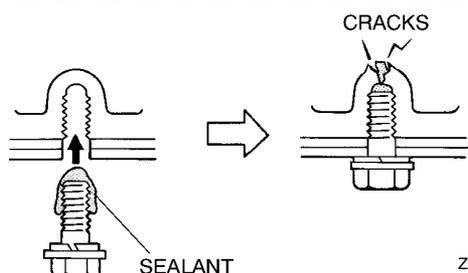


C5U110ZEB006

Oil pan assembly note (BP with TC)

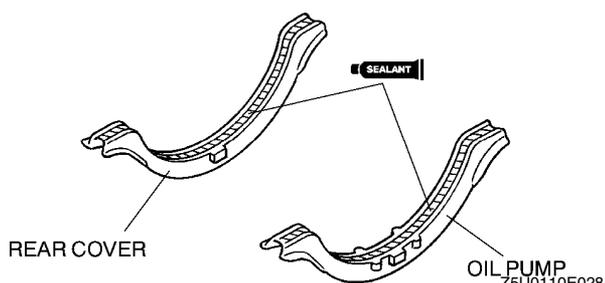
Caution

- If the bolts are reused, remove the old sealant from the bolt threads. Tightening a bolt that has old sealant on it can cause bolt hole damage.

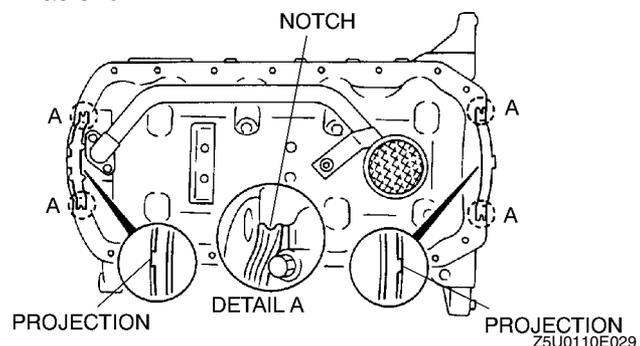


Z5U0110E034

1. Apply silicone sealant to oil pan gasket as shown.
Thickness
φ 2.0 mm {0.079 in}

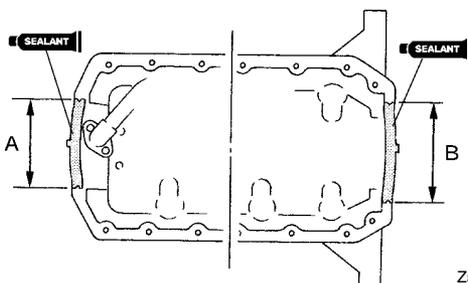


2. Install oil pan gaskets onto the oil pump body and the rear cover with the projections in the notches as shown.



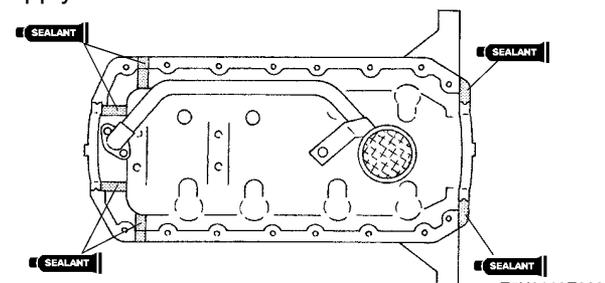
Z5U0110E029

3. Apply silicone sealant onto the area of oil pan gasket indicated by A and B.
Thickness
φ 2.0 mm {0.079 in}



Z5U0110E035

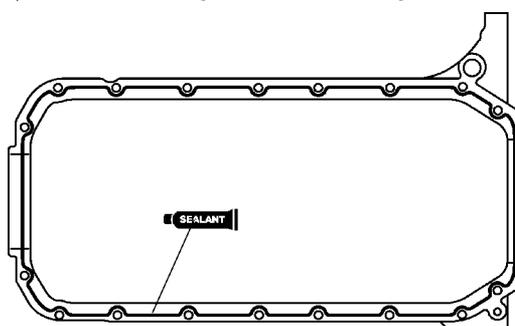
4. Apply silicone sealant to the shaded areas shown.



Z5U0110E036

5. Apply silicone sealant to the oil pan along the inside of the bolt holes, and install within five minutes.

Thickness
φ 2.5—3.5 mm {0.099—0.137 in}



Z5U0110E032

Flywheel (MT), drive plate (AT) assembly note

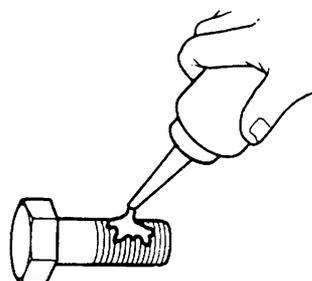
1. Remove the sealant from the bolt holes in the crankshaft and from the bolts.

Caution

- If all of the old thread locking sealant cannot be removed from the bolt, it will not torque properly. Replace the bolt.

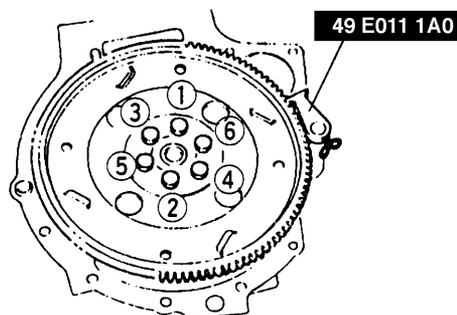
Note

- If a new bolt is used, do not apply thread locking sealant. New bolts have sealant on them.



X5U110ABL

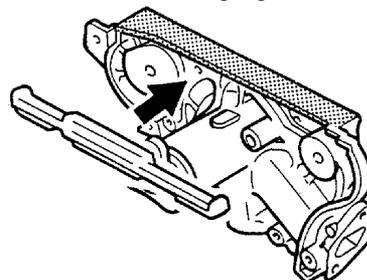
2. Set the flywheel or drive plate onto the crankshaft.
3. Apply sealant to the flywheel bolts and install them.
4. Hold the flywheel or drive plate using the SST.
5. Tighten the bolts in two or three steps in the order shown.



X5U110ABM

Water pump assembly note

1. Verify that the rubber seal is securely fixed onto the water pump.
2. If not as specified, remove the rubber seal and reinstall it with the bonding agent.

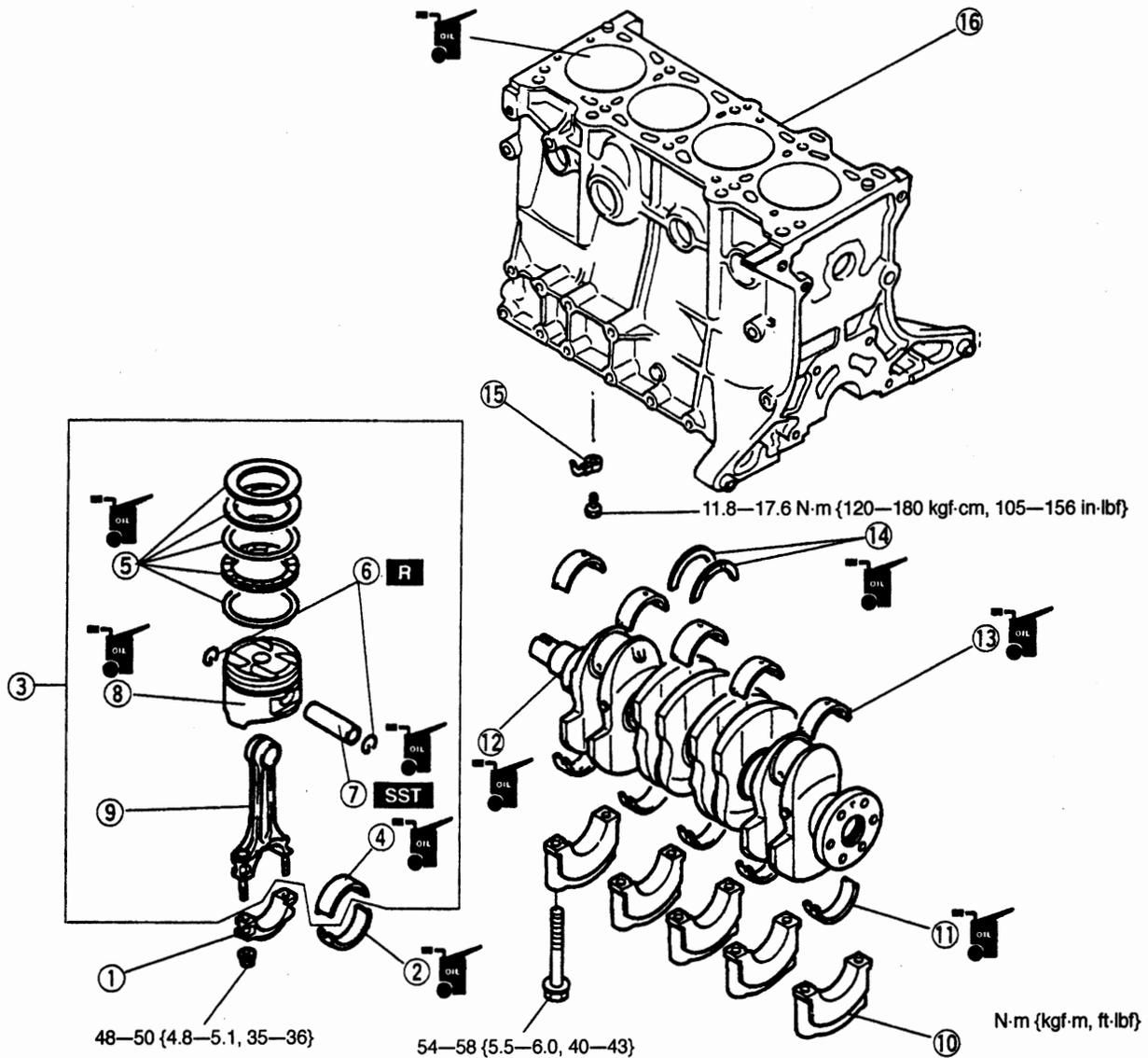


X5U110ABN

MECHANICAL

Cylinder Block Disassembly / Assembly (II)

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



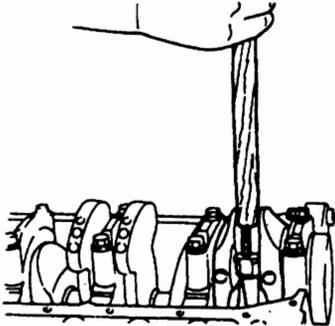
X5U110ABP

1	Connecting rod cap ☞ Assembly Note
2	Lower connecting rod bearing
3	Piston and connecting rod ☞ Disassembly Note ☞ Assembly Note
4	Upper connecting rod bearing
5	Piston ring
6	Piston pin clip
7	Piston pin
8	Piston

9	Connecting rod
10	Main bearing cap ☞ Disassembly Note ☞ Assembly Note
11	Lower main bearing
12	Crankshaft
13	Upper main bearing
14	Thrust bearing
15	Oil jet
16	Cylinder block

Piston and connecting rod disassembly note

1. Inspect the connecting rod side clearance. (Refer to 01-10 ENGINE INSPECTION / REPAIR, Connecting Rod Side Clearance Inspection.)
2. Use the handle of a hammer to remove the piston and connecting rod through the top of the cylinder block.



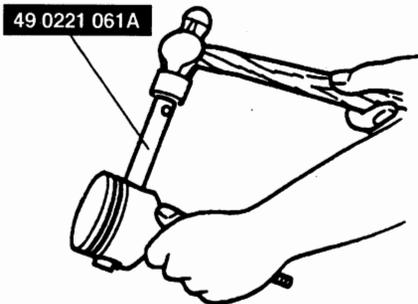
X5U110ABQ

3. Inspect the piston and connecting rod. (Refer to 01-10 ENGINE INSPECTION / REPAIR, Piston and Connecting Rod Inspection.)
4. Remove the piston rings by using a piston ring expander.



X5U110ABR

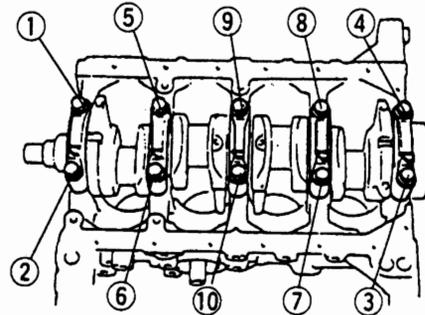
5. Remove the piston pin by using the SST.



X5U110ABS

Main bearing cap disassembly note

1. Inspect the crankshaft end play. (Refer to 01-10 ENGINE INSPECTION / REPAIR, Crankshaft End Play Inspection.)
2. Loosen the main bearing cap bolts in two or three steps in the order shown.

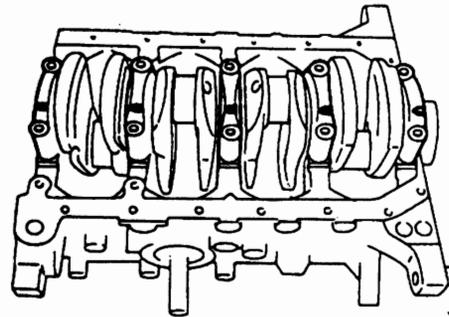


X5U110ABT

3. Remove the main bearing caps.

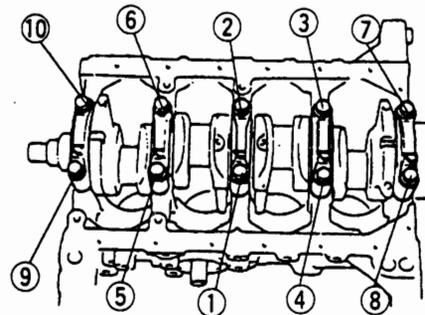
Main bearing cap assembly note

1. Install the crankshaft and the main bearing caps according to the cap number and "←" mark which indicates front side.



X5U110ABU

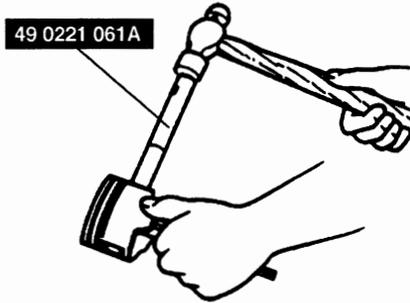
2. Tighten the main bearing cap bolts in two or three steps in the order shown.



X5U110ABV

Piston and connecting rod assembly note

1. Install one piston pin clip into the clip groove in the piston.
2. Assemble the piston and the connecting rod.
3. Apply clean engine oil to the piston pin.
4. Install the piston pin from the side opposite the clip.
5. Tap the piston pin in with the **SST** until the pin contacts the clip. If the pin cannot be installed easily, replace the connecting rod.



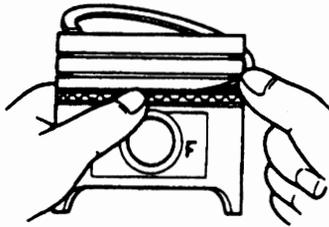
X5U110ABW

6. Install the second clip into the clip groove in the piston.
7. Install the three-piece oil rings on the pistons.
 - (1) Apply clean engine oil to the oil ring spacer and rails.
 - (2) Install the oil ring spacer with the ends upward.

Note

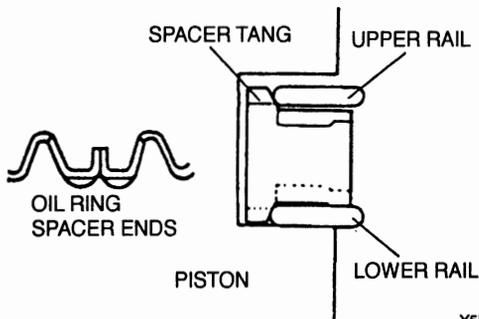
- The upper and lower rails are the same. They can be installed with either face upward.

- (3) Install the upper and lower rails.



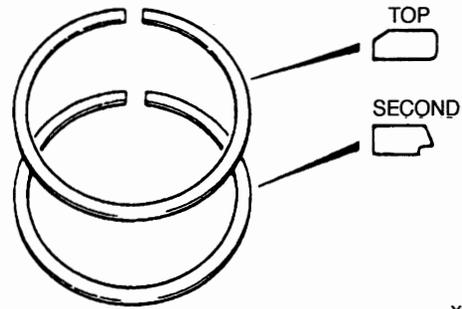
X5U110ABX

8. Verify that the spacer tang separates the rails, and that the rails turn smoothly in both directions.



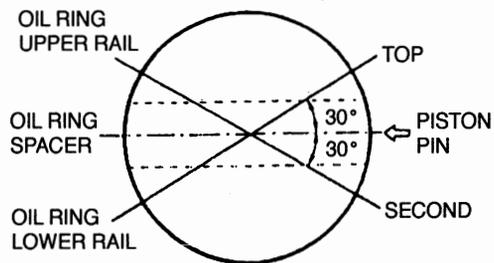
X5U110ABY

9. Using a piston ring expander, install the second ring with the scraper face downward.



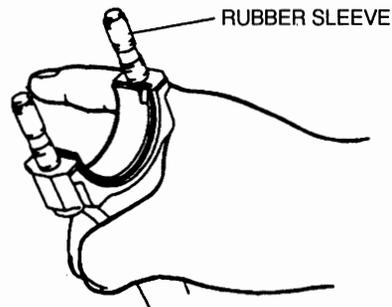
X5U110ABZ

10. Using a piston ring expander, install the top ring with the chamfer facing upward.
11. Apply clean engine oil to the top and second piston rings.
12. Position the end gaps of the rings as shown.



X5U110AC0

13. Protect the connecting rod bolts with rubber sleeves.



X5U110AC1

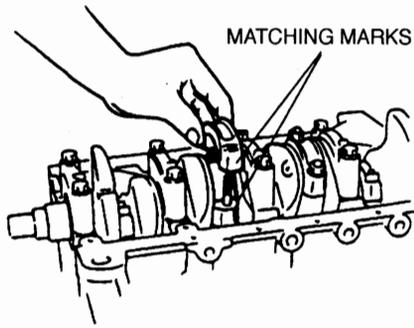
14. Apply clean engine oil to the cylinder walls, pistons, and piston rings.
15. Inspect the piston rings for correct end gap alignment.
16. Insert each piston into the cylinder block with the **F** mark facing the front of the engine. Use a piston ring compressor.



X5U110AC2

Connecting rod cap assembly note

1. Align the matching marks on the cap and the connecting rod and install the connecting rod cap.



X5U110AC3

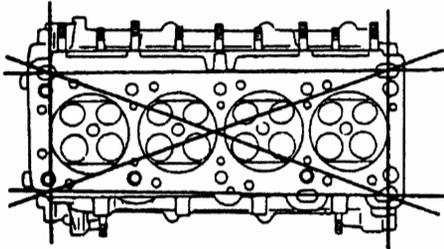
ENGINE INSPECTION / REPAIR

Cylinder Head Inspection / Repair

1. Carry out cooling flaw detection on the cylinder head surface. Replace the cylinder head as necessary.
2. Inspect for the following and repair or replace as necessary.
 - (1) Sunken valve seats
 - (2) Excessive camshaft oil clearance and end play
3. Measure the cylinder head for distortion in the six directions as shown.

Distortion

0.10 mm {0.004 in} max.



X5U110AC4

4. If the cylinder head distortion exceeds the maximum, repair by grinding height or replace the cylinder head. If the cylinder head height is not as specified, replace it.

Standard height

133.8—134.0 mm {5.268—5.275 in}

Grinding

0.10 mm {0.004 in} max.

5. Measure the manifold contact surface distortion as shown.

Distortion

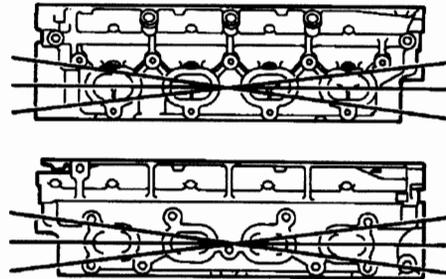
0.15 mm {0.006 in} max.

X5U110A04

6. If the distortion exceeds the specification, grind the surface or replace the cylinder head.

Grinding

0.20 mm {0.008 in} max.



X5U110AC5

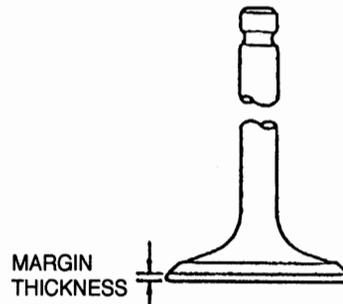
Valve Inspection

1. Measure the valve head margin thickness of each valve. Replace the valve as necessary.

Margin thickness

IN: 0.9 mm {0.035 in} min.

EX: 1.0 mm {0.039 in} min.



X5U110AC8

2. Measure the length of each valve. Replace the valve as necessary.

Standard length

IN: 101.71—102.31 mm {4.0044—4.0279 in}
EX: 101.71—102.31 mm {4.0044—4.0279 in}

Minimum length

IN: 101.61 mm {4.0004 in}
EX: 101.61 mm {4.0004 in}

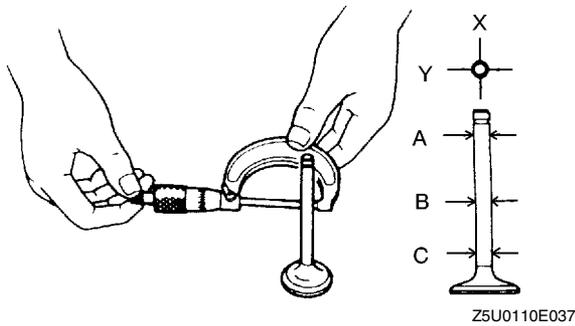
3. Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) shown. Replace the valves as necessary.

Standard diameter

IN: 5.970—5.985 mm {0.2351—0.2356 in}
EX: 5.965—5.980 mm {0.2349—0.2354 in}

Minimum diameter

IN: 5.920 mm {0.2331 in}
EX: 5.915 mm {0.2329 in}

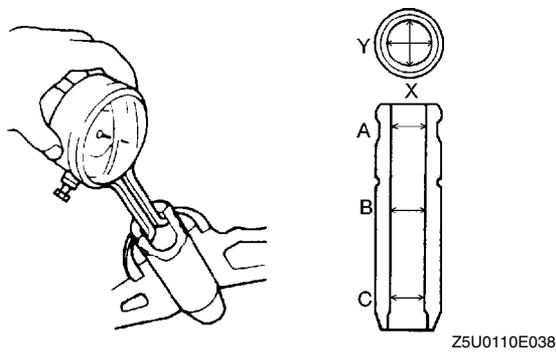


Valve Guide Inspection

1. Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) shown. Replace the valve guide as necessary.

Standard inner diameter

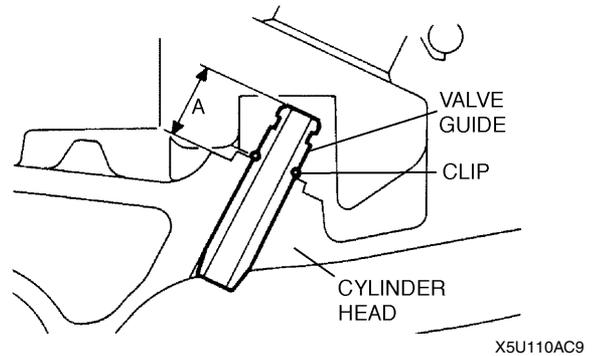
6.02—6.04 mm {0.2371—0.2377 in}



2. Measure the protrusion height (dimension A) of each valve guide without the lower valve spring seat. Replace the valve guide as necessary.

Standard height

18.3—18.9 mm {0.721—0.744 in}



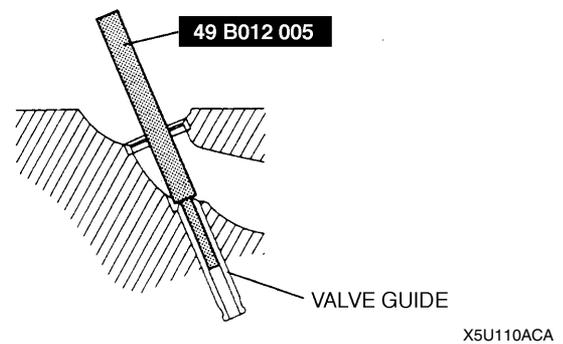
Valve Guide Replacement

Note

- Intake and exhaust valve guides are different.

Valve guide removal

- Remove the valve guide from the combustion chamber side by using the SST.

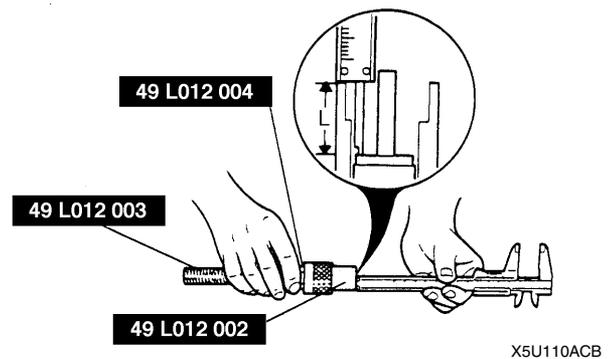


Valve guide installation

1. Assemble the SSTs so that depth L is as specified.

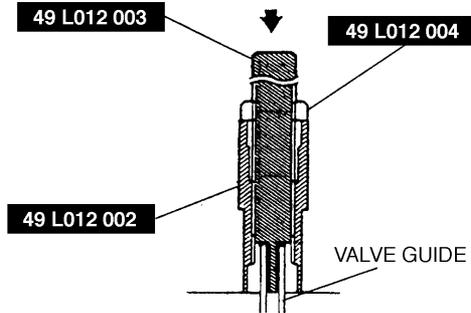
Depth L

18.3—18.9 mm {0.721—0.744 in}

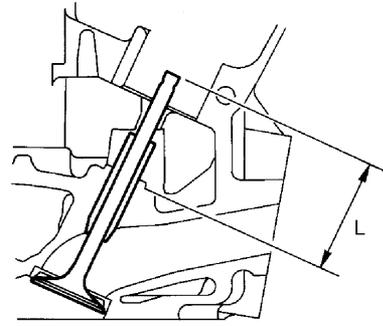


2. Tap the valve guide in from the side opposite the combustion chamber until the SST contacts the cylinder head.
3. Verify that the valve guide projection height (dimension) is as specified.

Standard height
18.3—18.9 mm {0.721—0.744 in}



X5U110ACC

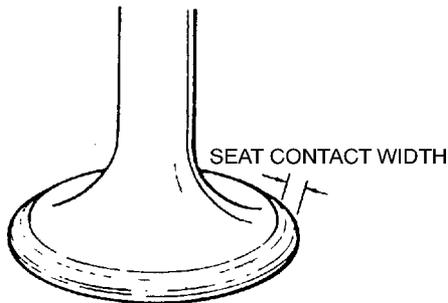


X5U110ACF

Valve Seat Inspection/Repair

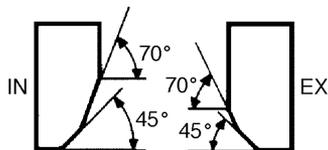
1. Measure the seat contact width. As necessary, resurface the valve seat using a 45° valve seat cutter and/or resurface the valve face.

Standard width
0.8—1.4 mm {0.032—0.055 in}



Z5U0110E039

2. Verify that the valve seating position is at the center of the valve face.
 - (1) If the seating position is too high, correct the valve seat using a 70° cutter, and a 45° cutter.
 - (2) If the seating position is too low, correct the valve seat using a 45° cutter.



X5U110ACE

3. Inspect the sinking of the valve seat. Measure the protruding length (dimension L) of the valve stem. Replace the cylinder head as necessary.

Standard dimension L
IN: 45.0 mm {1.772 in}
EX: 45.0 mm {1.772 in}

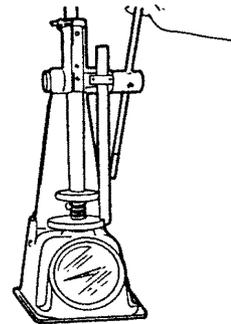
Maximum dimension L
IN: 45.6 mm {1.795 in}
EX: 45.6 mm {1.795 in}

Valve Spring Inspection

1. Apply pressing force to the pressure spring and measure the spring height. Replace the valve spring as necessary.

Pressing force
IN: 172.60—195.15 N
{17.6—19.9 kgf, 38.72—43.78 lbf}
EX: 172.60—195.15 N
{17.6—19.9 kgf, 38.72—43.78 lbf}

Standard height
IN: 39.5 mm {1.56 in}
EX: 39.5 mm {1.56 in}

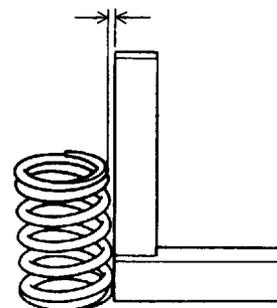


X5U110ACG

2. Measure the out-of-square of the valve spring. Replace the valve spring as necessary.

Valve spring out-of-square

	(mm {in})	
	BP	BP with TC
IN	1.63 {0.064} max.	1.58 {0.062} max.
EX	1.63 {0.064} max.	



Z5U0110E040

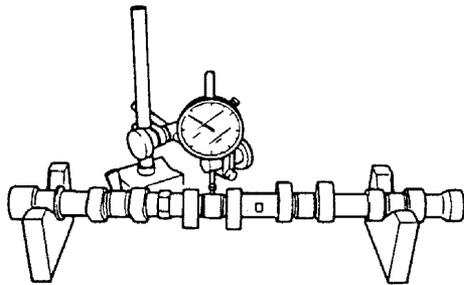
Engine Workshop Manual BP (1605-10-97K)
MECHANICAL

Camshaft Inspection

1. Set the No.1 and No.5 journals on V-blocks. Measure the camshaft runout. Replace the camshaft as necessary.

Runout

0.03 mm {0.0012 in} max.



X5U110ACJ

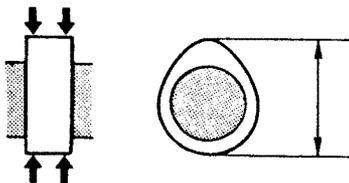
2. Measure the cam lobe height at the two points as shown. Replace the camshaft as necessary.

Standard height

(mm {in})		
	BP	BP with TC
IN	44.3 {1.744}	44.8 {1.764}
EX	44.9 {1.768}	

Minimum height

(mm {in})		
	BP	BP with TC
IN	44.1 {1.736}	44.6 {1.756}
EX	44.7 {1.760}	



X5U110ACK

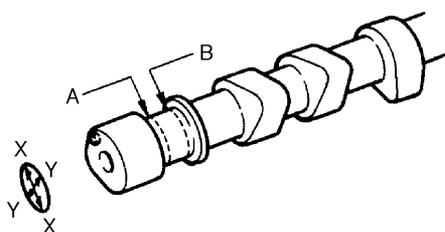
3. Measure the journal diameters in X and Y directions at the two points (A and B) as shown. Replace the camshaft as necessary.

Standard diameter

25.940—25.965 mm {1.0213—1.0222 in}

Minimum diameter

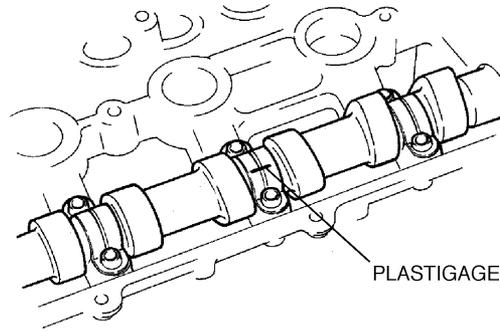
25.910 mm {1.0201 in}



X5U110ACL

Camshaft Oil Clearance Inspection

1. Position a plastigage on the top of the journals in the axial direction.



X5U110ACM

2. Install the camshaft cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Head Disassembly / Assembly (II), Camshaft disassembly note.)
3. Remove the camshaft cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Head Disassembly / Assembly (II), Camshaft disassembly note.)
4. Measure the oil clearance. Replace the cylinder head as necessary.

Standard clearance

0.035—0.081 mm {0.0014—0.0031 in}

Maximum clearance

0.15 mm {0.006 in}

Camshaft End Play Inspection

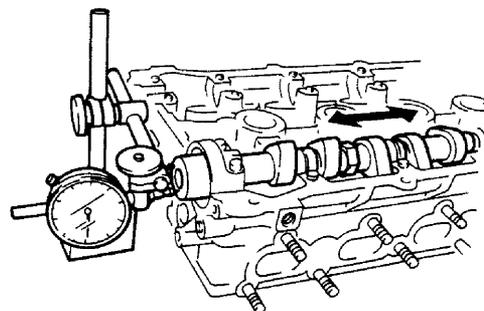
1. Install the camshaft cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Head Disassembly / Assembly (II), Camshaft disassembly note.)
2. Measure the camshaft end play. Replace the cylinder head or camshaft as necessary.

Standard end play

0.057—0.127 mm {0.0023—0.0049 in}

Maximum end play

0.20 mm {0.008 in}



X5U110ACN

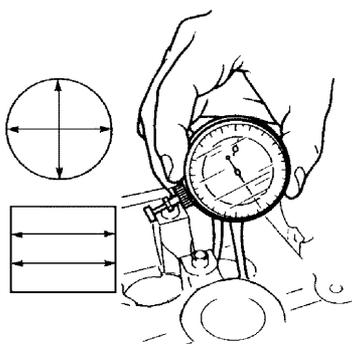
3. Remove the camshaft cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Head Disassembly / Assembly (II), Camshaft disassembly note.)

**Engine Workshop Manual BP (1605-10-97K)
MECHANICAL**

Tappet Inspection

1. Measure the diameter of each tappet bore.

Standard diameter
30.000—30.025 mm {1.1811—1.1820 in}



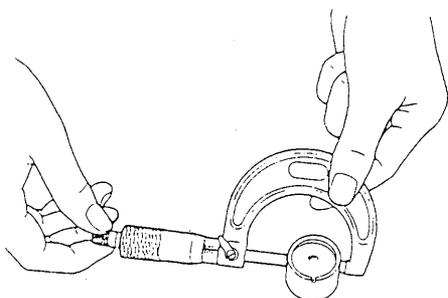
X5U110ACP

2. Measure the diameter of each tappet.

Standard diameter
29.959—29.975 mm {1.1795—1.1801 in}

3. Calculate the clearance between the tappet and the related tappet bore. Replace the tappet or cylinder head as necessary.

Standard clearance
0.025—0.066 mm {0.00099—0.00259 in}
Maximum clearance
0.180 mm {0.0071 in}

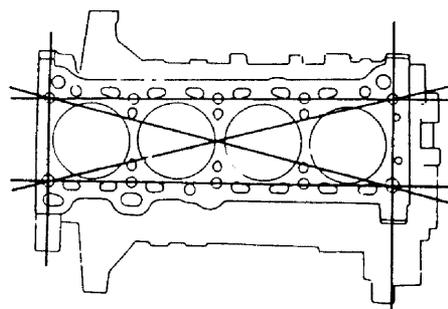


X5U110ACQ

Cylinder Block Inspection / Repair

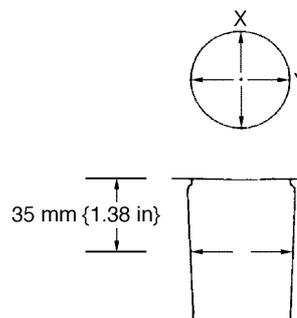
1. Measure the distortion of the cylinder block top surface in the six directions as shown. Repair by grinding or replace as necessary.

Cylinder block distortion
0.15 mm {0.006 in} max.
Cylinder block height
221.5 mm {8.720 in}
Grinding
0.20 mm {0.008 in} max.



X5U110ACR

2. Measure the cylinder bores in X and Y directions at 35 mm {1.38 in} below the top surface.



X5U110ACS

3. If the cylinder bore exceeds the wear limit, replace the cylinder block or rebores the cylinder and install the oversize pistons so that the specified piston-to-cylinder clearance is obtained.

Note

- Base the boring diameter on the diameter of an oversize piston. All cylinders must be the same diameter.

Cylinder bore

	mm {in}
Size	Diameter
Standard	83.000—83.019 {3.2678—3.2684}
0.25 {0.01} oversize	83.250—83.269 {3.2776—3.2783}
0.50 {0.02} oversize	83.500—83.519 {3.2874—3.2881}

Wear limit
0.15 mm {0.006 in}

Oil Jet Inspection

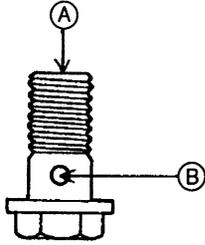
1. Apply compressed air to oil jet valve A and verify that air passes through oil jet valve B. If not, replace the oil jet valve.

MECHANICAL

Air pressure

167—225 kPa {1.7—2.3 kgf/cm², 25—32 psi}

- Inspect the oil jet nozzle for clogs. Replace the nozzle as necessary.



X5U110ACT

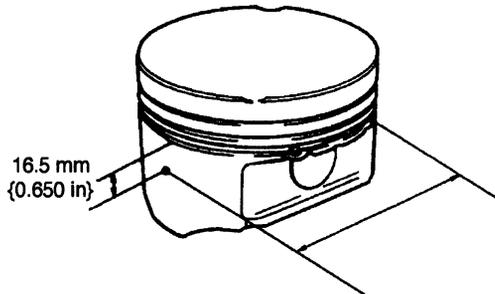
Piston Inspection

- Measure the outer diameter of each piston at right angle (90°) to the piston pin, 16.5 mm {0.650 in} below the oil ring groove lower edge.

Piston diameter

mm {in}

Size	Diameter
Standard	82.953—82.975 {3.2659—3.2667}
0.25 {0.01} oversize	83.203—83.225 {3.2758—3.2765}
0.50 {0.02} oversize	83.453—83.475 {3.2856—3.2864}



X5U110ACU

Piston Clearance Inspection / Repair

- Calculate the piston-to-cylinder clearance. Replace the piston or rebores the cylinders to fit oversize piston as necessary.

Standard clearance

0.025—0.066 mm {0.0010—0.0025 in}

Maximum clearance

0.15 mm {0.006 in}

- If the piston is replaced, the piston rings must also be replaced.

Piston Ring Clearance Inspection

- Measure the piston ring-to-ring land clearance around the entire circumference. Replace the piston and piston ring as necessary.

Standard clearance

Top : 0.030—0.065 mm {0.0012—0.0025 in}

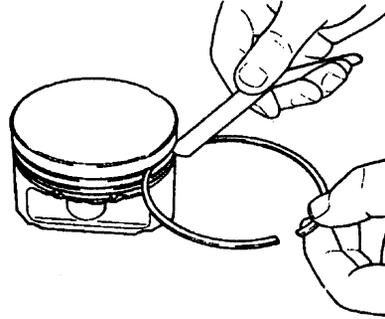
Second : 0.030—0.070 mm {0.0012—0.0027 in}

Oil : 0.07—0.16 mm {0.003—0.006 in}

Maximum clearance

Top, Second : 0.15 mm {0.006 in}

Oil : 0.20 mm {0.008 in}



X5U110ACV

- Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
- Measure each piston ring end gap by using a feeler gauge. Replace the piston ring as necessary.

Standard end gap

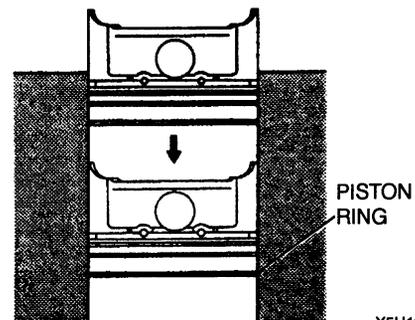
Top : 0.15—0.30 mm {0.006—0.011 in}

Second : 0.30—0.45 mm {0.012—0.017 in}

Oil rail : 0.20—0.70 mm {0.008—0.027 in}

Maximum end gap

1.0 mm {0.039 in}



X5U110ACW

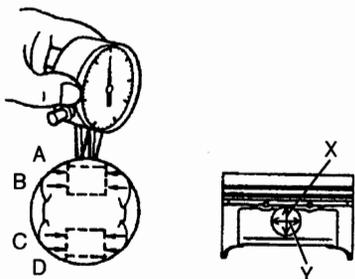
Piston Pin Clearance Inspection

- Measure each piston pin hole diameter in X and Y directions at the four points (A, B, C, and D) as shown.

MECHANICAL

Standard diameter

19.988—20.000 mm {0.7870—0.7874 in}

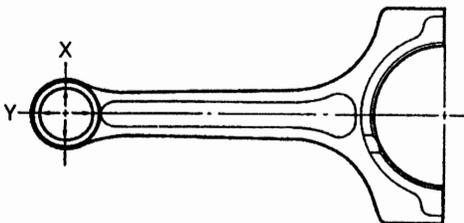


X5U110ACX

2. Measure each connecting rod small end inner diameter in X and Y directions as shown.

Standard diameter

20.003—20.014 mm {0.7876—0.7879 in}

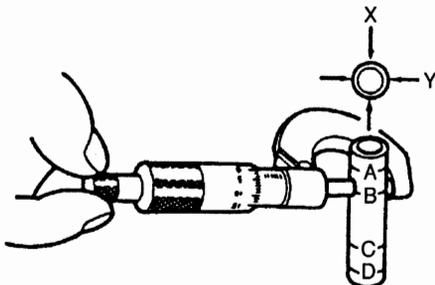


X5U110ACY

3. Measure each piston pin diameter in X and Y directions at the four points (A, B, C, and D) as shown.

Standard diameter

19.987—19.993 mm {0.7869—0.7871 in}



X5U110ACZ

4. Calculate the piston pin-to-piston pin bore clearance. Replace the piston and/or piston pin as necessary.

Standard clearance

−0.005—0.013 mm {−0.0002—0.0005 in}

5. Calculate the connecting rod small end-to-piston pin clearance. Replace the connecting rod or piston pin.

Standard clearance

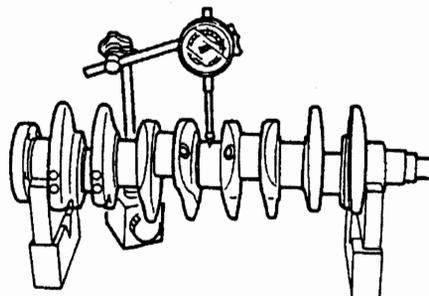
0.010—0.027 mm {0.004—0.0010 in}

Crankshaft Inspection

1. Measure the crankshaft runout. Replace the crankshaft as necessary.

Runout

0.04 mm {0.0016 in} max.



X5U110AD0

2. Measure the journal diameter in X and Y direction at the two points (A and B) as shown. Replace the crankshaft or grind the journal and install the undersize bearing as necessary.

Main Journal

mm {in}

Bearing size	Diameter
Standard	49.938—49.956 {1.9661—1.9667}
0.25 {0.01} undersize	49.688—49.706 {1.9563—1.9569}
0.50 {0.02} undersize	49.438—49.456 {1.9464—1.9470}
0.75 {0.03} undersize	49.188—49.206 {1.9366—1.9372}

Out-of-round

0.05 mm {0.002 in} max.

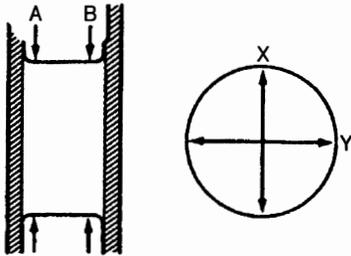
Crank pin

mm {in}

Bearing size	Diameter
Standard	44.940—44.956 {1.7693—1.7699}
0.25 {0.01} undersize	44.690—44.706 {1.7595—1.7600}
0.50 {0.02} undersize	44.440—44.456 {1.7497—1.7502}
0.75 {0.03} undersize	44.190—44.206 {1.7398—1.7403}

Out-of-round

0.05 mm {0.002 in} max.



X5U110AD1

Crankshaft Oil Clearance Inspection / Repair

1. Position plastigauge on the top of the journals in the axial direction.
2. Install the main bearing cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Block Disassembly / Assembly (II), Main bearing cap assembly note.)
3. Remove the main bearing cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Block Disassembly / Assembly (II), Main bearing cap disassembly note.)
4. Measure the main journal oil clearance. If the clearance exceeds the maximum, replace the main bearing or grind the main journal and install the undersize bearings so that the specified oil clearance is obtained.

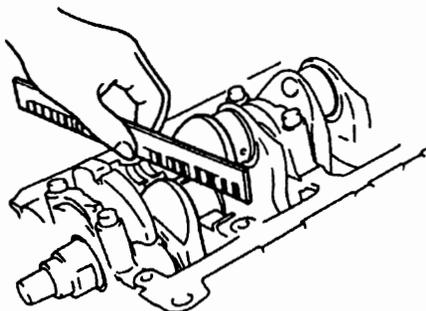
Standard clearance

0.018—0.036 mm {0.0008—0.0014 in}

Maximum clearance

0.10 mm {0.0039 in}

Bearing size	Bearing thickness
Standard	2.007—2.025 {0.0791—0.0797}
0.25 {0.01} undersize	2.133—2.137 {0.0840—0.0841}
0.50 {0.02} undersize	2.258—2.262 {0.0889—0.0890}
0.75 {0.03} undersize	2.383—2.387 {0.0939—0.0939}



X5U110AD2

Crankshaft End Play Inspection / Repair

1. Install the main bearing cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Block Disassembly / Assembly (II) Main bearing cap assembly note.)
2. Measure the crankshaft end play. If the end play exceeds the maximum, replace the thrust bearing or grind the crankshaft and install an undersize bearing so that the specified end play is obtained.

Standard end play

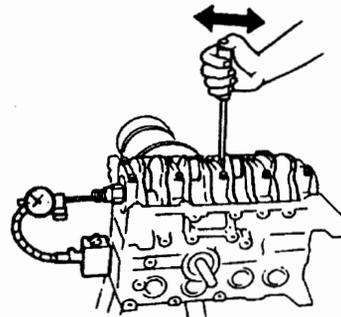
0.080—0.282 mm {0.0032—0.0111 in}

Maximum end play

0.30 mm {0.012 in}

mm {in}

Bearing size	Bearing thickness
Standard	2.500—2.550 {0.0985—0.1003}
0.25 {0.01} undersize	2.625—2.675 {0.1034—0.1053}
0.50 {0.02} undersize	2.750—2.800 {0.1083—0.1102}
0.75 {0.03} undersize	2.875—2.925 {0.1132—0.1151}



X5U110AD3

3. Remove the main bearing cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Block Disassembly / Assembly (II), Main bearing cap disassembly note.)

Connecting Rod Inspection

- Measure each connecting rod for bending and distortion. Replace the connecting rod as necessary.

Bending

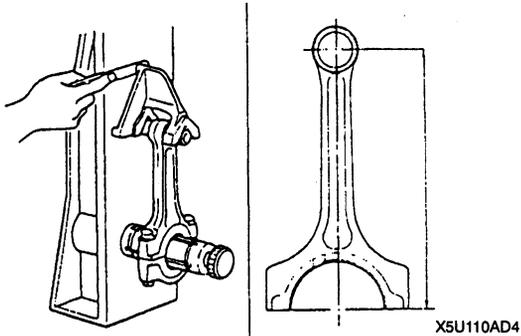
0.05 mm {0.0020 in} max. /50 mm {1.97 in}

Distortion

0.07 mm {0.0028 in} max. /50 mm {1.97 in}

Center-to-center distance

132.85—132.95 mm {5.2304—5.2342 in}



Connecting Rod Side Clearance Inspection

1. Install the connecting rod cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, Cylinder Block Disassembly / Assembly (II), Piston and connecting rod assembly note.)
2. Measure the connecting rod large end side clearance. Replace the connecting rod and cap as necessary.

Standard clearance

0.110—0.262 mm {0.005—0.010 in}

Maximum clearance

0.30 mm {0.012 in}

Connecting Rod Oil Clearance Inspection/Repair

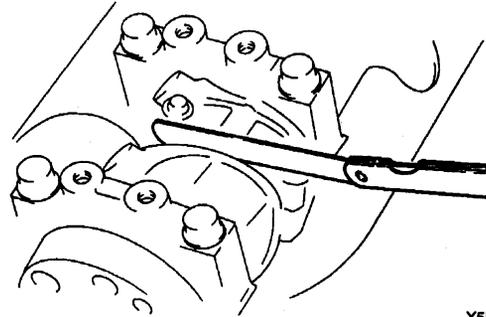
1. Position a plastigage on the top of the journals in the axial direction.
2. Install the connecting rod cap. (Refer to ENGINE DISASSEMBLY / ASSEMBLY, CYLINDER BLOCK Disassembly / Assembly (II), Piston and connecting rod assembly note.)
3. Remove the connecting rod cap.
4. Measure the crankpin oil clearance. If the clearance exceeds the maximum, replace the connecting rod bearing or grind the crankpin and use undersize bearings so that the specified clearance is obtained.

Standard clearance

0.028—0.048 mm {0.0012—0.0018 in}

Maximum clearance

0.10 mm {0.0039 in}

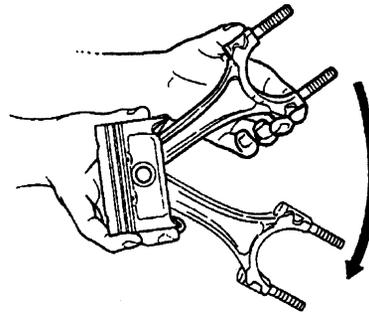


X5U110AD6

3. Remove the connecting rod cap.

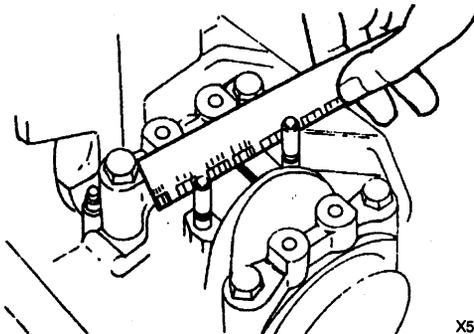
Piston and Connecting Rod Inspection

- Inspect the oscillation torque as shown. If the large end does not drop by its own weight, replace the piston or the piston pin.



X5U110AD7

mm {in}	
Bearing size	Bearing thickness
Standard	1.504—1.520 {0.05922—0.05984}
0.25 {0.01} undersize	1.631—1.635 {0.06422—0.06436}
0.50 {0.02} undersize	1.756—1.760 {0.06914—0.06929}
0.75 {0.03} undersize	1.881—1.885 {0.07406—0.07421}



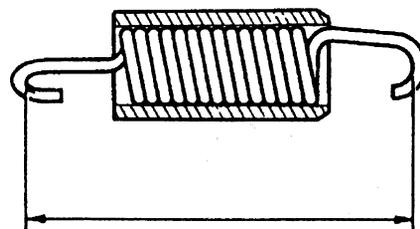
X5U110AD5

Tensioner Spring Inspection

- Measure the free length of the tensioner spring. Replace the tensioner spring as necessary.

Free length

59.2 mm {2.331 in}



X5U110AD8

Valve Clearance Inspection

1. Remove the cylinder head cover.
2. Verify that the engine is in cold condition.
3. Measure the valve clearance.
 - (1) Turn the crankshaft clockwise so that the No.1 piston is at TDC of the compression stroke.
 - (2) Measure the valve clearance at A in the figure.

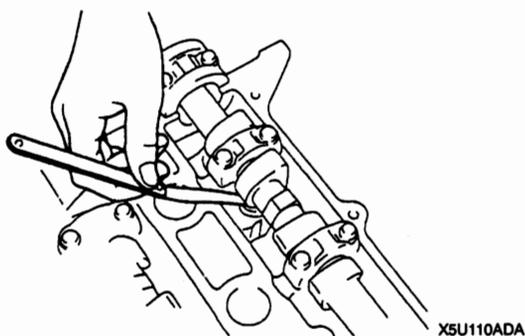
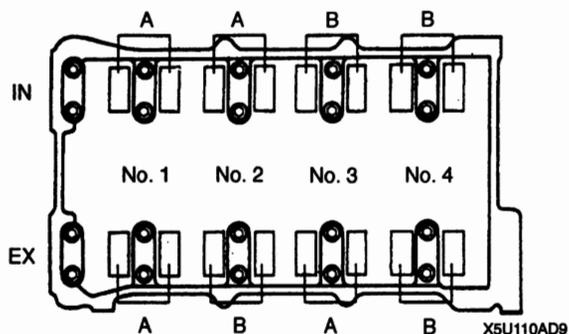
Standard valve clearance [Engine cold]

IN: 0.18—0.24 mm {0.0071—0.0094 in}

(0.21 ± 0.03 mm {0.0083 ± 0.0012 in})

EX: 0.28—0.34 mm {0.0111—0.0133 in}

(0.31 ± 0.03 mm {0.0122 ± 0.0012 in})



- (3) If the valve clearance exceeds the standard, replace the adjustment shim. (Refer to VALVE CLEARANCE ADJUSTMENT.)
- (4) Turn the crankshaft 360° clockwise so that the No.4 piston is at TDC of the compression stroke.
- (5) Measure the valve clearance at B in the figure.

Standard valve clearance [Engine cold]

IN: 0.18—0.24 mm {0.0071—0.0094 in}

(0.21 ± 0.03 mm {0.0083 ± 0.0012 in})

EX: 0.28—0.34 mm {0.0111—0.0133 in}

(0.31 ± 0.03 mm {0.0122 ± 0.0012 in})

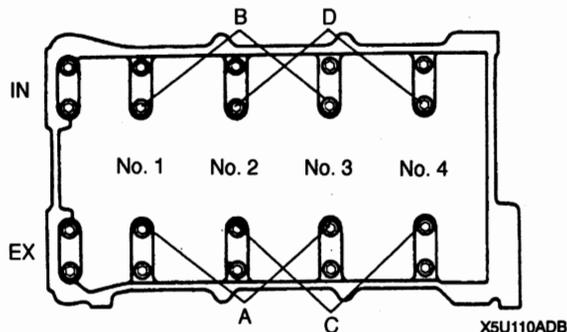
- (6) If the valve clearance exceeds the standard, replace the adjustment shim. (Refer to VALVE CLEARANCE ADJUSTMENT.)
4. Install the cylinder head cover.

Valve Clearance Adjustment

Perform this same procedure for all camshafts requiring valve clearance adjustment.

1. Turn the crankshaft clockwise so that the cams on the camshafts requiring valve clearance adjustment are positioned straight up.

2. Remove the camshaft cap bolts as necessary. Remove only one pair of cap bolts at a time. Reinstall the cap bolts before removing the next pair.
 - A: For EX side No.1, 2, 3 cylinder adjustment shim removal.
 - B: For IN side No.1, 2, 3 cylinder adjustment shim removal.
 - C: For EX side No.2, 3, 4 cylinder adjustment shim removal.
 - C: For IN side No.2, 3, 4 cylinder adjustment shim removal.



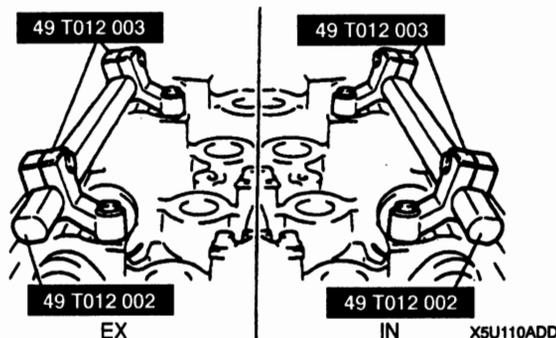
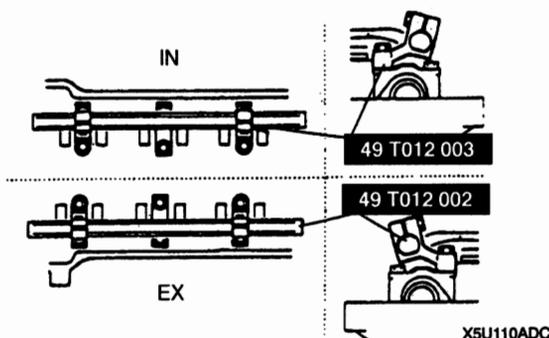
Note

- For EX side No.2, 3 cylinder adjustment shim removal, remove bolts either A or C.
- For IN side No.2, 3 cylinder adjustment shim removal, remove bolts either B or D.

3. Install the SSTs on the camshaft using the camshaft cap bolt holes.

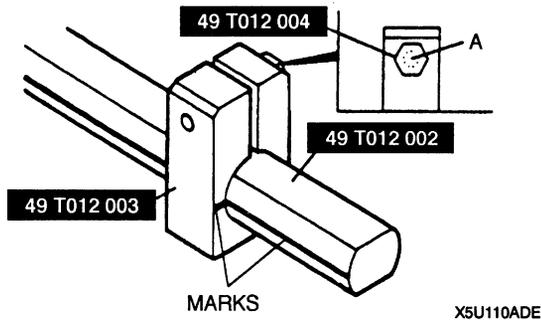
Tightening torque

11.3—14.2 N·m {115—145 kgf·cm, 100—125 in·lbf}

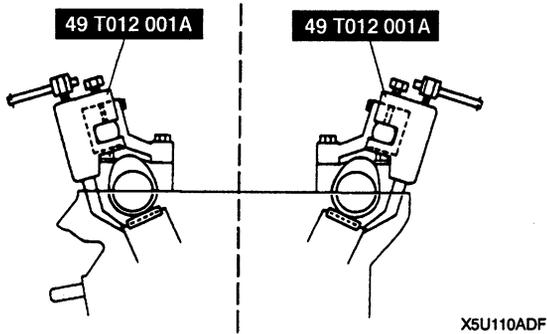


MECHANICAL

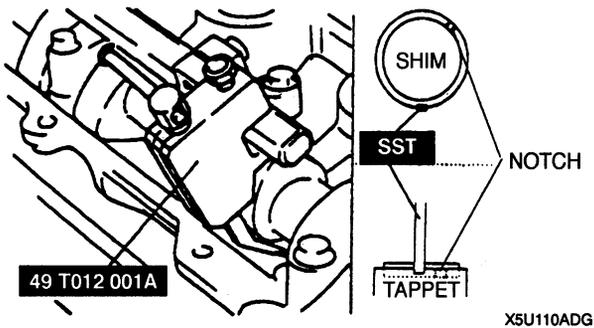
- Align the marks on the **SSTs** (shaft and shaft clamp).
- Tighten bolts A to secure the **SST** (shaft).



- Face the **SST** (body) outside of the cylinder head, and mount it on the **SST** (shaft) at the point of the adjustment shim to be replaced.



- Face the notch of the tappet so that a fine screwdriver can be installed.

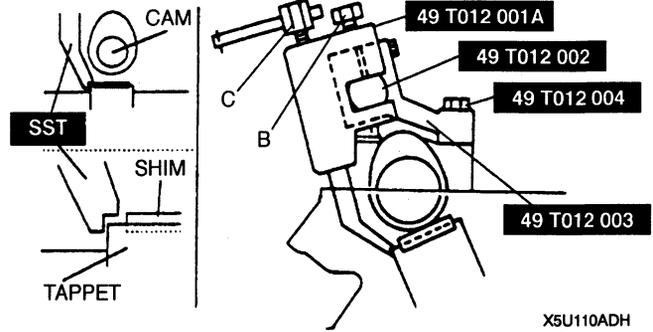


- Set the **SST** on the tappet by its notch.
- Tighten bolt B to secure the **SST** (body).

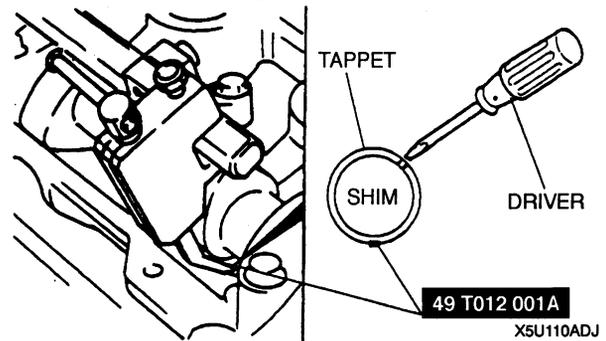
Caution

- Cylinder head can be damaged when the tappet is pressed down.

- Tighten bolt C, and press down the tappet.



- Using a fine screwdriver, pry up the adjustment shim through the notch on the tappet. Remove the shim by using a magnet.



- Select proper adjustment shim.

New adjustment shim

$$= \text{Removed shim thickness} + \text{Measured valve clearance} - \text{Standard valve clearance (IN: 0.21 mm \{0.0111 in\}, EX: 0.31 mm \{0.0122 in\})}$$

- Push the selected shim into the tappet.
- Loosen bolt C to allow the tappet to move up.
- Loosen bolt B and remove the **SST** (body).
- Remove the **SSTs** and tighten the camshaft cap bolts.

Tightening torque

$$11.3\text{--}14.2 \text{ N}\cdot\text{m} \{115\text{--}145 \text{ kgf}\cdot\text{cm}, 100\text{--}125 \text{ in}\cdot\text{lbf}\}$$

- Inspect for the valve clearance. (Refer to VALVE CLEARANCE, VALVE CLEARANCE INSPECTION.)

LUBRICATION SYSTEM

01-11 LUBRICATION SYSTEM

OIL PUMP

DISASSEMBLY / ASSEMBLY 01-11-1
 OIL PUMP INSPECTION 01-11-2

Inner Rotor, Outer Rotor,
 and Oil Pump Body Inspection 01-11-2
 Pressure Spring Inspection 01-11-2

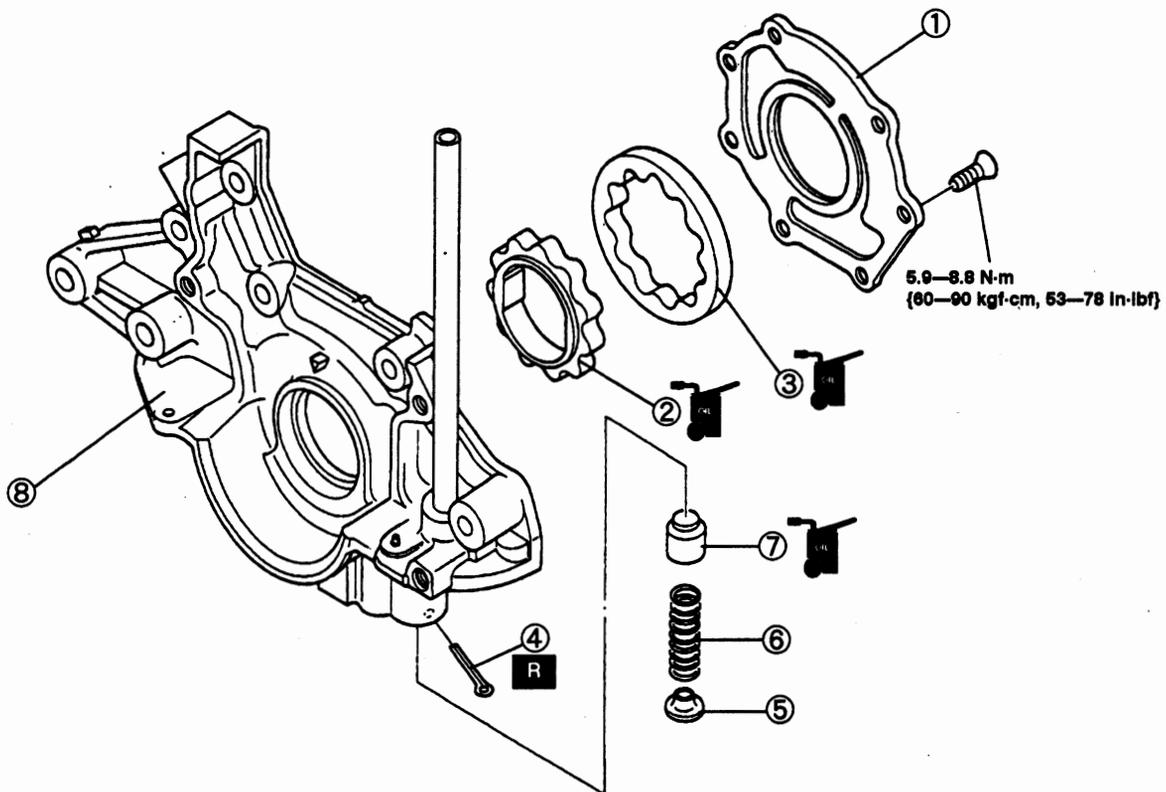
OIL PUMP DISASSEMBLY / ASSEMBLY

W5U111A01

Warning

- Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

1. Disassemble in the order indicated in the table.
2. Assemble in the reverse order of disassembly.



W5U111AA0

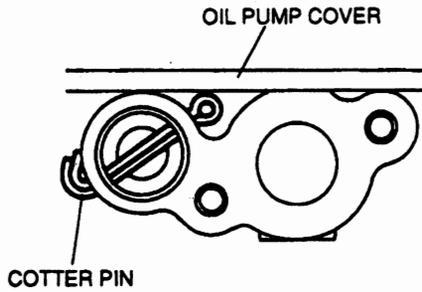
1	Oil pump cover
2	Inner rotor
3	Outer rotor
4	Cotter pin ☞ Assembly Note

5	Spring seat
6	Pressure spring
7	Control plunger
8	Oil pump body

LUBRICATION SYSTEM

Cotter Pin Assembly Note

- Bend the cotter pin so that its tip does not project from the oil pump cover mounting surface.



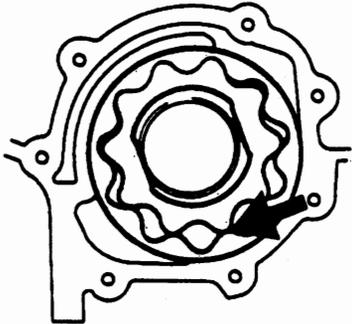
W5U111AA1

OIL PUMP INSPECTION

Inner Rotor, Outer Rotor, and Oil Pump Body Inspection

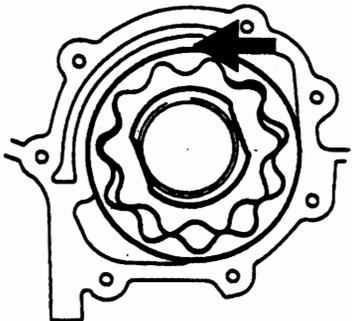
- Measure the following clearances. Replace the rotor or oil pump body as necessary.

Standard tooth tip clearance
0.02—0.18 mm {0.0008—0.0070 in}
Maximum tooth tip clearance
0.20 mm {0.0079 in}



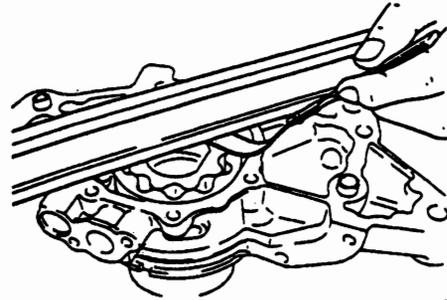
W5U111AA2

Standard outer rotor-to-oil pump body clearance
0.090—0.176 mm {0.0036—0.0069 in}
Maximum outer rotor-to-oil pump body clearance
0.22 mm {0.0087 in}



W5U111AA3

Standard side clearance
0.03—0.11 mm {0.0012—0.0043 in}
Maximum side clearance
0.14 mm {0.0055 in}



W5U111A02

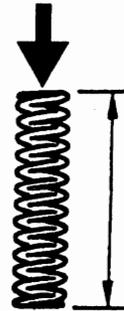
W5U111AA4

Pressure Spring Inspection

- Apply pressing force to the pressure spring and measure the spring height.

Standard height
35.42 mm {1.394 in} [Pressing force:
62.8—68.6 N {6.4—7.0 kgf, 14.1—15.4 lbf}]

PRESSING FORCE



W5U111AA5

01-50 TECHNICAL DATA

05 ENGINE 01-50-1

05 ENGINE

Z5U015001001E01

Item	Engine	
	BP	BP with TC
Cylinder head		
Height (mm {in})	133.8—134.0 {5.268—5.275}	
Distortion (mm {in})	0.10 {0.004} max.	
Grinding (mm {in})	0.10 {0.004} max.	
Valve clearance (mm {in})	IN	0.18—0.24 {0.0071—0.0094} (0.21±0.03 {0.0083±0.0011})
	EX	0.28—0.34 {0.0111—0.0133} (0.31±0.03 {0.0122±0.0012})
Valve and valve guide		
Margin thickness (mm {in})	IN	0.9 {0.035} min.
	EX	1.0 {0.039} min.
Valve length (mm {in})	IN	Standard 101.71—102.31 {4.0044—4.0279}
		Minimum 101.61 {4.0004}
	EX	Standard 101.71—102.31 {4.0044—4.0279}
		Minimum 101.61 {4.0004}
Valve stem diameter (mm {in})	IN	Standard 5.970—5.985 {0.2351—0.2356}
		Minimum 5.920 {0.2331}
	EX	Standard 5.965—5.980 {0.2349—0.2354}
		Minimum 5.915 {0.2329}
Valve guide inner diameter (mm {in})	6.02—6.04 {0.2371—0.2377}	
Valve guide protrusion height (mm {in})	IN	18.3—18.9 {0.721—0.744}
	EX	18.3—18.9 {0.721—0.744}
Valve seat		
Seat contact width (mm {in})	IN	0.8—1.4 {0.032—0.055}
	EX	0.8—1.4 {0.032—0.055}
Seat angle (mm {in})	IN	45°
	EX	45°
Seat sinking (Valve protrusion height) (mm {in})	IN	Standard 45.0 {1.772}
		Maximum 45.6 {1.795}
	EX	Standard 45.0 {1.772}
		Maximum 45.6 {1.795}
Valve spring		
Pressing force at valve spring height H (N {kgf, lbf})	IN	H: 39.5 {1.56} 172.60—195.15 {17.6—19.9, 38.72—43.78}
	EX	H: 39.5 {1.56} 172.60—195.15 {17.6—19.9, 38.72—43.78}
Out-of-square (mm {in})	IN	1.63 {0.064} max. 1.58 {0.062} max.
	EX	1.63 {0.064} max.

TECHNICAL DATA

Item			Engine	
			BP	BP with TC
Camshaft				
Camshaft runout (mm {in})			0.03 {0.0012} max.	
Lobe height (mm {in})	IN	Standard	44.3 {1.744}	44.8 {1.764}
		Minimum	44.1 {1.736}	44.6 {1.756}
	EX	Standard	44.9 {1.768}	
		Minimum	44.7 {1.760}	
Journal diameter (mm {in})	Standard		25.940—25.965 {1.0213—1.0222}	
	Minimum		25.910 {1.0201}	
Camshaft oil clearance (mm {in})	Standard		0.035—0.081 {0.0014—0.0031}	
	Minimum		0.15 {0.0059}	
Camshaft end play (mm {in})	Standard		0.057—0.127 {0.0023—0.0049}	
	Minimum		0.20 {0.008}	
Cylinder block				
Height (mm {in})			221.5 {8.720}	
Distortion (mm {in})			0.15 {0.006}	
Grinding (mm {in})			0.20 {0.008}	
Cylinder bore diameter (mm {in})	Standard		83.000—83.019 {3.2678—3.2684}	
	0.25 {0.01} oversize		83.250—83.269 {3.2776—3.2783}	
	0.50 {0.02} oversize		83.500—83.519 {3.2874—3.2881}	
Wear limit (mm {in})			0.15 {0.006}	
Piston				
Piston diameter (mm {in}) Measured at 90° to pin bore axis and 16.5 mm {0.65 in} below oil ring groove lower edge	Standard		82.953—82.975 {3.2659—3.2667}	
	0.25 {0.01} oversize		83.203—83.225 {3.2758—3.2765}	
	0.50 {0.02} oversize		83.453—83.475 {3.2856—3.2864}	
Piston-to-cylinder clearance (mm {in})	Standard		0.025—0.066 {0.0011—0.0025}	
	Minimum		0.15 {0.006}	
Piston ring				
Piston ring-to-ring groove clearance (mm {in})	Top		0.030—0.065 {0.0012—0.0025}	
	Second		0.030—0.070 {0.0012—0.0027}	
	Oil (rail)		0.07—0.16 {0.003—0.006}	
	Maximum	Top, Second		0.15 {0.006}
Oil		0.20 {0.008}		
End gap (Measured in cylinder) (mm {in})	Top		0.15—0.30 {0.006—0.011}	
	Second		0.30—0.45 {0.012—0.017}	
	Oil (rail)		0.20—0.70 {0.008—0.027}	
	Maximum		1.0 {0.039}	
Piston pin				
Diameter (mm {in})			19.987—19.993 {0.7869—0.7871}	
Connecting rod-to-piston pin clearance (mm {in})			0.010—0.027 {0.0004—0.0010}	
Piston pin bore-to-piston pin clearance (mm {in})			– 0.005—0.013 {–0.0002—0.0005}	

TECHNICAL DATA

Item		Engine	
		BP	
Crankshaft			
Crankshaft runout		(mm {in})	0.03 {0.0012} max.
Main journal diameter	(mm {in})	Standard	49.938—49.956 {1.9661—1.9667}
		0.25 {0.01} undersize	49.688—49.706 {1.9563—1.9569}
		0.50 {0.02} undersize	49.438—49.456 {1.9464—1.9470}
		0.75 {0.03} undersize	49.188—49.206 {1.9366—1.9372}
Out-of-round		(mm {in})	0.05 {0.002} max.
Crank pin diameter	(mm {in})	Standard	44.940—44.956 {1.7693—1.7699}
		0.25 {0.01} undersize	44.690—44.706 {1.7595—1.7600}
		0.50 {0.02} undersize	44.440—44.456 {1.7497—1.7502}
		0.75 {0.03} undersize	44.190—44.206 {1.7398—1.7403}
Out-of-round		(mm {in})	0.05 {0.002} max.
Main journal oil clearance	(mm {in})	Standard	0.018—0.036 {0.0008—0.0014}
		Minimum	0.10 {0.004}
Crankshaft end play	(mm {in})	Standard	0.080—0.282 {0.0032—0.0111}
		Minimum	0.30 {0.012}
Connecting rod and connecting rod bearing			
Length (Center to center)		(mm {in})	132.85—132.95 {5.2304—5.2342}
Bending		(mm {in})	0.05 {0.0020} max. /50 {1.97}
Distortion		(mm {in})	0.07 {0.0028} max. /50 {1.97}
Connecting rod side clearance	(mm {in})	Standard	0.110—0.262 {0.005—0.010}
		Minimum	0.30 {0.012}
Connecting rod bearing oil clearance	(mm {in})	Standard	0.028—0.048 {0.0012—0.0018}
		Minimum	0.10 {0.0039}
Tensioner spring			
Free length		(mm {in})	59.2 {2.331}
Oil pump			
Inner rotor tooth tip to outer rotor clearance	(mm {in})	Standard	0.02—0.18 {0.0008—0.0070}
		Minimum	0.20 {0.0079}
Outer rotor to body clearance	(mm {in})	Standard	0.090—0.176 {0.0036—0.0069}
		Minimum	0.22 {0.0087}
Side clearance	(mm {in})	Standard	0.03—0.11 {0.0012—0.0043}
		Minimum	0.14 {0.0055}
Plunger spring			
Pressing force at plunger spring height H	(N {kgf, lbf})	H: 35.42 mm {1.394 in}	62.8—68.6 {6.4—7.0, 14.1—15.4}

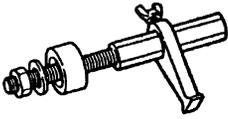
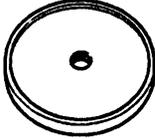
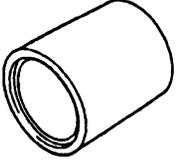
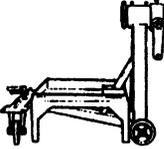
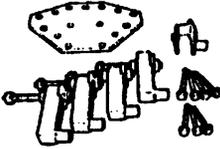
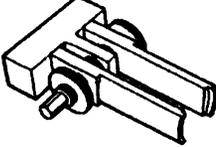
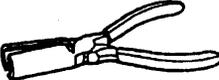
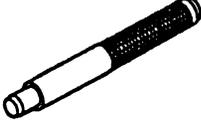
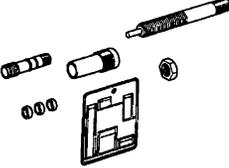
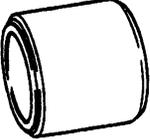
SERVICE TOOLS

01-60 SERVICE TOOLS

01 ENGINE SST 01-60-1

01 ENGINE SST

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<p>49 E011 1A0</p> <p>Ring gear drake set</p>  <p style="text-align: center;">TE0111A0X</p>	<p>49 W033 105</p> <p>Oil seal installer</p>  <p style="text-align: center;">TW033105X</p>	<p>49 G030 795</p> <p>Oil seal installer</p>  <p style="text-align: center;">TG030795X</p>
<p>49 T028 302</p> <p>Dust boot installer</p>  <p style="text-align: center;">TT028302X</p>	<p>49 0107 680A</p> <p>Engine stand</p>  <p style="text-align: center;">T0107680A</p>	<p>49 L010 1A0</p> <p>Engine stand hanger set</p>  <p style="text-align: center;">TL0101A0X</p>
<p>49 B012 0A2</p> <p>Pivot</p>  <p style="text-align: center;">TB0120A2X</p>	<p>49 T012 0A0A</p> <p>Tappet holder set</p>  <p style="text-align: center;">TT0120A0A</p>	<p>49 0636 100B</p> <p>Valve spring lifter</p>  <p style="text-align: center;">T0636100B</p>
<p>49 S120 170</p> <p>Valve seal remover</p>  <p style="text-align: center;">TS120170X</p>	<p>49 0221 061A</p> <p>Piston pin installer</p>  <p style="text-align: center;">T0221061A</p>	<p>49 B012 005</p> <p>Valve guide remover and installer</p>  <p style="text-align: center;">TB012005X</p>
<p>49 L012 0A0A</p> <p>Valve seal and valve guide installer set</p>  <p style="text-align: center;">TL0120A0A</p>	<p>49 B014 001</p> <p>Oil seal installer</p>  <p style="text-align: center;">TB014001X</p>	<p>—</p>

